WPAHG

Western Port Angeles Harbor Group

Appendix A
Western Port Angeles Harbor: RI/FS Approach White Paper

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study

Western Port Angeles Harbor: RI/FS Approach

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Appendix A Washington State Department of Ecology Memoranda

List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
BDU	Bivalve decision unit
cm	Centimeter
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSL	Cleanup screening level
dw	Dry weight
Ecology	Washington State Department of Ecology
ENR	Enhanced natural recovery
IHS	Indicator hazardous substance
LAET	Lowest apparent effects threshold
MLLW	Mean lower low water
µg/kg	Micrograms per kilogram
MTCA	Model Toxics Control Act
ng/kg	Nanograms per kilogram
OC	Organic carbon
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
REL	Remedial level
RI/FS	Remedial investigation/feasibility study
SCL	Sediment cleanup level
SCO	Sediment cleanup objective
SCU	Sediment cleanup unit
SCUM II	Sediment Cleanup Users Manual II
SMA	Sediment management area
SMS	Sediment Management Standards
SWAC	Surface-weighted average concentration
TEQ	Toxic equivalent
WAC	Washington Administrative Code
WPAH	Western Port Angeles Harbor

1.0 Introduction

1.1 BACKGROUND

Western Port Angeles Harbor (WPAH) is an important transportation port and working waterfront that supports critical family wage jobs for the Port Angeles community, along with commercial and industrial businesses that continue to operate in the face of severe economic challenges common to rural areas of the state. The Harbor waterfront must make the best use of its shoreline environment by balancing long-term goals for environmental protection with sustainable economic opportunity. Multiple environmental initiatives are being implemented by members of the WPAH Group, and WPAH Group members are collectively conducting a remedial investigation/feasibility study (RI/FS) cooperatively with the Washington State Department of Ecology (Ecology) to inform the development of a sediment cleanup plan that is appropriately balanced with source control, habitat restoration, and land use.

1.2 WHITE PAPER DEVELOPMENT PROCESS AND CONTENTS

As a key building block for the Agency Draft RI/FS, a draft "white paper" was submitted to Ecology on May 30, 2014 (WPAH Group 2014a). The white paper summarized the rationale for developing site-specific sediment cleanup levels (SCLs), remedial levels (RELs), and sediment management areas (SMAs) that are consistent with current cleanup requirements in the Sediment Management Standards (SMS; Ecology 2013a), including the requirements for bioaccumulative chemicals in WPAH.

In May 2015, Ecology provided initial comments on the white paper to the WPAH Group (Ecology 2015a), which identified several key issues requiring further discussion. Since the submittal of the white paper, the WPAH Group and Ecology have held a series of meetings to appropriately resolve Ecology's comments in a manner that is consistent with the Model Toxics Control Act (MTCA; Ecology 2013b), SMS, and Sediment Cleanup Users Manual II (SCUM II) guidance (Ecology 2015b). As a result of these meetings and extensive technical interaction on the elements of the Agency Draft RI/FS that are addressed in the white paper, the WPAH Group and Ecology have reached sufficient agreement on the technical approaches to allow the Agency Draft RI/FS to be prepared and submitted for Ecology review. These discussions largely focused on screening for benthic and bioaccumulative indicator hazardous substances (IHSs), development of site-specific SCLs, and methodology used to calculate surface-weighted average concentrations (SWACs) for the evaluation of SCL compliance for bioaccumulative chemicals.

During the course of these discussions in 2016, Ecology sent the WPAH Group three memoranda (see Appendix A) articulating its rationale for specific components of the Agency Draft RI/FS:

- ***Port Angeles Harbor: Total TEQ Site-Specific Rationale Memo*** **(Ecology 2016a)**. This memorandum proposed a site-specific SCL for the combined dioxin/furan toxic equivalent (TEQ) and the dioxin-like polychlorinated biphenyl (PCB) congener TEQ ("total TEQ"). Further details are provided in Sections 2.0 and 3.0.

- ***Port Angeles Harbor: Compliance for Bioaccumulative Chemicals Using Sediment Data in Port Angeles Harbor*** **(Ecology 2016b).** This memorandum presented the methodology to be used for demonstrating compliance with the benthic and bioaccumulative SCLs in Port Angeles Harbor in accordance with the SMS and describes the areas within which each bioaccumulative IHS will be averaged. Further details are provided in Section 4.0.
- ***Technical Memorandum: Port Angeles Harbor Sediment Interpolation and Recovery Modeling*** **(NewFields 2016).** The primary objective of this memorandum was to document the methodology used by NewFields (on behalf of Ecology) to interpolate surface sediment data across Port Angeles Harbor and calculate SWACs. It also described the assumptions and methodologies used to model natural recovery. The described methodologies were adopted by the WPAH Group to ensure consistency between the technical analyses of Ecology and the WPAH Group. Further details are provided in Section 5.0.

On the basis of discussions over the last 3 years between the WPAH Group and Ecology and Ecology's positions articulated in the memoranda listed above, the organization and content of the white paper were revised, resulting in the following structure, which represents the components of the Agency Draft RI/FS:

- **Section 2.0**, **Indicator Hazardous Substances.** This section presents the proposed list of benthic and bioaccumulative IHSs and the rationale for the selection of each IHS.
- **Section 3.0, Site-Specific Sediment Cleanup Levels.** The section describes the rationale for the selection of site-specific SCLs consistent with the SMS rules and the SCUM II guidance (Ecology 2013a, 2015b). It also discusses the point of compliance for the benthic and bioaccumulative SCLs.
- **Section 4.0, Site Boundary and Bivalve Decision Unit.** This section describes the rationale for the development of the Site[1] boundary and bivalve decision unit (BDU) within which the selected bioaccumulative IHSs are evaluated for compliance with the SCLs. As part of the RI, the SMS requires a "*site boundary as defined by the individual contaminants exceeding the proposed sediment cleanup standards as specified in WAC 173-204-560*" (Washington Administrative Code [WAC], Section 173-204-550(6)(d)(ii)). The BDU is a more confined area within the Site boundary, defined to assess exposures of bivalve organisms to bioaccumulative IHSs because bivalve organisms such as clams are sessile and not exposed on the same spatial scale as fish or other shellfish (e.g., Dungeness crabs) that migrate throughout the Site.
- **Section 5.0, Determination of Remedial Areas**. This section provides a general description of the approach for calculating SWACs, projecting future watershed loading and natural recovery, and developing RELs that are consistent with the SMS cleanup requirements. Remedial alternatives will be developed as part of the FS.

[1] In Ecology's comments on the draft white paper (Ecology 2015a) and the technical memoranda listed above, Ecology used the term "sediment cleanup unit (SCU)" rather than "Site" to describe the area in which the bioaccumulative IHSs are averaged. The rationale for the use of "Site" rather than "SCU" in both the white paper and the Agency Draft RI/FS report is described further in Section 4.0.

2.0 Indicator Hazardous Substances

To support the WPAH RI/FS, investigations of sediment quality have been conducted to evaluate the distribution of a wide range of chemicals of potential concern including metals, semivolatile organic compounds, polycyclic aromatic hydrocarbons (PAHs), PCBs (analyzed as both Aroclors and congeners), dioxins/furans, pesticides, and other hazardous substances. This section describes the process to be used in the Agency Draft RI/FS to screen these data and identify primary IHSs for the protection of benthic health and the prevention of potential bioaccumulation (i.e., to protect human health and wildlife at a higher trophic level that may consume fish and shellfish) in accordance with the SMS.

2.1 BENTHIC INDICATOR HAZARDOUS SUBSTANCES

Surface sediment characterization data collected during the RI were evaluated in a stepwise process to identify benthic IHSs, as described in Sections 2.1.1 and 2.1.2.

2.1.1 Step 1: Evaluation of Sediment Chemistry

The maximum detected surface sediment concentration of each chemical of potential concern with an SMS chemical criterion for the protection of benthic health was initially compared to the sediment cleanup objective (SCO) or the lowest apparent effects threshold (LAET) for the particular chemical. Dry weight (dw) normalized LAETs were used when the organic carbon (OC) content in a sample was outside the SMS-recommended range for OC normalization (0.5 to 4 percent OC). Likely due to the presence of wood debris, approximately 40 to 50 percent of the surface sediment samples collected during the RI had an OC content greater than 4 percent. Therefore, this evaluation used LAETs for those samples. As set forth in SCUM II (Ecology 2015b), compliance with benthic criteria is evaluated on a point-by-point basis.

The frequency of SCO exceedance for each chemical is presented in Table 2.1 (OC-normalization) and Table 2.2 (dw LAETs). If the chemical concentration exceeded the SCO/LAET in more than 1 percent of the samples, the chemical was carried forward to Step 2 of the screening. If the chemical concentration exceeded the SCO/LAET in less the 1 percent of the samples, the chemical was eliminated from consideration as a benthic IHS.

2.1.2 Step 2: Evaluation of Benthic Toxicity

As part of the RI, a full suite of SMS confirmatory bioassay testing was performed throughout WPAH to more directly characterize potential sediment toxicity for benthic organisms. The sediment bioassays included (1) the 10-day amphipod test (using *Eohaustorius estuaries*); (2) the larval development bioassay (using the sand dollar *Dendraster excentricus*) or the larval development bioassay with the resuspension protocol (using the mussel *Mytilus galloprovincialis);* and (3) the 20-day polychaete growth test (using *Neanthes* sp.).

If the confirmatory bioassay results exceeded the SCO biological criteria, as presented in Table IV of the SMS, the corresponding chemicals of potential concern in that sample were retained as benthic IHSs. Conversely, if the confirmatory bioassay results were less than the SCO biological criteria, the

corresponding chemicals of potential concern in that sample were eliminated as a benthic IHS. The results of the chemical screening and confirmatory bioassays in the Site are summarized in Figure 2.1.

2.1.3 Resulting Benthic IHSs

The rationale for the elimination or retention of each SMS chemical of potential concern as a benthic IHS is summarized in Table 2.3. The chemical screening and confirmatory bioassay process resulted in four benthic IHSs, which will be evaluated further in the Agency Draft RI/FS:

- Cadmium
- Mercury
- Zinc
- Fluoranthene

2.2 BIOACCUMULATIVE INDICATOR HAZARDOUS SUBSTANCES

As discussed in the SCUM II guidance (Ecology 2015b), compliance with the SCOs for bioaccumulative chemicals is based on the SWAC of the IHS calculated over an appropriate spatial scale. The scale of the averaging area reflects the primary exposure pathway for each bioaccumulative chemical, which is based on the consumption of fish and/or shellfish that has been exposed to bioaccumulative chemicals.

Ecology's May 2015 response to the draft white paper included a list of bioaccumulative IHSs and preliminary SCOs and cleanup screening levels (CSLs), as well as preliminary SCLs. The IHSs and criteria were later updated on the basis of information from Ecology:

- The final *North Olympic Peninsula Regional Background Sediment Characterization Data and Evaluation Report,* which revised the regional background value for the carcinogenic PAH (cPAH) TEQ, making it specific to Port Angeles (Ecology 2016c).
- *Port Angeles Harbor, Total TEQ Site-Specific Rationale Memo,* which proposed a preliminary SCL for dioxins/furans and PCBs (Ecology 2016a). Because dioxins/furans and some dioxin-like PCB congeners have a similar mechanism of toxicity, the dioxin/furan TEQ and the PCB congener TEQ are summed, resulting in a preliminary bioaccumulative SCL based on total TEQ.

This section describes the screening of the bioaccumulative IHSs proposed by Ecology, which include arsenic, cadmium, copper, selenium, zinc, mercury, alpha-hexachlorocyclohexane (alpha-BHC), cPAH TEQ, and total TEQ. The proposed list of bioaccumulative IHSs, as well as the rationale for the elimination or retention of each chemical of potential concern as a bioaccumulative IHS is discussed in Sections 2.2.1 and 2.2.2 and summarized in Table 2.4. As in the benthic IHS screening, surface sediment characterization data were evaluated in a stepwise process to identify bioaccumulative IHSs, as described in Sections 2.2.1 and 2.2.2.

2.2.1 Step 1: Comparison with Preliminary Sediment Cleanup Levels

The detected chemical concentrations of all potential bioaccumulative IHSs were compared against their respective SCLs. If any samples had chemical concentrations that exceeded their SCL, the chemical was carried forward to Step 2 of the screening. If the chemical concentration did not exceed the SCL in any samples, the chemical was eliminated from consideration as a bioaccumulative IHS. One of the potential IHSs, alpha-BHC, was not detected in the Site at concentrations greater than the SCL (1.4 micrograms per kilogram [µg/kg]) based on a point-by-point comparison at all locations. It was, therefore, eliminated as a bioaccumulative IHS.

2.2.2 Step 2: Calculation of Existing Surface-Weighted Average Concentrations

SWACs for all of the potential bioaccumulative IHSs were calculated within the appropriate averaging area (either the Site or the BDU) where sufficient data were available. The derivation of the averaging areas for the bioaccumulative IHSs is described in Section 4.0. SWACs for all potential bioaccumulative IHSs were initially calculated within the smaller BDU area, with the exception of total TEQ, which was averaged across the Site as set forth by Ecology (Ecology 2016b; see Section 4.0). All chemicals with SWACs less than the preliminary SCL were eliminated as bioaccumulative IHSs; arsenic, cadmium, and copper were eliminated as human health IHSs on this basis. The SWACS for total TEQ, cPAH TEQ, and mercury were greater than the preliminary SCLs; therefore, these chemicals were retained as bioaccumulative IHSs.

Although the SWAC for zinc calculated within the BDU was also greater than the preliminary SCL, zinc was not retained as a bioaccumulative IHS for the following reasons:

- According to the results of Ecology's evaluation of the available tissue data collected in Port Angeles Harbor, zinc contributes less than 1 percent of the total human health risk (NewFields 2013, Table 2), with a calculated hazard quotient only marginally greater than the protective levels (i.e., 1.1) and only for a worst-case child subsistence exposure scenario (Ecology 2012, Appendix G, Table 3-14).
- Zinc is an essential nutrient for human health.

Similarly, although insufficient data in the Site were available to reliably calculate a SWAC for selenium, it was not retained as a bioaccumulative IHS for the following reasons:

- According to the results of Ecology's evaluation of the available tissue data collected in Port Angeles Harbor, selenium contributes less than 2 percent of the total human health risk (NewFields 2013, Table 2).
- Ecology's sediment characterization study did not identify selenium as a chemical of potential concern in Port Angeles Harbor (Ecology 2012).
- Selenium is an essential nutrient for human health.

2.2.3 Resulting Bioaccumulative IHSs

The screening resulted in three bioaccumulative IHSs, which will be evaluated further in the Agency Draft RI/FS:

- Total TEQ
- cPAH TEQ
- Mercury

3.0 Site-Specific Sediment Cleanup Levels

As discussed in the previous section, the site-specific SCL can be adjusted upward from the SCO to a value no greater than the CSL on the basis of the following considerations:

- **Technical possibility.** Whether it is technically possible to achieve and maintain the cleanup level at the applicable point of compliance (WAC 173-204-560(2)(a)(ii)(A)).
- **Net adverse environmental impacts**. Whether achieving and maintaining the cleanup level will have a net adverse environmental impact on the aquatic environment (WAC 173-204-560(2)(a)(ii)(B)).

3.1 TECHNICAL POSSIBILITY

Technically possible is defined as "…capable of being designed, constructed and implemented in a reliable and effective manner, regardless of cost" (WAC 173-204-505(23)). Technical possibility depends on a variety of site-specific factors that include the ability to achieve the SCL using available technologies. Although achieving the SCOs is technically possible at least for a short post-construction period using large-scale enhanced natural recovery (ENR) and/or capping actions, ongoing estimates of watershed loading discussed in Section 5.2 indicate diffuse ongoing sources of cPAH TEQ (and potentially other bioaccumulative IHSs) with the potential to increase the post-construction SWAC to concentrations greater than the SCO (16 µg/kg). Therefore, although the ability to maintain natural background-based SCOs for the bioaccumulative IHSs may be considered *technically impossible* under Ecology's definition (WAC 173-204-505(23)), the net adverse environmental impacts resulting from the selection of SCOs versus CSLs can be assessed by means of a more straightforward evaluation under the SMS rules, as discussed in the next subsection.

3.2 NET ADVERSE ENVIRONMENTAL IMPACTS

The determination of net adverse environmental impacts is based on the short- and long-term positive and negative impacts of cleanup actions on natural resources, including shellfish, forage fish, and eelgrass beds; aquatic habitat; habitat restoration opportunities; and habitat enhancement opportunities (WAC 173-204-560(2)(a)(ii)(B)). Construction of a large-scale remediation to attempt to at least temporarily achieve the SCOs for the bioaccumulative IHSs is expected to extend over decades. This extended construction period will result in extensive adverse environmental impacts on natural resources as well as on the harvest of such resources from the Site.

The SCOs and CSLs for the bioaccumulative IHSs developed by Ecology for Port Angeles Harbor are summarized in Table 3.1. Table 3.1 also indicates the approximate acreage of the entire Site with concentrations of bioaccumulative IHSs that currently exceed the SCOs and CSLs. The SCO and CSL for mercury yield similar cleanup unit areas. In contrast, the SCOs for total TEQ and cPAH TEQ are significantly lower than their respective CSLs and would result in roughly double the Site cleanup unit area as compared to the CSLs. Moreover, because regional sediment cleanup projects can realistically construct sediment cleanup remedies at a maximum production rate of approximately 50 acres per year (e.g., ENR placement using two plants operating around regional fish windows, such as the

recently completed Port Gamble Bay remedial action), decades of construction could be required to achieve the SCOs for the bioaccumulative IHSs.

For these reasons, targeting areas of Site for remediation by establishing the Site SCLs on the basis of the CSLs for the bioaccumulative IHSs would reduce risks more rapidly by focusing remediation on the higher concentration areas. The duration of adverse impacts on natural resources and habitat associated with remedial construction would be more limited, and the natural recovery of the rest of the Site would be accelerated. Therefore, based on considerations of net adverse environmental impacts, the site-specific SCLs for the bioaccumulative IHSs in Site are appropriately set at the CSLs (Table 3.1).

Separate considerations of net adverse environmental impacts based on the short- and long-term positive and negative effects of cleanup actions on natural resources, as required under WAC 173-204-560(2)(a)(ii)(B), apply to benthic IHSs. For example, potential sediment toxicity impacts on natural resources resulting from setting site-specific benthic chemical criteria at levels greater than the SCO must be appropriately balanced with construction impacts during and after remediation. For benthic toxicity, the SCO is the criterion at which no adverse effects occur, including no acute or chronic adverse effects on biological resources. The CSL is the minor adverse effects level, which is the minimum level to be achieved in all cleanup actions under the SMS. Because of the far more localized exceedances of the benthic SCOs in the Site (Figure 2.1) compared with the bioaccumulative IHSs as summarized above, the site-specific SCLs for the benthic IHSs are appropriately set at the SCOs.

3.3 POINT OF COMPLIANCE

The point of compliance is location at which the SCLs must be achieved, consistent with the requirements of WAC 173-204-560(6). For the purpose of the Agency Draft RI/FS, the point of compliance is defined as follows:

- SCLs apply to surface sediments within the biologically active zone defined as the top 10 centimeters (cm) based on radioisotope results (Ecology 2012) and sediment profile imaging (WPAH Group 2014b). This depth is consistent with SCUM II, which states that “for a typical subtidal, soft-bottom marine sediment, the biologically active zone is typically 10 cm” (Ecology 2015b) and the Ecology-approved RI/FS work plan (WPAH Group 2013), as well as the Ecology sediment investigation program (Ecology 2012).
- As set forth in the SMS guidance (Ecology 2015b), compliance with the benthic criteria is evaluated on a point-by-point basis.
- As set forth in the SMS guidance (Ecology 2015b) and on the basis of site-specific determinations by Ecology (Ecology 2016b), compliance with the bioaccumulative criteria is evaluated on the basis of a SWAC over an appropriate spatial scale, as discussed in Section 4.0.

4.0 Site Boundary and Bivalve Decision Unit

4.1 BASIS OF SITE BOUNDARY

The Ecology memorandum (Ecology 2016b) states that "the SCU boundaries for WPAH and Rayonier Mill Sites will be the outer boundary of all chemical footprints exceeding the sediment cleanup standards. The administrative Study Area boundary, described in Agreed Order DE 6815 between Rayonier and Ecology will separate the two SCUs if needed." Subsequent to the memorandum, however, mapping of chemical exceedance footprints indicated a spatial separation between the footprint in WPAH with chemical concentrations that exceed the SCL and the Rayonier footprint, rendering the establishment of SCUs unnecessary. Therefore in this white paper and the Agency Draft RI/FS, the term Site will be used rather than SCU to describe the area in the Western Harbor with chemical concentrations that exceed the cleanup standards. This is consistent with the SMS (WAC 173-204-550(6)(d)(ii)), which requires as part of the RI a "site boundary as defined by the individual contaminants exceeding the proposed sediment cleanup standards as specified in WAC 173-204-560."

Furthermore, the SCU is defined in the SMS (WAC 173-204-505(20)) as "a discrete subdivision of a sediment site designated by the department for the purpose of expediting cleanups." This section refers to cleanup under piers, eelgrass beds, and navigational channels as examples of SCUs. This definition of an SCU, therefore, does not imply that an SCU is intended to be established as a large area that encompasses multiple areas with varying chemical and physical characteristics. These areas are more appropriately identified as SMAs within the larger Site area. The approach to the development of SMAs is described further in Section 5.4.

To generate the Site boundary, the interpolated exceedance areas of all bioaccumulative IHSs (CSL chemical criteria) as well as all benthic IHSs (SCO chemical criteria) were overlain. Interpolations were performed using the inverse-distance weighted algorithm from the ArcGIS Geostatistical Analyst extension in which all of the selected parameters were consistent with NewFields (2016). The final boundary of the Site encompasses all footprints of chemical exceedances for both the bioaccumulative and benthic IHSs. Consistent with the RI/FS work plan (WPAH Group 2013), the shoreline of the Site was generally based on mean higher high water, except in areas where this tidal level is covered by riprap or bulkheads. In this case, the Site shoreline was defined as the toe of the riprap slope or bulkhead.

The Site boundary, having been generated from interpolation contours, was originally defined by a line containing hundreds of vertices, creating a jagged boundary. In order to develop an accurate and consistent Site boundary, vertices were selected on the boundary that were 1,000 feet apart starting at the north end of the Site to draw the boundary, resulting in the final "smoothed" Site boundary shown on Figure 4.1.

As described further in Section 4.2, and in accordance with Ecology (Ecology 2016b), total TEQ is the one bioaccumulative IHS that must meet its SCL as a SWAC over the entire Site.

4.2 BASIS OF BIVALVE DECISION UNIT

Much of the potential cPAH TEQ and mercury bioaccumulation exposures in the Site are associated with potential human consumption of clams and other sessile bivalve organisms. Bivalve organisms are exposed to contamination only in their immediate area, compared to a much larger exposure area for fish or other shellfish (e.g., Dungeness crabs) that migrate throughout the Site. The relatively deep subtidal areas of the Site are currently closed to clam and shellfish harvests because of bacterial contamination associated with ongoing runoff from adjacent developed areas of the Site (WDOH 2017). Current source control actions, including the City of Port Angeles combined sewer overflow abatement project, have the potential address at least some of the concerns about bacterial contamination. Additionally, suitable clamming habitat is limited along the southern shoreline of the Site because of areas with bulkheads and riprap, steep slopes, and limited shoreline access.

However, the potential does exist for future tribal use of shellfish (bivalves) in certain areas within the Site; therefore, consumption of shellfish from areas where future shellfish beds could exist should be considered during the development of remedial alternatives according to Ecology (WAC 173-204-561(2)(b); Ecology 2016b). In addition to the BDU, site use considerations will be used to develop remedial alternatives, such as terminal operational areas.

Therefore, to address potential bivalve harvesting and consumption, the BDU has been delineated on the basis of the area within which shellfish beds could exist, and bivalve organism bioaccumulation exposures are being evaluated in this area. Although this BDU will be used in the Agency Draft RI/FS, its use does not imply that the areas within the BDU are safe or accessible for bivalve harvest. Most of the shoreline area is located within the management area of the Port of Port Angeles, which encompasses active terminal operations with additional constraints within marina and log rafting areas. Furthermore, these operational constraints will be considered during the development of SMAs in the Agency Draft RI/FS.

The final BDU boundary is shown on Figure 4.1. Ecology has defined the BDU (referred to as a sessile shellfish SMA in a 2016 Ecology memorandum [Ecology 2016b]) as "… all areas from mean higher high water (except in areas where intertidal elevations are covered by riprap or bulkheads. In this case, from the toe of the riprap slope or bulkhead) to an elevation of -70 feet MLLW." (Ecology 2016b).

The -70 feet mean lower low water (MLLW) boundary was determined on the basis of bathymetry data from the National Oceanic and Atmospheric Administration (NOAA 2007) and the greater water depth of geoduck marine subtidal harvest areas as defined by the Washington State Department of Fish and Wildlife (WDFW 2017). The SWACs calculated for cPAH TEQ and mercury have been averaged within this BDU because these chemicals are considered primary bioaccumulative risk drivers for sessile organisms. Total TEQ is not a primary bioaccumulative risk driver for bivalves (i.e., 92 percent of bioaccumulation exposures to dioxin/furan TEQ and 96 percent of exposures to total PCBs are the result of ingestion of crab [WPAH Group 2014a]) and, therefore, has been averaged within the larger Site boundary to address potential bioaccumulation exposures to fish and shellfish (bivalves and crabs).

5.0 Determination of Remediation Areas

The Agency Draft RI/FS will develop RELs and corresponding remedial alternatives for the Site using methodologies outlined in this section. Consistent with the requirements of MTCA (Ecology 2013b), RELs will be used to define the spatial extent to which different remediation technology components are assigned and evaluated for individual remedial alternatives (WAC 173-340-355), and also to evaluate varying restoration timeframe options. Remediation areas will be further divided into SMAs with common physical, operational, and chemical considerations for remediation. This section details the methodologies used for determining the SWACs, ongoing watershed loading (sedimentation rates and IHS concentrations), RELs, and SMAs.

5.1 SURFACE-WEIGHTED AVERAGE CONCENTRATIONS

In determining the SWACs, the Site data were interpolated using the inverse-distance weighted algorithm from the ArcGIS Geostatistical Analyst extension in which all of the selected parameters were consistent with NewFields (2016). Data used to generate the concentration surfaces were obtained from the Ecology-approved WPAH surface sediment database, using the maximum concentration for each chemical at each sampling location or the minimum concentration if all of the results were non-detections. The SWACs were then calculated based on the average interpolated concentration in each grid cell (using a cell size of 10 by 10 feet) within either the Site or BDU boundary, as appropriate.

5.2 ONGOING WATERSHED LOADING

Ongoing loading to the WPAH Site was calculated using a combination of data from the Puget Sound region as well as Port Angeles Harbor. Loading was calculated for the three bioaccumulative IHSs: total TEQ, cPAH TEQ, and mercury. The loading calculations were performed in three steps as described below.

5.2.1 Step 1: Calculation of Unit-Area Loading by Land Use Category

Ecology has conducted a number of detailed studies to quantify surface runoff loading rates to Puget Sound. Each successive study (phase) has improved upon the estimates of previous studies by including additional potential contaminant sources (i.e., land uses), increasing the number of parameters analyzed, and/or increasing the sensitivity of the analytical methods. The most recent Phase 3 studies and evaluations refined the estimates of chemical loading to Puget Sound via surface runoff by monitoring chemical concentrations and discharge from four land use categories: commercial/industrial, residential, agricultural, and forest/field/other (Herrera 2011). Watershed loading rates from each of the four land use categories were calculated using data collected by Ecology in 2009 and 2010 from 16 streams in the Puyallup and Snohomish watersheds that are broadly representative of basins throughout Puget Sound, including the WPAH watershed area. Each monitored stream received surface runoff that originated primarily from one of the four land use categories.

Because the cPAH loading rates reported by Herrera (2011) were not scaled to TEQ, the total cPAH to cPAH TEQ regression relationship was used to scale loading rates (refer to Figure 5.1 for the regression

relationship). Because cPAH concentrations and corresponding detection frequencies and unit-area loading rates were greatest in commercial/industrial areas, these areas were used to scale the cPAH loading rates to TEQ. Watershed loading of total TEQ was estimated using the total suspended solids unit loading rate for each land use category (Herrera 2011), multiplied by the concentrations of total dioxin/furan TEQ in surface soil in the Port Angeles Harbor watershed (Ecology & Environment and Glass 2011), which resulted in an approximate average of 15 nanograms per kilogram (ng/kg) for the combined commercial/industrial, residential, and agricultural categories and approximately 3.6 ng/kg for forest/field/other category. The unit-area loading rates by land use category are summarized in Table 5.1.A.

5.2.2 Step 2: Multiplication of Unit Loading Rates by Western Port Angeles Harbor Watershed Areas

Consistent with the methodology used by Ecology to extrapolate the surface runoff monitoring data from the 16 streams to larger watershed scales throughout Puget Sound, the unit-area loads summarized in Table 5.1.A were multiplied by the current land use acreages within the WPAH watershed (i.e., within the Tumwater, Valley, and Peabody Creek drainages, as well as shoreline properties that drain directly to the Harbor; Table 5.1.B). The calculated mass loading rates are summarized in Table 5.1.A.

5.2.3 Step 3: Calculation of Average Input Concentrations to Western Port Angeles Harbor

All of the watershed chemical loading that enters WPAH is assumed to settle within the Site for total TEQ and within the BDU for cPAH TEQ and mercury. As discussed in Section 4.0, the SWAC averaging area for total TEQ is larger than the averaging area for cPAH TEQ and mercury because of the BDU. Total TEQ is averaged within the Site; mercury and cPAH TEQ are averaged within the smaller BDU area. The watershed loading estimates summarized in Table 5.1.A were divided by the total amount of sediment deposited annually in WPAH (i.e., the total sediment loading associated with the overall average net sedimentation rate in the Harbor of 0.17 cm/year (Herrera 2011; refer to Table 5.1.C). The net sedimentation rate in WPAH is primarily attributable to in-water-generated sediment sources such as phytoplankton. The calculated average concentrations of watershed-sourced bioaccumulative IHSs accumulating in WPAH were estimated at 0.36 ng/kg dw for total TEQ, 22 µg/kg dw for cPAH TEQ, and 0.048 mg/kg dw for mercury (Table 5.1.A).

Note that the cPAH TEQ loading estimates and input concentrations summarized in Table 5.1.A do not reflect additional loadings from creosote piling (the predominant ongoing source of cPAH loading to Puget Sound; Ecology and WDOH 2012). The actual ongoing cPAH TEQ input concentration to WPAH including releases of creosote piling (e.g., from severely decayed piling) is likely greater than the estimate in Table 5.1.A, but data sufficient to reliably quantify this input are very difficult to obtain (Ecology and WDOH 2012). The uncertainties associated with the calculated input concentrations to WPAH will be discussed further in the Agency Draft RI/FS.

5.3 REMEDIAL LEVELS

As discussed above, RELs are action levels that trigger the need for remediation at specific locations. For the Agency Draft RI/FS, the RELs for the bioaccumulative IHSs will be determined over a range of restoration time frames that are specific to the individual remediation alternatives, using a two-step process.

5.3.1 Step 1: Determination of Target SWAC for Each Remedial Alternative

The surface sediment data that will be used to characterize conditions in the Site for the purpose of the RI/FS were collected largely over the period from 2008 to 2013, with an average sampling date of approximately 2011 (WPAH Group 2013, 2014b). Given the additional time required to complete the RI/FS, develop the cleanup action plan, develop the remedial design, and obtain the necessary permits, the earliest date that remedial construction could begin is approximately 2020. Depending on the remedy selected by Ecology, several years of remedial construction may be required, followed by a post-construction restoration time frame of 0 to 10 years (or more under a sediment recovery zone scenario) to meet the site-specific cleanup levels. Therefore, the Agency Draft RI/FS will include predictions of the anticipated natural recovery that will occur over a range of restoration time frames before, during, and after the remedial construction that are specific to the individual remediation alternatives.

Consistent with NewFields (NewFields 2016), as part of the Agency Draft RI/FS, changes in surface sediment concentrations of bioaccumulative IHSs over the natural recovery/restoration time frame specific to each remedial alternative will be predicted using the SEDCAM one-dimensional natural recovery model:

$$C_t = C_d \cdot \left[1 - e^{\frac{-Rt}{B}}\right] + C_i \cdot e^{\frac{-Rt}{B}}$$

where:

C_t = surface sediment bioaccumulative IHS concentration at time t after the alternative-specific restoration time frame

C_d = WPAH sediment input concentrations of bioaccumulative IHSs (i.e., in newly deposited sediment; Table 5.1.A)

C_i = surface sediment bioaccumulative IHS concentration used in the Agency Draft RI/FS, equating to an average sampling date of 2011

t = alternative-specific restoration time frame in years (likely ranging from approximately 16 to 60 years, depending on the remedial alterative evaluated)

R = average net sedimentation rate (0.17 cm/year; Table 5.1.C)

B = depth of the biologically active zone (10 cm; WPAH Group 2013)

The SEDCAM model will be used in the Agency Draft RI/FS to predict target SWACs specific to each remedial alternative by varying the natural recovery/restoration time frames to be evaluated (t) and

by setting C_t at the SCL and solving for C_i. The model will be configured to address preconstruction, construction, and post-construction changes in the SWAC as appropriate for each remedial alternative evaluated.

5.3.2 Step 2: Determination of RELs that Meet the Post-Construction Target SWACs

To identify point-based RELs that will achieve the alternative-specific SWAC targets determined in Step 1, a "hill topping" routine will be performed in which surface sediment bioaccumulative IHS concentrations will be ranked from greatest to least (using an interpolated data set), and the greatest concentrations will be sequentially replaced with a post-remedy bed sediment replacement value until the SWAC targets have been achieved. The estimated post-remedy surface sediment concentrations (replacement values) used for this analysis will be Puget Sound natural background concentrations consistent with NewFields (NewFields 2016), which are also similar to the prospective regional quarry material likely to be placed over all of the active remediation areas (i.e., either as an ENR layer, a cap, or a post-dredging residual cover).

5.4 SEDIMENT MANAGEMENT AREAS

SMAs have long been a tool used in sediment evaluations for RI/FSs performed under MTCA and the SMS to focus and compare remedial alternatives for areas with similar chemical and physical characteristics (a good example of SMA use is provided in Ecology 2015b). In the Agency Draft RI/FS, the SMAs will be differentiated on the basis of an overlay of the IHS concentrations, physical characteristics, operational areas, and other factors as appropriate. A range of remedial technologies will be identified and evaluated for each SMA according to the MTCA/SMS RI/FS process to help identify the most appropriate combination of remedial technologies to use in the Site.

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Tables

Table 2.1

Frequency of Exceedances of Sediment Management Standards Sediment Cleanup Levels for Samples with Total Organic Carbon from 0.5 to 4 Percent[1]

			Information about Detections								Information about Exceedances							
Chemicals	CAS	Units	Number of Results	Number of Detections	Percentage Detection	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detections	Date of Maximum Detection	Depth of Maximum Detection	SMS SCO	Number of Detected Exceedances of SMS SCO	Percentage of Detected Exceedances of SMS SCO	Exceedance Factor	SMS CSL	Number of Detected Exceedances of SMS CSL	Percentage of Detected Exceedances of SMS CSL	Exceedance Factor
Metals																		
Arsenic	7440-38-2	mg/kg dw	78	73	94%	1.7	69	PA_IH02A	6/16/2008	0 - 10 cm	57	1	1.3%	1.2	93	None	None	None
Cadmium	7440-43-9	mg/kg dw	81	77	95%	0.1	8.1	NPI-PA3	2/28/2008	0 - 10 cm	5.1	8	9.9%	1.6	6.7	4	4.9%	1.2
Chromium	7440-47-3	mg/kg dw	62	62	100%	11	45	PA_STP10-02	9/8/2010	0 - 10 cm	260	None	None	None	270	None	None	None
Copper	7440-50-8	mg/kg dw	78	78	100%	6.8	95	PA_IH01A	6/16/2008	0 - 10 cm	390	None	None	None	390	None	None	None
Lead	7439-92-1	mg/kg dw	62	62	100%	3.6	84	PA_LA01A	7/23/2008	0 - 10 cm	450	None	None	None	530	None	None	None
Mercury	7439-97-6	mg/kg dw	86	86	100%	0.022	3.5	PA_IH01A	6/16/2008	0 - 10 cm	0.41	24	28%	8.5	0.59	14	16%	5.9
Silver	7440-22-4	mg/kg dw	62	57	92%	0.027	0.24	PA_FT01A	6/17/2008	0 - 10 cm	6.1	None	None	None	6.1	None	None	None
Zinc	7440-66-6	mg/kg dw	81	81	100%	21	1,700	NPI-PA3	2/28/2008	0 - 10 cm	410	6	7.4%	4.1	960	3	3.7%	1.8
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LPAH	--	mg/kg OC	37	37	100%	2.1	180	PA_STP10-02	9/8/2010	0 - 10 cm	370	None	None	None	780	None	None	None
Naphthalene	91-20-3	mg/kg OC	37	26	70%	0.3	10	RAYONR05HS-07	8/19/2002	0 - 0 ft	99	None	None	None	170	None	None	None
Acenaphthylene	208-96-8	mg/kg OC	37	21	57%	0.34	8.5	PA_STP04CSO-006	9/23/2003	0 - 2 cm	66	None	None	None	66	None	None	None
Acenaphthene	83-32-9	mg/kg OC	37	18	49%	0.4	8.6	PA_STP10-02	9/8/2010	0 - 10 cm	16	None	None	None	57	None	None	None
Fluorene	86-73-7	mg/kg OC	37	25	68%	0.56	10	PA_STP10-02	9/8/2010	0 - 10 cm	23	None	None	None	79	None	None	None
Phenanthrene	85-01-8	mg/kg OC	37	37	100%	1.2	140	PA_STP10-02	9/8/2010	0 - 10 cm	100	1	2.7%	1.4	480	None	None	None
Anthracene	120-12-7	mg/kg OC	37	31	84%	0.73	17	PA_STP10-02	9/8/2010	0 - 10 cm	220	None	None	None	1,200	None	None	None
2-Methylnaphthalene	91-57-6	mg/kg OC	37	13	35%	0.24	3.2	PA_STP04CSO-006	9/23/2003	0 - 2 cm	38	None	None	None	64	None	None	None
Total HPAH	--	mg/kg OC	37	37	100%	5	860	PA_STP10-02	9/8/2010	0 - 10 cm	960	None	None	None	5,300	None	None	None
Fluoranthene	206-44-0	mg/kg OC	37	37	100%	1.8	250	PA_STP10-02	9/8/2010	0 - 10 cm	160	1	2.7%	1.6	1,200	None	None	None
Pyrene	129-00-0	mg/kg OC	37	37	100%	1.6	170	PA_STP10-02	9/8/2010	0 - 10 cm	1,000	None	None	None	1,400	None	None	None
Benzo(a)anthracene	56-55-3	mg/kg OC	37	36	97%	1.1	66	PA_STP10-02	9/8/2010	0 - 10 cm	110	None	None	None	270	None	None	None
Chrysene	218-01-9	mg/kg OC	37	37	100%	0.89	89	PA_STP10-02	9/8/2010	0 - 10 cm	110	None	None	None	460	None	None	None
Total Benzofluoranthenes	56832-73-6	mg/kg OC	39	39	100%	0.81	140	PA_STP10-02	9/8/2010	0 - 10 cm	230	None	None	None	450	None	None	None
Benzo(a)pyrene	50-32-8	mg/kg OC	37	35	95%	0.88	68	PA_STP10-02	9/8/2010	0 - 10 cm	99	None	None	None	210	None	None	None
Benzo(g,h,i)perylene	191-24-2	mg/kg OC	37	31	84%	0.81	34	PA_STP10-02	9/8/2010	0 - 10 cm	31	2	5.4%	1.1	78	None	None	None
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg OC	37	30	81%	0.73	36	PA_STP10-02	9/8/2010	0 - 10 cm	34	1	2.7%	1.1	88	None	None	None
Dibenzo(a,h)anthracene	53-70-3	mg/kg OC	37	20	54%	0.35	11	PA_STP10-02	9/8/2010	0 - 10 cm	12	None	None	None	33	None	None	None
Chlorinated Benzenes																		
1,2-Dichlorobenzene	95-50-1	mg/kg OC	35	None	None	None	None	None	None	None	2.3	None	None	None	2.3	None	None	None
1,4-Dichlorobenzene	106-46-7	mg/kg OC	35	4	11.4%	0.19	6.8	PA_STP04CSO-007	9/23/2003	0 - 2 cm	3.1	1	2.9%	2.2	9	None	None	None
1,2,4-Trichlorobenzene	120-82-1	mg/kg OC	35	None	None	None	None	None	None	None	0.81	None	None	None	1.8	None	None	None
Hexachlorobenzene	118-74-1	mg/kg OC	37	1	2.7%	0.21	0.21	PA_STP04CSO-007	9/23/2003	0 - 2 cm	0.38	None	None	None	2.3	None	None	None
Phthalate Esters																		
Dimethyl phthalate	131-11-3	mg/kg OC	37	2	5.4%	0.96	1.4	PA_STP04CSO-007	9/23/2003	0 - 2 cm	53	None	None	None	53	None	None	None
Diethylphthalate	84-66-2	mg/kg OC	37	6	16%	0.84	1.8	PA_KP05A	6/12/2008	0 - 10 cm	61	None	None	None	110	None	None	None
Di-n-butyl phthalate	84-74-2	mg/kg OC	37	8	22%	0.27	25	PA_STP10-02	9/8/2010	0 - 10 cm	220	None	None	None	1,700	None	None	None
Butyl benzyl phthalate	85-68-7	mg/kg OC	37	2	5.4%	0.57	1.5	PA_FT02A	6/17/2008	0 - 10 cm	4.9	None	None	None	64	None	None	None
bis(2-ethylhexyl)phthalate	117-81-7	mg/kg OC	37	32	86%	0.66	670	PA_STP10-01	9/8/2010	0 - 10 cm	47	3	8.1%	14	78	1	2.7%	8.6
Di-n-octyl phthalate	117-84-0	mg/kg OC	37	2	5.4%	1.1	2	PA_STP04CSO-007	9/23/2003	0 - 2 cm	58	None	None	None	4,500	None	None	None

Table 2.1

Frequency of Exceedances of Sediment Management Standards Sediment Cleanup Levels for Samples with Total Organic Carbon from 0.5 to 4 Percent[1]

			Information about Detections								Information about Exceedances							
Chemicals	CAS	Units	Number of Results	Number of Detections	Percentage Detection	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detections	Date of Maximum Detection	Depth of Maximum Detection	SMS SCO	Number of Detected Exceedances of SMS SCO	Percentage of Detected Exceedances of SMS SCO	Exceedance Factor	SMS CSL	Number of Detected Exceedances of SMS CSL	Percentage of Detected Exceedances of SMS CSL	Exceedance Factor
Miscellaneous Nonionizable Organic Compounds																		
Dibenzofuran	132-64-9	mg/kg OC	37	17	46%	0.26	6.3	PA_STP10-02	9/8/2010	0 - 10 cm	15	None	None	None	58	None	None	None
Hexachlorobutadiene	87-68-3	mg/kg OC	37	None	None	None	None	None	None	None	3.9	None	None	None	6.2	None	None	None
N-Nitrosodiphenylamine	86-30-6	mg/kg OC	35	2	5.7%	0.36	5.4	PA_STP10-02	9/8/2010	0 - 10 cm	11	None	None	None	11	None	None	None
Pesticides/Polychlorinated Biphenyls (PCBs)																		
PCBs (Total, Aroclors)	1336-36-3	mg/kg OC	37	10	27%	0.28	2.1	PA_STP10-01	9/8/2010	0 - 10 cm	12	None	None	None	65	None	None	None
Ionizable Organic Compounds																		
Phenol	108-95-2	µg/kg dw	60	44	73%	12	740	PA_MA04A	6/12/2008	0 - 10 cm	420	2	3.3%	1.8	1,200	None	None	None
2-Methylphenol	95-48-7	µg/kg dw	60	2	3.3%	40	61	KSS-2	7/9/2013	0 - 10 cm	63	None	None	None	63	None	None	None
4-Methylphenol	106-44-5	µg/kg dw	60	40	67%	5.1	190	WPAH003	7/1/2013	0 - 10 cm	670	None	None	None	670	None	None	None
2,4-Dimethylphenol	105-67-9	µg/kg dw	60	2	3.3%	12	15	KSS-2	7/9/2013	0 - 10 cm	29	None	None	None	29	None	None	None
Pentachlorophenol	87-86-5	µg/kg dw	60	None	None	None	None	None	None	None	360	None	None	None	690	None	None	None
Benzyl alcohol	100-51-6	µg/kg dw	55	None	None	None	None	None	None	None	57	None	None	None	73	None	None	None
Benzoic acid	65-85-0	µg/kg dw	58	3	5%	150	180	RAYONR05HS-02	8/21/2002	0 - 10 cm	650	None	None	None	650	None	None	None

Notes:

1 The following notes pertain to the content of this table:

- Only locations within the Site boundary are included.
- For sample/sample duplicate pairs, only the highest detected concentration (or lowest reporting limit if both were not detected) has been reported for each chemical at each location.
- For samples in which multiple analytical methods resulted in reported concentrations for a single chemical, only the highest detected concentration (or lowest reporting limit if none were detected) has been reported.
- Only surface samples (maximum depth of 10 cm) are included.
- Only SMS SCO/CSL chemicals are included; for chemicals that are OC normalized, only samples with TOC values between 0.5 to 4 percent are included; for samples outside this range see Table 2.2.
- Only the most recent results from reoccupied stations are included.
- The exceedance factor is rounded to two significant figures.

Abbreviations:

CAS Chemical Abstracts Service
cm Centimeter
CSL Cleanup screening level
dw Dry weight
HPAH High molecular weight polycyclic aromatic hydrocarbon
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
OC Organic carbon
SCO Sediment cleanup objective
SMS Sediment Management Standards
TOC Total organic carbon

Table 2.2

Frequency of Exceedances of Sediment Management Standards Sediment Cleanup Levels for Samples with Total Organic Carbon greater than 4 Percent[1]

			Information about Detections								Information about Exceedances							
Chemicals	CAS	Units	Number of Results	Number of Detections	Percentage of Detected Results	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detection	Date of Maximum Detection	Depth of Maximum Detection	LAET	Number of Detected Exceedances of LAET	Percentage of Detected Exceedances of LAET	Exceedance Factor	2LAET	Number of Detected Exceedances of 2LAET	Percentage of Detected Exceedances of 2LAET	Exceedance Factor
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LPAH	--	µg/kg dw	35	33	94%	26	3,200	KSS-2	7/9/2013	0 - 10 cm	5,200	None	None	None	5,200	None	None	None
Naphthalene	91-20-3	µg/kg dw	35	20	57%	10	1,100	KSS-2	7/9/2013	0 - 10 cm	2,100	None	None	None	2,100	None	None	None
Acenaphthylene	208-96-8	µg/kg dw	35	24	69%	7.6	430	KSS-2	7/9/2013	0 - 10 cm	1,300	None	None	None	1,300	None	None	None
Acenaphthene	83-32-9	µg/kg dw	35	22	63%	4.3	94	PA_MA02A	6/13/2008	0 - 10 cm	500	None	None	None	500	None	None	None
Fluorene	86-73-7	µg/kg dw	35	26	74%	8.9	280	NPI-PA10	3/17/2008	0 - 10 cm	540	None	None	None	540	None	None	None
Phenanthrene	85-01-8	µg/kg dw	35	33	94%	26	1,200	KSS-2	7/9/2013	0 - 10 cm	1,500	None	None	None	1,500	None	None	None
Anthracene	120-12-7	µg/kg dw	35	28	80%	22	1,500	NPI-PA10	3/17/2008	0 - 10 cm	960	1	2.9%	1.6	960	1	2.9%	1.6
2-Methylnaphthalene	91-57-6	µg/kg dw	35	17	49%	10	140	NPI-PA3	2/28/2008	0 - 10 cm	670	None	None	None	670	None	None	None
Total HPAH	--	µg/kg dw	35	33	94%	50	8,000	KSS-2	7/9/2013	0 - 10 cm	12,000	None	None	None	17,000	None	None	None
Fluoranthene	206-44-0	µg/kg dw	35	33	94%	23	2,600	KSS-2	7/9/2013	0 - 10 cm	1,700	2	5.7%	1.5	2,500	1	2.9%	1
Pyrene	129-00-0	µg/kg dw	35	33	94%	27	2,100	KSS-2	7/9/2013	0 - 10 cm	2,600	None	None	None	3,300	None	None	None
Benzo(a)anthracene	56-55-3	µg/kg dw	35	32	91%	20	670	WPAH006	6/27/2013	0 - 10 cm	1,300	None	None	None	1,600	None	None	None
Chrysene	218-01-9	µg/kg dw	35	32	91%	34	1,400	KSS-1	7/9/2013	0 - 10 cm	1,400	None	None	None	2,800	None	None	None
Total Benzofluoranthenes	56832-73-6	µg/kg dw	35	31	89%	48	1,400	WPAH006	6/27/2013	0 - 10 cm	3,200	None	None	None	3,600	None	None	None
Benzo(a)pyrene	50-32-8	µg/kg dw	35	31	89%	20	480	WPAH006	6/27/2013	0 - 10 cm	1,600	None	None	None	1,600	None	None	None
Benzo(g,h,i)perylene	191-24-2	µg/kg dw	35	27	77%	11	210	KSS-1 KSS-2	7/9/2013 7/9/2013	0 - 10 cm 0 - 10 cm	670	None	None	None	720	None	None	None
Indeno(1,2,3-cd)pyrene	193-39-5	µg/kg dw	35	27	77%	14	260	KSS-1	7/9/2013	0 - 10 cm	600	None	None	None	690	None	None	None
Dibenzo(a,h)anthracene	53-70-3	µg/kg dw	35	21	60%	4.2	70	WPAH006	6/27/2013	0 - 10 cm	230	None	None	None	230	None	None	None
Chlorinated Benzenes																		
1,2-Dichlorobenzene	95-50-1	µg/kg dw	25	None	None	None	None	None	None	None	35	None	None	None	50	None	None	None
1,4-Dichlorobenzene	106-46-7	µg/kg dw	25	None	None	None	None	None	None	None	110	None	None	None	110	None	None	None
1,2,4-Trichlorobenzene	120-82-1	µg/kg dw	25	None	None	None	None	None	None	None	31	None	None	None	51	None	None	None
Hexachlorobenzene	118-74-1	µg/kg dw	25	None	None	None	None	None	None	None	22	None	None	None	70	None	None	None
Phthalate Esters																		
Dimethyl phthalate	131-11-3	µg/kg dw	35	1	2.9%	19	19	KSS-2	7/9/2013	0 - 10 cm	71	None	None	None	160	None	None	None
Diethylphthalate	84-66-2	µg/kg dw	35	7	20%	6.2	93	PA_IH01A	6/16/2008	0 - 10 cm	200	None	None	None	1,200	None	None	None
Di-n-butyl phthalate	84-74-2	µg/kg dw	35	2	5.7%	7.2	24	NPI-PA6	2/28/2008	0 - 10 cm	1,400	None	None	None	5,100	None	None	None
Butyl benzyl phthalate	85-68-7	µg/kg dw	35	7	20%	31	670	PA_MA04A	6/12/2008	0 - 10 cm	63	3	8.6%	11	900	None	None	None
bis(2-ethylhexyl)phthalate	117-81-7	µg/kg dw	35	18	51%	17	220	NPI-PA10	3/17/2008	0 - 10 cm	1,300	None	None	None	3,100	None	None	None
Di-n-octyl phthalate	117-84-0	µg/kg dw	35	None	None	None	None	None	None	None	6,200	None	None	None	6,200	None	None	None
Miscellaneous Nonionizable Organic Compounds																		
Dibenzofuran	132-64-9	µg/kg dw	32	14	44%	5.6	180	KSS-2	7/9/2013	0 - 10 cm	540	None	None	None	540	None	None	None
Hexachlorobutadiene	87-68-3	µg/kg dw	25	None	None	None	None	None	None	None	11	None	None	None	120	None	None	None
N-Nitrosodiphenylamine	86-30-6	µg/kg dw	25	None	None	None	None	None	None	None	28	None	None	None	40	None	None	None
Pesticides/Polychlorinated Biphenyls (PCBs)																		
PCBs (Total, Aroclors)	1336-36-3	µg/kg dw	29	14	48%	11	74	NPI-PA1	2/28/2008	0 - 10 cm	130	None	None	None	1,000	None	None	None

Notes:

1 The following notes pertain to the content of this table:

- Only locations within the Site boundary are included.
- For sample/sample duplicate pairs, only the highest detected concentration (or lowest reporting limit if both were not detected) has been reported for each chemical at each location.
- For samples in which multiple analytical methods resulted in reported concentrations for a single chemical, only the highest detected concentration (or lowest reporting limit if none were detected) has been repc
- Only surface samples (maximum depth of 10 cm) are included.
- Only chemicals where SMS SCO/CSL criteria are OC Normalized are included.
- Only samples with TOC values outside the 0.5 to 4 percent range for OC normalization are included.
- Only the most recent results from reoccupied stations are included.
- The exceedance factor is rounded to two significant figures.

Abbreviations:

2LAET Second Lowest Apparent Effects Threshold
CAS Chemical Abstract Service
cm Centimeter
CSL Cleanup screening level
dw Dry weight
HPAH High molecular weight polycyclic aromatic hydrocarbon
LAET Lowest Apparent Effects Threshold
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg Micrograms per kilogram
mg/kg Milligrams per kilogram
OC Organic carbon
SCO Sediment cleanup objective
SMS Sediment Management Standards
TOC Total organic carbon

Table 2.3
Benthic Health Indicator Hazardous Substances Screening Summary

Proposed Indicator Hazardous Substance	Retained?	Rationale
Metals		
Arsenic	No	Result for only 1 of 78 samples (1.3% of results) exceeds the SCO.
Cadmium	Yes	Results for 8 of 81 samples (9.9% of results) exceed the SCO.
Chromium	No	No SCO exceedances.
Copper	No	No SCO exceedances.
Lead	No	No SCO exceedances.
Mercury	Yes	Results for 24 of 86 samples (28% of results) exceed the SCO.
Silver	No	No SCO exceedances.
Zinc	Yes	Results for 6 of 81 samples (7.4% of results) exceed the SCO.
Polycyclic Aromatic Hydrocarbons		
Total LPAH	No	No SCO exceedances.
Naphthalene	No	No SCO exceedances.
Acenaphthylene	No	No SCO exceedances.
Acenaphthene	No	No SCO exceedances.
Fluorene	No	No SCO exceedances.
Phenanthrene	No	Result for 1 of 72 samples (1.4% of results) exceeds the SCO. This sample is co-located with bioassays that did not indicate benthic toxicity.
Anthracene	No	Result of 1 of 72 samples (1.4% of results) exceeds the LAET. This sample is co-located with bioassays that did not indicate benthic toxicity.
2-Methylnaphthalene	No	No SCO exceedances.
Total HPAH	No	No SCO exceedances.
Fluoranthene	Yes	Results for 3 of 72 samples (4.2% of results) exceed the SCO or the LAET.
Pyrene	No	No SCO exceedances.
Benzo(a)anthracene	No	No SCO exceedances.
Chrysene	No	No SCO exceedances.
Total Benzofluoranthenes	No	No SCO exceedances.
Benzo(a)pyrene	No	No SCO exceedances.
Benzo(g,h,i)perylene	No	Results for 2 of 72 samples (2.8% of results) exceed the SCO. These samples are co-located with bioassays that did not indicate benthic toxicity.
Indeno(1,2,3-cd)pyrene	No	Result for 1 of 72 samples (1.4% of results) exceeds the SCO. This sample is co-located with bioassays that did not indicate benthic toxicity.
Dibenzo(a,h)anthracene	No	No SCO exceedances.
Chlorinated Benzenes		
1,2-Dichlorobenzene	No	No SCO exceedances.
1,4-Dichlorobenzene	No	Result for 1 of 60 samples (1.7% of results) exceeds the SCO. This sample is co-located with bioassays that did not indicate benthic toxicity.
1,2,4-Trichlorobenzene	No	No SCO exceedances.
Hexachlorobenzene	No	No SCO exceedances.
Phthalate Esters		
Dimethyl phthalate	No	No SCO exceedances.
Diethylphthalate	No	No SCO exceedances.
Di-n-butyl phthalate	No	No SCO exceedances.
Butyl benzyl phthalate	No	Results for 3 of 72 samples (4.2% of results) exceed the LAET. These samples are co-located with bioassays that did not indicate benthic toxicity.
bis(2-ethylhexyl)phthalate	No	Results for 3 of 72 samples (4.2% of results) exceed the SCO. These samples are co-located with bioassays that did not indicate benthic toxicity.
Di-n-octyl phthalate	No	No SCO exceedances.
Miscellaneous Nonionizable Organic Compounds		
Dibenzofuran	No	No SCO exceedances.
Hexachlorobutadiene	No	No SCO exceedances.
N-Nitrosodiphenylamine	No	No SCO exceedances.

Table 2.3
Benthic Health Indicator Hazardous Substances Screening Summary

Proposed Indicator Hazardous Substance	Retained?	Rationale
Pesticides/Polychlorinated Biphenyls (PCBs)		
PCBs (Total, Aroclors)	No	No SCO exceedances.
Ionizable Organic Compounds		
Phenol	No	Results for 2 of 60 samples (3.3% of results) exceed the SCO. These samples are co-located with bioassays that did not indicate benthic toxicity.
2-Methylphenol	No	No SCO exceedances.
4-Methylphenol	No	No SCO exceedances.
2,4-Dimethylphenol	No	No SCO exceedances.
Pentachlorophenol	No	No SCO exceedances.
Benzyl alcohol	No	No SCO exceedances.
Benzoic acid	No	No SCO exceedances.

Note:
Gray-shaded row indicates chemical retained as an indicator hazardous substance for further evaluation in the remedial investigation/feasibility study.

Abbreviations:
LAET Lowest apparent effects threshold
SCO Sediment cleanup objective

Table 2.4
Bioaccumulative Indicator Hazardous Substances Screening Summary

Proposed Indicator Hazardous Substance	Retained?	Rationale for Elimination or Retention
Arsenic	No	The current arsenic SWAC within the BDU (7.75 mg/kg) is less than the SCL (13.9 mg/kg).
Cadmium	No	The current cadmium SWAC within the BDU (1.2 mg/kg) is less than the SCL (2.4 mg/kg).
Copper	No	The current copper SWAC within the BDU (30 mg/kg) is less than the SCL (35 mg/kg).
Selenium	No	• Based on Ecology's evaluation of the available tissue data collected in Port Angeles Harbor, selenium contributes less than 2 percent of the total human health risk (NewFields 2013, Table 2). • Ecology's Port Angeles Harbor sediment characterization study also did not identify selenium as a chemical of potential concern in the harbor (Ecology 2012). • Selenium is an essential nutrient for human health.
Zinc	No	• Based on Ecology's evaluation of the available tissue data collected in Port Angeles Harbor, zinc contributes less than 1 percent of the total human health risk (NewFields 2013, Table 2), with a calculated hazard quotient only marginally greater than the protective levels (i.e., 1.1) and only for a worst-case child subsistence exposure scenario (Ecology 2012, Appendix G, Table 3-14). • Zinc is an essential nutrient for human health.
Mercury	Yes	The current mercury SWAC within the BDU (0.27 mg/kg) is greater than the SCL (0.13 mg/kg).
BHC	No	None of the concentrations in samples collected within the Site boundary were greater than the human health SCL (1.4 µg/kg).
cPAH TEQ	Yes	The cPAH TEQ current SWAC within the BDU (140 µg/kg is greater than the SCL (64 µg/kg).
Total TEQ	Yes	The current total TEQ SWAC within the Site boundary (14.1 ng/kg) is greater than the SCL (5.2 ng/kg).

Notes:

Gray-shaded row indicates chemical retained as an indicator hazardous substance for further evaluation in the remedial investigation/feasibility study.

Abbreviations:

BDU	Bivalve decision unit
BHC	alpha-Hexachlorocyclohexane
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
Ecology	Washington State Department of Ecology
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
ng/kg	Nanograms per kilogram
SCL	Sediment cleanup level
SWAC	Surface-weighted average concentration
TEQ	Toxic equivalent

Table 3.1
Approximate Areas Exceeding SCO and CSL Chemical Criteria for Bioaccumulative Indicator Hazardous Substances

Bioaccumulative Indicator Hazardous Substance	Sediment Chemical Criteria			Approximate Acres Exceeding Chemical Criteria[1]	
	Units	SCO	CSL	SCO	CSL
Total TEQ	ng/kg	1.3	5.2	1,990	1,110
cPAH TEQ	µg/kg	16	64	1,530	620
Mercury	mg/kg	0.11	0.13	780	560

Note:

1 Calculated for the Site; not constrained by the bivalve decision unit; consistent with the Washington State Department of Ecology's clarification that the Site "...will be the outer boundary of all chemical footprints exceeding the sediment cleanup standards" (Ecology 2016a).

Abbreviations:

cPAH Carcinogenic polycyclic aromatic hydrocarbon
CSL Cleanup screening level
mg/kg Milligrams per kilogram
ng/kg Nanograms per kilogram
SCO Sediment cleanup objective
TEQ Toxic equivalent

Table 5.1
Summary of Western Port Angeles Harbor Watershed Loading Calculations for Bioaccumulative Indicator Hazardous Substances

Table 5.1.A Western Port Angeles Harbor Watershed Loading			
Parameter	**Unit-Area Loading Rate[1] (gm/km^2-yr)**	**Western Port Angeles Harbor Watershed Loading[2] (gm/yr)**	**Western Port Angeles Harbor Sediment Input Concentration[3]**
Total TEQ			(ng/kg dw)
Commercial/Industrial	9.9E-05	2.4E-04	
Residential	1.0E-04	5.7E-04	
Agricultural	7.1E-05	1.4E-04	
Forest/Field/Other	3.1E-05	9.4E-04	
Total		**1.9E-03**	**0.36**
cPAH TEQ			(µg/kg dw)
Commercial/Industrial	9.2	22	
Residential	0.7	4	
Agricultural	0.7	1	
Forest/Field/Other	1.9	57	
Total		**84**	**22**
Mercury			(mg/kg dw)
Commercial/Industrial	4.4	10	
Residential	3.1	17	
Agricultural	5.2	10	
Forest/Field/Other	4.8	145	
Total		**183**	**0.048**

Table 5.1.B Western Port Angeles Harbor Watershed Land Use Areas		
Parameter	**Area (km^2)**	**Percentage**
Commercial/Industrial	2.4	6%
Residential	5.6	14%
Agricultural	2.0	5%
Forest/Field/Other	30	75%
Total	**40**	**100%**

Table 5.1.C Western Port Angeles Harbor Total Sediment Loading Calculation			
Parameter	**Value**	**Units**	**Comments**
Average net sedimentation rate	0.17	cm/yr	Arithmetic average of sedimentation rate measurements
Average total solids	46	% wet weight	Arithmetic average of all Western Port Angeles Harbor surface sediment samples
Average dry density	0.64	gm/cm^3	Lefkovitz et al. (1997) regression: Wet density = 0.1737 x (5.0245 + e(0.0238 x TS))
Net sediment accumulation rate	0.11	gm/cm^2-yr	Calculated
West Port Angeles Harbor	4.7 / 3.4	km^2	West Port Angeles Harbor SWAC area (1,170 acres for Total TEQ; 840 acres for bivalve decision unit)
Total sediment loading	5,300,000 / 3,800,000	kg/yr	Calculated

Notes:

1 **For cPAH TEQ:** the unit-area loading rate was calculated based on the total cPAH unit-area loading rates by land category in Ecology's Phase 3 loading study (Herrera 2011, Table 15). Total cPAH loading values reported in the loading study (Herrera 2011) were converted to TEQ based on the regression relationship between total cPAH and cPAH TEQ in commercial/industrial basins (slope = 0.195; R_2= 0.81; Figure 5.1).

For Total TEQ: the unit-area loading rate was estimated using total suspended solids unit-area loading rates by land category in Ecology's Phase 3 loading study (Herrera 2011), multiplied by the concentrations of total dioxin/furan TEQ measured in surface soil in the Port Angeles Harbor watershed (Ecology 2011). The average surface soil Total TEQ level measured in non-forest areas was approximately 15 ng/kg, while the average surface soil Total TEQ level measured in forested areas was approximately 3.6 ng/kg.

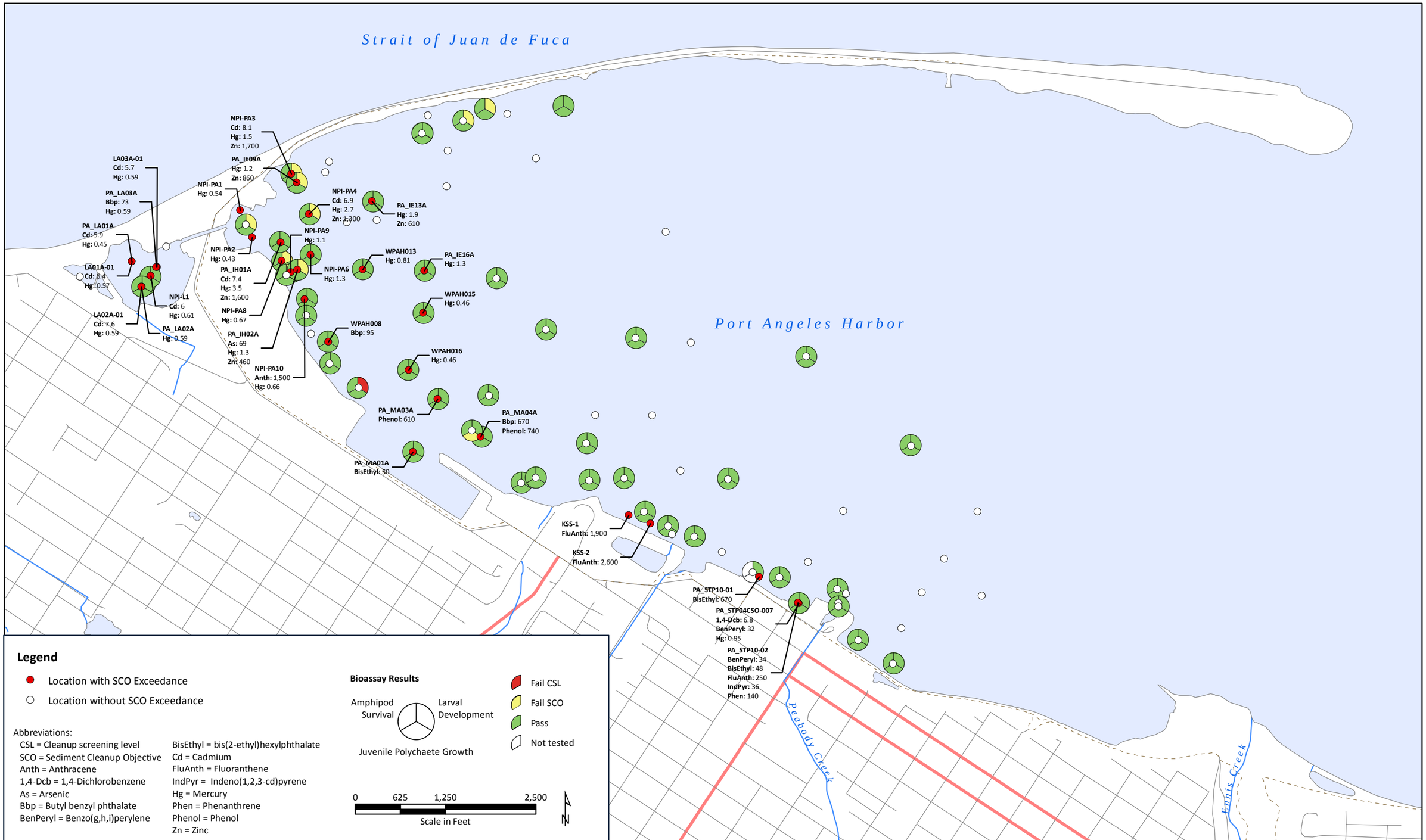
2 The Western Port Angeles Harbor watershed loading rates were calculated by multiplying the unit-area loading for each land category by the total area of each land type in the Western Port Angeles Harbor watershed (Table 5.1.B).

3 The Western Port Angeles Harbor sediment input concentrations were calculated by dividing the total loading for each bioaccumulative IHS by the total depositional solids flux into Western Port Angeles Harbor over the appropriate SWAC area (Table 5.1.C; 1,170 acres for total TEQ; 840 acres for the bivalve decision unit applied to cPAH TEQ and mercury).

Abbreviations:

cm/yr	Centimeters per year	km^2	Square kilometer
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	µg/kg	Micrograms per kilogram
dw	Dry weight	mg/kg	Milligrams per kilogram
Ecology	Washington State Department of Ecology	ng/kg	Nanograms per kilogram
gm/cm^2-year	Grams per square centimeter per year	SWAC	Surface-weighted average concentration
gm/cm^3	Grams per cubic centimeter	TEQ	Toxic equivalent
gm/yr	Grams per year	TS	Total solids
gm/km^2-yr	Grams per square kilometer per year		
IHS	Indicator hazardous substance		
km	Kilometer		

Figures



WPAHG

Western Port Angeles Harbor Group

Western Port Angeles Harbor Site
Port Angeles, Washington

Figure 2.1
Surface Sediment Chemistry and Bioassay Results within the Site

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3/16/2017

Strait of Juan de Fuca

Port Angeles Harbor

Tumwater Creek

Valley Creek

Peabody Creek

Ennis Creek

Legend

- Site Boundary (Based on Total TEQ Contamination Extent) ~ 1,169 Acres
- Bivalve Decision Unit (Based on a Depth of -70 Mean Lower Low Water) ~ 843 Acres
- WPAH Administrative Boundary

Notes:
- The Site boundary was generated by overlaying the areas of IHS CSL exceedances, with the final boundary encompassing all IHS exceedances. Total TEQ exceedances ultimately defined the boundary. A simplified Site boundary line was then generated by selecting vertices on the original contour boundary that were 1,000 feet apart starting at the north end of the boundary.
- Total TEQ CSL = 5.2 ng/kg

Abbreviations:
CSL = Cleanup screening Level
IHS = Indicator hazardous substance
ng/kg = Nanograms per kilogram
TEQ = Toxic equivalent
WPAH = Western Port Angeles Harbor

0 625 1,250 2,500
Scale in Feet

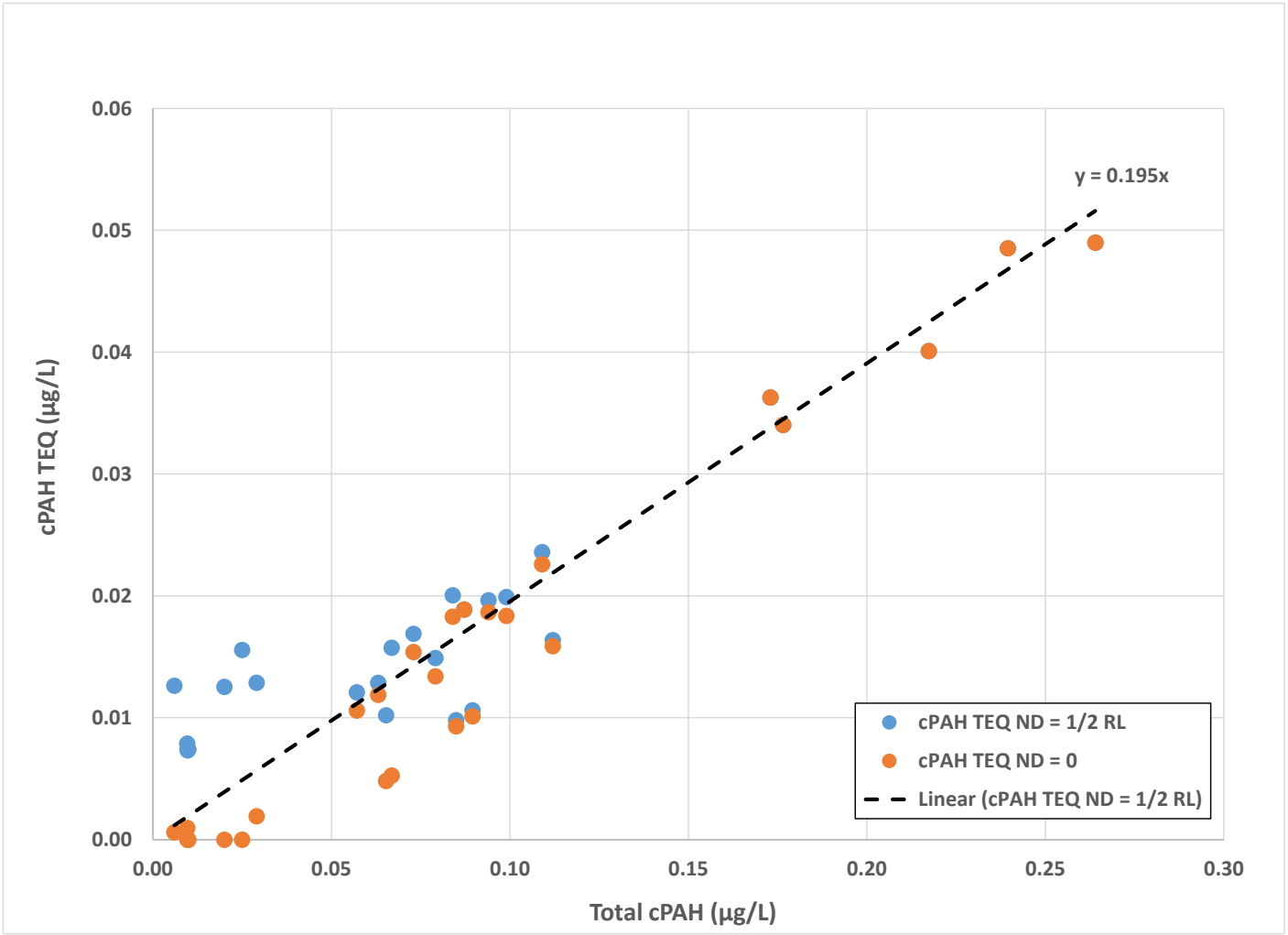
N

WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Site
Port Angeles, Washington

Figure 4.1
Site and Bivalve Decision Unit Boundaries

I:\GIS\Projects\WPAHG-RIFS\MXD\Figure 4.1 Site and Bivalve Decision Unit Boundaries.mxd
3/25/2017



Notes:

- Source: Herrera 2011
- The cPAH TEQ concentrations were calculated using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900 (Ecology 2013b). The cPAH TEQ was calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations: cPAH = Carcinogenic polycyclic aromatic hydrocarbon; µg/L = Micrograms per liter; ND = Nondetection; RL = Reporting Limit; TEQ = Toxic equivalent.

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Port Angeles, Washington

Figure 5.1
Total cPAH versus cPAH TEQ Levels in Commercial/Industrial Stormwater Samples – Ecology Phase 3 Loading Study

Appendix A
Washington State Department of Ecology Memoranda

Port Angeles Harbor: Total TEQ

Site-Specific Rationale Memo

To: Rayonier Mill Site and Western Port Angeles Harbor Site Potentially Liable Persons

From: Rebecca Lawson, P.E., LHG
Section Manager
Southwest Regional Office
Toxics Cleanup Program

Date: November 29, 2016

1.0 Purpose

The purpose of this memorandum is to document site-specific decisions by the Department of Ecology (Ecology) regarding sediment cleanup levels protective of human health and the environment for the following contaminants, when conducting cleanup actions in Port Angeles Harbor under the Model Toxics Control Act (MTCA) (WAC 173-340) (Ecology 2013a):

- Polychlorinated dibenzo-*p*-dioxins (PCDDs);
- Polychlorinated dibenzofurans (PCDFs); and
- Polychlorinated biphenyls (PCBs).

2.0 Background

2.1 Dioxins/Furans

PCDDs and PCDFs (dioxins/furans) are two classes of chemicals that are structurally similar in that they both contain two carbon ring structures. All dioxins include two oxygen atoms, while all furans include one oxygen atom. There are 210 unique dioxin/furan compounds (*congeners*) that differ from each other in the number and position of chlorine atoms (Figure 1).

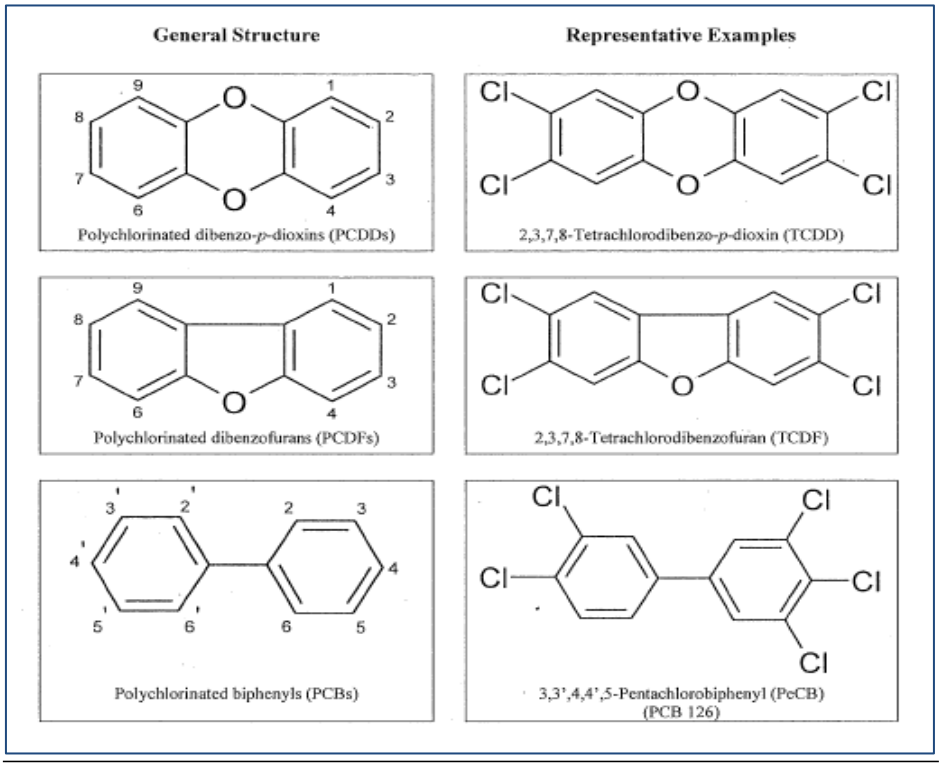

Figure 1. Chemical structure of PCDDs (dioxins), PCDFs (furans), and dioxin-like PCBs. Numbers by aromatic ring carbons in general structures represent potential chlorine substitutions (USEPA 2008).

Dioxins/furans enter the environment from a variety of sources and are typically present in the environment as complex mixtures. Both compound classes can be byproducts of combustion processes and chemical manufacturing involving chlorine compounds. Regulatory and health agencies are interested in dioxins/furans because they are a potential risk to humans and wildlife. Once released into the environment, dioxins/furans resist degradation, do not dissolve in water, and adhere to particles such as soil, dust, and sediment. Dioxins/furans are persistent, bioaccumulative in people and animals, and can be measured in environmental media long after they have been released.

Although there are 210 unique dioxin/furan congeners, only 17 of these are typically evaluated because they are considered by the U.S. Environmental Protection Agency (USEPA) and the World Health Organization (WHO) to be the most toxic. These 17 congeners have chlorine atoms in the 2, 3, 7, and 8 positions (Figure 1). Throughout the remainder of this memo, the terms "dioxins" and "furans" will be used to refer to the 17 congeners of primary toxicological interest, listed in Table 1.

The 17 dioxin/furan congeners of primary interest act through a common biological mechanism of toxicity by binding the aryl hydrocarbon (Ah) receptor (USEPA 2010). However, the individual congeners have different toxicities. Because dioxins/furans are present in the

environment as complex mixtures, their concentrations are often expressed based on relative toxicity. This toxicity equivalence (TEQ) methodology was developed to evaluate the toxicity and assess the risks associated with the entire mixture. The TEQ methodology is based on the concept that the various dioxin/furan congeners, and other structurally similar dioxin-like compounds, in a mixture essentially act as one chemical that affects the Ah receptor (NRC 2001).

The dioxin congener 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is considered to be the most toxic contaminant to bind to Ah receptor. Therefore, the TEQ methodology weights the concentrations of other contaminants with effects mediated through the Ah receptor pathway relative to the toxicity of TCDD. TCDD is most notorious for its presence as a contaminant in Agent Orange, used as a defoliant in the Vietnam War. It is a potent carcinogen, a mutagen which can cause birth defects, and can be deadly at high concentrations. TCDD is the best studied of the dioxin/furan congeners, making it an appropriate standard for comparison when applying the TEQ methodology.

2.2 PCBs

PCBs are a group of synthetic organic chemicals that comprise 209 individual chlorinated biphenyl compounds (*congeners*) that also differ in the number and location of chlorine atoms (Figure 1).

PCBs were domestically manufactured from 1929 until their production was banned in 1979 due to their environmental toxicity and classification as a persistent organic pollutant. PCBs were historically manufactured and sold as Aroclor mixtures, which could consist of 60 to 80 individual congeners. Aroclor names usually reflect the percent chlorine (by weight) of the mixture (e.g., Aroclor 1242 is 42 percent chlorine by weight), with the more chlorinated mixtures generally being the most persistent and toxic.

PCBs were used as coolants and lubricants in electrical equipment such as capacitors and transformers because of their insulating properties, non-flammability, and chemical stability (Ecology 2007). Other applications included use as plasticizers in paints, plastics, and rubber products, and as additives in pigments and dyes. Until recently, PCBs were produced worldwide and can still be found in some inks, paints, caulks, and newsprint.

2.2.1 Dioxin-like PCB Congeners

Twelve PCB congeners are referred to as “dioxin-like” because of their similar chemical structure to TCDD and their mode of action through the Ah receptor pathway. The *non-ortho* substituted (often referred to as *co-planar*) dioxin-like PCB congeners PCB-77, -81, -126, and -

169 are considered the most structurally similar to TCDD, and therefore the most toxicologically active PCBs. Eight additional *mono-ortho* substituted PCB congeners are also considered dioxin-like, but with less expected toxicity (McFarland and Clarke 1989). Because the dioxin-like PCBs have similar toxic responses as dioxins/furans, their concentrations can be expressed based on their relative toxicity to TCDD through the TEQ methodology.

2.2.2 Non-dioxin-like PCB Congeners

The remaining 197 PCB congeners are collectively referred to as "non-dioxin-like" and cannot be integrated into the TEQ methodology because their non-planar structures do not cause them to exhibit dioxin-like toxicity. Because the non-dioxin-like PCBs are structurally diverse, they may act via one or more toxicity pathways. Some non-dioxin-like PCBs have been shown to elicit different types of responses than dioxin-like PCBs, including neurological, endocrine, neuroendocrine, immunological, and carcinogenic effects (USEPA 2003). However, only a small number of individual non-dioxin-like PCBs have been linked to any one of these effects, as congener-specific toxicity data for non-dioxin-like PCBs is limited to less than a dozen congeners.

Most studies of the toxicity of PCBs have focused on either commercial mixtures, concentrated environmental samples, or laboratory defined mixtures. All of these media contain both dioxin-like and non-dioxin-like PCBs. In these studies it is often difficult to quantitatively determine the relative contribution of dioxin-like and non-dioxin-like PCBs to the toxic effects observed (USEPA 2003). Despite this, current evidence indicates that the greatest potential for effects to mammals from exposure to PCB mixtures is from the dioxin-like congeners (Giesy and Kannan 1998, Burgin et al. 2001, Kodavanti et al. 2001, Rice et al. 2002). Given that dioxin-like PCBs always occur as mixtures with non-dioxin-like PCBs and the dioxin-like effects occur at lower concentrations, it is generally assumed that assessment based on the dioxin-like congeners will be protective against potential effects from the non-dioxin-like congeners (Giesy and Kannan 1998).

2.3 Aryl Hydrocarbon Receptor

The Ah receptor is a cellular protein capable of binding planar organic compounds with high affinity, leading to various toxic effects. Binding to the Ah receptor is the common mode of action (*biological mechanism*) for the 29 dioxin-like congeners (7 dioxin, 10 furan, and 12 PCB), with TCDD being the most potent. Figure 2 depicts how the dioxin-like congener enters the body through the bloodstream and binds with the Ah receptor. The protein/dioxin complex can then bind to a deoxyribonucleic acid (DNA) molecule, potentially interfering with gene transcription, and ultimately causing a toxic response (BEC 2012).

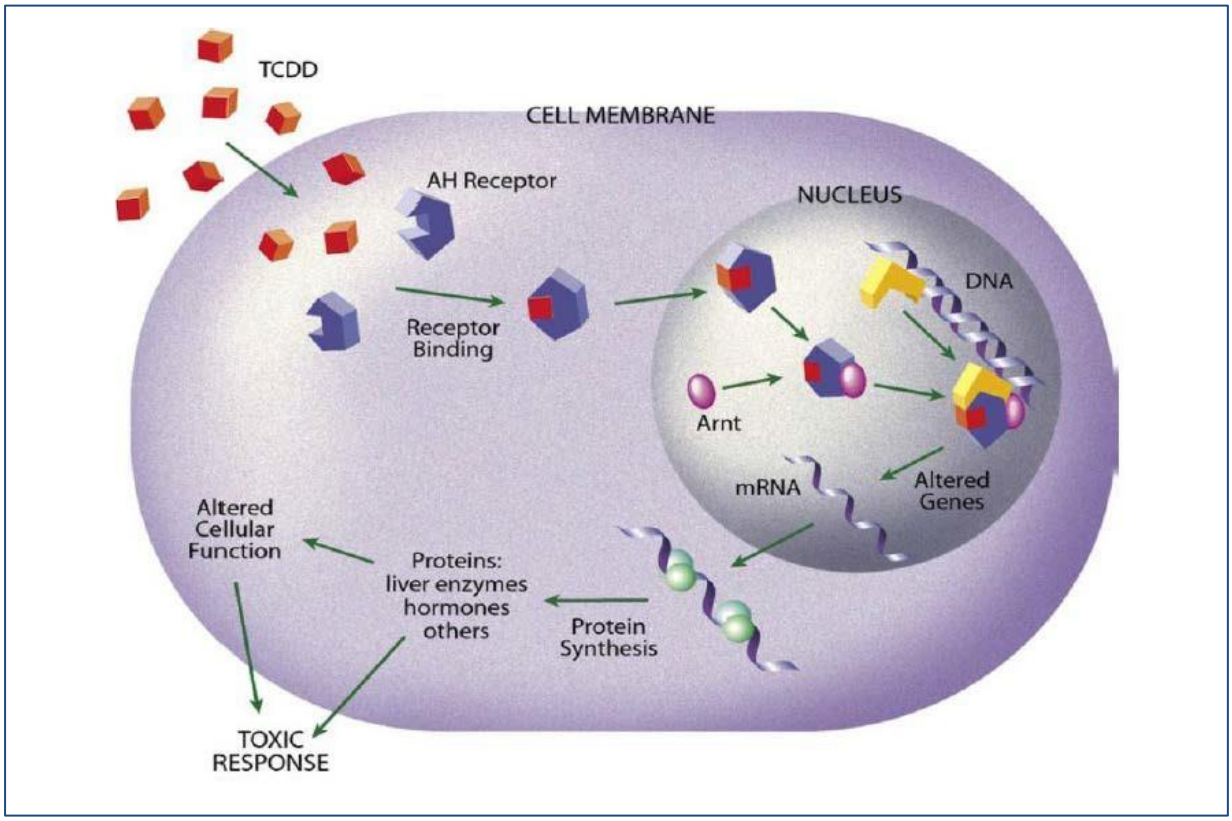

Figure 2: Illustration of the toxic response created by any of the 29 dioxin-like congeners (BEC 2012).

3.0 TEQ Methodology

3.1 Description

The TEQ methodology was developed as a tool to evaluate the toxicity and assess the risks of chemical mixtures that cause dioxin-like toxicity mediated through the Ah receptor. The New York State Department of Health first developed the TEQ concept to come up with re-entry criteria for an office building contaminated by a mixture of dioxins, furans, and PCBs following an electrical transformer fire (Eadon et al. 1986). The TEQ methodology was adopted by the international community in 1998 (Van den Berg et al. 1998) and revised congener-specific toxicity equivalency factors (TEFs) were adopted in 2006 as the most appropriate way to estimate the potential health risk from mixtures of dioxin-like compounds (Van den Berg et al. 2006). While the TEQ methodology can be used to assess the toxicity of dioxin/furan mixtures and dioxin-like PCB mixtures independently, the approach is equally valid for assessing the cumulative toxicity of complex mixtures of dioxins, furans, and dioxin-like PCBs (USEPA 2008, USEPA 2010).

3.2 TEFs and TEQ Concentrations

A TEF is the ratio of the estimated toxicity for a particular dioxin-like compound to the toxicity demonstrated by TCDD. Therefore, congener-specific TEFs can be used to convert dioxin, furan, and dioxin-like PCB congener concentrations into toxicity-scaled concentrations relative to TCDD. The sum of these TEF-scaled concentrations in a sample is called a TEQ concentration and is representative of the dioxin-like toxicity in a mixture. This TEQ concentration can then be used to compare environmental data to screening levels or in the establishment of protective cleanup levels. Table 1 summarizes the TEF values to be used for development of human health cleanup levels.

Table 1: PCDD, PCDF, and PCB toxicity equivalency factors

CAS Number	Hazardous Substance	TEF(1)
1746-01-6	2,3,7,8-Tetrachloro dibenzo-p-dioxin	1
40321-76-4	1,2,3,7,8-Pentachloro dibenzo-p-dioxin	1
39227-28-6	1,2,3,4,7,8-Hexachloro dibenzo-p-dioxin	0.1
57653-85-7	1,2,3,6,7,8-Hexachloro dibenzo-p-dioxin	0.1
19408-74-3	1,2,3,7,8,9-Hexachloro dibenzo-p-dioxin	0.1
35822-46-9	1,2,3,4,6,7,8-Heptachloro dibenzo-p-dioxin	0.01
3268-87-9	1,2,3,4,6,7,8,9-Octachloro dibenzo-p-dioxin	0.0003
51207-31-9	2,3,7,8-Tetrachloro dibenzofuran	0.1
57117-41-6	1,2,3,7,8-Pentachloro dibenzofuran	0.03
57117-31-4	2,3,4,7,8-Pentachloro dibenzofuran	0.3
70648-26-9	1,2,3,4,7,8-Hexachloro dibenzofuran	0.1
57117-44-9	1,2,3,6,7,8-Hexachloro dibenzofuran	0.1
72918-21-9	1,2,3,7,8,9-Hexachloro dibenzofuran	0.1
60851-34-5	2,3,4,6,7,8-Hexachloro dibenzofuran	0.1
67562-39-4	1,2,3,4,6,7,8-Heptachloro dibenzofuran	0.01
55673-89-7	1,2,3,4,7,8,9-Heptachloro dibenzofuran	0.01
39001-02-0	1,2,3,4,6,7,8,9-Octachloro dibenzofuran	0.0003
32598-13-3	3,3',4,4' TetraCB (77)	0.0001
70362-50-4	3,4,4',5 TetraCB (81)	0.0003
32598-14-4	2,3,3',4,4' PeCB (105)	0.00003
74472-37-0	2,3,4,4',5 PeCB (114)	0.00003
31508-00-6	2,3',4,4',5 PeCB (118)	0.00003
65510-44-3	2',3,4,4'5 PeCB (123)	0.00003
57465-28-8	3,3'4,4',5 PeCB (126)	0.1
38380-08-4	2,3,3',4,4',5 HxCB (156)	0.00003
69782-90-7	2,3,3',4,4',5' HxCB (157)	0.00003
52663-72-6	2,3',4,4',5,5' HxCB (167)	0.00003
32774-16-6	3,3',4,4',5,5' HxCB (169)	0.03
39635-31-9	2,3,3',4,4',5,5' HpCB (189)	0.00003

(1) Source: Van den Berg et al. (2006).

4.0 Establishing Cleanup Levels for Dioxin/Furan and PCBs in MTCA and SMS

MTCA establishes administrative processes and standards to identify, investigate, and clean up sites where hazardous substances have come to be located. MTCA, Chapter 70.105D RCW, authorizes Ecology to regulate environmental cleanups and is the implementing authority for Part V of the Sediment Management Standards (SMS) dealing with the sediment cleanup decision process. The SMS were developed to reduce and ultimately eliminate adverse effects on biological resources and significant threats to human health from surface sediment contamination.

In 2013, Ecology revised the SMS to establish a new framework for the determination and delineation of contaminated sediment sites where there is a potential human health risk (WAC 173-204) (Ecology 2013b). In order to support implementation of the revised rule, Ecology developed the Sediment Cleanup Users Manual II (SCUM II; Ecology 2015) as a guidance document on how to conduct cleanup of contaminated sediment sites. Key components of the rule revision include:

- Integrating requirements for cleanup of contaminated sediments specified in the SMS rule with requirements in the MTCA; and

- Updating the SMS cleanup decision framework to address bioaccumulative chemicals to protect human and environmental health.

The following subsections outline the regulations in MTCA and SMS related to the establishment of cleanup levels for dioxins/furans and PCBs. Also discussed is scientific information pertaining to the toxicity of dioxins/furans and PCBs, and how flexibility in the regulations allow for consideration of this information when establishing cleanup levels for individual sites.

4.1 MTCA

Currently in MTCA, mixtures of dioxins/furans and mixtures of PCBs are each assessed as single hazardous substances when establishing and determining compliance with cleanup levels (WAC 173-340-708(8)(d)(i) and (8)(f)(i)).

4.1.1 Dioxins/Furans

Under MTCA, cleanup levels established for TCDD are used as the cleanup levels for mixtures of dioxins/furans. When determining compliance with TCDD cleanup levels, the TEQ methodology is used to determine a dioxin/furan TEQ concentration in a sample (see Equation 1).

Equation 1: Dioxin/Furan TEQ Concentration

$$TEQ = \sum (PCDD_i \times TEF_i) + \sum (PCDF_i \times TEF_i)$$

4.1.2 PCBs

MTCA provides two approaches for establishing cleanup levels under Methods B and C for PCB mixtures based on:

1. Total Concentration - Assume the PCB mixture is equally potent and use the appropriate carcinogenic potency factor provided for under WAC 173-340-708(8)(a) through (c) for the entire mixture; or

2. Congener-Specific Analyses - Multiply the concentrations of the 12 dioxin-like PCB congeners by appropriate TEFs and sum the results for a TEQ concentration (see Equation 2). When using this approach the department may require that the health effects posed by the non-dioxin-like PCB congeners also be considered in the evaluation.

Equation 2: PCB TEQ Concentration

$$TEQ = \sum (PCB_i \times TEF_i)$$

4.2 SMS

As in MTCA, SMS considers mixtures of dioxins/furans and mixtures of PCBs as single hazardous substances. Under SMS, sediment cleanup levels (SCLs) are established for both:

- Benthic Risk - Acute and chronic toxicity to the benthic community (WAC 173-204-562 through 173-204-563), and

- Bioaccumulative Risk - Toxicity to humans and higher trophic level species (WAC 173-204-561 and -564).

For both benthic and bioaccumulative risks, SCLs are established through a two-tier framework by first establishing the sediment cleanup objective (SCO) and cleanup screening level (CSL) for each hazardous substance (Ecology 2015). The SCO is the long-term sediment quality goal. The CSL reflects slightly higher tolerance for human health risk and biological effects. The site-specific SCL can be adjusted upward from the SCO toward the CSL based on technical possibility and net adverse environmental impacts of remedial alternatives.

4.2.1 Benthic Risk-based Cleanup Levels

Dioxins/Furans

Marine sediment dioxin/furan concentration criteria for protection of the benthic community have not been established under SMS.

PCBs

Marine sediment PCB concentration criteria for protection of the benthic community consists of SCO and CSL values based on concentrations of total Aroclors developed using the Apparent Effects Threshold (AET) approach (Barrick, 1988). The reported total PCB concentrations are converted to TOC-normalized concentrations to allow direct comparison to the SMS marine chemical benthic criteria (Table 2) (WAC 173-204-320 Table 1; WAC 173-204-562 Table III). Ecology guidance recommends samples evaluated outside the typical range of 0.5 to 3.5 percent TOC be compared to dry weight normalized apparent effects thresholds (SCUM II Chapter 4, Section 4.2.2; Chapter 8, Table 8-1).

Table 2: Marine sediment Total PCB benthic risk-based criteria

Analyte	SMS Marine Sediment[(1)]		Marine Sediment AETs[(2)]	
	SCO	CSL	SCO	CSL
	mg/kg OC		µg/kg	
Total Aroclors	12	65	130	1000

(1) Values are normalized to total organic carbon.
(2) Dry weight normalized AETs are recommended when total organic carbon is outside the recommended range of 0.5 – 3.5% for organic carbon normalization.

4.2.2 Bioaccumulative Risk-based Cleanup Levels

For bioaccumulative chemicals, the SCO is established as the highest of:

1. Natural Background
2. Practical Quantitation Limit (PQL)
3. A risk-based value

For bioaccumulative chemicals, the CSL is established as the highest of:

1. Regional Background
2. PQL
3. A risk-based value

Dioxins/Furans

The 17 priority dioxin/furan congeners are considered to be persistent, bioaccumulative toxins (PBT; WAC 173-333-310), and therefore a dioxin/furan SCL is established for the protection of human health and higher trophic level species. SCO and CSL values for mixtures of dioxins/furans are established through the TEQ methodology (Section 4.1.1) as TEQ concentrations relative to TCDD.

PCBs

The dioxin-like PCB congeners are considered by Ecology to be PBTs. Similar to dioxins/furans, the dioxin-like PCB SCO and CSL values for the protection of human health and higher trophic level species are established through the TEQ methodology (Section 4.1.2) as a TEQ concentration relative to TCDD. Since it is generally assumed that assessment based on the dioxin-like congeners is protective against the potential effects from the non-dioxin-like congeners, MTCA allow the department to decide whether SCO and CSL values for non-dioxin-like PCBs need to be established (WAC 173-340-708(8)(f)(ii)(B)).

4.3 Integrating Dioxin-like Compounds

The following is a concise review of available information that has widespread acceptance within the relevant scientific community related to assessing the human health risks from dioxins/furans and PCBs. This information supports the establishment of a combined dioxin/furan TEQ and PCB congener TEQ metric as a cleanup level for the combined risk to human health from the mixture of these hazardous substances in sediment.

4.3.1 Use of PCB Congener-Specific Toxicities

As discussed above, MTCA allows for PCB cleanup levels to be established based on either total PCB concentrations or a congener-specific basis. When evaluating human health risks from total PCBs, the mixture is assumed to be equally toxic. Although this approach has been used at cleanup sites, the science has evolved to show that the use of total PCBs to predict toxicity from environmental PCBs may be inappropriate:

- Toxicity factors applied to total PCBs are based mainly on studies of commercial Aroclor mixtures. However, weathering effects after release to the environment tend to cause the composition of the PCBs in sediment to differ greatly from those of Aroclor mixtures.

- Bioaccumulation, biomagnification, and selective metabolism can further change the congener profile of PCBs between sediments and tissues.

- Toxicity varies considerably among PCB congeners, with a limited number of congeners commonly detected in environmental samples considered to be toxic or bioaccumulative in tissues (Cleverly 2005). Despite this, risk evaluation using total PCBs assumes the same toxicity for all congeners.

Because of these and other concerns, in 2001 the National Research Council (NRC) recommended that risk assessments be based on the specific congeners present at each site as opposed to generic total PCB values to better account for "the differences in the physicochemical, biochemical, and toxicological behavior of the different congeners in the risk calculations" (NRC 2001). As discussed in Section 2.2, the toxicities of the dioxin-like PCBs have been established relative to TCDD (Van den Berg et al. 2006). While congener-specific toxicity data for non-dioxin-like PCB congeners is very limited, it is widely recognized that dioxin-like congeners pose a greater risk to mammals (Giesy and Kannan 1998, Burgin et al. 2001, Kodavanti et al. 2001, Rice et al. 2002), and that cleanup levels established for dioxin-like congeners will be protective against potential effects from the non-dioxin-like congeners (Giesy and Kannan 1998).

4.3.2 Integrating the Toxicities of Dioxin-like Compounds

MTCA and SMS recognize and provide flexibility when developing cleanup levels. MTCA and SMS both assume hazardous substances with similar types of toxic response or cancer risk resulting from exposure to be additive (WAC 173-340-708). Current scientific information supports combining the risks of chemicals which have the same mode of action when determining a protective level (Van den Berg et al. 1998, Srogi 2008). The TEQ methodology provides an appropriate way to estimate the potential health risk from mixtures of dioxin-like compound with established TEFs (see Equation 3). Based on current toxicological methods used to evaluate the toxicity and assess the risk of complex chemical mixtures, the scientific literature recognizes that any screening level intended to be protective for dioxin-like toxic effects should encompass dioxins, furans, and dioxin-like PCBs (USEPA 2008, USEPA 2010, Van den Berg et al. 2006). The combined dioxin/furan/dioxin-like PCB TEQ concentration is further referred to as "Total TEQ" throughout the remainder of this memo.

Equation 3: Combined PCDD/PCDF/dioxin-like PCB TEQ Concentration (Total TEQ)

$$TEQ = \sum (PCDD_i \times TEF_i) + \sum (PCDF_i \times TEF_i) + \sum (PCB_i \times TEF_i)$$

5.0 Evaluating Human Health Risks of Dioxins/Furans and PCBs in Port Angeles Harbor

Dioxins, furans, dioxin-like PCBs, and non-dioxin-like PCBs are co-located in sediments throughout Port Angeles Harbor. Evaluation of harbor-wide surface sediment dioxin/furan and PCB concentrations are presented in NewFields (2012). It is likely that both dioxins/furans and PCBs share common upland source locations based on the spatial patterns observed. Additionally, forensic analysis of sediment dioxin/furan data identified probable source materials responsible for dioxin/furan contamination to the harbor, including a fingerprint attributable to dioxins/furans commonly found as impurities in PCB mixtures (NewFields 2013a).

The spatial coverage of dioxin/furan and PCB Aroclor data encompasses the entire harbor. In contrast, PCB congener data coverage is restricted to clusters in the western harbor, southcentral harbor, and in the vicinity of the former Rayonier Mill. Sampling locations in these clusters are within approximately 3,000 feet of the shoreline. Evaluation of the PCB Aroclor data beyond these clusters provides information about the relatively low levels of PCBs in the deep outer harbor where PCB congener data is not available. Based on the PCB Aroclors data beyond the clusters, PCB TEQs equal to regional background level or 0.21 parts per trillion were assumed for the purposes of evaluating Total TEQ.

5.1 Establishing Cleanup Levels

Port Angeles Harbor site-specific SCLs will be established between the SCOs and CSLs following the SMS framework as outlined in WAC 173-204-560. Preliminary SCOs for Port Angeles Harbor have been established (NewFields 2013b). Potential CSLs will be developed during the remedial investigation/feasibility study (RI/FS) process for each indicator hazardous substance (IHS). The CSLs will be established as the highest of the risk-based concentrations, the PQLs, and the regional background levels.

Ecology has established regional background levels of dioxin/furans, PCBs, and cPAHs for Port Angeles Harbor (Ecology 2016). If regional background levels are determined to be the CSLs, this value would represent the highest possible value at which the SCLs could be set. The rationale for adjustment of SCLs upward from the SCO toward the CSL must be presented in the RI/FS.

An evaluation of the North Olympic Peninsula (NOP) regional background levels shows that the dioxin/furan TEQ regional background level is 20 times greater than that of PCB TEQ and constitutes approximately 96 percent of regional background Total TEQ (Table 3). Since both dioxin/furan TEQ and PCB TEQ values have already been scaled by risk using the TEQ methodology, this means that regional background levels of dioxins/furans pose more than 20 times the risk to human health as dioxin-like PCBs. Establishment of an independent PCB TEQ

SCL equal to the regional background concentration (0.21 ng/kg) would be overly conservative, requiring cleanup of PCB toxicity to a level 20 times below what is considered protective for dioxins/furans.

Table 3: Comparison or Regional Background Concentrations

Analyte	NOP Regional Background	Percent of Total TEQ
Dioxin/Furan TEQ (ng/kg)	5.0	96
Dioxin-like PCB Congener TEQ (ng/kg)	0.21	4
Total TEQ (ng/kg)	5.2	100

5.2 Port Angeles Harbor Evaluations and Assumptions

The preliminary evaluation that follows is only for the assessment of human health risks associated with dioxins/furans and PCBs in Port Angeles Harbor and will be used in developing site-specific decisions regarding how Ecology would set cleanup levels for these contaminants.

MTCA requires a complete evaluation of the risks of these contaminants to benthic health, and of the risks of other contaminants of concern to benthic and human health. This evaluation will be included in the RI/FS reports for sites in Port Angeles Harbor. The SCLs presented in this memo are preliminary. Final sediment cleanup units (SCUs) and SCLs will be set in the cleanup action plan (CAP). This memo is not intended to support or make final decisions on SCUs or specific surface-weighted average concentration (SWAC) areas in Port Angeles.

5.2.1 Western Port Angeles Harbor - Relative Risk Reduction

Although dioxin/furan TEQ and PCB TEQ are generally co-located in WPAH sediments, the concentrations of dioxin/furan TEQs across a preliminary SCU are much greater than those of PCB TEQs. The greater significance of dioxin/furan TEQ compared to PCB TEQ can be seen in Figure 3, where both measures are depicted on the same concentration scale. This results in a large discrepancy in the relative human health risks posed by each of these hazardous substances, with dioxin-like PCB congeners accounting for less than 10 percent of the Total TEQ risk. Because of the general collocation of dioxin/furan and PCB contamination, remediation based on the Total TEQ targets the areas with the most risk and addresses hotspots.

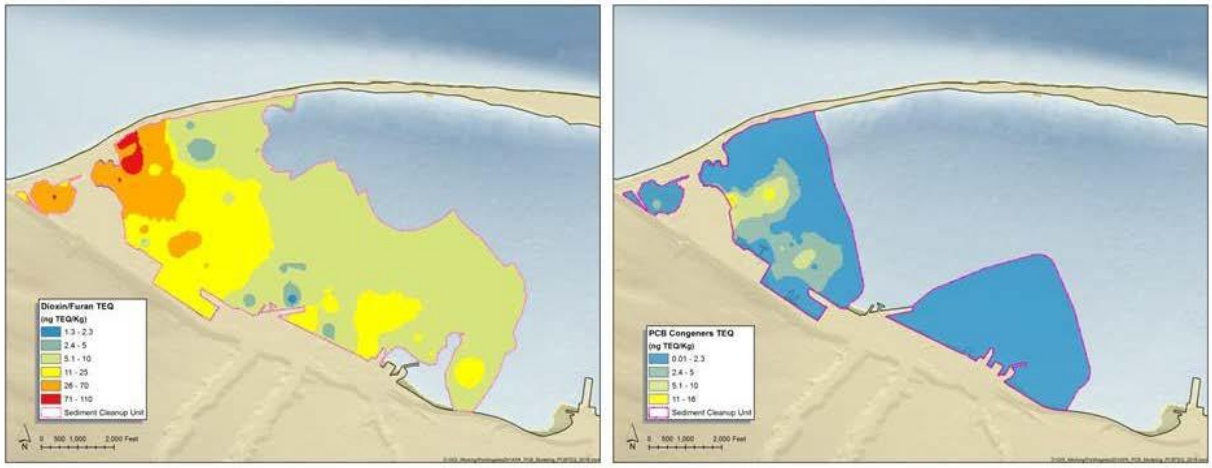

Figure 3: Comparison of WPAH Dioxin/Furan TEQ and PCB TEQ

5.2.2 Rayonier Mill - Relative Risk Reduction

In a similar manner to WPAH, the concentrations of dioxin/furan TEQs across the Rayonier Mill SCU is much greater than that of PCB TEQs. The greater significance of dioxin/furan TEQs compared to PCB TEQs can be seen in Figure 4, where both measures are depicted on the same concentration scale. Based on these concentrations, the relative human health risk posed by dioxin-like PCB congeners accounts for only about 20 percent of that from Total TEQ. Because of the general collocation of dioxin/furan and PCB contamination, remediation based on the Total TEQ targets the areas with the most risk and addresses hotspots.

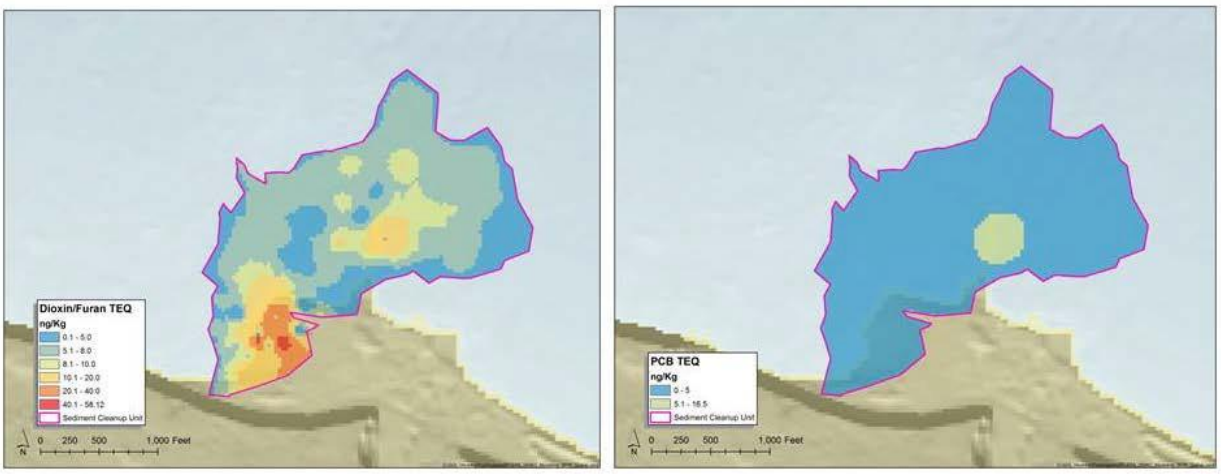

Figure 4: Comparison of Rayonier Mill Dioxin/Furan TEQ and PCB TEQ

6.0 Port Angeles Harbor Site-Specific Decision

Ecology's guidance for implementing sediment cleanup decisions under SMS has the goal of balancing protectiveness, predictability, and flexibility at cleanup sites (Ecology 2015). The preceding sections provide background information, scientific rationale, and site-specific data evaluations that will be considered by Ecology in the development of site-specific decisions regarding SCLs protective of human health for dioxins/furans and PCBs when conducting cleanup actions in Port Angeles Harbor under MTCA and SMS. Final SCLs will be dependent on additional factors during the RI/FS process, including the determination of SCUs and specific SWAC areas in Port Angeles Harbor.

Ecology has made the site-specific decision to use the combined dioxin/furan TEQ and PCB TEQ metric, Total TEQ, for the establishment of SCLs representative of the combined risk to human health from dioxins/furans and PCBs in Port Angeles Harbor. Ecology will not require the evaluation of dioxins/furans and/or PCBs as individual hazardous substances for the assessment of human health. It is Ecology's intention that Total TEQ be evaluated during the RI/FS process, and subsequently for such activities as remedial design, conformational sampling following active remedial actions, and long-term monitoring.

The decision to use Total TEQ for the evaluation of human health risks in Port Angeles Harbor is based on:

MTCA and SMS regulations -

- Independent cleanup levels for dioxin/furan congeners and PCB congeners can be established using the TEQ methodology.
- Some flexibility exists when establishing site-specific cleanup levels and remediation levels for individual sites.

Scientific Information -

- The 17 dioxin/furan congeners of primary interest and the 12 dioxin-like PCBs act through a common biological mechanism of toxicity.
- The TEQ methodology allows for evaluation of the toxicity and risks associated with mixtures of dioxins, furans, and dioxin-like PCBs.
- The greatest potential for effects to humans from exposure to PCB mixtures is from the dioxin-like congeners.
- The scientific basis for calculating risks from non-dioxin-like PCBs has not been established.
- Chemicals which have the same mode of action should be combined when determining a protective level and evaluating the toxicity and risks from complex mixtures.

Evaluation of site-specific data -

- Bioaccumulation-based sediment cleanup levels for dioxins/furans and PCBs will be based on NOP regional background levels.
- Mixtures of dioxins, furans, dioxin-like PCBs and non-dioxin-like PCBs exist at all locations in Port Angeles Harbor.
- Dioxins/furans and PCBs generally have the same sources and footprints in surface sediments.
- In both WPAH and the Rayonier Mill area, PCB TEQ is a minor component of Total TEQ.
- Remediation using Total TEQ will focus on the areas of highest toxicity and address hot spots.
- In Port Angeles Harbor, the targeted remediation of Total TEQ to regional background based cleanup levels will result in a protective cleanup and an appropriate reduction of risk to human health and the environment posed by dioxin-like compounds.

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Port Angeles Harbor: Compliance for Bioaccumulative Chemicals Using Sediment Data in Port Angeles Harbor

To: Rayonier Mill Site and Western Port Angeles Harbor Site Potentially Liable Persons

From: Rebecca Lawson, P.E., LHG
Section Manager
Southwest Regional Office
Toxics Cleanup Program

Date: November 29, 2016

1.0 Purpose

This memo documents Ecology's evaluation of compliance methods for bioaccumulative chemicals in sediments of Port Angeles Harbor.

2.0 Sediment Management Standards

In Port Angeles Harbor, sediment cleanup standards for protection of human health from exposures to bioaccumulative chemicals through ingestion of seafood are expected to be based on human health risk-based values, background values, or practical quantitation limit (PQL)-based standards. Compliance will be evaluated by comparing a surface-weighted average concentration (SWAC) over an appropriate spatial extent to the sediment cleanup standard.

2.1 Compliance Methods

Washington's Sediment Management Standards (SMS, WAC 173-204) specify a station by station approach for determining compliance with sediment cleanup standards based on benthic criteria, but allows area-weighted, station by station, or a combination of both approaches for cleanup standards based on other criteria.

> "For sediment cleanup standards based on the benthic criteria in WAC 173-204-562 or 173-204-563, as applicable, the department will determine compliance on an individual station by station approach. For sediment cleanup standards based on other criteria, the department will

determine compliance by area weighted or other averaging approach, individual station by station approach, or a combination or both" (WAC 173-204-560(7)(c)).

The Washington State Department of Ecology's Sediment Cleanup User's Manual II (SCUM II, Publication No. 12-09-057, March 2015) provides additional guidance on when to use these options for evaluating compliance monitoring data:

Option A – Point-by-point

> This option is used for sites, sediment cleanup units (SCUs) or sediment management areas (SMAs) with cleanup standards based on benthic toxicity or when the compliance data set is comprised of mostly (or all) non-detects and the PQL is below the cleanup standard (SCUM II, Chapter 13.6.1).

Option B – Comparison using the mean or Area-Weighted Mean

> For sites with cleanup standards based on area-wide exposures (e.g., human health or ecological risk-based, background-based, or PQL-based standards), the site compliance data set may be evaluated by comparing the mean of the measured sediment concentrations to the cleanup standard. This approach reflects the fact that the route of exposure for bioaccumulative chemicals is largely through ingestion of fish and shellfish and that these receptors average their exposures over the entire area of concern (Section 13.6.1, SCUM II, March 2015). The surface-weighted average concentration (SWAC) area "… over which the data are averaged should be the same as the point of compliance for the cleanup standard, which may be established site-wide or for a specific SMA" (Section 13.6.1).

2.1.1 Comparison with benthic standards – Port Angeles Harbor

In Port Angeles, Option A (point-by-point comparison) will be used for compliance with benthic cleanup standards.

2.1.2 Comparison with human health-, background- or PQL-based standards – Port Angeles Harbor

A sufficient set of Port Angeles Harbor surface sediment data with detected values is available to calculate a reliable mean (Section 13.6.1, SCUM II, March 2015), so Option B will be used for compliance with human-health standards. SWACs will be compared with sediment cleanup levels established in accordance with WAC 173-204-560.

2.2 Site/SCU Boundaries and SMA Boundaries

Site boundaries in SMS are "…defined by the individual contaminants exceeding the proposed sediment cleanup standards as specified in WAC 173-204-560. Delineations shall be made at the point where the concentration of the contaminants would meet the criteria in (c) of this subsection" (WAC 173-204-550(6)(d)(ii). SCUM II states the "…boundaries of the site should include all areas that exceed the site-specific cleanup standards…" (Section 13.1, SCUM II, March 2015).

Sediment Cleanup Units (SCUs) are defined in SMS as a "discrete subdivision of a sediment site designated by the department for the purpose of expediting cleanups. A SCU may be established based on unique chemical concentrations or parameters, regional background, environmental, spatial, or contaminant source characteristics, or other method determined appropriate by the department, e.g., development-related cleanups, cleanup under piers, cleanup in eelgrass beds, and cleanup in

navigational lanes." (WAC 173-204-505(20)). In SCUM II, "A SCU is an area within a cleanup site that may be remediated separately from other areas of the site and/or may have different cleanup standards." "The decision to divide a site into SCUs can be based on physical, chemical, and biological factors that affect the practicality and implementability of the cleanup action alternatives, the cost of the cleanup action alternatives, the environmental benefits of restoration, the adverse environmental impacts of active cleanup, and the potential risks to human health and the environment" (Section 13.1, SCUM II, March 2015).

Sediment Management Areas (SMAs) are not mentioned in SMS, but are described in SCUM II as areas within a site or SCU in which different cleanup actions may be taken. "SMAs may differ by:

- The types of concentrations of chemicals.
- The depth of contamination.
- Habitats.
- Exposed receptors.
- Aquatic land uses (e.g., navigation lanes).
- Obstructions or structures (docks, pilings).
- Other reasons to be sampled or handled differently in the RI/FS" (Section 3.3.7, SCUM II, March 2015).

Additional information on establishing SCUs and SMAs is found in Section 12.3 of SCUM II.

2.2.1 SCU boundaries – Port Angeles Harbor

In Port Angeles Harbor, the SCU boundaries for Western Port Angeles Harbor and Rayonier Mill Sites will be the outer boundary of all chemical footprints exceeding the sediment cleanup standards. The administrative Study Area boundary, described in Agreed Order DE 6815 between Rayonier and Ecology will separate the two SCUs if needed. For both sites, SWACs of bioaccumulative indicator hazardous substances are to meet the sediment cleanup levels throughout the SCUs in a reasonable restoration timeframe.

2.2.2 SMA boundaries – Port Angeles Harbor

Ecology considered whether there are special exposure areas within Port Angeles Harbor where SMAs should be defined. Examples of special exposure areas include eelgrass beds, shellfish beds, and beaches where people have the potential to be exposed.

For human health, SMS requires consideration of an exposure scenario based on tribal fish and shellfish consumption. Historic, current, and potential future use of fish and shellfish from the general vicinity of the site must be considered (173-204-561(2)(b)).

The Washington State Department of Health (DOH) currently classifies shellfish areas within Port Angeles Harbor as prohibited due to pollution from the Wastewater Treatment Plant Outfall and combined sewer outfalls (CSOs). The City of Port Angeles is currently upgrading their system to decrease CSO discharges to not more than one discharge per year, per outfall, on average. In addition, the old Rayonier industrial outfall will be retrofitted and placed into service as the city's primary wastewater treatment plant outfall. This outfall is larger, longer, and deeper than the city's existing outfall, and will diffuse treated wastewater more effectively and in a location farther away from the harbor. These actions, along with the remedial actions to address chemical contamination under the

Model Toxics Control Act (MTCA), are anticipated to address the pollution concerns in the harbor potentially allowing subsistence, recreational and commercial shellfishing to be resumed.

Sessile shellfish, such as geoduck or clams, can be collected across large areas, but do not move significant distances and are exposed only to levels of contamination in their immediate area. To ensure remedial actions at Port Angeles Harbor cleanup sites adequately consider the protection of human health from ingestion of sessile shellfish, the SMA for sessile shellfish should include those areas where current, or potential future shellfish beds exist.

The Port Angeles Harbor Intertidal Clam and Biological Survey, (Bishop and Devitt, August 1970), determined "…that Port Angeles Harbor has all the requirements and no natural barriers for intertidal clam populations." Washington State Department of Fish and Wildlife (WDFW) defines potential commercial shellfish beds in Port Angeles Harbor as all areas shallower than -70 feet mean lower low water (MLLW). The Lower Elwha Tribe confirms many types of shellfish were historically found in Port Angeles Harbor and this is supported by the shell middens and multiple species of shell fragments found at the Tse-Whit-zen cultural site.

Evaluation of tissue concentrations in the draft Site-Specific Sediment Cleanup Levels, Remediation Levels, and Sediment Management Areas for Bioaccumulative Chemicals: Western Port Angeles Harbor (White Paper; Exponent, Anchor QEA, Integral, Floyd|Snider; May 30, 2014) show that 92% of dioxin/furan toxicity equivalence (TEQ) bioaccumulation exposures and 96% of total polychlorinated biphenyls (Total PCBs) bioaccumulation exposures are from ingestion of crab. Taking into account the percentage of the diet represented by each species and the average tissue concentrations, only a small percentage of the dioxin/furan TEQ and Total PCBs bioaccumulation exposures are a result of ingestion of representative sessile shellfish sampled, including geoduck and horse clam. The opposite is true for carcinogenic polycyclic aromatic hydrocarbons (cPAHs). The tissue concentrations show that 95% of cPAH TEQ bioaccumulation exposures and 29% of the mercury bioaccumulation exposures result from ingestion of sessile shellfish.

3.0 Conclusion

To ensure protection of human health from ingestion of fish and mobile shellfish, the SWACs of bioaccumulative chemicals must meet the sediment cleanup levels throughout the SCUs in a reasonable restoration timeframe.

Sessile shellfish beds in Port Angeles Harbor warrant SMA designation. Within the SCUs for the Western Port Angeles Harbor and Rayonier Mill Sites, the SMA for sessile shellfish should be defined by:

- All areas from mean higher high water (except in areas where intertidal elevations are covered by riprap or bulkheads. In this case, from the toe of the riprap slope or bulkhead) to an elevation of -70 feet MLLW.

Site-specific tissue data from Port Angeles Harbor shows only a small percentage of the bioaccumulation exposure from dioxins/furans and PCBs results from ingestion of sessile shellfish. To ensure protection of human health from ingestion of sessile shellfish, the SWACs of all other bioaccumulative chemicals must also meet the sediment cleanup levels throughout the sessile shellfish SMA in a reasonable restoration timeframe.

Technical Memorandum

To: Rebecca Lawson
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From: Dr. Jonathan Nuwer, NewFields
Leon Delwiche, NewFields
Tim Hammermeister, NewFields

Date: June 21, 2016

Subject: Port Angeles Harbor – Sediment Interpolation and Recovery Modeling

1.0 Introduction

The purpose of this memorandum is to document the methodology that NewFields has used to support the Department of Ecology (Ecology) for modeling surface sediment chemistry data in Port Angeles Harbor. Geographic information system (GIS) models have been applied to Port Angeles Harbor data for the purposes of:

- Interpolating surface sediment chemistry across the study area;
- Determining whether existing conditions are compliant with proposed sediment cleanup screening levels (CSL);
- Predicting surface sediment concentrations over a natural recovery timeframe; and
- Identifying the sediment remediation level (REL) needed to attain compliance with sediment CSL and sediment cleanup objectives (SCO).

Two basic types of GIS-based models have been developed for these purposes: data interpolation models and sediment recovery models. Each of these model types have been applied to sediment indicator hazardous substances (IHS) data to aid in Ecology's decision making through the ongoing Port Angeles Harbor remedial investigation.

This memo outlines the parameters and assumptions used when developing and implementing the data interpolation and sediment recovery models. This memo does not detail the methods of model implementation.

2.0 Data Interpolation Models

Table 1 includes modeling parameters and assumptions used in developing surface sediment interpolation models for IHS. Each parameter/assumption is described below.

Surface Sediment Samples Included:
The number of surface sediment samples for each IHS is identified, along with the Environmental Information Management (EIM) study name with which the samples are associated.

Treatment of Non-detects:
Analytical results identified by the laboratory as not detected were replaced with one-half the reported method detection limit (MDL). An exception was made for polychlorinated biphenyl (PCB) toxicity equivalence (TEQ), when a value of zero was substituted for non-detected PCB congener results. This was done because of the dramatically higher (200x) PCB TEQ values which resulted from the PORT ANGELES DNR08 data set when one-half MDL substitution was used.

Treatment of Older Data:
The Western Port Angeles Harbor Group (WPAHG) collected and analyzed surface sediment samples in 2013 from a number of locations previously sampled for other studies. The WPAHG data was used to replace the older data at these reoccupied locations.

Substitution:
Surface sediment PCB congener data is limited to discrete nearshore areas. For interpolation purposes, the regional background value for PCB TEQ was assumed in areas of the harbor with no PCB congener data.

Interpolation Method:
IHS data interpolations were created using ESRI's ArcGIS version 10.3 software. All data interpolations were performed using the ArcGIS Inverse Distance Weighted (IDW) model.

Power:
An underlying assumption of the IDW model type is that nearby locations are more alike than those farther apart. Given this assumption, a power of 2 (squared) was used to give more weight of prediction to the closest location. Because IDW is an exact interpolator, this allowed for the minimum and maximum data values to be retained and the actual measured concentration at sampled locations to remain.

Single Sector Search Radius:
A search radius of 1000 feet was used to limit the number of measured values used in the prediction.

Minimum and Maximum Neighbors:
The search radius was allowed to drift slightly because of the uneven spatial distribution of sample locations. This was accomplished by setting the minimum and maximum number of neighbors to include. The minimum and maximum neighbors used were determined based on the spatial distribution of those samples within the area. For this reason, PCB TEQ used few neighbors than IHS with more available data.

Cell Size:
Interpolated surfaces consist of 30 foot by 30 foot grid cells.

Spatial Extent:
Surfaces were interpolated to the shoreline boundary within the Harbor and to the data extent for locations East of Ediz Hook. An exception was made for the Western Harbor lagoon due to few sample points within the area. For simplicity, the model was allowed to interpolate over the section of land between the lagoon and the Western Harbor and then clipped to the lagoon shoreline.

3.0 Recovery Models

Sediment recovery modeling can be used to predict the change over time of sediment chemical concentrations in the dynamic surface sediment mixed layer. The SEDCAM sediment attenuation model was developed for the Commencement Bay Nearshore/Tideflats Feasibility Study (Tetra Tech 1988), and is listed as an approved method to estimate sediment recovery under the SMS program. The SEDCAM model is as follows:

$$C_t = \frac{M}{(M + kS)} \cdot C_d \cdot \left[1 - e^{\frac{-(kS+M)t}{S}}\right] + C_0 \cdot e^{\frac{-(kS+M)t}{S}}$$

Where:

C_t = surface sediment chemical concentration at time t (µg/kg)
C_d = chemical concentration of newly deposited sediment (µg/kg)
C_0 = chemical concentration in mixed layer at t = 0 (µg/kg)
M = rate of mass accumulation of solid material in sediments (g/cm^2-yr)
S = total accumulation of sediments in surface mixed layer (g/cm^2)
k = combined first order rate constant for loss by diffusion and degradation (yr^{-1})
t = time (yr)

By conservatively assuming that 1) depositing solids and solids in the mixed layer have the same density, and 2) chemicals of concern experience no diffusion/degradation, the above equation can be simplified to:

$$C_t = C_d \cdot \left[1 - e^{\frac{-Rt}{B}}\right] + C_i \cdot e^{\frac{-Rt}{B}}$$

Where:

R = sedimentation rate (cm/yr)
B = depth of biologically active zone (cm)

This equation was used to model sediment recovery in Port Angeles Harbor surface sediments. **Table 2** includes the model parameters and assumptions for the IHS. Each of the parameters/assumptions are described below.

Watershed Loading Concentrations (C_d):
Watershed loading concentrations reflect estimated contaminant concentrations of ongoing depositional sediment. The dioxin/furan TEQ loading concentration is the average of Port Angeles upland surface soil samples (E&E and Glass 2011). The PCB TEQ loading concentration is the natural background concentration. The total TEQ loading concentration is the sum of dioxin/furan TEQ and PCB TEQ watershed loading concentrations. Both cPAH TEQ and mercury loading concentrations are median stormwater runoff concentrations (Herrera 2011), adjusted for relative land cover classifications.

Sedimentation Rate (R):
The sedimentation rate is based on the observed net sedimentation rate observed by sediment profile imaging (SPI) during the WPAHG's 2013 sediment survey.

Biologically Active Zone (B):
The depth of bioturbation is an assumed depth of 10 cm.

Recovery Timeframe (t):
For modeling purposes, different recovery timeframes have been applied to Western Port Angele Harbor (30 years) and the Rayonier marine area (0 years) based on the tentative cleanup strategies proposed by the responsible parties.

Remediation Replacement Concentration:
When evaluating remediation scenarios, this sediment IHS concentration is used as the assumed surface sediment concentration in regions that have undergone active remediation. Replacement concentrations for all IHS are their natural background concentrations.

4.0 References

E & E and Glass G.L. 2011. Rayonier Mill Off-Property Soil Dioxin Study, Port Angeles, WA: Public Review Draft. Prepared for the Washington State Department of Ecology Toxics Cleanup Program, Lacey WA by Ecology and Environment, Inc. and G.L. Glass. June 2011.

Herrera (Herrera Environmental Consultants, Inc.) 2011. Control of Toxic Chemicals in Puget Sound: Phase 3 Data Loads and Estimates. Washington State Department of Ecology Publication No. 11-03-010.

Tetra Tech. 1988. Commencement Bay Nearshore/Tideflats Feasibility Study. Report prepared for Washington State Department of Ecology by Tetra Tech, Inc., Bellevue, WA.

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Table 1. Data Interpolation Model Input

Model Input		Dioxin/Furan TEQ	PCB TEQ	Total TEQ	cPAH TEQ	Mercury
Surface Sediment Samples Included	PAMILLRI	48	48	NA*	--	--
	PASED08	75	--		86	108
	PORT ANGELES DNR08	8	5		12	15
	RAYONR05	41	--		56	54
	WPAH13	15	17		6	6
	NIPPON PAPER MILL05	--	--		--	4
Treatment of Non-detects		ND = 1/2 MDL	ND = 0	NA*	ND = 1/2 MDL	ND = 1/2 MDL
Treatment of Older data		Replace data at reoccupied locations				
Substitution		--	Regional Background	--	--	--
Interpolation Method		Inverse Distance Weighted using ESRI ArcGIS version 10.3				
Power		2				
Single Sector Search Radius		1000 ft				
Maximum Neighbors		8	5	8	8	8
Minimum Neighbors		4	3	4	4	4
Cell size		30 ft x 30 ft				
Spatial Extent		Interpolated to shoreline boundary within Harbor and to data extent for location east of Ediz Hook. Interpolation includes Western Harbor lagoon, which was then clipped to the lagoon shoreline.				

* Total TEQ surface model derived from summation of dioxin/furan TEQ and PCB TEQ interpolations

Table 2. Recovery Model Input

Model Input	Dioxin/Furan TEQ	PCB TEQ	Total TEQ	cPAH TEQ	Mercury
Watershed Loading Concentration (C_d)	0.2 ng/kg	0.1 ng/kg	0.3 ng/kg	24 µg/kg	0.02 mg/kg
Sedimentation Rate (R)	0.17 cm/yr				
Biologically Active Zone (B)	10 cm				
Recovery Timeframe (t)	30 yr (WPAH); 0 yr (Rayonier Area)				
Remediation Replacement Concentration	1.2 ng/kg	0.1 ng/kg	1.3 ng/kg	16 µg/kg	0.11 mg/kg

Appendix B
Estimated Net Sedimentation Rates and Watershed Loading Evaluation

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

Table B.1
Western Port Angeles Harbor Net Sedimentation Rates

Source	Station	Measured Net Sedimentation Rate (cm/yr)	Method
Washington State Department of Ecology[1]	MA06	0.18	Pb-210 analysis
	RL03	0.18	Pb-210 analysis
Western Port Angeles Harbor Remedial Investigation/ Feasibility Study	WPAH009	0.12	Buried pulp depth - station average
	WPAH010	0.14	Buried pulp depth - station average
	WPAH011	0.17	Buried pulp depth - station average
	WPAH013	0.15	Buried pulp depth - station average
	WPAH014	0.18	Buried pulp depth - station average
	WPAH026	0.21	Buried pulp depth - station average
	WPAH054	0.21	Buried pulp depth - station average
	WPAH058	0.23	Buried pulp depth - station average
	WPAH062	0.15	Buried pulp depth - station average
	WPAH064	0.15	Buried pulp depth - station average
	WPAH065	0.18	Buried pulp depth - station average
	WPAH075	0.18	Buried pulp depth - station average
	WPAH076	0.22	Buried pulp depth - station average
	WPAH081	0.15	Buried pulp depth - station average

Note:
1 Source: Ecology 2012.

Abbreviations:
cm Centimeter
yr Year

Table B.2
Western Port Angeles Harbor Watershed Loading Evaluation

B.2.A Western Port Angeles Harbor Watershed Loading

Parameter	Unit Loading (gm/km^2-yr)	Total Harbor Watershed Loading[1] (gm/yr)	Total Harbor Input Concentration[2]
Total TEQ[3]			(ng/kg dw)
Commercial/Industrial	9.9E-05	2.4E-04	
Residential	1.0E-04	5.7E-04	
Agricultural	7.1E-05	1.4E-04	
Forest/Field/Other	3.1E-05	9.4E-04	
Total		**1.9E-03**	**0.37**
cPAH TEQ[4]			(µg/kg dw)
Commercial/Industrial	9.2	22	
Residential	0.7	4	
Agricultural	0.7	1	
Forest/Field/Other	1.9	56	
Total		**84**	**16**
Mercury[5]			(mg/kg dw)
Commercial/Industrial	4.4	10	
Residential	3.1	17	
Agricultural	5.2	10	
Forest/Field/Other	4.8	145	
Total		**183**	**0.035**

B.2.B. Port Angeles Harbor Watershed Land Use Areas

Parameter[3]	Area (km^2)	Percentage[6]
Commercial/Industrial	2.4	6%
Residential	5.6	14%
Agricultural	2.0	5%
Forest/Field/Other	30	75%
Total	40	100%

B.2.C. Port Angeles Harbor Total Sediment Loading Calculation

Parameter	Value	Units	Comments
Average Net Sedimentation Rate	0.17	cm/yr	Arithmetic average of sedimentation rate measurements (refer to Table B.1 for the basis of the sedimentation rates).
Average Total Solids	46	% wet weight	Arithmetic average of surface sediment samples located within the Western Port Angeles Harbor Study Area reported in Ecology (2012).
Average Dry Density	0.64	gm/cm^3	Lefkovitz et al. (1997) regression: Wet density = 0.1737 * (5.0245 + e(0.0238*TS))
Net Sediment Accumulation Rate	0.11	gm/cm^2-yr	Calculated (Net Sedimentation Rate * Dry Density)
Sediment Cleanup Unit area	4.7	km^2	Sediment Cleanup Unit SWAC area (1,170 acres for Total TEQ)
Total Sediment Loading	5,153,591	kg/yr	Calculated (Net Sediment Accumulation Rate * Sediment Cleanup Unit area)

Notes:

1 The total Port Angeles Harbor loading was calculated by multiplying the unit loading for each land type by the total area of each land type in the Port Angeles Harbor Watershed (Table B.2.B).

2 The total Port Angeles Harbor loading concentrations were calculated by dividing the total loading for chemical divided by the total solids load to Port Angeles Harbor Watershed (Table B.2.C).

3 Chemical data for Total TEQ were not presented in Herrera 2011, so the net loading was estimated using the net total suspended solids loading from Herrera 2011, multiplied by the concentrations of total dioxins/furans TEQ in soil in the Port Angeles Harbor area presented in Herrera 2011. The 25th and 75th percentile concentrations were estimated to be 10 ng/kg and 20 ng/kg for the three non-forest/field/other land types. The 25th and 75th percentile concentrations were estimated to be 1.5 ng/kg and 5.6 ng/kg for the forest/field/other land types. Like the other analytes, the net loading for each land type was divided by the area of each land type to calculate the loading rate per km^2-year for each land type.

4 The cPAH TEQ unit loading rate was calculated based on the net chemical loading rate to Puget Sound from each land type in Herrera 2011, Table 15. The average unit loading rate was calculated for the average of the 25th and 75th percentile values presented in Herrera 2011. Non-detects were assumed to equal 1/2 of the reporting limit (representing the average of the two values shown in Herrera 2011, Table 15). Total cPAH values in Herrera 2011 were not normalized to benzo(a)pyrene TEQ; therefore, total cPAH loadings were multiplied by 0.195 based on the regression relationship between Total cPAH and cPAH TEQ in the commercial/industrial basins (linear regression curve fit with R^2= 0.81). Next, the net chemical loading rate for each land type was divided by the watershed areas for each land type (Herrera 2011, Table 8) to calculate the loading rate per km^2-year for each land type.

5 The unit loading for mercury was calculated that same way as for total cPAH TEQ, however, there were no non-detects and the total TEQ conversion was not necessary. The net loading for each land type was simply divided by the area of each land type to calculate the loading rate per km^2-year for each land type.

6 Land use area percentages were determined based on digitizing the parcel maps from the Clallam County Assessor.

Abbreviations:

cm/yr	Centimeters per year	kg/yr	Kilograms per year
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	km^2	Square kilometers
dw	Dry weight	µg/kg dw	Micrograms per kilogram dry weight
gm/cm^2-yr	Gigameters per square centimeters per year	mg/kg dw	Milligrams per kilogram dry weight
gm/cm^3	Gigameters per cubic centimeter	ng/kg dw	Nanograms per kilogram dry weight
gm/km^2-yr	Gigameters per square kilometer per year	SWAC	Surface-weighted average concentration
gm/yr	Gigameters per year	TEQ	Toxic equivalent

References:

Herrera Environmental Consultants (Herrera). 2011. *Control of Toxic Chemicals in Puget Sound: Phase 3 Data and Load Estimates.* Prepared for the Washington State Department of Ecology Environmental Assessment Program. Publication No. 11-03-010. April.

Lefkovitz, L.F., V.I. Cullinan, and E.A. Crecelius. 1997. *Historical Trends in the Accumulation of Chemicals in Puget Sound.* NOAA Technical Memorandum NOS ORCA 111. National Oceanic and Atmospheric Administration, Silver Spring, MD. December.

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Appendix C
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Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05HS-01	RAYONR05HS-02	RAYONR05HS-06	RAYONR05HS-07	RAYONR05HS-08	RAYONR05IT-01	RAYONR05IT-02	RAYONR05IT-03	RAYONR05IT-04	RAYONR05IT-05	RAYONR05IT-06	RAYONR05IT-07	RAYONR05IT-08	RAYONR05LP-01	RAYONR05LP-02	RAYONR05LP-03
Sample ID		HS-01-SS	HS-02-SS	HS-06-SS	HS-07-SS	HS-08-SS	IT-01-SS	IT-02-SS	IT-03-SS	IT-04-SS	IT-05-SS	IT-06-SS	IT-07-SS	IT-08-SS	LP-01-SS	LP-02-SS	LP-03-SS
Sample Date		8/21/2002	8/21/2002	8/19/2002	8/19/2002	8/21/2002	8/6/2002	8/6/2002	8/6/2002	8/7/2002	8/7/2002	8/7/2002	8/8/2002	8/8/2002	8/13/2002	8/13/2002	8/16/2002
Depth Range (cm)		0–10	0–10	0–0	0–0	0–0	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Conventionals																	
Acid-Volatile Sulfide	mg/kg dw	190	55	12	19 J	79				510 J	0.4 U	180 J	190	280	25 J	43 J	45
Sulfides	mg/kg dw	38 J	240 J	6 J	35 J	9 J				67	120	180	150	810	2.1	53	11
Total Organic Carbon	%	0.96	2.8	1.2	1.5	1.8				0.24	0.46	13.7	24.6	19.5	0.58	6.8	4.02
Total Solids	%	68	61.7	76.9	73.9	63.8	79.3	71.8	82.1	91.1	94.2	80.6	51.8	56.6	78.5	67.1	63.5
Total Volatile Solids	%	4.1	6.7	3.4	3.6	4				2.1	1.3	25.5			2.6	17	7.3
Nutrients																	
Ammonia	mg/kg dw	7.2	12	17	4.5	11				4.1	11	14	17	21	12 J	11 J	15
Particle/Grain Size																	
Percent Gravel	%	0.42	0.5	4.2	1.5	0.23	48	28	94	49	44	15	10	26	39	4.4	17
Percent Sand	%	61	52	63	63	57	48	63	3.3	49	51	71	79	60	63	79	75
Percent Silt	%	30	41	28	32	38	1.4	4.9	0.2	1.5	2.6	14	13	5.4	3.2	13	6.8
Percent Clay	%	6.8	4.7	2.9	6.2	5.2	0.67	1	0.34	0.56	0.38	3.8	4.1	2.1	1.4	2.6	2.8
Percent Fines (clay & silt)	%	36	45	31	38	43	2.1	5.9	0.54	2	3	18	17	7.5	4.5	16	9.6
Biochemical Measures																	
12-Chlorodehydroabietic Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
14-Chlorodehydroabietic Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
3,4,5-Trichloroguaiacol	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Dehydroabietic Acid	mg/kg dw	0.48 U	1.4	0.47	0.45 U	0.52 U				0.5	0.35 U	3.2	3.1	2.4	0.42 U	2	1.3
Abietic Acid	mg/kg dw	0.48 U	0.6	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	2	2.7 J	1.4 J	0.42 U	1.2 J	0.74
Dichlorodehydroabietic Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Dichlorostearic Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Isopimaric Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Linoleic Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.79	0.42 U	0.49 U	1.2
Oleic Acid	mg/kg dw																
Oleic-Linolenic Acid Mixture	mg/kg dw	0.48 U	4	1.6	0.58	1.3				0.37 U	0.35 U	0.41 U	0.86	0.97	0.49	1	3.3
Pimaric Acid	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Tetrachloroguaiacol	mg/kg dw	0.48 U	0.53 U	0.43 U	0.45 U	0.52 U				0.37 U	0.35 U	0.41 U	0.64 U	0.58 U	0.42 U	0.49 U	0.53 U
Metals																	
Arsenic	mg/kg dw	4.7	6.3	5.5	4.3	3.8				2.4	1.8	3.1	5	3	2.7	4	3.7
Cadmium	mg/kg dw	0.1	0.61	0.53	0.47	0.24				0.089	0.054	0.47	0.59	0.43	0.11	0.5	0.39
Chromium	mg/kg dw	26 J	18 J	14	17	19 J									9.9	12	17
Copper	mg/kg dw	18	17	9.4	12	14				27	14	26	27	21	6.5	14	28 J
Lead	mg/kg dw	6.3	10	5.6	10	8.4				8.1 J	2.7 J	60 J	85	70	3.1	22	61 J
Mercury	mg/kg dw	0.07	0.28	0.05	0.13	0.1				0.01 J	0.01 J	0.14	0.19	0.11	0.024	0.067	0.087 J
Selenium	mg/kg dw	0.6 J	0.9 J	0.5 J	0.6 J	0.7 J				0.2 U	0.2 U	0.5 J	0.6 J	0.4 J	0.2 J	0.5 J	0.5 J
Silver	mg/kg dw	0.23 J	0.22 J	0.15 J	0.16 J	0.19 J									0.047	0.1	0.13
Zinc	mg/kg dw	47	50	35	37	39				36	28	36	43	36	18	29	40
Pesticides																	
4,4'-DDD	µg/kg dw	0.24 J	6.6	0.2 U	5.6	2.2				0.17 U	0.17 U	14	27	9	0.2 U	2.4	14
4,4'-DDE	µg/kg dw	0.52 J	2.7 J	1.3 U	1.5 J	1.2 J				0.27 U	0.27 U	3.7 J	5.8 J	1.8 U	0.32 U	1.5 J	2.2 J
4,4'-DDT	µg/kg dw	0.77 J	1.1 J	0.22 U	1.6	0.7 J				0.5 J	0.31 J	9.9	17	9.7	0.22 U	4.5	70
alpha-Hexachlorocyclohexane	µg/kg dw	0.15 U	0.17 U	0.14 U	0.15 U	0.16 U				0.12 U	0.11 U	0.13 U	0.2 U	0.19 U	0.13 U	0.33 U	0.17 U
beta-Hexachlorocyclohexane	µg/kg dw	0.22 U	1.7 U	1.3 U	1.4 U	1.6 U				0.17 U	0.16 U	0.19 U	2 U	0.26 U	1.3 U	0.22 U	1.6 U

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05HS-01	RAYONR05HS-02	RAYONR05HS-06	RAYONR05HS-07	RAYONR05HS-08	RAYONR05IT-01	RAYONR05IT-02	RAYONR05IT-03	RAYONR05IT-04	RAYONR05IT-05	RAYONR05IT-06	RAYONR05IT-07	RAYONR05IT-08	RAYONR05LP-01	RAYONR05LP-02	RAYONR05LP-03
Sample ID		HS-01-SS	HS-02-SS	HS-06-SS	HS-07-SS	HS-08-SS	IT-01-SS	IT-02-SS	IT-03-SS	IT-04-SS	IT-05-SS	IT-06-SS	IT-07-SS	IT-08-SS	LP-01-SS	LP-02-SS	LP-03-SS
Sample Date		8/21/2002	8/21/2002	8/19/2002	8/19/2002	8/21/2002	8/6/2002	8/6/2002	8/6/2002	8/7/2002	8/7/2002	8/7/2002	8/8/2002	8/8/2002	8/13/2002	8/13/2002	8/16/2002
Depth Range (cm)		0–10	0–10	0–0	0–0	0–0	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Pesticides (cont.)																	
delta-Hexachlorocyclohexane	µg/kg dw	0.55 U	0.68 U	0.48 U	0.5 U	0.58 U				0.41 U	0.4 U	0.46 U	1.3 U	1.3 U	0.48 U	0.55 U	0.59 U
gamma-Hexachlorocyclohexane	µg/kg dw	0.36 U	1.7 U	1.3 U	1.7 U	0.39 U				0.27 U	0.26 U	0.31 U	3.1 U	1.8 U	0.31 U	2.1 U	1.6 U
Dioxins/Furans																	
2,3,7,8-TCDD	ng/kg dw	0.057 U	0.364 J	0.092 U	0.097	0.293 J				0.089 U	0.091 U	0.52 J	0.521 J	0.855 J	0.084 U	0.391 J	0.601 J
1,2,3,7,8-PeCDD	ng/kg dw	0.207 J	0.74 J	0.454 J	0.191	1 J				0.151 U	0.189 U	4.24 J	1.7 J	2.71 J	0.08 U	0.752 J	2.3 J
1,2,3,4,7,8-HxCDD	ng/kg dw	0.108 U	0.755 J	0.516 J	0.223	0.775 J				0.4 U	0.316 U	6.78	1.58 J	2.77 J	0.1 U	0.821 J	1.8 J
1,2,3,6,7,8-HxCDD	ng/kg dw	0.564 J	2.97 J	1.85 J	1	3.58 J				0.431 U	0.331 U	14.8	6.63	8.58	0.688 J	2.49 J	5.29
1,2,3,7,8,9-HxCDD	ng/kg dw	0.515 J	2.1 J	1 J	0.488	2.26 J				0.393 U	0.306 U	14.4	4.17	6.51	0.102 U	1.67 J	3.9 J
1,2,3,4,6,7,8-HpCDD	ng/kg dw	8.94	61.3	32.2	12.8	49				1.71 J	1.24 U	203	256	123	16 JB	24 JB	65.5
Total OCDD	ng/kg dw	76 JB	604 JB	420 JB	100	540 JB				23.7	13 J	2,640 J	4,990 JB	1,760 JB	160 JB	186 JB	720 JB
2,3,7,8-TCDF	ng/kg dw	0.367 U	1.33 J	1.1 J	0.416	1.95 J				0.076 U	0.114 U	8.64 J	10.8 J	7.2 J	0.433 U	2.1 J	3.54 J
1,2,3,7,8-PeCDF	ng/kg dw	0.045 U	0.531 J	0.456 J	0.131	0.805 J				0.129 U	0.111 U	8.5	5.48 J	3.4 J	0.078 U	0.969 J	2.45 J
2,3,4,7,8-PeCDF	ng/kg dw	0.046 U	0.92 J	0.733 J	0.118	1.42 J				0.129 U	0.114 U	14.3	11	5.63	0.079 U	1.44 J	3.8 J
1,2,3,4,7,8-HxCDF	ng/kg dw	0.159 J	0.893 J	1.06 J	0.393	1.19 J				0.345 U	0.298 U	21.7	9.3	4.78 J	0.228 J	1.69 J	4.21 J
1,2,3,6,7,8-HxCDF	ng/kg dw	0.076 U	0.872 J	0.535 J	0.226	0.618 J				0.338 U	0.291 U	5.95	2.1 J	1.45 J	0.089 U	0.576 J	1.37 J
1,2,3,7,8,9-HxCDF	ng/kg dw	0.112 U	0.163 U	0.15 U	0.171	0.28 U				0.655 U	0.643 U	1.3 U	0.381 U	0.222 U	0.119 U	0.341 U	0.222 U
2,3,4,6,7,8-HxCDF	ng/kg dw	0.087 U	0.841 J	0.59 J	0.256	1.1 J				0.422 U	0.36 U	5.79	3.28	2.03 J	0.094 U	0.76 J	1.68 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw	1.59 J	7.57	7.77	4.58	16.2				0.461 U	0.729 U	38	52.1	21.4	2.1 J	7.41	14
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.244 U	0.539 J	0.547 J	0.277	0.856 J				0.95 U	1.64 U	5.33 U	1.34 J	1.34 J	0.508 U	0.955 J	0.7 J
Total OCDF	ng/kg dw	3.1 J	20.3	58.4	13.1	74.4				3 U	3.63 U	440 J	941	203	15	23.8	82.8
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	0.46	3.25	1.9	0.855	3.74				0.0242	0.0039	20.4	14.3 J	10.7	0.325	3	7.34 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	0.535	3.26	1.95	0.855	3.75				0.326	0.314	20.5	14.4 J	10.7	0.47	3.02	7.35 J
Polychlorinated Biphenyls (PCBs)																	
Aroclor 1242	µg/kg dw	1.3 U	1.4 U	1.1 U	1.2 U	1.3 U				0.91 U	0.88 U	1.1 U	1.6 U	1.5 U	1.1 U	1.3 U	1.3 U
Aroclor 1254	µg/kg dw	7.9 J	1.4 U	1.1 U	1.2 U	1.3 U				0.91 U	0.88 U	1.1 U	1.6 U	1.5 U	1.1 U	1.3 U	1.3 U
Aroclor 1260	µg/kg dw	1.3 U	13 J	6.3 J	22	13 J				6.7 J	2.7 J	130	230	110	2.2 J	34	58
Total PCBs, Aroclors	µg/kg dw	7.9	13	6.3	22	13				6.7	2.7	130	230	110	2.2	34	58
Aroclor 1242	mg/kg OC	0.14 U	0.05 U	0.092 U	0.08 U	0.072 U				0.38 U	0.19 U				0.19 U		
Aroclor 1254	mg/kg OC	0.82 J	0.05 U	0.092 U	0.08 U	0.072 U				0.38 U	0.19 U				0.19 U		
Aroclor 1260	mg/kg OC	0.14 U	0.46 J	0.53 J	1.5	0.72 J				2.8 J	0.59 J				0.38 J		
Total PCBs, Aroclors	mg/kg OC	0.82	0.46	0.53	1.5	0.72				2.8	0.59				0.38		
Other																	
Total TEQ	ng/kg dw	0.745	3.47	2.16	1.07	3.96				0.536	0.524	20.7	14.6	11	0.68	3.23	7.56
Aromatic Hydrocarbons																	
Total LPAH	µg/kg dw	370	570	210	400	380				40	12	400	1,000	790	28	570	290
Naphthalene	µg/kg dw	8.4 J	100	52	150 J	110				3.2 J	2.2 J	95	300	170 J	5.5 J	160	87
Acenaphthylene	µg/kg dw	4.5 J	27	10 J	35 J	32				0.65 J	0.72 J	6.3 J	42 J	26 J	1.8 U	23	10 J
Acenaphthene	µg/kg dw	22	34	14	16 J	17				3.9 J	0.53 J	34	100 J	75 J	1.8 J	53	24
Fluorene	µg/kg dw	32	51	18	21 J	25				3 J	1.1 J	39	120 J	83 J	2.7 J	60	34
Phenanthrene	µg/kg dw	250	250	83	140 J	150				26	5.8	180	300	320	13 J	200	94
Anthracene	µg/kg dw	49	110	33	41 J	44				3.5 J	1.7 J	43	140 J	120 J	5.2 J	75	42
2-Methylnaphthalene	µg/kg dw	4.9 J	25	11 J	17 J	20				3.5 J	0.75 J	24	65 J	45 J	1.9 J	39	27
Total HPAH	µg/kg dw	1,800	2,200	610	670	770				110	40	1,100	3,200	1,900	110	1,300	740

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05HS-01	RAYONR05HS-02	RAYONR05HS-06	RAYONR05HS-07	RAYONR05HS-08	RAYONR05IT-01	RAYONR05IT-02	RAYONR05IT-03	RAYONR05IT-04	RAYONR05IT-05	RAYONR05IT-06	RAYONR05IT-07	RAYONR05IT-08	RAYONR05LP-01	RAYONR05LP-02	RAYONR05LP-03
Sample ID		HS-01-SS	HS-02-SS	HS-06-SS	HS-07-SS	HS-08-SS	IT-01-SS	IT-02-SS	IT-03-SS	IT-04-SS	IT-05-SS	IT-06-SS	IT-07-SS	IT-08-SS	LP-01-SS	LP-02-SS	LP-03-SS
Sample Date		8/21/2002	8/21/2002	8/19/2002	8/19/2002	8/21/2002	8/6/2002	8/6/2002	8/6/2002	8/7/2002	8/7/2002	8/7/2002	8/8/2002	8/8/2002	8/13/2002	8/13/2002	8/16/2002
Depth Range (cm)		0–10	0–10	0–0	0–0	0–0	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Aromatic Hydrocarbons (cont.)																	
Fluoranthene	µg/kg dw	370	430	160	190 J	180				40	10	410	1,000	640	25	310	170
Pyrene	µg/kg dw	380	530	160	200 J	220				33	9.8	290	840	530	23	310	140
Benzo(a)anthracene	µg/kg dw	150	190	47	44 J	56				4.8 J	2.8 J	59	260	120 J	8.1 J	110	59
Chrysene	µg/kg dw	190	250	60	53 J	75				10	3.7 J	97	380	230	12 J	200	170
Total Benzofluoranthenes	µg/kg dw	280	350	79	76	99				11	5.6	110	430	210	16	200	100
Benzo(b)fluoranthene	µg/kg dw	210	260	60	57 J	74				7.1	3.7 J	61	260	110 J	8.2 J	120	74
Benzo(k)fluoranthene	µg/kg dw	72	90	19	19 J	25				4 J	1.9 J	52	170 J	100 J	8 J	75	26
Benzo(a)pyrene	µg/kg dw	150	160	37	39 J	52				3.3 J	2.4 J	42	140 J	86 J	8.5 J	97	40
Benzo(g,h,i)perylene	µg/kg dw	120	120	28	37 J	44				3.5 J	2.5 J	26	78 J	41 U	9.3 J	58	27
Indeno(1,2,3-cd)pyrene	µg/kg dw	130	120	28	29 J	37				2.4 J	2.2 J	26	80 J	36 J	5.6 J	59	26
Dibenzo(a,h)anthracene	µg/kg dw	29	31	6.1 J	5.2 J	7.5 J				0.68 JB	0.62 JB	5.1 J	43 U	39 U	2.9 U	3.3 U	7.4 J
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	210	230	54	55	73				5.3	3.6	63	220	120	12	140	61
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	210	230	54	55	73				5.3	3.6	63	220	130	12	140	61
Total LPAH	mg/kg OC	38	20	18	27	21				17	2.6				4.9		
Naphthalene	mg/kg OC	0.88 J	3.6	4.3	10 J	6.1				1.3 J	0.48 J				0.95 J		
Acenaphthylene	mg/kg OC	0.47 J	0.96	0.83 J	2.3 J	1.8				0.27 J	0.16 J				0.31 U		
Acenaphthene	mg/kg OC	2.3	1.2	1.2	1.1 J	0.94				1.6 J	0.12 J				0.31 J		
Fluorene	mg/kg OC	3.3	1.8	1.5	1.4 J	1.4				1.3 J	0.24 J				0.47 J		
Phenanthrene	mg/kg OC	26	8.9	6.9	9.3 J	8.3				11	1.3				2.2 J		
Anthracene	mg/kg OC	5.1	3.9	2.8	2.7 J	2.4				1.5 J	0.37 J				0.9 J		
2-Methylnaphthalene	mg/kg OC	0.51 J	0.89	0.92 J	1.1 J	1.1				1.5 J	0.16 J				0.33 J		
Total HPAH	mg/kg OC	190	78	50	45	43				45	8.6				19		
Fluoranthene	mg/kg OC	39	15	13	13 J	10				17	2.2				4.3		
Pyrene	mg/kg OC	40	19	13	13 J	12				14	2.1				4		
Benzo(a)anthracene	mg/kg OC	16	6.8	3.9	2.9 J	3.1				2 J	0.61 J				1.4 J		
Chrysene	mg/kg OC	20	8.9	5	3.5 J	4.2				4.2	0.8 J				2.1 J		
Total Benzofluoranthenes	mg/kg OC	29	13	6.6	5.1	5.5				4.6	1.2				2.8		
Benzo(b)fluoranthene	mg/kg OC	22	9.3	5	3.8 J	4.1				3	0.8 J				1.4 J		
Benzo(k)fluoranthene	mg/kg OC	7.5	3.2	1.6	1.3 J	1.4				1.7 J	0.41 J				1.4 J		
Benzo(a)pyrene	mg/kg OC	16	5.7	3.1	2.6 J	2.9				1.4 J	0.52 J				1.5 J		
Benzo(g,h,i)perylene	mg/kg OC	13	4.3	2.3	2.5 J	2.4				1.5 J	0.54 J				1.6 J		
Indeno(1,2,3-cd)pyrene	mg/kg OC	14	4.3	2.3	1.9 J	2.1				1 J	0.48 J				0.97 J		
Dibenzo(a,h)anthracene	mg/kg OC	3	1.1	0.51 J	0.35 J	0.42 J				0.28 JB	0.13 JB				0.5 U		
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC	22	8.3	4.5	3.7	4				2.2	0.77				2		
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC	22	8.3	4.5	3.7	4				2.2	0.77				2		
1,2-Dichlorobenzene	µg/kg dw	2 U	2.2 U	1.7 U	1.8 U	2.1 U				1.5 U	1.4 U	1.7 U	26 U	23 U	1.7 U	2 U	2.1 U
1,4-Dichlorobenzene	µg/kg dw	2.8 U	30	2.5 U	2.8 J	3 U				2.1 U	2.1 U	2.5 U	37 U	34 U	2.5 U	3.4 J	3 U
1,2,4-Trichlorobenzene	µg/kg dw	2.3 U	2.5 U	2 U	2.1 U	2.4 U				1.7 U	1.6 U	2 U	29 U	27 U	2 U	2.3 U	2.4 U
Hexachlorobenzene	µg/kg dw	3.1 U	3.5 U	2.8 U	2.9 U	3.3 U				2.4 U	2.3 U	2.8 U	41 U	38 U	2.7 U	3.2 U	3.4 U
1,2-Dichlorobenzene	mg/kg OC	0.21 U	0.079 U	0.14 U	0.12 U	0.12 U				0.63 U	0.3 U				0.29 U		
1,4-Dichlorobenzene	mg/kg OC	0.29 U	1.1	0.21 U	0.19 J	0.17 U				0.88 U	0.46 U				0.43 U		
1,2,4-Trichlorobenzene	mg/kg OC	0.24 U	0.089 U	0.17 U	0.14 U	0.13 U				0.71 U	0.35 U				0.34 U		
Hexachlorobenzene	mg/kg OC	0.32 U	0.13 U	0.23 U	0.19 U	0.18 U				1 U	0.5 U				0.47 U		

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05HS-01	RAYONR05HS-02	RAYONR05HS-06	RAYONR05HS-07	RAYONR05HS-08	RAYONR05IT-01	RAYONR05IT-02	RAYONR05IT-03	RAYONR05IT-04	RAYONR05IT-05	RAYONR05IT-06	RAYONR05IT-07	RAYONR05IT-08	RAYONR05LP-01	RAYONR05LP-02	RAYONR05LP-03
Sample ID		HS-01-SS	HS-02-SS	HS-06-SS	HS-07-SS	HS-08-SS	IT-01-SS	IT-02-SS	IT-03-SS	IT-04-SS	IT-05-SS	IT-06-SS	IT-07-SS	IT-08-SS	LP-01-SS	LP-02-SS	LP-03-SS
Sample Date		8/21/2002	8/21/2002	8/19/2002	8/19/2002	8/21/2002	8/6/2002	8/6/2002	8/6/2002	8/7/2002	8/7/2002	8/7/2002	8/8/2002	8/8/2002	8/13/2002	8/13/2002	8/16/2002
Depth Range (cm)		0–10	0–10	0–0	0–0	0–0	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Phthalate Esters																	
Dimethyl Phthalate	µg/kg dw	2.7 U	3 U	2.4 U	2.5 U	2.9 U				2 U	2 U	2.4 U	35 U	32 U	2.3 U	2.7 U	2.9 U
Diethyl Phthalate	µg/kg dw	5.2 U	5.7 U	4.6 U	4.8 U	5.5 U				3.9 U	3.8 U	4.6 U	68 U	62 U	4.5 U	5.3 U	5.6 U
Di-n-butyl Phthalate	µg/kg dw	3.9 U	7.5 J	3.4 U	6.8 J	4.1 U				2.9 U	2.8 U	3.4 U	51 U	46 U	3.4 U	4 J	4.1 U
Butylbenzyl Phthalate	µg/kg dw	2.3 U	2.5 U	2 U	2.1 U	2.4 U				1.7 U	1.6 U	2 U	29 U	27 U	2 U	2.3 U	2.4 U
bis(2-ethylhexyl)phthalate	µg/kg dw	120 JB	320 JB	40 JB	30 J	52 JB				13 JB	15 JB	69 JB	110 JB	83 JB	30 JB	39 JB	2,700 J
Phthalate Esters (cont.)																	
Di-n-octyl Phthalate	µg/kg dw	1.8 U	2 U	1.6 U	1.7 U	1.9 U				1.4 U	1.3 U	1.6 U	24 U	22 U	1.6 U	1.8 U	1.9 U
Dimethyl Phthalate	mg/kg OC	0.28 U	0.11 U	0.2 U	0.17 U	0.16 U				0.83 U	0.43 U				0.4 U		
Diethyl Phthalate	mg/kg OC	0.54 U	0.2 U	0.38 U	0.32 U	0.31 U				1.6 U	0.83 U				0.78 U		
Di-n-butyl Phthalate	mg/kg OC	0.41 U	0.27 J	0.28 U	0.45 J	0.23 U				1.2 U	0.61 U				0.59 U		
Butylbenzyl Phthalate	mg/kg OC	0.24 U	0.089 U	0.17 U	0.14 U	0.13 U				0.71 U	0.35 U				0.34 U		
bis(2-ethylhexyl)phthalate	mg/kg OC	13 JB	11 JB	3.3 JB	2 J	2.9 JB				5.4 JB	3.3 JB				5.2 JB		
Di-n-octyl Phthalate	mg/kg OC	0.19 U	0.071 U	0.13 U	0.11 U	0.11 U				0.58 U	0.28 U				0.28 U		
Miscellaneous Nonionizable Organic Compounds																	
Dibenzofuran	µg/kg dw	17	41	18	24 J	28				4.5 J	1.4 U	41	98 J	64 J	2.8 J	53	26
Hexachlorobutadiene	µg/kg dw	2.1 U	2.3 U	1.9 U	1.9 U	2.2 U				1.6 U	1.5 U	1.9 U	28 U	25 U	1.8 U	2.1 U	2.3 U
N-nitrosodiphenylamine	µg/kg dw	3.3 U	3.6 U	2.9 U	3 U	6.5 J				2.5 U	2.4 U	2.9 U	43 U	39 U	2.9 U	3.3 U	3.5 U
Dibenzofuran	mg/kg OC	1.8	1.5	1.5	1.6 J	1.6				1.9 J	0.3 U				0.48 J		
Hexachlorobutadiene	mg/kg OC	0.22 U	0.082 U	0.16 U	0.13 U	0.12 U				0.67 U	0.33 U				0.31 U		
N-nitrosodiphenylamine	mg/kg OC	0.34 U	0.13 U	0.24 U	0.2 U	0.36 J				1 U	0.52 U				0.5 U		
Ionizable Organic Compounds																	
Phenol	µg/kg dw	53	48 J	82	73 J	85				23 JB	18 JB	110	190 JB	85 JB	76	110	250
2-Methylphenol	µg/kg dw	5 U	5.6 U	4.5 U	4.7 U	5.4 U				3.8 U	3.7 U	4.5 U	66 U	61 U	4.4 U	5.6 J	5.4 U
4-Methylphenol	µg/kg dw	5.8 J	130	18	29 J	65				3.2 U	3.1 U	370	1,700	650	6.8 J	240	180
2,4-Dimethylphenol	µg/kg dw	8.1 U	9 U	7.2 U	7.5 U	8.7 U				6.1 U	5.9 U	7.2 U	11 U	9.8 U	7.1 U	8.2 U	8.7 U
Pentachlorophenol	µg/kg dw	13 U	14 U	12 U	12 U	14 U				9.4 U	9.1 U	17 J	170 U	160 U	11 U	13 U	14 U
Benzoic Acid	µg/kg dw	150 U	180 J	130 U	160 J	160 U				110 J	110 U	260 J	1,900 U	1,700 U	130 U	150 U	170 J
Other Semivolatile Organic Compounds																	
Pyridine	µg/kg dw	4.5 U	4.9 U	4 U	4.1 U	4.8 U				3.3 U	3.2 U	3.9 U	58 U	54 U	3.9 U	4.5 U	4.8 U

Notes:

Source: Malcolm Pirnie. 2007. *Remedial Investigation for the Marine Environment near the Former Rayonier Mill Site, Port Angeles, Washington*. Public Review Draft. Prepared for Rayonier. February.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DDT Dichlorodiphenyltrichloroethane
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Micrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PAH Polycyclic aromatic hydrocarbon
PeCDD Pentachlorodibenzodioxin
PeCDF Pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-04	RAYONR05LP-04	RAYONR05LP-05	RAYONR05LP-06	RAYONR05LP-06	RAYONR05LP-07	RAYONR05LP-07	RAYONR05LP-08	RAYONR05LP-09	RAYONR05LP-10	RAYONR05LP-11	RAYONR05LP-12	RAYONR05LP-13	RAYONR05LP-13	RAYONR05LP-14	RAYONR05LP-14
Sample ID		LP-04-SS-SP	LP-04-SSb	LP-05-SS	LP-06-SS-SP	LP-06-SSb	LP-07-SS-SP	LP-07-SSb	LP-08-SS	LP-09-SS	LP-10-SS	LP-11-SSb	LP-12-SS	LP13DCS0-1	LP-13-SS	LP-14-SS-SP	LP-14-SSb
Sample Date		8/15/2002	8/29/2002	8/14/2002	8/16/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/14/2002	8/14/2002	8/29/2002	8/13/2002	8/10/2002	8/14/2002	8/15/2002	8/29/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–0	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Conventionals																	
Acid-Volatile Sulfide	mg/kg dw	1.4		130 J	270		53		33 J	2 U	1,400 J	43 J	790 J		1,100 J	3.1	
Sulfides	mg/kg dw		69	420		670		16	9 J	900	1,700	46	1,400		1,400		62
Total Organic Carbon	%	1.2	1.3	11.3	18.5	10.2	0.42	0.44	1.3	20.6	10	1.01	21.2	0.7	14.4	8.1	7.5
Total Solids	%	80	73.8	63.1	35.8	48.9	81.6	75.7	83.9	42.9	27.6	81.7	37.9	84.2	28	67.6	61.1
Total Volatile Solids	%		3.7	13.6		20.8		1.4	3.3	33.1	25.8	2.2	45.1	5.1	22.7		13.5
Nutrients																	
Ammonia	mg/kg dw		5.3	10		44		9.9	21	20	89	13	28 J		44		16
Particle/Grain Size																	
Percent Gravel	%	1.4		21 J	4.6		11		19 J	8.4 J	31 J	35	40	21	17 J	8.1	
Percent Sand	%	90		72	59		84		74	77	28	66	35	34	40	74	
Percent Silt	%	5.8		5	29		4.2		3.7	12	33	3.5	19	30	32	14	
Percent Clay	%	1.3		2.6	8.4		0.88		1.3	4.6	9.7	1	6.2	12	12	2.7	
Percent Fines (clay & silt)	%	7.1		7.6	37		5.1		5	16	43	4.5	25	42	44	17	
Biochemical Measures																	
12-Chlorodehydroabietic Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
14-Chlorodehydroabietic Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
3,4,5-Trichloroguaiacol	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
Dehydroabietic Acid	mg/kg dw	0.42 U		5.9	8.9		0.4 U		0.39 U	5.5	15	0.4 U	6.5	6.7	13	2.2 J	
Abietic Acid	mg/kg dw	0.42 U		4.5	6.2		0.4 U		0.39 U	3.3	9.7	0.4 U	3.2 J	6	6.2	1 J	
Dichlorodehydroabietic Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
Dichlorostearic Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
Isopimaric Acid	mg/kg dw	0.42 U		0.5 U	1.1		0.4 U		0.39 U	0.7 U	4.6	0.4 U	0.88 U	1.2	1.3	0.49 U	
Linoleic Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	7.6	0.4 U	3.6		1.1 U	0.49 U	
Oleic Acid	mg/kg dw													0.72			
Oleic-Linolenic Acid Mixture	mg/kg dw	1.1		2.1	3.7		1.6		0.86	3.8	7.6	0.57 J	3.3		1.1 U	6.1 J	
Pimaric Acid	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
Tetrachloroguaiacol	mg/kg dw	0.42 U		0.5 U	0.93 U		0.4 U		0.39 U	0.7 U	1.1 U	0.4 U	0.88 U		1.1 U	0.49 U	
Metals																	
Arsenic	mg/kg dw	2.9		3.8	10		2.7		3.8	8.9	11	3.1	7.5	5	9.1	7.7	
Cadmium	mg/kg dw	0.21 J		0.48	1.5 J		0.11 J		0.15	1.2	1.8	0.14	0.92	1.4	2.1	0.47 J	
Chromium	mg/kg dw	13		11	31		13		12	13	22	11	13		26	18	
Copper	mg/kg dw	8.7		18	75		7		6.6	16	30	10	19		37	13	
Lead	mg/kg dw	5		26	270		2.7		3	22	50	2.8	19		58	6.6	
Mercury	mg/kg dw	0.03		0.04 J	0.43		0.04		0.03 J	0.07 J	0.11 J	0.03 JB	0.06		0.17 J	0.08	
Selenium	mg/kg dw	0.3 U		0.6	1.1		0.2 U		0.2 J	1.4	2.3	0.2 U	1.4	1.2 JB	2	0.4 J	
Silver	mg/kg dw	0.039		0.097	0.22		0.042		0.06	0.1	0.23	0.06	0.11		0.27	0.07	
Zinc	mg/kg dw	25		32	28		23		19	39	63	23	37	73	79	33	
Pesticides																	
4,4'-DDD	µg/kg dw	0.52 J		3.1 J	7.9		0.19 U		0.19 U	2.2 J	0.8 U	0.19 U	2.5 U		4.4	0.52 U	
4,4'-DDE	µg/kg dw	0.31 U		2 U	2.8 U		0.31 U		0.31 U	2.5 U	3.6 U	0.3 U	0.65 U		2.2 J	1.5 U	
4,4'-DDT	µg/kg dw	0.22 U		49	16		0.21 U		0.21 U	3.6 U	15	1.1 U	6 U		4.5	1.5	
alpha-Hexachlorocyclohexane	µg/kg dw	0.13 U		0.39 J	3 J		0.13 U		0.13 U	0.71 J	0.67 J	0.13 U	0.54 U		0.37 U	0.46 J	
beta-Hexachlorocyclohexane	µg/kg dw	1.3 U		1.6 U	2.8 U		1.3 U		0.19 U	2.4 U	0.52 U	0.18 U	2.7 U		3.6 U	1.5 U	

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-04	RAYONR05LP-04	RAYONR05LP-05	RAYONR05LP-06	RAYONR05LP-06	RAYONR05LP-07	RAYONR05LP-07	RAYONR05LP-08	RAYONR05LP-09	RAYONR05LP-10	RAYONR05LP-11	RAYONR05LP-12	RAYONR05LP-13	RAYONR05LP-13	RAYONR05LP-14	RAYONR05LP-14
Sample ID		LP-04-SS-SP	LP-04-SSb	LP-05-SS	LP-06-SS-SP	LP-06-SSb	LP-07-SS-SP	LP-07-SSb	LP-08-SS	LP-09-SS	LP-10-SS	LP-11-SSb	LP-12-SS	LP13DCS0-1	LP-13-SS	LP-14-SS-SP	LP-14-SSb
Sample Date		8/15/2002	8/29/2002	8/14/2002	8/16/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/14/2002	8/14/2002	8/29/2002	8/13/2002	8/10/2002	8/14/2002	8/15/2002	8/29/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–0	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Pesticides (cont.)																	
delta-Hexachlorocyclohexane	µg/kg dw	0.47 U		0.59 U	1.1 U		0.46 U		0.46 U	0.86 U	1.4 U	0.46 U	0.98 U		4.7 U	0.55 U	
gamma-Hexachlorocyclohexane	µg/kg dw	1.3 U		2 U	4.9 U		1.3 U		0.31 U	2.4 U	4.4 U	1.3 U	3.1 U		5 U	2.1 U	
Dioxins/Furans																	
2,3,7,8-TCDD	ng/kg dw		0.103 J	0.765 J		4.91		0.208 U	0.11 J	0.692 J	0.256 J		0.149 U	0.56 U	1.14 J		0.128 U
1,2,3,7,8-PeCDD	ng/kg dw		0.187 J	1.75 J		25.2		0.246 U	0.177 J	1.6 J	0.679 J		0.472 J	0.91 U	4.36 J		0.502 J
1,2,3,4,7,8-HxCDD	ng/kg dw		0.334 J	2 J		27.5		0.22 U	0.237 J	0.975 J	0.528 J		0.346 J	1.2 J	4.1 J		0.437 J
1,2,3,6,7,8-HxCDD	ng/kg dw		0.443 J	5.6		61		0.504 J	0.829 J	4.38 J	2.21 J		1.87 J	5.42 J	12.9		1.6 J
1,2,3,7,8,9-HxCDD	ng/kg dw		0.326 J	4.1 J		0.302 U		0.223 U	0.554 J	2.6 J	1.54 J		1.28 J	2.14 J	9.96		1.18 J
1,2,3,4,6,7,8-HpCDD	ng/kg dw		8.96	93		448		32	12.1	75.1	36		47.9 JB	61.8	243		18
Total OCDD	ng/kg dw		120	920		2,390 J		523	87	943 J	378		733 JB	482	2,480		190
2,3,7,8-TCDF	ng/kg dw		0.42 U	5.41 J		23.6 JB		0.273 U	0.585 J	4.8 J	1.74 J		1.3 J	2.29	4.86 J		0.83 U
1,2,3,7,8-PeCDF	ng/kg dw		0.202 J	1.9 J		19.3 J		0.212 U	0.195 J	1.64 J	0.626 J		0.602 J	0.74 U	0.904 J		0.584 J
2,3,4,7,8-PeCDF	ng/kg dw		0.249 J	3.1 J		22.4		0.185 U	0.34 J	2.72 J	1.18 J		0.848 J	2.2 J	4.61 J		0.761 J
1,2,3,4,7,8-HxCDF	ng/kg dw		0.183 J	5		18.6 J		0.202 J	0.388 J	1.95 J	1 J		0.702 J	1.46 J	3.95 J		0.747 J
1,2,3,6,7,8-HxCDF	ng/kg dw		0.191 J	1.99 J		12		0.128 U	0.174 J	0.781 J	0.426 J		0.296 J	0.98 J	2 J		0.372 J
1,2,3,7,8,9-HxCDF	ng/kg dw		0.165 U	0.702 J		2.2 J		0.165 U	0.095 U	0.233 U	0.405 U		0.295 U	0.73 U	0.489 U		0.097 U
2,3,4,6,7,8-HxCDF	ng/kg dw		0.128 U	1.71 J		11.8 J		0.14 U	0.176 J	1.2 J	0.644 J		0.228 U	0.65 U	2.8 J		0.336 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw		2 J	20.1		93		7.2	1.82 J	14	8		14.7	20.9	33.7		4.8
1,2,3,4,7,8,9-HpCDF	ng/kg dw		0.338 U	2.1 J		6.4		0.304 U	0.288 U	0.78 U	1 U		0.797 U	1.02 U	1.1 J		0.212 U
Total OCDF	ng/kg dw		22.9 JB	98.1		240 J		127 JB	12.5	80.4 J	39.8		203	56.2	180		66.1 JB
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw		0.671	7.61		59.3 J		0.658	0.858	6.02	2.68		2.23	3 J	14.5 J		1.52
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw		0.708	7.61		59.4 J		0.975	0.864	6.04	2.71		2.34	3.82 J	14.6 J		1.63
Polychlorinated Biphenyls (PCBs)																	
Aroclor 1242	µg/kg dw	1.1 U		1.4 U	2.3 U		1.1 U		1.1 U	1.9 U	3.1 U	1.1 U	2.2 U	6.4 U	3.1 U	1.3 U	
Aroclor 1254	µg/kg dw	1.1 U		640	210		1.1 U		1.1 U	1.9 U	210	1.1 U	2.2 U	6.4 U	61	1.3 U	
Aroclor 1260	µg/kg dw	5.3 J		1.4 U	110		1.1 U		1.1 U	180	140	3.6 J	68	78	99	20	
Total PCBs, Aroclors	µg/kg dw	5.3		640	320		1.1 U		1.1 U	180	350	3.6	68	78	160	20	
Aroclor 1242	mg/kg OC	0.092 U					0.26 U		0.085 U			0.11 U		0.91 U			
Aroclor 1254	mg/kg OC	0.092 U					0.26 U		0.085 U			0.11 U		0.91 U			
Aroclor 1260	mg/kg OC	0.44 J					0.26 U		0.085 U			0.36 J		11			
Total PCBs, Aroclors	mg/kg OC	0.44					0.26 U		0.085 U			0.36		11			
Other																	
Total TEQ	ng/kg dw		0.918	7.82		59.6		1.18	1.07	6.25	2.92		2.55	4.03	14.8		1.84
Aromatic Hydrocarbons																	
Total LPAH	µg/kg dw	97		760	3,300		19		70	1,800	790	100	700		1,800	880	
Naphthalene	µg/kg dw	34		140	1,100		4.5 J		17	170	160 J	21 JB	190		460	140	
Acenaphthylene	µg/kg dw	2.8 J		19 J	120 J		1.8 U		3 J	71 J	39 J	4.5 J	29		63 J	16	
Acenaphthene	µg/kg dw	8.4 J		75 J	290		1.3 U		4.5 J	110 J	66 J	5.5 J	61		180 J	60	
Fluorene	µg/kg dw	11 J		79 J	380		2.1 U		7.2 J	130	82 J	11 J	93		230	76	
Phenanthrene	µg/kg dw	29		360	1,100		11 J		27	1,200	330	38	230		620	450	
Anthracene	µg/kg dw	12 J		83	260 J		3.4 J		11 J	100 J	110 J	22	100		270	140	
2-Methylnaphthalene	µg/kg dw	7.3 J		49 J	270 J		1.5 U		3.8 J	52 J	53 J	4.5 J	55		160 J	32	
Total HPAH	µg/kg dw	180		1,800	3,200		99		250	3,300	2,300	400	1,700		3,500	2,600	

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-04	RAYONR05LP-04	RAYONR05LP-05	RAYONR05LP-06	RAYONR05LP-06	RAYONR05LP-07	RAYONR05LP-07	RAYONR05LP-08	RAYONR05LP-09	RAYONR05LP-10	RAYONR05LP-11	RAYONR05LP-12	RAYONR05LP-13	RAYONR05LP-13	RAYONR05LP-14	RAYONR05LP-14
Sample ID		LP-04-SS-SP	LP-04-SSb	LP-05-SS	LP-06-SS-SP	LP-06-SSb	LP-07-SS-SP	LP-07-SSb	LP-08-SS	LP-09-SS	LP-10-SS	LP-11-SSb	LP-12-SS	LP13DCS0-1	LP-13-SS	LP-14-SS-SP	LP-14-SSb
Sample Date		8/15/2002	8/29/2002	8/14/2002	8/16/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/14/2002	8/14/2002	8/29/2002	8/13/2002	8/10/2002	8/14/2002	8/15/2002	8/29/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–0	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Aromatic Hydrocarbons (cont.)																	
Fluoranthene	µg/kg dw	52		610	1,000		22		66	1,400	640	81	400		1,000	680	
Pyrene	µg/kg dw	48		560	920		21		62	950	540	80	490		890	530	
Benzo(a)anthracene	µg/kg dw	14		120	270 J		7.8 J		22	160	170 J	44	160		290	250	
Chrysene	µg/kg dw	17		160	360		11 J		32	300	330	61	270		460	250	
Total Benzofluoranthenes	µg/kg dw	25		190	270		17		37	290	340	68	220		470	350	
Benzo(b)fluoranthene	µg/kg dw	19		100	270 J		13		21	160	180 J	52	120		270	270	
Benzo(k)fluoranthene	µg/kg dw	6.4 J		91	70 U		4.2 J		16	130	160 J	16	95		200	84	
Benzo(a)pyrene	µg/kg dw	10 J		84	160 J		7.2 J		14	93 J	110 J	31	88		170 J	210	
Benzo(g,h,i)perylene	µg/kg dw	7.3 J		47 J	120 J		6.3 J		9.7 J	50 J	72 J	16	57		110 J	130	
Indeno(1,2,3-cd)pyrene	µg/kg dw	7.8 J		39 J	83 J		6.5 J		10 J	62 J	91 J	18	58		110 J	140	
Dibenzo(a,h)anthracene	µg/kg dw	2.8 U		20 J	62 U		2.7 U		2.7 U	26 U	40 U	4.6 J	5.9 U		40 U	33	
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	15		120	230		10		21	150	170	45	130		260	290	
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	15		120	230		11		21	150	180	45	130		260	290	
Total LPAH	mg/kg OC	8.1					4.5		5.4			10					
Naphthalene	mg/kg OC	2.8					1.1 J		1.3			2.1 JB					
Acenaphthylene	mg/kg OC	0.23 J					0.43 U		0.23 J			0.45 J					
Acenaphthene	mg/kg OC	0.7 J					0.31 U		0.35 J			0.54 J					
Fluorene	mg/kg OC	0.92 J					0.5 U		0.55 J			1.1 J					
Phenanthrene	mg/kg OC	2.4					2.6 J		2.1			3.8					
Anthracene	mg/kg OC	1 J					0.81 J		0.85 J			2.2					
2-Methylnaphthalene	mg/kg OC	0.61 J					0.36 U		0.29 J			0.45 J					
Total HPAH	mg/kg OC	15					24		19			40					
Fluoranthene	mg/kg OC	4.3					5.2		5.1			8					
Pyrene	mg/kg OC	4					5		4.8			7.9					
Benzo(a)anthracene	mg/kg OC	1.2					1.9 J		1.7			4.4					
Chrysene	mg/kg OC	1.4					2.6 J		2.5			6					
Total Benzofluoranthenes	mg/kg OC	2.1					4.1		2.8			6.7					
Benzo(b)fluoranthene	mg/kg OC	1.6					3.1		1.6			5.1					
Benzo(k)fluoranthene	mg/kg OC	0.53 J					1 J		1.2			1.6					
Benzo(a)pyrene	mg/kg OC	0.83 J					1.7 J		1.1			3.1					
Benzo(g,h,i)perylene	mg/kg OC	0.61 J					1.5 J		0.75 J			1.6					
Indeno(1,2,3-cd)pyrene	mg/kg OC	0.65 J					1.5 J		0.77 J			1.8					
Dibenzo(a,h)anthracene	mg/kg OC	0.23 U					0.64 U		0.21 U			0.46 J					
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC	1.2					2.5		1.6			4.5					
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC	1.3					2.5		1.6			4.5					
1,2-Dichlorobenzene	µg/kg dw	1.7 U		11 U	37 U		1.6 U		1.6 U	16 U	24 U	1.6 U	3.5 U		24 U	2 U	
1,4-Dichlorobenzene	µg/kg dw	2.4 U		16 U	54 U		2.4 U		2.3 U	23 U	35 U	2.4 U	5.1 U		34 U	2.9 U	
1,2,4-Trichlorobenzene	µg/kg dw	1.9 U		12 U	42 U		1.9 U		1.8 U	18 U	28 U	1.9 U	4 U		27 U	2.3 U	
Hexachlorobenzene	µg/kg dw	2.7 U		17 U	59 U		2.6 U		2.6 U	25 U	39 U	2.6 U	5.6 U		38 U	3.2 U	
1,2-Dichlorobenzene	mg/kg OC	0.14 U					0.38 U		0.12 U			0.16 U					
1,4-Dichlorobenzene	mg/kg OC	0.2 U					0.57 U		0.18 U			0.24 U					
1,2,4-Trichlorobenzene	mg/kg OC	0.16 U					0.45 U		0.14 U			0.19 U					
Hexachlorobenzene	mg/kg OC	0.23 U					0.62 U		0.2 U			0.26 U					

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-04	RAYONR05LP-04	RAYONR05LP-05	RAYONR05LP-06	RAYONR05LP-06	RAYONR05LP-07	RAYONR05LP-07	RAYONR05LP-08	RAYONR05LP-09	RAYONR05LP-10	RAYONR05LP-11	RAYONR05LP-12	RAYONR05LP-13	RAYONR05LP-13	RAYONR05LP-14	RAYONR05LP-14
Sample ID		LP-04-SS-SP	LP-04-SSb	LP-05-SS	LP-06-SS-SP	LP-06-SSb	LP-07-SS-SP	LP-07-SSb	LP-08-SS	LP-09-SS	LP-10-SS	LP-11-SSb	LP-12-SS	LP13DCS0-1	LP-13-SS	LP-14-SS-SP	LP-14-SSb
Sample Date		8/15/2002	8/29/2002	8/14/2002	8/16/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/14/2002	8/14/2002	8/29/2002	8/13/2002	8/10/2002	8/14/2002	8/15/2002	8/29/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–0	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																
Phthalate Esters																	
Dimethyl Phthalate	µg/kg dw	2.3 U		15 U	51 U		2.3 U		2.2 U	21 U	33 U	2.3 U	11 J		33 U	2.7 U	
Diethyl Phthalate	µg/kg dw	4.4 U		28 U	98 U		4.3 U		4.2 U	41 U	64 U	4.3 U	9.3 U		63 U	5.2 U	
Di-n-butyl Phthalate	µg/kg dw	3.3 U		21 U	73 U		3.2 U		3.1 U	31 U	48 U	3.2 U	6.9 U		47 U	27	
Butylbenzyl Phthalate	µg/kg dw	1.9 U		12 U	42 U		1.9 U		1.8 U	18 U	28 U	1.9 U	4 U		27 U	2.3 U	
bis(2-ethylhexyl)phthalate	µg/kg dw	13 J		61 JB	200 JB		140 J		44 JB	78 JB	110 JB	17 JB	110 JB		150 JB	93 J	
Phthalate Esters (cont.)																	
Di-n-octyl Phthalate	µg/kg dw	1.5 U		9.6 U	34 U		1.5 U		1.5 U	14 U	22 U	1.5 U	3.2 U		22 U	1.8 U	
Dimethyl Phthalate	mg/kg OC	0.19 U					0.55 U		0.17 U			0.23 U					
Diethyl Phthalate	mg/kg OC	0.37 U					1 U		0.32 U			0.43 U					
Di-n-butyl Phthalate	mg/kg OC	0.28 U					0.76 U		0.24 U			0.32 U					
Butylbenzyl Phthalate	mg/kg OC	0.16 U					0.45 U		0.14 U			0.19 U					
bis(2-ethylhexyl)phthalate	mg/kg OC	1.1 J					33 J		3.4 JB			1.7 JB					
Di-n-octyl Phthalate	mg/kg OC	0.13 U					0.36 U		0.12 U			0.15 U					
Miscellaneous Nonionizable Organic Compounds																	
Dibenzofuran	µg/kg dw	11 J		73 J	290		1.6 U		6.4 J	92 J	63 J	9.3 J	76		190	52	
Hexachlorobutadiene	µg/kg dw	1.8 U		12 U	40 U		1.8 U		1.7 U	17 U	26 U	1.8 U	3.7 U		25 U	2.1 U	
N-nitrosodiphenylamine	µg/kg dw	2.8 U		18 U	62 U		2.7 U		2.7 U	26 U	40 U	2.7 U	5.9 U		40 U	3.3 U	
Dibenzofuran	mg/kg OC	0.92 J					0.38 U		0.49 J			0.92 J					
Hexachlorobutadiene	mg/kg OC	0.15 U					0.43 U		0.13 U			0.18 U					
N-nitrosodiphenylamine	mg/kg OC	0.23 U					0.64 U		0.21 U			0.27 U					
Ionizable Organic Compounds																	
Phenol	µg/kg dw	76		76 JB	400 JB		72		250	130 JB	480 JB	23 JB	360		100 JB	72	
2-Methylphenol	µg/kg dw	4.3 U		27 U	200 J		4.2 U		4.1 U	40 U	62 U	4.2 U	12 J		61 U	5.1 U	
4-Methylphenol	µg/kg dw	58		190	1,300		69		83	310	490	25	600		820	66	
2,4-Dimethylphenol	µg/kg dw	6.9 U		8.8 U	54 J		6.8 U		6.6 U	13 U	20 U	6.8 U	15 U		20 J	8.2 U	
Pentachlorophenol	µg/kg dw	11 U		68 U	240 U		11 U		11 U	100 U	160 U	11 U	23 U		160 U	44 J	
Benzoic Acid	µg/kg dw	120 J		770 U	2,700 U		130 J		120 U	1,200 U	1,800 U	120 U	260 U		1,800 U	160 J	
Other Semivolatile Organic Compounds																	
Pyridine	µg/kg dw	3.8 U		24 U	160 J		3.7 U		3.6 U	35 U	55 U	4.2 J	8 U		54 U	4.5 U	

Notes:

Source: Malcolm Pirnie. 2007. *Remedial Investigation for the Marine Environment near the Former Rayonier Mill Site, Port Angeles, Washington.* Public Review Draft. Prepared for Rayonier. February.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DDT Dichlorodiphenyltrichloroethane
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Micrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PAH Polycyclic aromatic hydrocarbon
PeCDD Pentachlorodibenzodioxin
PeCDF Pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-15	RAYONR05LP-16	RAYONR05LP-17	RAYONR05LP-18	RAYONR05LP-18	RAYONR05LP-19	RAYONR05LP-19	RAYONR05LP-20	RAYONR05MD-01	RAYONR05MD-02	RAYONR05MD-02	RAYONR05MD-03	RAYONR05MD-03	RAYONR05MD-04	RAYONR05MD-05
Sample ID		LP-15-SS	LP-16-SS	LP-17-SS	LP-18-SS-SP	LP-18-SSb	LP-19-SS-SP	LP-19-SSb	LP-20-SS	MD-01-SS	MD-02-SS-SP	MD-02-SSb	MD-03-SS-SP	MD-03-SSb	MD-04-SS	MD-05-SS-SP
Sample Date		8/14/2002	8/14/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/11/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/19/2002	8/15/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Conventionals																
Acid-Volatile Sulfide	mg/kg dw	7 J	240 J	29 J	240		1.4 U		2,700 J	1,000 J	84		220		30 J	120
Sulfides	mg/kg dw	42 J	860	28 J		1,000		0.4 J	3,500	650		200		380	20 J	
Total Organic Carbon	%	10.9	16.5	1.2	23.3	23.1	1.9	1.6	13.5	0.29	15	11.3	2.2	2.8	1.08	2.2
Total Solids	%	64.2	42.3	86.3	44.7	41.6	79.2	81.3	14.4	84.9	45.2	49.8	62.6	60.3	68.1	66.8
Total Volatile Solids	%	12.8	28.7	2.4		46.4		3.5	26	2.4		32.6		6.1	3.5	
Nutrients																
Ammonia	mg/kg dw	25	26	6.9		19		18	640	15 J		13		8.6	5.3	
Particle/Grain Size																
Percent Gravel	%	4.6 J	14 J	28	7		18		1.8 J	72	5.4		0.14		0.4	1.1
Percent Sand	%	85	69	66	77		74		33	27	69		48		83	55
Percent Silt	%	9.5	14	5.7	6.8		4.7		39	1.2	20		44		14	34
Percent Clay	%	3.2	5.6	1.4	4.5		1.3		19	0.69	5		6.5		3.5	6.3
Percent Fines (clay & silt)	%	13	20	7	11		5.9		58	1.8	25		51		17	41
Biochemical Measures																
12-Chlorodehydroabietic Acid	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
14-Chlorodehydroabietic Acid	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
3,4,5-Trichloroguaiacol	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Dehydroabietic Acid	mg/kg dw	2.4	20	0.39 U	8.3		0.44 J		5.5	0.39 U	6.4		0.9		0.49 U	1
Abietic Acid	mg/kg dw	1.1	15	0.39 U	4		0.42 U		2.4	0.39 U	3.5		0.52 U		0.49 U	0.5 U
Dichlorodehydroabietic Acid	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Dichlorostearic Acid	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Isopimaric Acid	mg/kg dw	0.52 U	2.1	0.39 U	1		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Linoleic Acid	mg/kg dw	0.7	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Oleic Acid	mg/kg dw															
Oleic-Linolenic Acid Mixture	mg/kg dw	2.6	3.7	0.52	12		2.1 J		5.6	0.39 U	11		3.7		0.49 U	2.1
Pimaric Acid	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Tetrachloroguaiacol	mg/kg dw	0.52 U	0.7 U	0.39 U	0.74 U		0.42 U		2.1 U	0.39 U	0.7 U		0.52 U		0.49 U	0.5 U
Metals																
Arsenic	mg/kg dw	5	7.8	3.3	8.8		5.4		7.3	1.5	7.8		6		3.2	4.3
Cadmium	mg/kg dw	0.36	0.98	0.13	0.91 J		0.12 J		2.1	0.049	0.78 J		0.33 J		0.1	0.36 J
Chromium	mg/kg dw	11	19	14	16		13		22							
Copper	mg/kg dw	13	30	8.5	29		8.5		37	21	26		30		21	28
Lead	mg/kg dw	9.5	26	2.7	15		2.6		62	3.1	14		6.7		4.6	7.4
Mercury	mg/kg dw	0.04 J	0.07 J	0.03	0.07		0.04		0.15 J	0.011 J	0.16		0.05		0.03	0.05
Selenium	mg/kg dw	0.6	1.2	0.4 J	0.7 J		0.2 U		3.8	0.1 U	0.6 J		0.2 U		0.5 J	0.2 U
Silver	mg/kg dw	0.085	0.13	0.047 J	0.089		0.041		0.25							
Zinc	mg/kg dw	24	50	22	44		22		68	26	47		53		38	56
Pesticides																
4,4'-DDD	µg/kg dw	0.68 U	1.8 J	0.18 U	2.3 U		0.2 U		16	0.18 U	1.4 U		1.6 U		0.23 U	0.23 U
4,4'-DDE	µg/kg dw	1.1 U	4.1 U	0.29 U	1.6 U		0.31 U		7.1 U	0.29 U	1.7 U		0.4 U		5.3 U	0.54 U
4,4'-DDT	µg/kg dw	3.5	9	1.3	7.5 J		0.59 J		110	0.68 J	7.8		4.3		1.5 U	5.1
alpha-Hexachlorocyclohexane	µg/kg dw	0.48 J	0.26 U	0.12 U	0.23 U		0.13 U		0.72 U	0.13 U	0.81 J		0.18 U		0.15 U	0.16 U
beta-Hexachlorocyclohexane	µg/kg dw	0.24 U	2.6 U	1.2 U	2.3 U		0.4 J		8.4 U	0.18 U	2.3 U		0.37 U		1.5 U	0.23 U

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		**RAYONR05LP-15**	**RAYONR05LP-16**	**RAYONR05LP-17**	**RAYONR05LP-18**	**RAYONR05LP-18**	**RAYONR05LP-19**	**RAYONR05LP-19**	**RAYONR05LP-20**	**RAYONR05MD-01**	**RAYONR05MD-02**	**RAYONR05MD-02**	**RAYONR05MD-03**	**RAYONR05MD-03**	**RAYONR05MD-04**	**RAYONR05MD-05**
Sample ID		**LP-15-SS**	**LP-16-SS**	**LP-17-SS**	**LP-18-SS-SP**	**LP-18-SSb**	**LP-19-SS-SP**	**LP-19-SSb**	**LP-20-SS**	**MD-01-SS**	**MD-02-SS-SP**	**MD-02-SSb**	**MD-03-SS-SP**	**MD-03-SSb**	**MD-04-SS**	**MD-05-SS-SP**
Sample Date		**8/14/2002**	**8/14/2002**	**8/19/2002**	**8/15/2002**	**8/29/2002**	**8/15/2002**	**8/29/2002**	**8/14/2002**	**8/11/2002**	**8/15/2002**	**8/29/2002**	**8/15/2002**	**8/29/2002**	**8/19/2002**	**8/15/2002**
Depth Range (cm)		**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**	**0–10**
Field QC		**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**
Reoccupied		**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Analyte	**Units**															
Pesticides (cont.)																
delta-Hexachlorocyclohexane	µg/kg dw	0.6 U	1.3 U	0.43 U	1.1 U		0.47 U		2.6 U	0.44 U	0.82 U		1.1 U		0.55 U	0.56 U
gamma-Hexachlorocyclohexane	µg/kg dw	2.3 U	4.9 U	1.2 U	5.2 U		1.3 U		8.5 U	0.29 U	3.3 U		1.6 U		1.5 U	1.5 U
Dioxins/Furans																
2,3,7,8-TCDD	ng/kg dw	0.176 J	0.727 J	0.066 U		0.531 J		0.114 U	0.652 J			0.424 J		0.189 J		
1,2,3,7,8-PeCDD	ng/kg dw	0.48 J	2.09 J	0.086 U		1.5 J		0.149 U	1.27 J			1.15 J		0.466		
1,2,3,4,7,8-HxCDD	ng/kg dw	0.3 J	2.51 J	0.08 U		1.25 J		0.306 J	1.35 J			0.868 J		0.367 J		
1,2,3,6,7,8-HxCDD	ng/kg dw	1.24 J	6.26	0.647 J		5.13		0.995 J	5.19			3 J		1.67 J		
1,2,3,7,8,9-HxCDD	ng/kg dw	0.7 J	4.93	0.457 J		3.1 J		0.76 J	2.69 J			2.1 J		0.15 J		
1,2,3,4,6,7,8-HpCDD	ng/kg dw	14.8	67.8	7.28		80		42.4	70.9			65.9		33.6		
Total OCDD	ng/kg dw	144	510	72.3		1,030		585	681			698		404		
2,3,7,8-TCDF	ng/kg dw	1.42 J	6 J	0.495 J		2.79 JB		0.544 U	5.1 J			2.89 JB		1.35		
1,2,3,7,8-PeCDF	ng/kg dw	0.67 J	3.61 J	0.065 U		1.94 J		0.286 J	1.9 J			1.53 J		0.67 J		
2,3,4,7,8-PeCDF	ng/kg dw	1.1 J	4.83 J	0.258 J		2.92 J		0.287 J	3.1 J			1.82 J		0.813 J		
1,2,3,4,7,8-HxCDF	ng/kg dw	1.12 J	20.3	0.294 J		3.94 J		0.286 J	3.1 J			1.44 J		0.999 J		
1,2,3,6,7,8-HxCDF	ng/kg dw	0.471 J	4.71 J	0.168 J		1.41 J		0.148 J	0.889 J			0.753 J		1 J		
1,2,3,7,8,9-HxCDF	ng/kg dw	0.203 U	1.13 J	0.092 U		0.255 U		0.166 U	0.697 U			0.206 U		0.251 U		
2,3,4,6,7,8-HxCDF	ng/kg dw	0.441 J	2.95 J	0.235 J		1.82 J		0.151 U	1.04 J			0.733 J		0.434 J		
1,2,3,4,6,7,8-HpCDF	ng/kg dw	3.79 J	51.8	1.63 J		42.3		5.7	15.8			9.61		6.9		
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.493 U	10.3	0.256 U		1.19 J		0.21 J	1.84 U			0.694 U		0.498 U		
Total OCDF	ng/kg dw	15.9	117	10.9		197 JB		84.9	86.6			57.8 JB		67.2		
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	1.81	10.7	0.421		6.51		1.03	5.94			4.33		2.06		
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	1.82	10.7	0.508		6.52		1.2	5.99			4.34		2.08		
Polychlorinated Biphenyls (PCBs)																
Aroclor 1242	µg/kg dw	1.4 U	2 U	3.6 U	1.9 U		1.1 U		5.8 U				1.4 U		1.3 U	1.3 U
Aroclor 1254	µg/kg dw	40	97	3.6 U	1.9 U		1.1 U		80				1.4 U		190	1.3 U
Aroclor 1260	µg/kg dw	35	94	110	86		8.1 J		5.8 U				67		1.3 U	95
Total PCBs, Aroclors	µg/kg dw	75	190	110	86		8.1		80				67		190	95
Aroclor 1242	mg/kg OC			0.3 U			0.058 U						0.064 U		0.12 U	0.059 U
Aroclor 1254	mg/kg OC			0.3 U			0.058 U						0.064 U		18	0.059 U
Aroclor 1260	mg/kg OC			9.2			0.43 J						3		0.12 U	4.3
Total PCBs, Aroclors	mg/kg OC			9.2			0.43						3		18	4.3
Other																
Total TEQ	ng/kg dw	2.03	11	0.718		6.73		1.41	6.2			4.55		2.29		
Aromatic Hydrocarbons																
Total LPAH	µg/kg dw	590	1,100	55	2,300		200		600	37	1,700		210		96	400
Naphthalene	µg/kg dw	110	300	13			52			28			26		27	33
Acenaphthylene	µg/kg dw	22	32 J	2.7 J			23			13			6.4		5.1	8.2
Acenaphthene	µg/kg dw	42	110 J	3.3 J			15			10			6.8		4.5	9.1
Fluorene	µg/kg dw	49	110 J	4.8 J			2.9			1.7 J			2.1		1.9	2.6
Phenanthrene	µg/kg dw	300	340	23			4.9			1.8 J			2.9		3	4
Anthracene	µg/kg dw	71	190	7.8 J			3.6			1.1			3.5		6.3	4.2
2-Methylnaphthalene	µg/kg dw	31	66 J	2.7 J			2.8			1.1 J			2.7		5.1	3.2
Total HPAH	µg/kg dw	1,700	3,300	160	320		61		150 J	9.4 J	460		35		14 J	120

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-15	RAYONR05LP-16	RAYONR05LP-17	RAYONR05LP-18	RAYONR05LP-18	RAYONR05LP-19	RAYONR05LP-19	RAYONR05LP-20	RAYONR05MD-01	RAYONR05MD-02	RAYONR05MD-02	RAYONR05MD-03	RAYONR05MD-03	RAYONR05MD-04	RAYONR05MD-05
Sample ID		LP-15-SS	LP-16-SS	LP-17-SS	LP-18-SS-SP	LP-18-SSb	LP-19-SS-SP	LP-19-SSb	LP-20-SS	MD-01-SS	MD-02-SS-SP	MD-02-SSb	MD-03-SS-SP	MD-03-SSb	MD-04-SS	MD-05-SS-SP
Sample Date		8/14/2002	8/14/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/11/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/19/2002	8/15/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Aromatic Hydrocarbons (cont.)																
Fluoranthene	µg/kg dw	550	1,100	37	76 J		11 J		98 U	1.7 U	63 J		11 J		8.3 J	18
Pyrene	µg/kg dw	560	1,000	37	180 J		6.2 J		70 U	8.3 J	130 J		14 J		5.2 J	21
Benzo(a)anthracene	µg/kg dw	110	250	14	160 J		8.9 J		120 U	3.8 J	170 J		20		7.7 J	33
Chrysene	µg/kg dw	240	410	18	1,300		89		300 J	11 J	590		95		41	160
Total Benzofluoranthenes	µg/kg dw	170	360	24	260		24		150 J	4.7 J	290		34		20	48
Benzo(b)fluoranthene	µg/kg dw	91	200	18	78 J		7.5 J		84 U	4 J	110 J		11 J		6 J	19
Benzo(k)fluoranthene	µg/kg dw	81	160	5.5 J	130 J		15		190 J	3 U	150 J		18		13 J	22
Benzo(a)pyrene	µg/kg dw	51	110 J	11 J	170 J		23		190 J	1.9 U	310		37		30	45
Benzo(g,h,i)perylene	µg/kg dw	26	55 J	8 J	86 J		11 J		160 U	2.8 U	150 J		25		17	29
Indeno(1,2,3-cd)pyrene	µg/kg dw	29	62 J	8 J	97 J		13 J		150 J	2.3 U	170 J		25		20	29
Dibenzo(a,h)anthracene	µg/kg dw	6.3 J	27 U	2.6 U	50 U		2.9 J		160 U	2.6 U	49 U		7.8 J		5.1 J	6.2 J
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	85	180	16	280		38		270	0.88	450		53		42	64
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	85	180	16	280		38		280	2.2	450		53		42	64
Total LPAH	mg/kg OC			4.6	7,200		1,000		2,400	81	4,500		570		300	730
Naphthalene	mg/kg OC			1.1	3,100		440		550 J	38	1,100		140		55	180
Acenaphthylene	mg/kg OC			0.23 J	2,200		290		510 J	29	960		150		49	200
Acenaphthene	mg/kg OC			0.28 J	390		56		210 J	5 J	450		46		20	58
Fluorene	mg/kg OC			0.4 J	640		93		380 J	5.3 J	670		64		32	89
Phenanthrene	mg/kg OC			1.9	550		68		430	3.3	690		77		68	92
Anthracene	mg/kg OC			0.65 J	420		53		240 J	3.3 J	540		59		55	70
2-Methylnaphthalene	mg/kg OC			0.23 J			11			13			9.5		8.9	18
Total HPAH	mg/kg OC			13			3.2			3.2 J			1.6		1.3 J	5.5
Fluoranthene	mg/kg OC			3.1			0.58 J			0.59 U			0.5 J		0.77 J	0.82
Pyrene	mg/kg OC			3.1			0.33 J			2.9 J			0.64 J		0.48 J	0.95
Benzo(a)anthracene	mg/kg OC			1.2			0.47 J			1.3 J			0.91		0.71 J	1.5
Chrysene	mg/kg OC			1.5			4.7			3.8 J			4.3		3.8	7.3
Total Benzofluoranthenes	mg/kg OC			2			1.3			1.6 J			1.5		1.9	2.2
Benzo(b)fluoranthene	mg/kg OC			1.5			0.39 J			1.4 J			0.5 J		0.56 J	0.86
Benzo(k)fluoranthene	mg/kg OC			0.46 J			0.79			1 U			0.82		1.2 J	1
Benzo(a)pyrene	mg/kg OC			0.92 J			1.2			0.66 U			1.7		2.8	2
Benzo(g,h,i)perylene	mg/kg OC			0.67 J			0.58 J			0.97 U			1.1		1.6	1.3
Indeno(1,2,3-cd)pyrene	mg/kg OC			0.67 J			0.68 J			0.79 U			1.1		1.9	1.3
Dibenzo(a,h)anthracene	mg/kg OC			0.22 U			0.15 J			0.9 U			0.35 J		0.47 J	0.28 J
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC			1.3			2			0.3			2.4		3.9	2.9
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC			1.3			2			0.77			2.4		3.9	2.9
1,2-Dichlorobenzene	µg/kg dw	3.1 J	16 U	1.6 U	30 U		1.7 U		91 U							
1,4-Dichlorobenzene	µg/kg dw	3 U	23 U	2.3 U	43 U		2.4 U		140 U							
1,2,4-Trichlorobenzene	µg/kg dw	2.4 U	18 U	1.8 U	34 U		1.9 U		110 U							
Hexachlorobenzene	µg/kg dw	3.3 U	25 U	2.5 U	47 U		2.7 U		150 U							
1,2-Dichlorobenzene	mg/kg OC			0.13 U			0.089 U									
1,4-Dichlorobenzene	mg/kg OC			0.19 U			0.13 U									
1,2,4-Trichlorobenzene	mg/kg OC			0.15 U			0.1 U									
Hexachlorobenzene	mg/kg OC			0.21 U			0.14 U									

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05LP-15	RAYONR05LP-16	RAYONR05LP-17	RAYONR05LP-18	RAYONR05LP-18	RAYONR05LP-19	RAYONR05LP-19	RAYONR05LP-20	RAYONR05MD-01	RAYONR05MD-02	RAYONR05MD-02	RAYONR05MD-03	RAYONR05MD-03	RAYONR05MD-04	RAYONR05MD-05
Sample ID		LP-15-SS	LP-16-SS	LP-17-SS	LP-18-SS-SP	LP-18-SSb	LP-19-SS-SP	LP-19-SSb	LP-20-SS	MD-01-SS	MD-02-SS-SP	MD-02-SSb	MD-03-SS-SP	MD-03-SSb	MD-04-SS	MD-05-SS-SP
Sample Date		8/14/2002	8/14/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/14/2002	8/11/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/19/2002	8/15/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Phthalate Esters																
Dimethyl Phthalate	µg/kg dw	21	22 U	2.1 U	41 U		2.3 U		130 U							
Diethyl Phthalate	µg/kg dw	5.5 U	42 U	4.1 U	79 U		4.5 U		250 U							
Di-n-butyl Phthalate	µg/kg dw	4.1 U	31 U	3.5 JB	160 J		9.6 J		190 U							
Butylbenzyl Phthalate	µg/kg dw	2.4 U	18 U	1.8 U	34 U		1.9 U		110 U							
bis(2-ethylhexyl)phthalate	µg/kg dw	46 JB	92 JB	130 JB	79 JB		13 J		220 JB							
Phthalate Esters (cont.)																
Di-n-octyl Phthalate	µg/kg dw	1.9 U	15 U	1.4 U	27 U		1.6 U		84 U							
Dimethyl Phthalate	mg/kg OC			0.18 U			0.12 U									
Diethyl Phthalate	mg/kg OC			0.34 U			0.24 U									
Di-n-butyl Phthalate	mg/kg OC			0.29 JB			0.51 J									
Butylbenzyl Phthalate	mg/kg OC			0.15 U			0.1 U									
bis(2-ethylhexyl)phthalate	mg/kg OC			11 JB			0.68 J									
Di-n-octyl Phthalate	mg/kg OC			0.12 U			0.084 U									
Miscellaneous Nonionizable Organic Compounds																
Dibenzofuran	µg/kg dw	41	99 J	4.2 J	130 J		10 J		91 U							
Hexachlorobutadiene	µg/kg dw	2.2 U	17 U	1.7 U	32 U		1.8 U		98 U							
N-nitrosodiphenylamine	µg/kg dw	3.5 U	27 U	2.6 U	50 U		2.8 U		160 U							
Dibenzofuran	mg/kg OC			0.35 J			0.53 J									
Hexachlorobutadiene	mg/kg OC			0.14 U			0.095 U									
N-nitrosodiphenylamine	mg/kg OC			0.22 U			0.15 U									
Ionizable Organic Compounds																
Phenol	µg/kg dw	93	220 JB	51 JB	200 JB		150		270 JB	6.3 JB	140 JB		17 J		69 JB	17 J
2-Methylphenol	µg/kg dw	5.3 U	41 U	4 U	77 U		4.3 U		240 U	4.1 U	76 U		5.5 U		5 U	5.1 U
4-Methylphenol	µg/kg dw	170	840	13	560		230		11,000	3.5 U	690		75		12 J	210
2,4-Dimethylphenol	µg/kg dw	8.6 U	14 U	6.4 U	13 U		7 U		39 U	6.5 U	13 U		8.8 U		8.1 U	8.3 U
Pentachlorophenol	µg/kg dw	14 U	110 U	9.9 U	200 U		11 U		600 U	11 U	190 U		14 U		13 U	13 U
Benzoic Acid	µg/kg dw	150 U	1,200 U	120 J	2,200 U		180 J		6,700 U							
Other Semivolatile Organic Compounds																
Pyridine	µg/kg dw	4.7 U	36 U	3.5 U	68 U		3.8 U		210 U	3.6 U	67 U		4.8 U		4.5 U	4.5 U

Notes:

Source: Malcolm Pirnie. 2007. *Remedial Investigation for the Marine Environment near the Former Rayonier Mill Site, Port Angeles, Washington.* Public Review Draft. Prepared for Rayonier. February.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DDT Dichlorodiphenyltrichloroethane
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Micrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PAH Polycyclic aromatic hydrocarbon
PeCDD Pentachlorodibenzodioxin
PeCDF Pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Station ID		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Sample ID		MD-05-SSb	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS-SP	MD-09-SSb	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS-SP	MD-14-SSb	MD-15-SS-SP	MD-15-SSb	MD-16-SS
Sample Date		8/29/2002	8/16/2002	8/16/2002	8/16/2002	8/15/2002	8/29/2002	8/19/2002	8/16/2002	8/13/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/6/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Conventionals																
Acid-Volatile Sulfide	mg/kg dw		20	4	1.2	120		150 J	65	110 J	0.9 U	2.5		980		8.2 J
Sulfides	mg/kg dw	540	66	210	380		480	400	28	160	0.5 J		35		3,200	3.4
Total Organic Carbon	%	2.4	1.1	1.6	2.4	1.8	2.2	3.9	1.5	1.9	0.31	0.48	0.74	2.3	2.6	4.2
Total Solids	%	57.9	73.3	69.8	67.6	71.9	57.5	60.6	64	64.8	92.5	78.9	71	56.2	50.2	86.7
Total Volatile Solids	%	6.1	3	3.2	4.5		6.5	6.8	4	6.5	1.7		2.8		6.7	8.3
Nutrients																
Ammonia	mg/kg dw	15	6.2	22	8.4		11	8.1	14	13 J	0.7		7.4		16	9.5
Particle/Grain Size																
Percent Gravel	%		0.6	26	7.1	62		0.93	0.61	10	80	0.16		0.65		0.64
Percent Sand	%		88	58	63	20		49	70	57	21	87		30		87
Percent Silt	%		9	21	17	19		41	26	24	0.52	10		58		11
Percent Clay	%		2.6	3.8	5.4	4.3		8.9	6.1	6.3	0.26	2.9		11		3.6
Percent Fines (clay & silt)	%		12	25	22	23		50	32	31	0.78	13		69		15
Biochemical Measures																
12-Chlorodehydroabietic Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
14-Chlorodehydroabietic Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
3,4,5-Trichloroguaiacol	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Dehydroabietic Acid	mg/kg dw		0.98	0.64	0.55	0.57		2.8	0.63	0.52 U	0.36 U	0.42 U		0.82		1.3
Abietic Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		3.1	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.71
Dichlorodehydroabietic Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Dichlorostearic Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Isopimaric Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Linoleic Acid	mg/kg dw		0.45 U	0.96	0.49 U	0.46 U		0.58	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Oleic Acid	mg/kg dw															
Oleic-Linolenic Acid Mixture	mg/kg dw		0.45 U	1.7	0.68	2.4		1.7	0.77	0.52 U	0.61	0.84		3.3		0.38 U
Pimaric Acid	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Tetrachloroguaiacol	mg/kg dw		0.45 U	0.47 U	0.49 U	0.46 U		0.54 U	0.52 U	0.52 U	0.36 U	0.42 U		0.58 U		0.38 U
Metals																
Arsenic	mg/kg dw		4.1	3.5	4.2	4.2		5.5	3.8	3.5	3.1	3.2		5.3		4
Cadmium	mg/kg dw		0.24	0.21	0.3	0.27 J		0.45	0.23	0.22	0.04	0.16 J		0.49 J		0.29
Chromium	mg/kg dw															
Copper	mg/kg dw		9.3 J	13 J	15 J	20		21	14 J	13	33	25		31		22
Lead	mg/kg dw		4 J	4.7 J	7.1 J	5.9		10	7 J	5.2	3.1	4.7		11		9.9 J
Mercury	mg/kg dw		0.05 J	0.034 J	0.045 J	0.05		0.28	0.052 J	0.044	0.02	0.03		0.07		0.04
Selenium	mg/kg dw		0.5 J	0.5 J	0.5 J	0.4 J		0.8 J	0.5 J	0.5 J	0.3 J	0.2 U		0.8 J		0.3 J
Silver	mg/kg dw															
Zinc	mg/kg dw		24	29	33	41		49	38	28	28	48		67		36
Pesticides																
4,4'-DDD	µg/kg dw		0.21 U	0.48 J	0.74 J	0.43 U		2	1 J	0.56 J	0.17 U	0.2 U		0.81 J		2
4,4'-DDE	µg/kg dw		0.34 U	0.36 U	3 U	0.69 U		1.7 U	1.7 U	1 J	0.27 U	0.32 U		0.44 U		2.2
4,4'-DDT	µg/kg dw		1.1 J	1.2 J	8.4	2.8		8.2	3	2.9	0.19 U	0.67 J		5.3		17
alpha-Hexachlorocyclohexane	µg/kg dw		0.14 U	0.15 U	0.16 U	0.19 U		0.17 U	0.2 U	0.2 J	0.12 U	0.13 U		0.2 U		0.12 U
beta-Hexachlorocyclohexane	µg/kg dw		0.21 U	2.1 U	0.22 U	3.2 U		1.7 U	1.6 U	1.6 U	0.16 U	0.19 U		2.1		1.2 U

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Station ID		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Sample ID		MD-05-SSb	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS-SP	MD-09-SSb	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS-SP	MD-14-SSb	MD-15-SS-SP	MD-15-SSb	MD-16-SS
Sample Date		8/29/2002	8/16/2002	8/16/2002	8/16/2002	8/15/2002	8/29/2002	8/19/2002	8/16/2002	8/13/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/6/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Pesticides (cont.)																
delta-Hexachlorocyclohexane	µg/kg dw		0.51 U	0.53 U	0.55 U	0.63 U		0.61 U	0.58 U	0.57 U	0.4 U	0.47 U		1.7 U		0.43 U
gamma-Hexachlorocyclohexane	µg/kg dw		1.4 U	1.5 U	0.36 U	1.4 U		2.1 U	1.6 U	0.38 U	0.49 U	1.3 U		1.8 U		2.7 U
Dioxins/Furans																
2,3,7,8-TCDD	ng/kg dw				0.208 U											0.374 U
1,2,3,7,8-PeCDD	ng/kg dw				0.553 J											0.538 U
1,2,3,4,7,8-HxCDD	ng/kg dw				0.252 U											1.68 U
1,2,3,6,7,8-HxCDD	ng/kg dw				3.5 J											1.72 U
1,2,3,7,8,9-HxCDD	ng/kg dw				0.964 J											1.61 U
1,2,3,4,6,7,8-HpCDD	ng/kg dw				82.4											163
Total OCDD	ng/kg dw				874 JB											1,450 J
2,3,7,8-TCDF	ng/kg dw				1.14 J											1.5 J
1,2,3,7,8-PeCDF	ng/kg dw				0.629 J											0.343 U
2,3,4,7,8-PeCDF	ng/kg dw				0.961 J											0.39 U
1,2,3,4,7,8-HxCDF	ng/kg dw				1.43 JQ											0.775 U
1,2,3,6,7,8-HxCDF	ng/kg dw				0.673 J											0.798 U
1,2,3,7,8,9-HxCDF	ng/kg dw				0.338 U											1.3 U
2,3,4,6,7,8-HxCDF	ng/kg dw				0.295 U											1.12 U
1,2,3,4,6,7,8-HpCDF	ng/kg dw				20.2											12.3
1,2,3,4,7,8,9-HpCDF	ng/kg dw				0.556 J											6.22 U
Total OCDF	ng/kg dw				47.4											45 J
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw				2.94 J											2.35
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw				3.09 J											3.35
Polychlorinated Biphenyls (PCBs)																
Aroclor 1242	µg/kg dw					1.2 U		1.4 U	1.3 U		1.1 U	1.1 U		1.5 U		0.95 U
Aroclor 1254	µg/kg dw					1.2 U		1.4 U	1.3 U		1.1 U	1.1 U		1.5 U		0.95 U
Aroclor 1260	µg/kg dw					30		150	40		1.1 U	8.5 J		73		85
Total PCBs, Aroclors	µg/kg dw					30		150	40		1.1 U	8.5		73		85
Aroclor 1242	mg/kg OC					0.067 U			0.087 U		0.35 U	0.23 U		0.065 U		
Aroclor 1254	mg/kg OC					0.067 U			0.087 U		0.35 U	0.23 U		0.065 U		
Aroclor 1260	mg/kg OC					1.7			2.7		0.35 U	1.8 J		3.2		
Total PCBs, Aroclors	mg/kg OC					1.7			2.7		0.35 U	1.8		3.2		
Other																
Total TEQ	ng/kg dw				3.3											3.56
Aromatic Hydrocarbons																
Total LPAH	µg/kg dw	340	230	1,000	290		600	350	440	6.1	130		320		1,300	
Naphthalene	µg/kg dw	75	48	330	46			32	57	11	88		40			
Acenaphthylene	µg/kg dw	18	13	67	10			8.7	15	5.2	18		10			
Acenaphthene	µg/kg dw	18	12	71	11			10	15	2.3 J	23		11			
Fluorene	µg/kg dw	6.1	3.3	34	3.7			2.2	3.5	0.9 J	8.5		3			
Phenanthrene	µg/kg dw	8.7	5.8	54	6.7			2.7	8.9	1.3 J	14		4.8			
Anthracene	µg/kg dw	11	6.9	58	6.9			3.7	7.6	1.3	13		5.7			
2-Methylnaphthalene	µg/kg dw	8.7	5.3	41	5.2			2.9	4.2	1.3 J	10		4.3			
Total HPAH	µg/kg dw	90	50	94	59		150	150	92	1.9 J	19		88		240	

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Station ID		05	06	07	08	09	09	10	11	12	13	14	14	15	15	16
Sample ID		MD-05-SSb	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS-SP	MD-09-SSb	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS-SP	MD-14-SSb	MD-15-SS-SP	MD-15-SSb	MD-16-SS
Sample Date		8/29/2002	8/16/2002	8/16/2002	8/16/2002	8/15/2002	8/29/2002	8/19/2002	8/16/2002	8/13/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/6/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Aromatic Hydrocarbons (cont.)																
Fluoranthene	µg/kg dw		15	12 J	93	17		39 J	18	22	1.6 U	5.7 J		15 J		41
Pyrene	µg/kg dw		15	12 J	36	17		28 J	12 J	19	1.1 U	9.8 J		17 J		110
Benzo(a)anthracene	µg/kg dw		23	17	70	24		45 J	18	27	1.9 U	15		25		180
Chrysene	µg/kg dw		140	100	280	110		240	120	220	4.2 J	53		120		560
Total Benzofluoranthenes	µg/kg dw		54	38	460	59		99	33	59	1.6 U	26		53		160
Benzo(b)fluoranthene	µg/kg dw		17	14 J	35	16		33 J	20	23	1.5 J	6.9 J		20		96
Benzo(k)fluoranthene	µg/kg dw		29	26	390	30		62 J	13 J	65	2.8 U	15		31		150
Benzo(a)pyrene	µg/kg dw		58	43	580	52		110	28	53	1.8 U	26		51		220
Benzo(g,h,i)perylene	µg/kg dw		34	29	240	34		59 J	21	32	2.5 U	13		35		130
Indeno(1,2,3-cd)pyrene	µg/kg dw		35	29	290	34		63 J	19	32	2.1 U	15		34		140
Dibenzo(a,h)anthracene	µg/kg dw		9.1 J	7.6 J	90	10 J		19 U	4.1 J	8.5 J	2.4 U	4.2 J		9.2 J		36
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw		83	64	850	77		160	40	80	0.71	39		76		320
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw		83	64	850	77		160	40	80	2	39		76		320
Total LPAH	mg/kg OC		820	760	8,000	820		1,500	480	1,100	34	420		930		3,500
Naphthalene	mg/kg OC		200	210	1,600	180		330	130	280	16	85		240		880
Acenaphthylene	mg/kg OC		200	190	1,700	200		340	150	290	7.1 J	110		250		870
Acenaphthene	mg/kg OC		67	53	820	66		130	33	67	2.8 J	41		70		290
Fluorene	mg/kg OC		96	92	1,300	120		210	41	170	4 J	67		110		400
Phenanthrene	mg/kg OC		130	110	1,400	120		240	56	140	3.9	63		130		520
Anthracene	mg/kg OC		96	85	990	94		180	43	79	3.9 J	48		99		370
2-Methylnaphthalene	mg/kg OC		31	14	43	16			23	23	2	27		14		
Total HPAH	mg/kg OC		8.2	3.1	3.9	3.3			10	4.8	0.61 J	4		3.8		
Fluoranthene	mg/kg OC		1.4	0.75 J	3.9	0.94			1.2	1.2	0.52 U	1.2 J		0.65 J		
Pyrene	mg/kg OC		1.4	0.75 J	1.5	0.94			0.8 J	1	0.35 U	2 J		0.74 J		
Benzo(a)anthracene	mg/kg OC		2.1	1.1	2.9	1.3			1.2	1.4	0.61 U	3.1		1.1		
Chrysene	mg/kg OC		13	6.3	12	6.1			8	12	1.4 J	11		5.2		
Total Benzofluoranthenes	mg/kg OC		4.9	2.4	19	3.3			2.2	3.1	0.52 U	5.4		2.3		
Benzo(b)fluoranthene	mg/kg OC		1.5	0.88 J	1.5	0.89			1.3	1.2	0.48 J	1.4 J		0.87		
Benzo(k)fluoranthene	mg/kg OC		2.6	1.6	16	1.7			0.87 J	3.4	0.9 U	3.1		1.3		
Benzo(a)pyrene	mg/kg OC		5.3	2.7	24	2.9			1.9	2.8	0.58 U	5.4		2.2		
Benzo(g,h,i)perylene	mg/kg OC		3.1	1.8	10	1.9			1.4	1.7	0.81 U	2.7		1.5		
Indeno(1,2,3-cd)pyrene	mg/kg OC		3.2	1.8	12	1.9			1.3	1.7	0.68 U	3.1		1.5		
Dibenzo(a,h)anthracene	mg/kg OC		0.83 J	0.48 J	3.8	0.56 J			0.27 J	0.45 J	0.77 U	0.88 J		0.4 J		
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC		7.5	4	35	4.3			2.6	4.2	0.23	8.1		3.3		
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC		7.5	4	35	4.3			2.6	4.2	0.64	8.1		3.3		
1,2-Dichlorobenzene	µg/kg dw															
1,4-Dichlorobenzene	µg/kg dw															
1,2,4-Trichlorobenzene	µg/kg dw															
Hexachlorobenzene	µg/kg dw															
1,2-Dichlorobenzene	mg/kg OC															
1,4-Dichlorobenzene	mg/kg OC															
1,2,4-Trichlorobenzene	mg/kg OC															
Hexachlorobenzene	mg/kg OC															

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Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05MD-05	RAYONR05MD-06	RAYONR05MD-07	RAYONR05MD-08	RAYONR05MD-09	RAYONR05MD-09	RAYONR05MD-10	RAYONR05MD-11	RAYONR05MD-12	RAYONR05MD-13	RAYONR05MD-14	RAYONR05MD-14	RAYONR05MD-15	RAYONR05MD-15	RAYONR05MD-16
Sample ID		MD-05-SSb	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS-SP	MD-09-SSb	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS-SP	MD-14-SSb	MD-15-SS-SP	MD-15-SSb	MD-16-SS
Sample Date		8/29/2002	8/16/2002	8/16/2002	8/16/2002	8/15/2002	8/29/2002	8/19/2002	8/16/2002	8/13/2002	8/19/2002	8/15/2002	8/29/2002	8/15/2002	8/29/2002	8/6/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**															
Phthalate Esters																
Dimethyl Phthalate	µg/kg dw															
Diethyl Phthalate	µg/kg dw															
Di-n-butyl Phthalate	µg/kg dw															
Butylbenzyl Phthalate	µg/kg dw															
bis(2-ethylhexyl)phthalate	µg/kg dw															
Phthalate Esters (cont.)																
Di-n-octyl Phthalate	µg/kg dw															
Dimethyl Phthalate	mg/kg OC															
Diethyl Phthalate	mg/kg OC															
Di-n-butyl Phthalate	mg/kg OC															
Butylbenzyl Phthalate	mg/kg OC															
bis(2-ethylhexyl)phthalate	mg/kg OC															
Di-n-octyl Phthalate	mg/kg OC															
Miscellaneous Nonionizable Organic Compounds																
Dibenzofuran	µg/kg dw															
Hexachlorobutadiene	µg/kg dw															
N-nitrosodiphenylamine	µg/kg dw															
Dibenzofuran	mg/kg OC															
Hexachlorobutadiene	mg/kg OC															
N-nitrosodiphenylamine	mg/kg OC															
Ionizable Organic Compounds																
Phenol	µg/kg dw	23 JB	120	27 JB	29 J		61 JB	82	250	12 JB	15 J		46 J		60	
2-Methylphenol	µg/kg dw	4.7 U	4.9 U	5.1 U	4.8 U		29 U	5.4 U	5.3 U	3.7 U	4.4 U		6.1 U		4 U	
4-Methylphenol	µg/kg dw	29	210	140	77		300	150	1,400	3.2 U	22		210		230	
2,4-Dimethylphenol	µg/kg dw	7.6 U	7.9 U	8.2 U	7.7 U		9.1 U	8.6 U	8.5 U	6 U	7 U		9.8 U		6.4 U	
Pentachlorophenol	µg/kg dw	12 U	13 U	13 U	12 U		71 U	14 U	14 U	9.2 U	11 U		16 U		9.9 U	
Benzoic Acid	µg/kg dw															
Other Semivolatile Organic Compounds																
Pyridine	µg/kg dw	4.1 U	4.3 U	4.5 U	4.2 U		25 U	4.7 U	4.7 U	3.3 U	3.9 U		5.4 U		3.5 U	

Notes:

Source: Malcolm Pirnie. 2007. *Remedial Investigation for the Marine Environment near the Former Rayonier Mill Site, Port Angeles, Washington.* Public Review Draft. Prepared for Rayonier. February.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DDT Dichlorodiphenyltrichloroethane
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Micrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PAH Polycyclic aromatic hydrocarbon
PeCDD Pentachlorodibenzodioxin
PeCDF Pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05MD-17	RAYONR05MD-18	RAYONR05OF-01	RAYONR05OF-02	RAYONR05OF-03	RAYONR05OF-04	RAYONR05OF-05	RAYONR05OF-06	RAYONR05OF-07	RAYONR05OF-08
Sample ID		MD-17-SS	MD-18-SS	OF-01-SS	OF-02-SS	OF-03-SS	OF-04-SS	OF-05-SS	OF-06-SS	OF-07-SS	OF-08-SS
Sample Date		8/20/2002	8/6/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/19/2002	8/20/2002	8/19/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Conventionals											
Acid-Volatile Sulfide	mg/kg dw	1,800	91 J			1.5 J	3.1 J	5.5 J			
Sulfides	mg/kg dw	790	10	3 J	2 J	1.8	5 U	2 J			
Total Organic Carbon	%	2.5	1.7	0.64	0.72	0.63	0.64	0.47	0.4	0.57	0.61
Total Solids	%	50.8	79.8	68.1	70.5	73.8	73.4	76.7	75.6	69.5	71.5
Total Volatile Solids	%	7.8	4	2.3	2.4	2.4	2.4	2	1.7	17.1	3
Nutrients											
Ammonia	mg/kg dw	17	8.1	5.8	6	7.6	7.6	7.9			
Particle/Grain Size											
Percent Gravel	%	15	2.3	0.14	0.18	0.11	0.08	0.1	0.58	0.17	4
Percent Sand	%	46	90	73	78	78	81	84	87	78	76
Percent Silt	%	33	10	18	17	16	14	11	8.5	14	14
Percent Clay	%	10	2.3	7.6	7.9	5.9	5.7	4.6	3.5	6.4	4.9
Percent Fines (clay & silt)	%	43	12	25	25	21	20	16	12	20	19
Biochemical Measures											
12-Chlorodehydroabietic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
14-Chlorodehydroabietic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
3,4,5-Trichloroguaiacol	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Dehydroabietic Acid	mg/kg dw	1.4	0.44			0.46 U	0.46 U	0.43 U			
Abietic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Dichlorodehydroabietic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Dichlorostearic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Isopimaric Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Linoleic Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Oleic Acid	mg/kg dw										
Oleic-Linolenic Acid Mixture	mg/kg dw	0.74	0.41 U			0.46 U	0.46 U	0.43 U			
Pimaric Acid	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Tetrachloroguaiacol	mg/kg dw	0.65 U	0.41 U			0.46 U	0.46 U	0.43 U			
Metals											
Arsenic	mg/kg dw	4.6	4.8			2.6	2.4	2.4			
Cadmium	mg/kg dw	0.51	0.34			0.088	0.092	0.071			
Chromium	mg/kg dw	29									
Copper	mg/kg dw	27	12			11	11	10			
Lead	mg/kg dw	9.2	20 J			4.7	4.3	4			
Mercury	mg/kg dw	0.06	0.06			0.03	0.03	0.03			
Selenium	mg/kg dw	0.7 J	0.5 J			0.5 J	0.5 J	0.4 J			
Silver	mg/kg dw	0.2 J									
Zinc	mg/kg dw	51	31			40	39	40			
Pesticides											
4,4'-DDD	µg/kg dw	1.2 J	0.38 U			0.22 U	0.21 U	0.2 U			
4,4'-DDE	µg/kg dw	2 U	1.1 U			0.34 U	0.34 U	0.32 U			
4,4'-DDT	µg/kg dw	9.7	11			0.42 J	0.24 U	0.23 U			
alpha-Hexachlorocyclohexane	µg/kg dw	0.64 U	0.13 U			0.14 U	0.14 U	0.14 U			
beta-Hexachlorocyclohexane	µg/kg dw	2 U	0.19 U			1.4 U	1.4 U	0.2 U			

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05MD-17	RAYONR05MD-18	RAYONR05OF-01	RAYONR05OF-02	RAYONR05OF-03	RAYONR05OF-04	RAYONR05OF-05	RAYONR05OF-06	RAYONR05OF-07	RAYONR05OF-08
Sample ID		MD-17-SS	MD-18-SS	OF-01-SS	OF-02-SS	OF-03-SS	OF-04-SS	OF-05-SS	OF-06-SS	OF-07-SS	OF-08-SS
Sample Date		8/20/2002	8/6/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/19/2002	8/20/2002	8/19/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Pesticides (cont.)											
delta-Hexachlorocyclohexane	µg/kg dw	0.73 U	0.56 U			0.5 U	0.51 U	0.49 U			
gamma-Hexachlorocyclohexane	µg/kg dw	0.48 U	0.31 U			1.4 U	0.34 U	1.4 U			
Dioxins/Furans											
2,3,7,8-TCDD	ng/kg dw	2.63	0.308 U					0.087 U	0.086 U		
1,2,3,7,8-PeCDD	ng/kg dw	1.1 J	0.376 U					0.082 U	0.118 U		
1,2,3,4,7,8-HxCDD	ng/kg dw	1.22 J	0.745 U					0.088 U	0.131 U		
1,2,3,6,7,8-HxCDD	ng/kg dw	8.51	2.19 J					0.743 J	0.475 J		
1,2,3,7,8,9-HxCDD	ng/kg dw	4.5 J	0.702 U					0.091 U	0.124 U		
1,2,3,4,6,7,8-HpCDD	ng/kg dw	263	55					5.32	3.7 J		
Total OCDD	ng/kg dw	3,830 JB	589 J					29.4	20.7		
2,3,7,8-TCDF	ng/kg dw	2.1 J	0.954 J					0.504 J	0.146 U		
1,2,3,7,8-PeCDF	ng/kg dw	0.904 J	0.276 U					0.101 U	0.106 U		
2,3,4,7,8-PeCDF	ng/kg dw	1.6 J	0.281 U					0.099 U	0.105 U		
1,2,3,4,7,8-HxCDF	ng/kg dw	3.47 J	0.351 U					0.251 J	0.219 J		
1,2,3,6,7,8-HxCDF	ng/kg dw	1 J	0.37 U					0.069 U	0.187 J		
1,2,3,7,8,9-HxCDF	ng/kg dw	0.309 U	0.538 U					0.095 U	0.116 U		
2,3,4,6,7,8-HxCDF	ng/kg dw	1.31 J	0.464 U					0.073 U	0.078 U		
1,2,3,4,6,7,8-HpCDF	ng/kg dw	26.7	5.44					1.3 J	0.833 J		
1,2,3,4,7,8,9-HpCDF	ng/kg dw	1.6 J	1.67 U					0.259 U	0.297 U		
Total OCDF	ng/kg dw	160	25.7 J					1.99 J	1.46 J		
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	10.6 J	1.1					0.225	0.14		
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	10.6 J	1.66					0.348	0.291		
Polychlorinated Biphenyls (PCBs)											
Aroclor 1242	µg/kg dw	1.7 U	1.1 U	0.96 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U	0.89 U
Aroclor 1254	µg/kg dw	150	1.1 U	0.96 U	3.5 J	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U	0.89 U
Aroclor 1260	µg/kg dw	140	130	0.96 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U	0.89 U
Total PCBs, Aroclors	µg/kg dw	290	130	0.96 U	3.5	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U	0.89 U
Aroclor 1242	mg/kg OC	0.068 U	0.065 U	0.15 U	0.17 U	0.19 U	0.19 U	0.23 U	0.28 U	0.19 U	0.15 U
Aroclor 1254	mg/kg OC	6	0.065 U	0.15 U	0.49 J	0.19 U	0.19 U	0.23 U	0.28 U	0.19 U	0.15 U
Aroclor 1260	mg/kg OC	5.6	7.6	0.15 U	0.17 U	0.19 U	0.19 U	0.23 U	0.28 U	0.19 U	0.15 U
Total PCBs, Aroclors	mg/kg OC	12	7.6	0.15 U	0.49	0.19 U	0.19 U	0.23 U	0.28 U	0.19 U	0.15 U
Other											
Total TEQ	ng/kg dw	10.8	1.87					0.558	5.01		
Aromatic Hydrocarbons											
Total LPAH	µg/kg dw	1,900	2,200	28	48	27	26	16			
Naphthalene	µg/kg dw	250	430	9.6	16	4.1	4.2	3			
Acenaphthylene	µg/kg dw	44	130	1.9 J	3.5	0.9 J	0.88 J	0.89 J			
Acenaphthene	µg/kg dw	44	130	2 J	3.3	1.1 J	1.2 J	1 J			
Fluorene	µg/kg dw	27	24	1 J	1.4 J	0.44 J	0.39 J	0.4 U			
Phenanthrene	µg/kg dw	44	46	2.2 J	1.7 J	0.65 J	0.63 J	0.6 J			
Anthracene	µg/kg dw	47	53	1.2	2.5	0.62	0.63	0.7 U			
2-Methylnaphthalene	µg/kg dw	34	32	1.2 J	1.9 J	0.62 J	0.63 J	0.7 U			
Total HPAH	µg/kg dw	150	140	7.7 J	8.8 J	9.1 J	8.9 J	4.9 J			

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05MD-17	RAYONR05MD-18	RAYONR05OF-01	RAYONR05OF-02	RAYONR05OF-03	RAYONR05OF-04	RAYONR05OF-05	RAYONR05OF-06	RAYONR05OF-07	RAYONR05OF-08
Sample ID		MD-17-SS	MD-18-SS	OF-01-SS	OF-02-SS	OF-03-SS	OF-04-SS	OF-05-SS	OF-06-SS	OF-07-SS	OF-08-SS
Sample Date		8/20/2002	8/6/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/19/2002	8/20/2002	8/19/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Aromatic Hydrocarbons (cont.)											
Fluoranthene	µg/kg dw	98	71	2.1 U	2 U	1.9 U	2 U	1.9 U			
Pyrene	µg/kg dw	120	65	1.5 U	2.8 J	1.4 U	1.4 U	1.4 U			
Benzo(a)anthracene	µg/kg dw	190	83	3.5 J	5.1 J	4.2 J	3.6 J	2.5 J			
Chrysene	µg/kg dw	700	1,600	14 J	27	14	13 J	8.4 J			
Total Benzofluoranthenes	µg/kg dw	620	220	2.9 J	4.7 J	1.9 U	2 U	1.9 U			
Benzo(b)fluoranthene	µg/kg dw	85	60	10 J	12 J	18	12 J	6.7 J			
Benzo(k)fluoranthene	µg/kg dw	310	350	3.7 U	4.1 J	3.4 U	3.5 U	3.3 U			
Benzo(a)pyrene	µg/kg dw	460	350	4.4 J	11 J	2.5 J	3.4 J	2.4 J			
Benzo(g,h,i)perylene	µg/kg dw	210	160	3.4 U	9.5 J	3.2 U	3.2 U	3 U			
Indeno(1,2,3-cd)pyrene	µg/kg dw	260	190	3.3 J	8.8 J	2.6 U	2.6 U	2.5 U			
Dibenzo(a,h)anthracene	µg/kg dw	81	61	3.3 U	3.2 U	3 U	3 U	2.9 U			
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	690	510	6.3	15	3.2	4.1	2.4			
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	690	510	6.7	15	3.7	4.5	3.1			
Total LPAH	mg/kg OC	6,200	7,200	61	120	26	27	14			
Naphthalene	mg/kg OC	1,100	2,200	12 J	25	5.7 J	5.6 J	4.2 J			
Acenaphthylene	mg/kg OC	1,100	2,200	13 J	24	7.1 J	7.6 J	4.9 J			
Acenaphthene	mg/kg OC	680	400	6.7 J	10 J	2.8 J	2.5 J	1.9 U			
Fluorene	mg/kg OC	1,100	780	14 J	12 J	4.1 J	4 J	2.8 J			
Phenanthrene	mg/kg OC	1,200	900	7.9	18	3.9	4	3.3 U			
Anthracene	mg/kg OC	860	550	7.9 J	14 J	3.9 J	4 J	3.3 U			
2-Methylnaphthalene	mg/kg OC	75	130	4.4	6.7	4.3	4	3.4			
Total HPAH	mg/kg OC	6	8.2	1.2 J	1.2 J	1.4 J	1.4 J	1 J			
Fluoranthene	mg/kg OC	3.9	4.2	0.33 U	0.28 U	0.3 U	0.31 U	0.4 U			
Pyrene	mg/kg OC	4.8	3.8	0.23 U	0.39 J	0.22 U	0.22 U	0.3 U			
Benzo(a)anthracene	mg/kg OC	7.6	4.9	0.55 J	0.71 J	0.67 J	0.56 J	0.53 J			
Chrysene	mg/kg OC	28	94	2.2 J	3.8	2.2	2 J	1.8 J			
Total Benzofluoranthenes	mg/kg OC	25	13	0.45 J	0.65 J	0.3 U	0.31 U	0.4 U			
Benzo(b)fluoranthene	mg/kg OC	3.4	3.5	1.6 J	1.7 J	2.9	1.9 J	1.4 J			
Benzo(k)fluoranthene	mg/kg OC	12	21	0.58 U	0.57 J	0.54 U	0.55 U	0.7 U			
Benzo(a)pyrene	mg/kg OC	18	21	0.69 J	1.5 J	0.4 J	0.53 J	0.51 J			
Benzo(g,h,i)perylene	mg/kg OC	8.4	9.4	0.53 U	1.3 J	0.51 U	0.5 U	0.64 U			
Indeno(1,2,3-cd)pyrene	mg/kg OC	10	11	0.52 J	1.2 J	0.41 U	0.41 U	0.53 U			
Dibenzo(a,h)anthracene	mg/kg OC	3.2	3.6	0.52 U	0.44 U	0.48 U	0.47 U	0.62 U			
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC	28	30	0.99	2.1	0.51	0.64	0.52			
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC	28	30	1	2.1	0.58	0.71	0.66			
1,2-Dichlorobenzene	µg/kg dw										
1,4-Dichlorobenzene	µg/kg dw										
1,2,4-Trichlorobenzene	µg/kg dw										
Hexachlorobenzene	µg/kg dw										
1,2-Dichlorobenzene	mg/kg OC										
1,4-Dichlorobenzene	mg/kg OC										
1,2,4-Trichlorobenzene	mg/kg OC										
Hexachlorobenzene	mg/kg OC										

Table C.1
Remedial Investigation for the Marine Environment near the Former Rayonier Site (2002)

Station ID		RAYONR05MD-17	RAYONR05MD-18	RAYONR05OF-01	RAYONR05OF-02	RAYONR05OF-03	RAYONR05OF-04	RAYONR05OF-05	RAYONR05OF-06	RAYONR05OF-07	RAYONR05OF-08
Sample ID		MD-17-SS	MD-18-SS	OF-01-SS	OF-02-SS	OF-03-SS	OF-04-SS	OF-05-SS	OF-06-SS	OF-07-SS	OF-08-SS
Sample Date		8/20/2002	8/6/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/20/2002	8/19/2002	8/20/2002	8/19/2002
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Phthalate Esters											
Dimethyl Phthalate	µg/kg dw										
Diethyl Phthalate	µg/kg dw										
Di-n-butyl Phthalate	µg/kg dw										
Butylbenzyl Phthalate	µg/kg dw										
bis(2-ethylhexyl)phthalate	µg/kg dw										
Phthalate Esters (cont.)											
Di-n-octyl Phthalate	µg/kg dw										
Dimethyl Phthalate	mg/kg OC										
Diethyl Phthalate	mg/kg OC										
Di-n-butyl Phthalate	mg/kg OC										
Butylbenzyl Phthalate	mg/kg OC										
bis(2-ethylhexyl)phthalate	mg/kg OC										
Di-n-octyl Phthalate	mg/kg OC										
Miscellaneous Nonionizable Organic Compounds											
Dibenzofuran	µg/kg dw										
Hexachlorobutadiene	µg/kg dw										
N-nitrosodiphenylamine	µg/kg dw										
Dibenzofuran	mg/kg OC										
Hexachlorobutadiene	mg/kg OC										
N-nitrosodiphenylamine	mg/kg OC										
Ionizable Organic Compounds											
Phenol	µg/kg dw	26 JB	26 JB	120	230	240	240	170			
2-Methylphenol	µg/kg dw	6.7 U	3.9 U	5 U	4.9 U	4.7 U	4.7 U	4.5 U			
4-Methylphenol	µg/kg dw	210	69	6.5 J	11 J	30	63	12 J			
2,4-Dimethylphenol	µg/kg dw	11 U	6.3 U	8.1 U	7.9 U	7.5 U	7.5 U	7.2 U			
Pentachlorophenol	µg/kg dw	17 U	9.7 U	13 U	13 U	12 U	12 U	12 U			
Benzoic Acid	µg/kg dw										
Other Semivolatile Organic Compounds											
Pyridine	µg/kg dw	6 U	3.4 U	4.5 U	4.3 U	4.1 U	4.1 U	4 U			

Notes:

Source: Malcolm Pirnie. 2007. *Remedial Investigation for the Marine Environment near the Former Rayonier Mill Site, Port Angeles, Washington.* Public Review Draft. Prepared for Rayonier. February.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm	Centimeters	DL	Detection limit	HxCDF	Hexachlorodibenzofi	Hexachlorodibenzofuran	ng/kg dw	Nanograms per kilogram dry weight	PeCDF	Pentachlorodibenzofuran
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	HPAH	High molecular weight polycyclic aromatic hydrocarbon	LPAH	Low molecular weigl	Low molecular weight polycyclic aromatic hydrocarbon	OCDD	Octachlorodibenzodioxin	QC	Quality control
DDD	Dichlorodiphenyldichloroethane	HpCDD	Heptachlorodibenzodioxin	µg/kg dw	Micrograms per kilo	Micrograms per kilogram dry weight	OCDF	Octachlorodibenzofuran	TCDD	Tetrachlorodibenzodioxin
DDE	Dichlorodiphenyldichloroethylene	HpCDF	Heptachlorodibenzofuran	mg/kg dw	Milligrams per kilogr	Milligrams per kilogram dry weight	PAH	Polycyclic aromatic hydrocarbon	TCDF	Tetrachlorodibenzodioxin
DDT	Dichlorodiphenyltrichloroethane	HxCDD	Hexachlorodibenzodioxin	mg/kg OC	Milligrams per kilogr	Milligrams per kilogram organic carbon normalized	PeCDD	Pentachlorodibenzodioxin	TEQ	Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.

JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.

JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.

U Analyte was not detected, concentration given is the reporting limit.

Table C.2
Cypress Ediz Hook Smolt and American Gold Seafoods NPDES Permit Monitoring (2003, 2007, and 2010)

						Conventionals	Metals		Particle/Grain Size		
					Analyte	Total Organic Carbon	Copper	Zinc	Percent Gravel	Percent Sand	Percent Fines (Clay & Silt)
					Units	%	mg/kg dw	mg/kg dw	%	%	%
Station ID	Sample ID	Sample Date	Depth Range (cm)	Field QC	Reoccupied						
2003											
CIPA2003PASE0_1	PASE0_1	9/23/2003	0–2	Field Sample	No	1.7	25	98	0.04	55	
CIPA2003PASE0_2	PASE0_2	9/23/2003	0–2	Field Sample	No	1.8	24	80	0.09	58	
CIPA2003PASE0_3	PASE0_3	9/23/2003	0–2	Field Sample	No	1.4	23	85		63	
CIP2003PASE50_1	PASE50_1	9/23/2003	0–2	Field Sample	No	1.4	21	70	0.21	63	
CIP2003PASE50_2	PASE50_2	9/23/2003	0–2	Field Sample	No	1.7	23	73	0.04	56	
CIP2003PASE50_3	PASE50_3	9/23/2003	0–2	Field Sample	No	1.3	22	72		61	
CIP2003PASE1001	PASE100_1	9/23/2003	0–2	Field Sample	No	1.4	21	69	0.03	60	
CIP2003PASE1002	PASE100_2	9/23/2003	0–2	Field Sample	No	1.5	21	69		59	
CIP2003PASE1003	PASE100_3	9/23/2003	0–2	Field Sample	No	1.6	23	74	0.08	55	
CIP2003PASN1001	PASN100_1	9/23/2003	0–2	Field Sample	No	1.8	33	100	0.08	47	
CIP2003PASN1002	PASN100_2	9/23/2003	0–2	Field Sample	No	1.8	30	120	0.41	47	
CIP2003PASN1003	PASN100_3	9/23/2003	0–2	Field Sample	No	1.8	26	76	0.05	39	
CIP2003PASS1001	PASS100_1	9/23/2003	0–2	Field Sample	No	1.1	21	65	4.7	57	
CIP2003PASS1002	PASS100_2	9/23/2003	0–2	Field Sample	No	1.6	24	72	0.02	55	
CIP2003PASS1003	PASS100_3	9/23/2003	0–2	Field Sample	No	1.4	22	70	0.79	55	
CIP2003PASW1001	PASW100_1	9/23/2003	0–2	Field Sample	No	1.7	27	83	0.03	50	
CIP2003PASW1002	PASW100_2	9/23/2003	0–2	Field Sample	No	2	29	97		47	
CIP2003PASW1003	PASW100_3	9/23/2003	0–2	Field Sample	No	1.5	34	86	0.24	52	
2007											
PAEE00	PAEE00	8/29/2007	0–2	Field Sample	No	1.67	18	80			57
	PAEE00	8/29/2007	0–2	Duplicate	No	1.9	21	87			60
	PAEE00	8/29/2007	0–2	Triplicate	No	1.8	22	78			61
	PAEE00	8/29/2007	0–2	Quad	No	1.73	19	74			59
	PAEE00	8/29/2007	0–2	Quint	No	1.79	19	77			65
PAEE50_2010	PAEE50	8/29/2007	0–2	Field Sample	No	1.89	84	81			59
	PAEE50	8/29/2007	0–2	Duplicate	No	2.04	22	82			59
	PAEE50	8/29/2007	0–2	Triplicate	No	1.63	17	66			56
	PAEE50	8/29/2007	0–2	Quad	No	1.37	20	69			55
	PAEE50	8/29/2007	0–2	Quint	No	1.96	19	71			56
PAEN00	PAEN00	8/29/2007	0–2	Field Sample	No	1.99	20	66			83
	PAEN00	8/29/2007	0–2	Duplicate	No	1.9	20	68			80
	PAEN00	8/29/2007	0–2	Triplicate	No	2.28	19	68			77
	PAEN00	8/29/2007	0–2	Quad	No	2.25	18	66			74
	PAEN00	8/29/2007	0–2	Quint	No	1.95	23	70			80

Table C.2
Cypress Ediz Hook Smolt and American Gold Seafoods NPDES Permit Monitoring (2003, 2007, and 2010)

						Conventionals	Metals		Particle/Grain Size		
					Analyte	Total Organic Carbon	Copper	Zinc	Percent Gravel	Percent Sand	Percent Fines (Clay & Silt)
					Units	%	mg/kg dw	mg/kg dw	%	%	%
Station ID	**Sample ID**	**Sample Date**	**Depth Range (cm)**	**Field QC**	**Reoccupied**						
2007 (cont.)											
PAES00	PAES00	8/29/2007	0–2	Field Sample	No	1.67	15	61			38
	PAES00	8/29/2007	0–2	Duplicate	No	1.9	13	60			44
	PAES00	8/29/2007	0–2	Triplicate	No	1.8	15	63			40
	PAES00	8/29/2007	0–2	Quad	No	1.73	13	57			40
	PAES00	8/29/2007	0–2	Quint	No	1.79	15	60			40
PAEW00	PAEW00	8/29/2007	0–2	Field Sample	No	2.68	22	110			59
	PAEW00	8/29/2007	0–2	Duplicate	No	1.83	19	100			55
	PAEW00	8/29/2007	0–2	Triplicate	No	1.93	13	140			51
	PAEW00	8/29/2007	0–2	Quad	No	1.66	22	110			55
	PAEW00	8/29/2007	0–2	Quint	No	2.32	29	1,500			59
PAWE00	PAWE00	8/29/2007	0–2	Field Sample	No	2.1	21	76			68
	PAWE00	8/29/2007	0–2	Duplicate	No	1.92	19	77			67
	PAWE00	8/29/2007	0–2	Triplicate	No	1.97	19	77			67
	PAWE00	8/29/2007	0–2	Quad	No	2.18	16	68			66
	PAWE00	8/29/2007	0–2	Quint	No	2.13	19	74			64
PAWS00	PAWS00	8/29/2007	0–2	Field Sample	No	1.92	18	67			54
	PAWS00	8/29/2007	0–2	Duplicate	No	1.85	17	67			55
	PAWS00	8/29/2007	0–2	Triplicate	No	1.86	21	65			52
	PAWS00	8/29/2007	0–2	Quad	No	1.81	15	64			50
	PAWS00	8/29/2007	0–2	Quint	No	1.49	16	69			54
PAWW00	PAWW00	8/29/2007	0–2	Field Sample	No	2.06	17	57			74
	PAWW00	8/29/2007	0–2	Duplicate	No	1.88	26	150			71
	PAWW00	8/29/2007	0–2	Triplicate	No	2.26	21	67			69
	PAWW00	8/29/2007	0–2	Quad	No	2.34	26	100			77
	PAWW00	8/29/2007	0–2	Quint	No	2.32	25	200			76
PAWW50_2010	PAWW50	8/29/2007	0–2	Field Sample	No	2.41	23	89			67
	PAWW50	8/29/2007	0–2	Duplicate	No	2.25	22	75			73
	PAWW50	8/29/2007	0–2	Triplicate	No	2.36	38	350			68
	PAWW50	8/29/2007	0–2	Quad	No	2.02	25	74			65
	PAWW50	8/29/2007	0–2	Quint	No	2.92	34	660			67
2010											
PAEE100	PAEE100	8/10/2010	0–2	Field Sample	No	2.35	59	72			47
	PAEE100	8/10/2010	0–2	Duplicate	No	2.63	47	69			53
	PAEE100	8/10/2010	0–2	Triplicate	No	2.07	32	73			50
	PAEE100	8/10/2010	0–2	Quad	No	2.77	35	72			53
	PAEE100	8/10/2010	0–2	Quint	No	2.51	32	72			54

Table C.2
Cypress Ediz Hook Smolt and American Gold Seafoods NPDES Permit Monitoring (2003, 2007, and 2010)

						Conventionals	Metals		Particle/Grain Size		
					Analyte	Total Organic Carbon	Copper	Zinc	Percent Gravel	Percent Sand	Percent Fines (Clay & Silt)
					Units	%	mg/kg dw	mg/kg dw	%	%	%
Station ID	**Sample ID**	**Sample Date**	**Depth Range (cm)**	**Field QC**	**Reoccupied**						
2010 (cont.)											
PAEE50_2010	PAEE50	8/10/2010	0–2	Field Sample	No	3.74	43	81			52
	PAEE50	8/10/2010	0–2	Duplicate	No	2.65	91	77			47
	PAEE50	8/10/2010	0–2	Triplicate	No	2.82	46	81			46
	PAEE50	8/10/2010	0–2	Quad	No	2.4	160	79			55
	PAEE50	8/10/2010	0–2	Quint	No	2.26	27	100			42
PAEN100	PAEN100	8/10/2010	0–2	Field Sample	No	2.47	33	70			57
	PAEN100	8/10/2010	0–2	Duplicate	No	2.31	27	66			52
PAEW100	PAEW100	8/10/2010	0–2	Field Sample	No	1.37	20	63			41
	PAEW100	8/10/2010	0–2	Duplicate	No	2.89	22	71			45
	PAEW100	8/10/2010	0–2	Triplicate	No	2.74	32	91			41
	PAEW100	8/10/2010	0–2	Quad	No	1.82	29	87			39
	PAEW100	8/10/2010	0–2	Quint	No	1.87	37	68			32
PAWE100	PAWE100	8/10/2010	0–2	Field Sample	No	2.79	29	60			66
	PAWE100	8/10/2010	0–2	Duplicate	No	2.3	28	64			66
	PAWE100	8/10/2010	0–2	Triplicate	No	2.97	30	69			55
	PAWE100	8/10/2010	0–2	Quad	No	4.08	30	70			61
	PAWE100	8/10/2010	0–2	Quint	No	2.89	30	67			61
PAWS100	PAWS100	8/10/2010	0–2	Field Sample	No	2.53	34	69			61
	PAWS100	8/10/2010	0–2	Duplicate	No	2.83	31	61			49
PAWW100	PAWW100	8/10/2010	0–2	Field Sample	No	2.17	31	230			61
	PAWW100	8/10/2010	0–2	Duplicate	No	2.63	31	76			59
	PAWW100	8/10/2010	0–2	Triplicate	No	2.76	26	69			56
	PAWW100	8/10/2010	0–2	Quad	No	3.39	26	67			59
	PAWW100	8/10/2010	0–2	Quint	No	2.76	35	73			59
PAWW50_2010	PAWW50	8/10/2010	0–2	Field Sample	No	2.82	44	68			58
	PAWW50	8/10/2010	0–2	Duplicate	No	2.8	39	220			56
	PAWW50	8/10/2010	0–2	Triplicate	No	3.42	46	69			57
	PAWW50	8/10/2010	0–2	Quad	No	2.4	33	78			62
	PAWW50	8/10/2010	0–2	Quint	No	3.13	28	75			63

Note:
Blank cells are intentional.

Abbreviations:
cm Centimeters
NPDES National Pollutant Discharge Elimination System
QC Quality Control

Table C.3
City of Port Angeles NPDES Permit Monitoring (2003, 2004 and 2010)

Station ID		PA_STP04CSO-006	PA_STP04CSO-007	PA_STP04CSO-008	PA_STP04CSO-010	PA_STP04E250	PA_STP04N250	PA_STP04NE-35	PA_STP04NW-35	PA_STP04SE-35		PA_STP04SW-35	PA_STP04W250	PA_STP10-01	PA_STP10-02
Sample ID		CSO-006	CSO-007	CSO-008	CSO-010	E250	N250	NE-35	NW-35	SE-35	SE-35	SW-35	W250	PA_STP10-01	PA_STP10-02
Sample Date		9/23/2003	9/23/2003	9/23/2003	9/23/2003	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	9/8/2010	9/8/2010
Depth Range (cm)		0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH038	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Conventionals															
Sulfides	mg/kg dw	160	920	83	10	29 J	15 J	16 J	18 J	12 UJ	11 UJ	11 J	13 UJ	360	110
Total Organic Carbon	%	1.49	2.53	0.73	0.39	0.736	0.893	1.18	0.829	0.44	0.46	0.392	0.647	0.999	0.56
Total Solids	%	70.1	60.9	75.9	78.7	71	68.8	72.5	72.1	77.7	77.4	78.6	71.9	73.9	71.1
Total Solids, Preserved	%													74	74
Nutrients															
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	110	150	47	66	88	84	75	68	44	49	48	65	26	9.2
Particle/Grain Size															
Phi Class 10.00+	%													1.4	1.4
Phi Class 9.00+ to 10.00	%													0.6	0.4
Phi Class 8.00+ to 9.00	%													0.5	0.5
Phi Class 7.00+ to 8.00	%													0.5	0.6
Phi Class 6.00+ to 7.00	%													1.1	1.3
Phi Class 5.00+ to 6.00	%													3.5	2.5
Phi Class 4.00+ to 5.00	%													8	2.4
Phi Class 3.00+ to 4.00	%													21	12
Phi Class 2.00+ to 3.00	%													15	28
Phi Class 1.00+ to 2.00	%													9.2	20
Phi Class 0.00+ to 1.00	%													8.1	12
Phi Class -1.00+ to 0.00	%													11	6.9
Phi Class less (size greater) than -1.00	%													20	12
Percent Fines (clay & silt)	%													16	9.2
Percent Gravel	%	0.1 U	0.2	11	0.8	0.1 U	0.1 U	0.1 U	0.1	0.2	0.2	0.7	0.1 U		
Percent Sand	%	39	46	78	88	68	65	72	76	81	81	86	73		
Metals															
Arsenic	mg/kg dw	1.7	3.6	2.8	1.3 U	3.4	3.9	3.2	3.1	2.4	2.2	2.6	3.6	7 U	20 U
Cadmium	mg/kg dw	0.68 U	0.9	0.65 U	0.63 U	1.1	0.096	0.13	0.073	0.42	0.5	0.13	0.38	0.8	0.7 U
Chromium	mg/kg dw	23	30	36	15	21	23	21	18	16	16	16	21	28	45
Copper	mg/kg dw	19	53	32	7.2	16	16	14	13	12	12	9.9	16	64	36
Lead	mg/kg dw	28	27	8.6	2.7	5	5.1	4.6	3.9	8.8	2.9	2.6	5	46	13
Mercury	mg/kg dw	0.12	0.95	0.041	0.039	0.041	0.04	0.04	0.034	0.013	0.017	0.022	0.045	0.07	0.05
Silver	mg/kg dw	1.4 UJ	1.6 U	1.3 U	1.3 U	0.068 U	0.06 U	0.063 U	0.067 U	0.064 U	0.068 U	0.065 U	0.08	0.4 U	1 U
Zinc	mg/kg dw	58	230	86	22	51	53	41	41	37	32	32	51	100	120
Polychlorinated Biphenyls (PCBs)															
Aroclor 1016	µg/kg dw	67 U	76 U	5.8 UJ	62 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	3.9 U	3.9 U
Aroclor 1221	µg/kg dw	130 U	150 U	12 UJ	120 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	3.9 U	3.9 U
Aroclor 1232	µg/kg dw	67 U	76 U	5.8 UJ	62 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	3.9 U	5.8 U
Aroclor 1242	µg/kg dw	67 U	76 U	5.8 UJ	62 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	3.9 U	3.9 U
Aroclor 1248	µg/kg dw	67 U	76 U	5.8 UJ	62 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	5.8 U	3.9 U
Aroclor 1254	µg/kg dw	67 U	75 U	5.8 UJ	62 U	2 U	2.2 U	2.1 U	2 U	2.1 U	1.9 U	1.8 U	2.1 U	14	9.7 U

Table C.3
City of Port Angeles NPDES Permit Monitoring (2003, 2004 and 2010)

Station ID		PA_STP04CSO-006	PA_STP04CSO-007	PA_STP04CSO-008	PA_STP04CSO-010	PA_STP04E250	PA_STP04N250	PA_STP04NE-35	PA_STP04NW-35	PA_STP04SE-35		PA_STP04SW-35	PA_STP04W250	PA_STP10-01	PA_STP10-02
Sample ID		CSO-006	CSO-007	CSO-008	CSO-010	E250	N250	NE-35	NW-35	SE-35	SE-35	SW-35	W250	PA_STP10-01	PA_STP10-02
Sample Date		9/23/2003	9/23/2003	9/23/2003	9/23/2003	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	9/8/2010	9/8/2010
Depth Range (cm)		0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH038	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Polychlorinated Biphenyls (cont.)															
Aroclor 1260	µg/kg dw	67 U	75 U	5.8 UJ	62 U	2 U	2.2 U	2.1 U	2 U	2.1 U	1.9 U	1.8 U	2.1 U	6.9	3.9 U
Total PCBs, Aroclors	µg/kg dw	130 U	150 U	12 U	120 U	3.6 U	4.1 U	3.8 U	3.6 U	3.8 U	3.5 U	3.3 U	3.8 U	21	9.7 U
Aroclor 1016	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	0.39 U	0.7 U
Aroclor 1221	mg/kg OC	9 U	6 U	1.6 UJ	32 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	0.39 U	0.7 U
Aroclor 1232	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	0.39 U	1 U
Aroclor 1242	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	0.39 U	0.7 U
Aroclor 1248	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	0.58 U	0.7 U
Aroclor 1254	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0027 U	0.0025 U	0.0018 U	0.0024 U	0.0047 U	0.0042 U	0.0046 U	0.0032 U	1.4	1.7 U
Aroclor 1260	mg/kg OC	4.5 U	3 U	0.79 UJ	16 U	0.0027 U	0.0025 U	0.0018 U	0.0024 U	0.0047 U	0.0042 U	0.0046 U	0.0032 U	0.69	0.7 U
Total PCBs, Aroclors	mg/kg OC	9 U	6 U	1.6 U	32 U	0.0049 U	0.0046 U	0.0032 U	0.0043 U	0.0086 U	0.0076 U	0.0084 U	0.0058 U	2.1	1.7 U
Aromatic Hydrocarbons															
Total LPAH	µg/kg dw	740	2,500	650	14	14	6.1	15	6.1	12	12	8.7	17		
Naphthalene	µg/kg dw	100	42	18 U	3.9	2.4	1.7	2.9	1.6	3.3	2.5	2.3	4	10 J	19 U
Acenaphthylene	µg/kg dw	130	130	18 U	1.8 U	0.7 U	0.77 U	1.1	0.72 U	0.67 U	0.7 U	0.75 U	0.8	30	19 U
Acenaphthene	µg/kg dw	47	130	43	1.8 U	0.61 U	0.67 U	0.64 U	0.63 U	0.62	0.61 U	0.65 U	0.65 U	9.8 J	48
Fluorene	µg/kg dw	95	160	49	1.8 U	1.1	0.84 U	1.2	0.79 U	1.3	0.99	0.82 U	1.2	22	58
Phenanthrene	µg/kg dw	96	1,700	490	10	6	2.4	4.8	2.6	5.4	5.1	3.4	6.1	310	810
Anthracene	µg/kg dw	220	310	73	1.8 U	1.5	0.5 U	1.5	0.46 U	1.1	0.98	0.93	0.79	79	96
2-Methylnaphthalene	µg/kg dw	47	31	18 U	1.8 U	2.7	1.9	3.2	2	0.6 U	2.9	2.2	3.7	19 U	19 U
Total HPAH	µg/kg dw	6,300 J	12,000 J	2,400 J	58 J	140	22	100	18	25	21	29	41	3,800	4,800
Fluoranthene	µg/kg dw	2,000	3,400	680	17	16	2.8	6	3	5.9	5.9	3.8	10	1,300	1,400
Pyrene	µg/kg dw	1,600	2,900	600	13	16	3	5.9	3.1	5.5	5.1	3.4	8.3	780	970
Benzo(a)anthracene	µg/kg dw	550	1,300	250	6.1	14	1.5	7.3	1.7	2.5	1.8	2.5	2.9	230	370
Chrysene	µg/kg dw	860	1,800	300	6.3	13	1.5	9.4	1.9	2.5	3	2.7	4.3	520	500
Total Benzofluoranthenes	µg/kg dw					49	5.4	38	3.4	0.66 U	0.69 U	7.5	5.9	580	760
Benzo(b)fluoranthene	µg/kg dw					24	2.7	19	3.4	0.6 U	0.62 U	3.8	5.9	290	380
Benzo(k)fluoranthene	µg/kg dw					24	2.7	19	0.71 U	0.66 U	0.69 U	3.8	0.73 U	290	380
Benzo(a)pyrene	µg/kg dw	500	1,200	230	5.8	15	1.8	12	1.6	2.2	1.4	2.2	2.6	220	380
Benzo(g,h,i)perylene	µg/kg dw	380	820	160	4.7	7.5	1.6	8	1.4	1.7	1.4	1.8	2	86	190
Indeno(1,2,3-cd)pyrene	µg/kg dw	220	720	160	4.7	7.7	2.5	8.5	2.4	2.5	2.4	2.6	3	86	200
Dibenzo(a,h)anthracene	µg/kg dw	83	170	18 U	1.8 U	4.4	1.9	4.9	0.76 U	2	0.73 U	2	2.1	33	64
Carcinogenic PAH TEQ, 0 DL[1,2]	µg/kg dw	590 J	1,400 J	270 J	7 J	22	2.9	18	2.4	2.9	1.9	3.7	4.1	320	520
Carcinogenic PAH TEQ, 1/2 DL[1,3]	µg/kg dw	590 J	1,400 J	280 J	7.1 J	22	2.9	18	2.5	3	2	3.7	4.1	320	520
Total LPAH	mg/kg OC	46	97	89	3.5	0.015	0.0046	0.0097	0.005	0.026	0.021	0.017	0.02	46 J	180
Naphthalene	mg/kg OC	6.8	1.7	2.5 U	0.99	0.0032	0.0019	0.0025	0.0019	0.0074	0.0055	0.0058	0.0061	1 J	3.4 U
Acenaphthylene	mg/kg OC	8.5	5.2	2.5 U	0.47 U	0.00096 U	0.00086 U	0.00091	0.00086 U	0.0015 U	0.0015 U	0.0019 U	0.0012	3	3.4 U
Acenaphthene	mg/kg OC	3.1	5	5.9	0.47 U	0.00083 U	0.00075 U	0.00054 U	0.00075 U	0.0014	0.0013 U	0.0017 U	0.001 U	0.98 J	8.6
Fluorene	mg/kg OC	6.4	6.5	6.7	0.47 U	0.0014	0.00095 U	0.001	0.00095 U	0.0029	0.0022	0.0021 U	0.0018	2.2	10
Phenanthrene	mg/kg OC	6.4	67	66	2.6	0.0082	0.0027	0.0041	0.0031	0.012	0.011	0.0086	0.0094	31	140

Table C.3
City of Port Angeles NPDES Permit Monitoring (2003, 2004 and 2010)

Station ID		PA_STP04CSO-006	PA_STP04CSO-007	PA_STP04CSO-008	PA_STP04CSO-010	PA_STP04E250	PA_STP04N250	PA_STP04NE-35	PA_STP04NW-35	PA_STP04SE-35		PA_STP04SW-35	PA_STP04W250	PA_STP10-01	PA_STP10-02
Sample ID		CSO-006	CSO-007	CSO-008	CSO-010	E250	N250	NE-35	NW-35	SE-35	SE-35	SW-35	W250	PA_STP10-01	PA_STP10-02
Sample Date		9/23/2003	9/23/2003	9/23/2003	9/23/2003	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	9/8/2010	9/8/2010
Depth Range (cm)		0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH038	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Aromatic Hydrocarbons (cont.)															
Anthracene	mg/kg OC	15	12	9.9	0.47 U	0.002	0.00056 U	0.0013	0.00056 U	0.0024	0.0021	0.0024	0.0012	7.9	17
2-Methylnaphthalene	mg/kg OC	3.2	1.2	2.5 U	0.47 U	0.0037	0.0022	0.0027	0.0024	0.0014 U	0.0062	0.0055	0.0057	1.9 U	3.4 U
Total HPAH	mg/kg OC	420 J	480 J	330 J	15 J	0.19	0.025	0.084	0.022	0.056	0.045	0.073	0.064	380	860
Fluoranthene	mg/kg OC	140	130	94	4.5	0.022	0.0031	0.0051	0.0036	0.013	0.013	0.0097	0.016	130	250
Pyrene	mg/kg OC	110	120	82	3.2	0.022	0.0033	0.005	0.0037	0.013	0.011	0.0088	0.013	78	170
Benzo(a)anthracene	mg/kg OC	37	50	34	1.6	0.019	0.0017	0.0062	0.0021	0.0057	0.0039	0.0064	0.0045	23	66
Chrysene	mg/kg OC	58	69	41	1.6	0.018	0.0017	0.008	0.0023	0.0056	0.0064	0.0068	0.0066	52	89
Total Benzofluoranthenes	mg/kg OC					0.066	0.0061	0.032	0.0041	0.0015 U	0.0015 U	0.019	0.009	58	140
Benzo(b)fluoranthene	mg/kg OC					0.033	0.0031	0.016	0.0041	0.0014 U	0.0013 U	0.0096	0.009	29	68
Benzo(k)fluoranthene	mg/kg OC					0.033	0.003	0.016	0.00085 U	0.0015 U	0.0015 U	0.0097	0.0011 U	29	68
Benzo(a)pyrene	mg/kg OC	34	47	32	1.5	0.02	0.002	0.01	0.002	0.005	0.0031	0.0057	0.0041	22	68
Benzo(g,h,i)perylene	mg/kg OC	26	32	22	1.2	0.01	0.0018	0.0068	0.0016	0.004	0.003	0.0047	0.0031	8.6	34
Indeno(1,2,3-cd)pyrene	mg/kg OC	14	28	22	1.2	0.01	0.0027	0.0072	0.0029	0.0056	0.0052	0.0066	0.0046	8.6	36
Dibenzo(a,h)anthracene	mg/kg OC	5.6	6.6	2.5 U	0.47 U	0.006	0.0021	0.0041	0.00091 U	0.0044	0.0016 U	0.005	0.0033	3.3	11
Carcinogenic PAH TEQ, 0 DL[1,2]	mg/kg OC	40 J	56 J	38 J	1.8 J	0.03	0.0033	0.015	0.0029	0.0066	0.0041	0.0095	0.0063	32	94
Carcinogenic PAH TEQ, 1/2 DL[1,3]	mg/kg OC	40 J	56 J	38 J	1.8 J	0.03	0.0033	0.015	0.003	0.0068	0.0043	0.0095	0.0063	32	94
Chlorinated Benzenes															
1,2-Dichlorobenzene	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	0.81 U	0.89 U	0.85 U	0.83 U	0.78 U	0.8 U	0.86 U	0.86 U	19 U	19 U
1,3-Dichlorobenzene	µg/kg dw					1 U	1.1 U	1.1 U	1 U	0.97 U	1 U	1.1 U	1.1 U		
1,4-Dichlorobenzene	µg/kg dw	12	170	73 U	7.3 U	1 U	1.1 U	1.7	1 U	0.96 U	0.99 U	1.1 U	1.1 U	19 U	19 U
1,2,4-Trichlorobenzene	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	1 U	1.1 U	1.1 U	1 U	0.97 U	1 U	1.1 U	1.1 U	19 U	19 U
Hexachlorobenzene	µg/kg dw	2.6 U	5.4	2.1 U	2 U	1.2 U	1.3 U	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U	1 U	0.97 U	0.97 U
1,2-Dichlorobenzene	mg/kg OC	0.57 U	0.37 U	10 U	1.9 U	0.0011 U	0.00099 U	0.00072 U	0.001 U	0.0018 U	0.0017 U	0.0022 U	0.0013 U	1.9 U	3.4 U
1,4-Dichlorobenzene	mg/kg OC	0.82	6.8	10 U	1.9 U	0.0014 U	0.0012 U	0.0015	0.0012 U	0.0022 U	0.0022 U	0.0027 U	0.0016 U	1.9 U	3.4 U
1,2,4-Trichlorobenzene	mg/kg OC	0.57 U	0.37 U	10 U	1.9 U	0.0014 U	0.0012 U	0.0009 U	0.0012 U	0.0022 U	0.0022 U	0.0028 U	0.0017 U	1.9 U	3.4 U
Hexachlorobenzene	mg/kg OC	0.17 U	0.21	0.29 U	0.52 U	0.0016 U	0.0014 U	0.001 U	0.0014 U	0.0025 U	0.0024 U	0.0028 U	0.0016 U	0.097 U	0.17 U
Phthalate Esters															
Dimethyl Phthalate	µg/kg dw	8.4 U	34	73 U	7.3 U	2.3 U	2.6 U	2.4 U	2.4 U	2.2 U	2.3 U	2.5 U	2.5 U	19 U	19 U
Diethyl Phthalate	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	4.3 U	5.3 JB	4.5 U	5 JB	4.4 JB	5.1 JB	4.7 JB	4.9 JB	19 U	19 U
Di-n-butyl Phthalate	µg/kg dw	10 JB	130	73 U	7.3 U	3.1 JB	2.9 JB	5 JB	3.2 JB	4.1 JB	4.1 JB	4 JB	5.5 JB	19 U	140
Butylbenzyl Phthalate	µg/kg dw	11 U	12 U	92 U	21	11 JB	11 JB	12 JB	11 JB	11 JB	11 JB	11 JB	12 JB	19 U	19 U
bis(2-ethylhexyl)phthalate	µg/kg dw	8.4 U	1,100	110	16 JB	29 JB	21 JB	28 JB	26 JB	31 JB	20 JB	31 JB	30 JB	6,700 JB	270 JB
Di-n-octyl Phthalate	µg/kg dw	8.4 U	51	73 U	7.3 U	2.2 U	2.4 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.3 U	19 U	19 U
Dimethyl Phthalate	mg/kg OC	0.57 U	1.4	10 U	1.9 U	0.0032 U	0.0029 U	0.0021 U	0.0029 U	0.0051 U	0.005 U	0.0064 U	0.0038 U	1.9 U	3.4 U
Diethyl Phthalate	mg/kg OC	0.57 U	0.37 U	10 U	1.9 U	0.0059 U	0.0059 JB	0.0038 U	0.006 JB	0.0099 JB	0.011 JB	0.012 JB	0.0076 JB	1.9 U	3.4 U
Di-n-butyl Phthalate	mg/kg OC	0.68 JB	5	10 U	1.9 U	0.0042 JB	0.0032 JB	0.0042 JB	0.0038 JB	0.0092 JB	0.0089 JB	0.01 JB	0.0084 JB	1.9 U	25
Butylbenzyl Phthalate	mg/kg OC	0.7 U	0.46 U	13 U	5.3	0.014 JB	0.012 JB	0.01 JB	0.013 JB	0.025 JB	0.024 JB	0.029 JB	0.018 JB	1.9 U	3.4 U
bis(2-ethylhexyl)phthalate	mg/kg OC	0.57 U	42	16	4.1 JB	0.039 JB	0.024 JB	0.023 JB	0.031 JB	0.07 JB	0.043 JB	0.08 JB	0.046 JB	670 JB	48 JB
Di-n-octyl Phthalate	mg/kg OC	0.57 U	2	10 U	1.9 U	0.003 U	0.0027 U	0.0019 U	0.0027 U	0.0048 U	0.0047 U	0.006 U	0.0036 U	1.9 U	3.4 U

Table C.3
City of Port Angeles NPDES Permit Monitoring (2003, 2004 and 2010)

Station ID		PA_STP04CSO-006	PA_STP04CSO-007	PA_STP04CSO-008	PA_STP04CSO-010	PA_STP04E250	PA_STP04N250	PA_STP04NE-35	PA_STP04NW-35	PA_STP04SE-35		PA_STP04SW-35	PA_STP04W250	PA_STP10-01	PA_STP10-02
Sample ID		CSO-006	CSO-007	CSO-008	CSO-010	E250	N250	NE-35	NW-35	SE-35	SE-35	SW-35	W250	PA_STP10-01	PA_STP10-02
Sample Date		9/23/2003	9/23/2003	9/23/2003	9/23/2003	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	6/21/2004	9/8/2010	9/8/2010
Depth Range (cm)		0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH038	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Miscellaneous Nonionizable Organic Compounds															
Dibenzofuran	µg/kg dw	49	62	73 U	7.3 U	0.85	0.6 U	0.78	0.56 U	0.94	1.1	0.59 U	0.96	19 U	35
Hexachlorobutadiene	µg/kg dw	1.3 U	1.6 U	1.1 U	1 U	0.58 U	0.62 U	0.58 U	0.58 U	0.54 U	0.54 U	0.53 U	0.5 U	0.97 U	0.97 U
N-nitrosodiphenylamine	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	1.1	1.2	1.2	1.3	0.65 U	0.68 U	0.73 U	0.72 U	19 U	30
Dibenzofuran	mg/kg OC	3.3	2.5	10 U	1.9 U	0.0011	0.00068 U	0.00066	0.00068 U	0.0021	0.0023	0.0015 U	0.0015	1.9 U	6.3
Hexachlorobutadiene	mg/kg OC	0.087 U	0.063 U	0.15 U	0.26 U	0.00078 U	0.00069 U	0.00049 U	0.00069 U	0.0012 U	0.0012 U	0.0013 U	0.00077 U	0.097 U	0.17 U
N-nitrosodiphenylamine	mg/kg OC	0.57 U	0.37 U	10 U	1.9 U	0.0015	0.0013	0.001	0.0016	0.0015 U	0.0015 U	0.0019 U	0.0011 U	1.9 U	5.4
Ionizable Organic Compounds															
Phenol	µg/kg dw	28	93	73 U	43	12	7.1	49	9.9	37	27	36	13	240 JB	90 U
2-Methylphenol	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.2 U	1.2 U	19 U	19 U
4-Methylphenol	µg/kg dw	82	19 U	150 U	15 U	8.3	1.5 U	1.5 U	7.6	6	5.1	1.5 U	8.5	160	19 U
2,4-Dimethylphenol	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	0.91 U	1 U	0.95 U	0.93 U	0.88 U	0.9 U	0.97 U	0.97 U	12 J	19 U
Pentachlorophenol	µg/kg dw	8.4 U	9.3 U	73 U	7.3 U	2.3 U	2.5 U	2.4 U	2.4 U	2.2 U	2.3 U	2.5 U	2.5 U	96 U	95 U
Benzyl Alcohol	µg/kg dw	11 U	12 U	92 U	9.2 U	2.4 U	2.6 U	2.5 U	2.4 U	2.3 U	2.4 U	2.5 U	2.5 U	19 UJ	19 UJ
Benzoic Acid	µg/kg dw	42 U	46 U	370 U	37 U	19 U	21 U	20 U	20 U	18 U	19 U	20 U	20 U	190 U	190 U
Other Semivolatile Organic Compounds															
Hexachloroethane	µg/kg dw					2 U	2.2 U	2.1 U	2.1 U	1.9 U	2 U	2.2 U	2.1 U		

Notes:

Blank cells are intentional.

1 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

2 Calculated using detected cPAH concentrations.

3 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
HPAH High molecular weight polycyclic aromatic hydrocarbon
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Micrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
NPDES National Pollutant Discharge Elimination System
PAH Polycyclic aromatic hydrocarbon
QC Quality control
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JB Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.4
Nippon Sediment Grab Sampling and Log Density Survey (2005)

Station ID		**AN-NPI-SS-01**	**AN-NPI-SS-02**	**AN-NPI-SS-03**	**AN-NPI-SS-04**
Sample ID		**AN-NPI-SS-01**	**AN-NPI-SS-02**	**AN-NPI-SS-03**	**AN-NPI-SS-04**
Sample Date		**4/20/2005**	**4/20/2005**	**4/20/2005**	**4/20/2005**
Depth Range (cm)		**0–10**	**0–10**	**0–7**	**0–10**
Field QC		**Field Sample**	**Field Sample**	**Field Sample**	**Field Sample**
Reoccupied		**No**	**No**	**No**	**No**
Analyte	**Units**				
Conventionals					
Sulfide	mg/kg dw	1,500	1,400	210	2,000
Total Organic Carbon	%	7.31	5.38	3.55	4.91
Total Solids	%	25	35.5	61.9	30.1
Total Solids, Preserved	%	24.3	35	65.5	31.6
Metals					
Arsenic	mg/kg dw	20 U	10	8 U	20 U
Cadmium	mg/kg dw	2.4	0.8	0.3 U	0.9
Copper	mg/kg dw	43	42	30	33
Mercury	mg/kg dw	0.4	0.2	0.36	0.1
Zinc	mg/kg dw	270	200	79	93

Note:

Source: Anchor Environmental LLC. 2005. *Sampling and Analysis Report, Sediment Grab Sampling and Log Density Survey, Nippon Paper Industries USA Pulp and Paper Mill, Port Angeles Facility.* Prepared for Nippon Paper Industries. June.

Abbreviations:

cm Centimeters
mg/kg dw Milligrams per kilogram dry weight
NPDES National Pollutant Discharge Elimination System
QC Quality control

Qualifier:

U Analyte was not detected, concentration given is the reporting limit.

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		EP-01-SD	EP-02-SD	EP-03-SD	EP-04-SD	EP-05-SD	EP-06-SD	EP-07-SD	EP-08-SD	EP-09-SD	EP-10-SD	EP-11-SD	LP-01-SD	LP-02-SD	LP-03-SD	LP-04-SD	LP-05-SD	LP-06-SD
Sample ID		EP-01-SS	EP-02-SS	EP-03-SS	EP-04-SS	EP-05-SS	EP-06-SS	EP-07-SS	EP-08-SS	EP-09-SS	EP-10-SS	EP-11-SS	LP-01-SS	LP-02-SS	LP-03-SS	LP-04-SS	LP-05-SS	LP-06-SS
Sample Date		10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Conventionals																		
Acid-Volatile Sulfide	mg/kg dw												7.4	22	1,100	1,300	9.2	1.2 U
Sulfides	mg/kg dw												2	41	1,200	1,800	46	4
Total Organic Carbon	%	1.67	3.12	2.65	2.2	2.99	2.77	1.92	2.01	1.58	1.66	3.13	0.517	3.44	11.9	8.31	0.988	1.57
Total Solids	%	63.5	48.9	48.5	60.4	59.4	45.7	53.9	62.3	63	62	43.2	77.4	73.8	30.3	26.1	77.1	77
Total Solids, Preserved	%												80	72	27	24	77	82
Total Volatile Solids	%	4.52	8.7	8.28	5.49	5.74	9.28	6.06	4.8	5.49	4.23	9.37	1.67	4.25	34.1	30.9	2.97	2.8
Particle/Grain Size																		
Percent Gravel	%	1	0.2	0.3	0.3	1.9	0.2	3.8	0.1 U	0.3	0.1	0.3	3	3.5	8.3	7.6	3.8	10
Phi Class 10.00+	%	5.1	9.9	6.7	4.3	8.3	11	8.3	6.9	2.9	7.3	11	1.1	1.3	9	11	1	
Phi Class 9.00+ to 10.00	%	1.8	4	2.3	1.1	2.8	4.4	3.2	2.4	0.9	2.6	4	0.1	0.1	1.4	1.5	0.1	
Phi Class 8.00+ to 9.00	%	2.4	5.2	3.5	1.6	3.5	5.2	4.1	3	0.9	3.1	4.2	0.1	0.1	1.6	2	0.1 U	
Phi Class 7.00+ to 8.00	%	3	7	4.8	2.2	4.5	7.8	5.3	4	1.2	4.1	5.7	0.2	0.3	2.8	3	0.2	
Phi Class 6.00+ to 7.00	%	4.7	12	9.9	4.9	8.5	14	9.1	7.3	3.1	6.3	18	0.2	0.3	4.5	6.3	0.1	
Phi Class 5.00+ to 6.00	%	8	19	15	11	13	17	12	9.7	7.6	9.6	23	0.4	0.7	10	14	0.4	
Phi Class 4.00+ to 5.00	%	13	16	20	19	18	21	17	14	25	14	16	3	1.2	18	14	2.2	
Phi Class 3.00+ to 4.00	%	13	12	13	16	18	9.3	19	16	22	28	8	16	9	9.4	6.7	16	3.6
Phi Class 2.00+ to 3.00	%	16	6.8	10	11	12	4.2	12	18	18	22	4.5	48	33	11	7.6	43	20
Phi Class 1.00+ to 2.00	%	21	4.2	7.3	18	6.5	3.7	2.8	16	15	1.6	3.8	20	35	12	10	21	36
Phi Class 0.00+ to 1.00	%	7.5	1.8	4	9.3	2.4	1.7	1.9	2.3	2.8	0.8	2	5.7	10	7.5	8.3	7.2	17
Phi Class -1.00+ to 0.00	%	3.1	1.2	2.2	0.9	1.3	1.2	1.9	0.2	0.5	0.4	1.5	2.8	5.8	3.8	8.1	4.8	11
Percent Fines (clay & silt)	%	38	74	63	44	58	80	59	47	41	47	80	5.1	4	48	52	4	2.6
Dioxins/Furans																		
2,3,7,8-TCDD	ng/kg dw	0.581	1.29	0.958	0.968	1.06	1.22	0.794	0.852	0.623	0.483	0.88	0.142 U	0.397 J	5.02	3.67	0.169 U	0.165 U
1,2,3,7,8-PeCDD	ng/kg dw	1.51 J	4.42	2.95	3.05	2.93	3.93	2.45	2.36 J	1.85 J	1.57 J	3.06	0.446 J	2.25 J	18	14.8	0.194 U	0.17 U
1,2,3,4,7,8-HxCDD	ng/kg dw	1.67 J	5.24	3.18	3.6	2.93	4.89	3.02	2.62	1.9 J	1.57 J	3.16	0.341 J	2.35 J	17.3	13.8	0.424 U	0.435 U
1,2,3,6,7,8-HxCDD	ng/kg dw	5.27	16.7	9.31	8.63	11.6	15.6	10.7	9.28	6.75	6.38	11.8	0.582 J	7.48	37	31	0.596 J	0.263 J
1,2,3,7,8,9-HxCDD	ng/kg dw	2.78	8.72	5.04	5.58	5.81	8.3	5.81	4.96	2.98	3.25	6.12	0.224 U	3.83	24.1	18.8	0.409 J	0.448 U
1,2,3,4,6,7,8-HpCDD	ng/kg dw	75.4	192	107	155	119	188	115	116	484	76.4	185	5.27	82.4	366	510	5.38	3.64
Total OCDD	ng/kg dw	670	1,780	844	1,690	903	1,340	858	997	11,100 J	732	1,670	32.5	742	2,320	5,240	27.8	25.5
2,3,7,8-TCDF	ng/kg dw	2.23	5.54	4.2	3.93	4.53	5.46	3.76	3.65	2.84	2.12	4.23	0.283 J	3.11	26.4	16	0.57	0.348 J
1,2,3,7,8-PeCDF	ng/kg dw	1.26 J	3.18	2.14 J	2.57	2.28	3.13	1.87 J	1.9 J	1.4 J	1.12 J	2.43 J	0.195 U	2.1 J	14.7	10.7	0.265 J	0.209 U
2,3,4,7,8-PeCDF	ng/kg dw	2.26 J	5.28	3.78	4.13	3.88	5.51	3.1	3.25	2.41	1.87 J	4.48	0.159 U	3.39	21.6	16.1	0.424 J	0.209 U
1,2,3,4,7,8-HxCDF	ng/kg dw	1.28 J	3.06	1.99 J	2.38 J	2.18	3.14	2.14 J	1.78 J	1.84 J	1.13 J	2.59	0.0924 U	2.14 J	10.7	9.61	0.148 U	0.0847 U
1,2,3,6,7,8-HxCDF	ng/kg dw	1.07 J	2.75	1.67 J	2.16 J	1.81 J	2.59	1.53 J	1.45 J	1.09 J	0.966 J	2.15 J	0.0893 U	1.02 J	8.98	7.17	0.143 U	0.0799 U
1,2,3,7,8,9-HxCDF	ng/kg dw	0.358 J	0.941 J	0.602 J	0.746 J	0.69 J	1.05 J	0.657 J	0.598 J	0.3 U	0.379 J	0.899 J	0.119 U	0.31 J	3.14	2.29 J	0.178 U	0.105 U
2,3,4,6,7,8-HxCDF	ng/kg dw	1.44 J	3.76	2.36 J	2.6	2.56	3.8	2.26 J	2.15 J	1.49 J	1.44 J	3.27	0.25 U	1.29 J	11.2	9.39	0.155 U	0.0868 U
1,2,3,4,6,7,8-HpCDF	ng/kg dw	15.5	46.4	25.3	22.7	31.4	42.6	27.6	26.1	92.5	18	38.5	1.04 J	10.5	74	112	0.912 J	0.748 J
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.943 J	2.49	1.52 J	1.4 J	1.64 J	2.31 J	1.57 J	1.4 J	4.81	1.01 J	2.11 J	0.193 U	0.489 J	4.16	4.89	0.239 U	0.151 U
Total OCDF	ng/kg dw	47.9	211	59	77.8	87.1	98.7	67.2	105	2,080	67.2	131	3.84 J	107	209	835	2.12 J	2.35 J
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	5.55	15.1	9.55	10.6	10.3	14.1	8.94	8.66	14.9	5.56	11.6	0.641	7.07	49	42.5	0.365	0.113
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	5.55	15.1	9.55	10.6	10.3	14.1	8.94	8.66	14.9	5.56	11.6	0.778	7.07	49	42.5	0.6	0.378

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		EP-01-SD	EP-02-SD	EP-03-SD	EP-04-SD	EP-05-SD	EP-06-SD	EP-07-SD	EP-08-SD	EP-09-SD	EP-10-SD	EP-11-SD	LP-01-SD	LP-02-SD	LP-03-SD	LP-04-SD	LP-05-SD	LP-06-SD
Sample ID		EP-01-SS	EP-02-SS	EP-03-SS	EP-04-SS	EP-05-SS	EP-06-SS	EP-07-SS	EP-08-SS	EP-09-SS	EP-10-SS	EP-11-SS	LP-01-SS	LP-02-SS	LP-03-SS	LP-04-SS	LP-05-SS	LP-06-SS
Sample Date		10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (PCBs)																		
PCB-1	ng/kg dw	15	39	71	120	31	40	26	22	27	24	30	1.8	13	96	68	5.5	1.4
PCB-2	ng/kg dw	15	45	38	46	36	47	32	28	28	19	33	2.5	8.4	160	110	3.6	2.1
PCB-3	ng/kg dw	19	70	130	99	57	66	49	40	41	30	48	2.9	18	190	120	5.8	2.1
PCB-4	ng/kg dw	16	32	31	1,400	24	34	20	26	17	17	31	2.3	10	53	67	5.9	1.3
PCB-5	ng/kg dw	1.5	3.8	4	54	3.4	4.2	2.6	2.1 U	3	1.8	3.8	0.99 U	2.5	12	12	1.6 U	0.72 U
PCB-6	ng/kg dw	11	25	27	520	18	28	16	15	15	11	29	1.9	9.2	42	45	3.8	0.77 U
PCB-7	ng/kg dw	3.6	8	9.7	92	5.5	8.4	5.3	5.4	4.5	3.5	6.5	0.94 U	2.6	13	11	1.5 U	0.68 U
PCB-8	ng/kg dw	77	150	160	3,100	110	160	96	100	70	64	150	9	41	170	210	13	3.6
PCB-9	ng/kg dw	3.8	7.5	9.3	190	5.6	8.2	5.2	5.2	4.6	3.9	8.6	1.1 U	3.6	15	15	1.7 U	0.75 U
PCB-10	ng/kg dw	1.1	2.3	2	68	1.7	2.4	1.3	1.4	1.3	1.1	3.1 U	0.43 U	0.58	3.4	3.8	1.2 U	0.55 U
PCB-11	ng/kg dw	25	52	46	45	39	52	43	38	32	33	56	9.5	12	120	120	11	6.8
PCB-12, 13	ng/kg dw	11	32	30	150	25	31	22	16	19	12	26	2.4	14	100	70	4.2	1.5
PCB-14	ng/kg dw	1.2 U	2.3	2.3	3	2 U	2.5	1.7	2 U	2.2	1.1	3.9 U	0.93 U	0.62	10	6.3	1.5 U	0.67 U
PCB-15	ng/kg dw	44	120	110	1,200	79	140	75	68	54	45	110	7.9	34	170	190	12	3.5
PCB-16	ng/kg dw	27	78	53	2,300	48	72	37	51	29	25	57	4.9	25	100	150	9.2	2.9
PCB-17	ng/kg dw	35	96	68	2,000	63	89	46	68	34	31	63	4.9	21	99	140	7.6	2.6
PCB-18, 30	ng/kg dw	66	200	130	4,900	120	170	94	140	73	65	150	12	53	230	310	18	6.7
PCB-19	ng/kg dw	6.8	18	12	480	12 J	15	9.1	16	6.6	6.8	12	0.96 U	4	20	25	1.9 J	0.8 U
PCB-20, 28	ng/kg dw	170	440	340	5,400	290	450	240	290	200	160	340	21	110	450	630	38	18
PCB-21, 33	ng/kg dw	60	170	130	2,700	110	170	91	110	69	59	130	8.3	51	180	250	18	7.9
PCB-22	ng/kg dw	43	120	94	2,000	81	120	69	82	51	43	92	6.4	37	140	200	13	6.4
PCB-23	ng/kg dw	1.2 U	0.71 U	2 U	7.3	2.5 U	1.5 U	1.3 U	1.2 U	1.8 U	1 U	3.2 U	0.86 U	0.53 U	1.9 J	2 U	0.8 U	1 U
PCB-24	ng/kg dw	0.58 U	1.7	1.4 J	70	1.6 J	2.2 J	0.93 J	0.99	1.1 J	0.83	1.4 U	0.61 U	1.2	3.9	6	0.48 U	0.51 U
PCB-25	ng/kg dw	11	26	22	400	19	28	16	16	13	10	22	1.4 J	8.7	35	44	2.9	1.2
PCB-26, 29	ng/kg dw	21	52	43	880	37	53	30	32	24	20	43	2.9 J	24	78	100	6.7	2.6
PCB-27	ng/kg dw	5.8	17	12	340	11	16	8.6	11	7.6	7.1	13	0.7 U	3.9	19	25	1.6	0.59 U
PCB-31	ng/kg dw	100	290	220	4,200	200	290	160	200	120	110	230	14	89	320	450	27	15
PCB-32	ng/kg dw	28	82	56	1,300	54	71	40	60	29	27	51	3.6	16	72	100	5.6	2.2
PCB-34	ng/kg dw	1.3 U	1.7	2 U	19	2.7 U	1.7	1.3 U	1.3 U	1.9 U	1.1 U	3.4 U	0.9 U	0.66	3.2	2.9 J	0.84 U	1.1 U
PCB-35	ng/kg dw	5.6 J	17	15	72	13	17	10	9.8	11	7.2	10 J	0.91 U	8.1	44	36	1.8 J	1.1 U
PCB-36	ng/kg dw	1.1 U	3.5	2.7	2.6 J	2.4 U	2.8 J	2.3	1.9 J	2 J	1 U	3.1 U	0.8 U	1.2 J	9.3	8.8	0.73 U	0.94 U
PCB-37	ng/kg dw	48	140	110	1,400	91	160	84	89	60	53	110	7.3	42	190	230	12	6.3
PCB-38	ng/kg dw	1.2 U	1.9 J	1.9 U	3.8	2.4 U	1.4 U	1.2 U	1.2 U	1.7 U	1 U	3.1 U	0.81 U	0.7	4.8	3.9 J	0.75 U	0.98 U
PCB-39	ng/kg dw	1.2 U	3.6	1.9 U	2.5 U	2.4 U	1.4 U	1.2 U	1.2 U	1.7 U	0.99 U	3.1 U	0.81 U	0.49 U	6.9	4.1 J	0.74 U	0.95 U
PCB-40, 41, 71	ng/kg dw	62	160	110	1,200	130	150	97	150	74	68	130	9.3	64	260	300	16	21
PCB-41	ng/kg dw	8.7	23	17	320	19	24	15	19	9.8	8.9	21	1.8	14	39	69	4.5	3.9
PCB-42	ng/kg dw	38	93	66	750	75	92	58	83	44	38	84	5.6	37	160	190	9.9	12
PCB-43	ng/kg dw	4.1	11	8.2	120	9	10	6.1	9	4.4 J	4.1	8.1 J	0.97	6.8	20	36	1.6	1.6
PCB-44, 47, 65	ng/kg dw	150	370	270	2,300	300	380	220	340	180	160	330	28	240	920	970	43	43
PCB-45	ng/kg dw	15	36	23	470	28	37	22	32	13	14	31	2	11	53	55	4.5	4.5
PCB-46	ng/kg dw	8.4	16	11	180	17	15	11	18	7.3	9	13	0.91	4.8	22	26	2	2.1
PCB-48	ng/kg dw	25	60	43	590	49	59	37	54	26	25	51	3.8	29	96	130	7.9	7.5
PCB-49, 69	ng/kg dw	94	220	160	1,300	170	240	130	200	130	95	220	16	120	480	530	23	23
PCB-50, 53	ng/kg dw	23	45	33	390	50	43	33	52	21	27	37	2.6	17	65	73	4.2	4.3
PCB-51	ng/kg dw	4.6	12	8.8	110	13	9.5	7.1	12	5.4	6.1	11	0.75	4.7	16	20	1.3	1.3

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		EP-01-SD	EP-02-SD	EP-03-SD	EP-04-SD	EP-05-SD	EP-06-SD	EP-07-SD	EP-08-SD	EP-09-SD	EP-10-SD	EP-11-SD	LP-01-SD	LP-02-SD	LP-03-SD	LP-04-SD	LP-05-SD	LP-06-SD
Sample ID		EP-01-SS	EP-02-SS	EP-03-SS	EP-04-SS	EP-05-SS	EP-06-SS	EP-07-SS	EP-08-SS	EP-09-SS	EP-10-SS	EP-11-SS	LP-01-SS	LP-02-SS	LP-03-SS	LP-04-SS	LP-05-SS	LP-06-SS
Sample Date		10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-52	ng/kg dw	220	510	400	2,300	420	550	310	480	300	250	500	57	610	1,900	1,900	69	54
PCB-54	ng/kg dw	2.1	2	1.8	11	4.6	1.5	2	3.4	0.97 J	2.3	0.88 U	0.3 U	0.26 U	1.3	1.5	0.39 U	0.32 U
PCB-55	ng/kg dw	1.2 U	8.9	6.3	61	5.9 J	9.9	1.3 U	6 J	4.2	3	7	0.6 U	4	13	13	0.97 U	0.63 U
PCB-56	ng/kg dw	74	220	150	1,100	160	210	130	160	97	84	180	11	91	270	280	12	22
PCB-57	ng/kg dw	1 U	2.2	1.8 J	15	2.4	2.5 J	1.7	1.5	1.3 J	1.1	2.6 U	0.5 U	1.2 J	5.5	6.9	0.78 U	0.51 U
PCB-58	ng/kg dw	1.2 U	1.3	0.77	4.5 J	2.4 U	2.3	0.93 J	1.4 U	0.85 J	0.49 J	3 U	0.59 U	0.89	3.5	3.3	0.94 U	0.61 U
PCB-59, 62, 75	ng/kg dw	11	28	20	240	23	29	18	24	14	12	25	1.9	12	48	60	2.8	3.1
PCB-60	ng/kg dw	39	110	76	630	86	110	69	80	47	44	93	5.4	41	130	140	5.2	12
PCB-61, 70, 74, 76	ng/kg dw	340	940	650	3,600	690	960	560	720	470	400	830	67	630	1,800	1,700	74	86
PCB-63	ng/kg dw	5.5	14	10	77	12	15	8.9	11	6.9	6.2	13	0.81 J	6.4	22	22	1.2	1.5
PCB-64	ng/kg dw	51	140	95	880	110	140	84	120	65	58	120	9.7	75	290	320	14	17
PCB-66	ng/kg dw	170	500	340	2,100	360	520	310	380	220	210	440	26	200	670	630	28	42
PCB-67	ng/kg dw	6 J	16	12	100	13	18	10	11	8.8	6.3	14	1.1	9.8	28	31	1.6	1.2
PCB-68	ng/kg dw	1 U	2.5	2	6.9	2 U	2.9	1.7 J	1.4 J	1.9	1.2	2.7 U	0.51 U	1	4.7	4.5	0.78 U	0.5 U
PCB-72	ng/kg dw	2.5	4.9	4.2	12	3.8	5.4	2.9 J	3.2	4.4	2	3.7 J	0.51 U	4.6	13	13	0.79 U	0.51 U
PCB-73	ng/kg dw	0.59 U	0.64	0.43 U	3.6	1.1 U	0.59	0.53 J	0.56	0.38 J	0.35 U	1.2 U	0.37 U	0.22 U	1.2	0.79 U	0.36 U	0.39 U
PCB-77	ng/kg dw	24	71	49	210	50	70	42	43	32	27	55	3.6	27	130	110	4.5	4.6
PCB-78	ng/kg dw	1.2 U	0.92 U	1.2 U	1.6 U	2.3 U	1.4 U	1.2 U	1.3 U	1.3 U	0.84 U	2.9 U	0.54 U	0.62 U	4.1	1.5 U	0.89 U	0.58 U
PCB-79	ng/kg dw	3.8	11	8.7	13	8.7 J	12	5.9	6.7 J	6.1	4.1 J	6.8 J	0.48 U	14	41	29	1.4	0.85
PCB-80	ng/kg dw	1 U	5.7	1.1 U	1.4 U	2 U	1.2 U	1 U	1.1 U	4	0.73 U	2.5 U	0.5 U	0.55 U	25	1.3 U	0.77 U	0.5 U
PCB-81	ng/kg dw	1.2 U	2.9	1.3 U	12	2.4 U	3.5	1.8	1.5	1.4 U	1.5	2.9	0.57 U	1.1	5.6	4.7	0.92 U	0.6 U
PCB-82	ng/kg dw	49	140	92	180	98	130	71	87	53	48	88	11	150	380	350	11	9.4
PCB-83	ng/kg dw	18	49	34	52	31	45	22	29	23	17	26	3.4	75	160	170	5.9	4.1
PCB-84	ng/kg dw	84	220	150	290	160	230	120	140	100	86	170	24	310	710	630	24	17
PCB-85, 116, 117	ng/kg dw	66	170	120	210	120	180	90	110	72	68	140	14	180	490	430	14	12
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	300	790	560	890	560	830	430	510	370	310	560	75	1,000	2,600	2,400	81	52
PCB-88	ng/kg dw	1.1 U	0.33 U	0.97 U	2.1 J	1.6 U	0.82 U	0.65 U	0.99 U	1 U	0.66 U	2.7 U	0.6 U	0.44 U	4.3 U	5.2	0.71 U	0.6 U
PCB-89	ng/kg dw	3.5	9.4	5.6 J	24	7.2	8.7	5.4	6.4	3.8	3.8	6.6	0.69 U	11	23	24	1.1 J	1.3
PCB-90, 101, 113	ng/kg dw	630	1,600	1,200	1,600	1,200	1,700	810	1,000	910	610	1,100	190	3,000	6,400	6,200	230	130
PCB-91	ng/kg dw	41	100	70	140	75	100	55	68	41	39	76	12	140	290	320	9.7	8.4
PCB-92	ng/kg dw	100	260	190	260	180	270	130	160	150	96	180	30	440	980	950	32	20
PCB-93, 98, 100, 102	ng/kg dw	2.9	6.5	4.6	13	5	6.1	3.8	4.7	3.1 J	2.4	4.3	0.66 U	7.6	16	19	1	0.78
PCB-94	ng/kg dw	1.9 J	4.5	3.3	8	4.1	4.7	3	3.7	2.7	2.5	2.5 U	0.7 U	4.2	10	9.7	0.71 U	0.69
PCB-95	ng/kg dw	350	900	670	1,000	680	1,000	470	620	510	360	620	110	2,100	3,900	3,800	140	76
PCB-96	ng/kg dw	3.8	7.6	5.6	17	7.5 J	6.9	5.5	6	3.3	4.1	4.6	0.47 J	6.6	15	14	0.68	0.72
PCB-98	ng/kg dw	1 U	1.6	0.96 U	1.1 U	1.6 U	1.4 J	1.5 J	0.95 U	1.5	0.68 J	2.3 U	0.72 U	0.87	4.1	2.9 J	0.64 U	0.54 U
PCB-99	ng/kg dw	230	540	400	600	380	590	310	380	290	220	450	57	510	1,500	1,400	47	34
PCB-102	ng/kg dw	14	27	19	45	29	26	18	26	12	15	17	2.3	23	61	51	2.7	2.3 J
PCB-103	ng/kg dw	5.5	11	9.3	13	9.2	13	6.5	8.5	11	4.8	7.9	1.2	6.3	19	21	1	0.69 J
PCB-104	ng/kg dw	0.39 U	0.13 U	0.38 U	0.47 U	0.78 U	0.37 U	0.33 U	0.35 U	0.4 U	0.26 U	0.75 U	0.32 U	0.24 U	0.55 J	0.69 U	0.27 U	0.28 U
PCB-105	ng/kg dw	180	500	370	490	350	520	280	320	220	190	370	43	540	1,500	1,400	45	29
PCB-106	ng/kg dw	0.8 U	0.25 U	0.74 U	0.82 U	1.3 U	0.55 U	0.43 U	0.7 U	0.69 U	0.44 U	1.8 U	0.46 U	0.41 U	3 U	1.1 U	0.49 U	0.42 U
PCB-107, 124	ng/kg dw	18	48	34	46	32	49	26	29	22	18	34	4.1	60	160	150	4.9	2.8
PCB-109	ng/kg dw	32	81	59	76	56	84	44	47	39	31	56	6.7	75	230	200	7.1	4.2
PCB-110	ng/kg dw	540	1,400	1,000	1,400	1,000	1,700	860	1,000	780	620	1,100	140	2,200	4,900	4,800	160	90

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		EP-01-SD	EP-02-SD	EP-03-SD	EP-04-SD	EP-05-SD	EP-06-SD	EP-07-SD	EP-08-SD	EP-09-SD	EP-10-SD	EP-11-SD	LP-01-SD	LP-02-SD	LP-03-SD	LP-04-SD	LP-05-SD	LP-06-SD
Sample ID		EP-01-SS	EP-02-SS	EP-03-SS	EP-04-SS	EP-05-SS	EP-06-SS	EP-07-SS	EP-08-SS	EP-09-SS	EP-10-SS	EP-11-SS	LP-01-SS	LP-02-SS	LP-03-SS	LP-04-SS	LP-05-SS	LP-06-SS
Sample Date		10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-111	ng/kg dw	0.76 U	1.5	0.7 U	0.78 U	1.2 U	0.51 U	0.4 U	0.67 U	0.64 U	0.41 U	1.7 U	0.47 U	1.3	5	5.7	0.48 U	0.4 U
PCB-112	ng/kg dw	0.87 U	0.9	1.3	1.9 J	1.4 U	0.58 U	0.81 J	0.78 U	0.65 J	0.47 U	1.9 U	0.53 U	0.44 U	3.4 U	1.1 U	0.56 U	0.47 U
PCB-114	ng/kg dw	8.2	23	17	28	17	24	13	14	9.2	9.2	17	2.4	29	82	72	2.1	1.9
PCB-115	ng/kg dw	0.73 U	0.22 U	0.67 U	0.75 U	1.1 U	0.44 U	0.35 U	0.59 U	0.55 U	0.36 U	6.8 J	1.1	18	58	47	1.2 J	1.1 J
PCB-117	ng/kg dw	9.8	23	15	28	17 J	26	15	15	9.7 J	8.4	14	2	22	59	80	2	1.3
PCB-118	ng/kg dw	450	1,200	880	1,100	840	1,300	680	780	580	470	890	100	1,400	4,000 J	3,700	110	65
PCB-120	ng/kg dw	2.4 J	5.9	4.8	5.8	4.3	6.3	3.4	3.2	4.3 J	2.1 J	4.3 J	0.5 U	6.8	19	21	0.77	0.43 U
PCB-121	ng/kg dw	0.75 U	0.23 U	0.69 U	0.77 U	1.2 U	0.51 U	0.4 U	0.66 U	0.64 U	0.41 U	1.7 U	0.47 U	0.38 U	2.9 U	0.99 U	0.48 U	0.41 U
PCB-122	ng/kg dw	4.1 J	13	9.5	16	9.5	13	7.2	7.4	5.8	5	8.2	1.2	15	42	39	1.3 J	1
PCB-123	ng/kg dw	7.7	20	16	22	14	20	12	14	9.1	8	16	1.4	20	62	49	1.9	1.6
PCB-126	ng/kg dw	2.7	8.2	5.2	6.5	5.7	8.7	4	4.3	3.8	2.7	2 U	0.43 U	8.1	37	30	0.97	0.69 J
PCB-127	ng/kg dw	0.71 U	0.23 U	0.63 U	0.68 U	1.1 U	0.51 U	0.38 U	0.65 U	0.66 U	0.39 U	1.6 U	0.48 U	0.38 U	2.6 U	0.97 U	0.46 U	0.4 U
PCB-128, 166	ng/kg dw	120	330	250	220	250	360	170	180	140	120	190	27	500	1,200	1,200	32	19
PCB-130	ng/kg dw	56	140	110	100	98	160	78	82	66	54	88	14	250	630	600	19	9.3
PCB-131	ng/kg dw	9.9	23	17	18	17	24	13	14	11	8.9	14	2.6	44	99	92	2.7	1.7
PCB-132	ng/kg dw	270	680	520	520	500	740	350	390	320	240	390	75	1,500	3,300	3,200	93	53
PCB-133	ng/kg dw	14	34	26	25	25	37	19	19	17	13	17 J	3.8	62	150	150	4.5	2.6
PCB-134	ng/kg dw	48	120	90	91	86	140	66	73	62	46	76	13	290	570	570	16	10
PCB-135, 151	ng/kg dw	400	980	780	830	750	1,100	500	570	510	350	540	120	2,700	5,300	5,300	150	89
PCB-136	ng/kg dw	150	360	280	320	290	420	170	220	170	130	200	40	1,200	1,900	2,000	49	30
PCB-137	ng/kg dw	18	47	38	30 J	28 J	47	24	25	19	17	32	5	62	180	200	3.9	2.6
PCB-139, 140	ng/kg dw	11	24	18	17	17	27	14	15	12	9.7	18	2.5	35	91	76	2.4	1.7
PCB-141	ng/kg dw	190	490	390	430	370	510	250	290	250	170	230	58	1,300	3,000	2,900	89	47
PCB-142	ng/kg dw	0.58 U	0.19 U	0.58 U	0.79 U	1.2 U	0.55 U	0.52 U	0.44 U	0.62 U	0.35 U	1.3 U	0.7 U	0.53 U	0.83 U	1.4 U	0.63 U	0.58 U
PCB-143	ng/kg dw	2.2	4	3.3	2.8 J	4.7	5.5	3.3 J	2.6 J	1.5 J	1.6 J	1.2 U	0.65 U	5.2	0.79 U	11 J	0.6 U	0.55 U
PCB-144	ng/kg dw	65	170	130	150	130	190	85	97	83	60	85	21	440	900	840	27	14
PCB-145	ng/kg dw	0.37 U	0.57 J	0.36 U	0.51 U	0.8 U	0.38 U	0.3 U	0.3 U	0.36 U	0.44 J	0.75 U	0.39 U	1.1	2.2	2.5	0.33 U	0.31 U
PCB-146	ng/kg dw	180	430	340	340	310	470	230	250	240	170	250	49	820	2,000	1,900	59	33
PCB-147, 149	ng/kg dw	850	2,100	1,600	1,700	1,600	2,300	1,100	1,200	1,100	770	1,200	260	5,400	11,000	11,000	320	180
PCB-148	ng/kg dw	1.3	2.6	2.5	2	1.1 U	3	1.6 J	1.8	2.1 J	1.4	2.2	0.63 U	2.4	7.1	6.2 J	0.54 U	0.5 U
PCB-150	ng/kg dw	1.8 J	3.4	3	3.2	2.3 J	4	1.5 J	2.2	2.7	1.3	2.2	0.42 U	4.7	8.9	10	0.35 U	0.33 U
PCB-152	ng/kg dw	0.37 U	1.1 J	0.36 U	0.51 U	0.8 U	1.7	0.3 U	0.71 J	0.81	0.22 U	0.75 U	0.41 U	2.5	4.4	5	0.34 U	0.32 U
PCB-153, 168	ng/kg dw	1,100	2,700	2,200	2,200	2,000	2,900	1,400	1,600	1,500	1,000	1,500	300	5,700	13,000	13,000	390	210
PCB-154	ng/kg dw	12	25	20	20	17	28	15	16	19	10	18	2.5	25	62	67	2.3	1.5
PCB-155	ng/kg dw	0.35 U	0.34	0.33 U	0.47 U	0.75 U	0.37 U	0.29 U	0.29 U	0.35 U	0.21 U	0.72 U	0.4 U	0.33 U	0.9	0.98 U	0.34 U	0.32 U
PCB-156, 157	ng/kg dw	100	260	230	190	200	290	140	170	130	97	160	24	410	1,100	1,100	28	17
PCB-158	ng/kg dw	110	270	220	220	200	280	140	160	130	99	140	29	510	1,200	1,300	37	20
PCB-159	ng/kg dw	18	40	33	37	36	52	20	24	20	15	22	5	110	190	240	6.4	3.2
PCB-160	ng/kg dw	0.43 U	0.14 U	0.43 U	0.58 U	0.89 U	0.4 U	0.38 U	0.33 U	0.46 U	0.26 U	0.98 U	0.48 U	0.41 U	3.6	1.1 U	0.46 U	0.42 U
PCB-161	ng/kg dw	0.36 U	0.12 U	0.37 U	0.5 U	0.76 U	0.35 U	0.33 U	0.28 U	0.4 U	0.22 U	0.85 U	0.43 U	0.35 U	0.51 U	0.89 U	0.38 U	0.35 U
PCB-162	ng/kg dw	3	7.9	6.3	6.9	7.9	9.5	4.3	3.9	3.8 J	3.3	5.2	0.94	12	31	34	0.98	0.45 U
PCB-163, 164	ng/kg dw	1,100	2,900	2,300	2,200	2,100	3,100	1,500	1,700	1,400	1,100	1,700	300	5,400	13,000	13,000	390	220
PCB-164	ng/kg dw	66	170	130	140	130	190	90	100	89	63	94	18	360	890	790	28	14
PCB-165	ng/kg dw	1.1	1.5 J	1.5	0.61 U	0.93 U	1.8	0.95	1	0.48 U	0.94	1 U	0.52 U	1.2 J	5.7	5.7	0.47 U	0.43 U
PCB-167	ng/kg dw	40	100	84	76	77	110	53	64	49	38	59	9.9	160	410	440	12	6.9

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		EP-01-SD	EP-02-SD	EP-03-SD	EP-04-SD	EP-05-SD	EP-06-SD	EP-07-SD	EP-08-SD	EP-09-SD	EP-10-SD	EP-11-SD	LP-01-SD	LP-02-SD	LP-03-SD	LP-04-SD	LP-05-SD	LP-06-SD
Sample ID		EP-01-SS	EP-02-SS	EP-03-SS	EP-04-SS	EP-05-SS	EP-06-SS	EP-07-SS	EP-08-SS	EP-09-SS	EP-10-SS	EP-11-SS	LP-01-SS	LP-02-SS	LP-03-SS	LP-04-SS	LP-05-SS	LP-06-SS
Sample Date		10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	10/1/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-169	ng/kg dw	2.2	5.9	4.5	1.9 U	2.6 U	7.1	3.3	4.1	2.6	2.1	2.6 U	0.62 J	17	3.2 U	44	0.71 J	0.53 U
PCB-170	ng/kg dw	380	930	740	680	730	1,000	490	560	410	350	510	85	1,500	4,100	4,200	110	63
PCB-171, 173	ng/kg dw	130	310	220	240	250	340	140	180	140	110	160	33	670	1,500	1,700	37	23
PCB-172	ng/kg dw	66	170	120	130	130	180	79	96	73	59	89	17	310	820	870	20	12
PCB-174	ng/kg dw	450	1,100	780	870	900	1,200	520	650	490	390	570	120	2,600	5,700	6,200	140	81
PCB-175	ng/kg dw	21	50	37	40	40	55	23	31	23	18	28	5.6	120	280	300	7.3	4.1
PCB-176	ng/kg dw	50	120	98	100	100	150	56	76	53	42	65	12	300	550	630	14	8.1
PCB-177	ng/kg dw	280	690	500	510	550	740	320	420	300	240	370	73	1,400	3,400	3,700	81	50
PCB-178	ng/kg dw	91	220	180	170	180	260	110	140	97	78	110	22	450	920	1,200	24	14
PCB-179	ng/kg dw	210	500	400	410	400	600	230	310	220	170	260	53	1,200	2,300	2,600	56	34
PCB-180, 193	ng/kg dw	870	2,100	1,600	1,800	1,700	2,200	980	1,300	970	710	1,000	210	4,000	10,000	11,000	260	150
PCB-181	ng/kg dw	1.5	3.5	3.3	2.7	3.4 J	4.2	1.8	1.6 J	0.76 U	1.3 J	1.7 U	0.67 U	8.3	20	24	0.79 U	0.52 U
PCB-182	ng/kg dw	0.76 U	3.3	2.7	3	2 U	3.6	0.92 U	2.4	0.78 U	0.54 U	1.7 U	0.7 U	6.7	15	15	0.82 U	0.54 U
PCB-183	ng/kg dw	240	580	420	480	470	610	260	330	250	200	290	64	1,300	2,900	3,100	74	42
PCB-184	ng/kg dw	0.36 U	0.83	0.62 U	0.59 U	0.84 U	0.45 U	0.47 U	0.41 U	0.45 U	0.27 U	0.9 U	0.63 U	1.5	4.1	3.6	0.49 U	0.44 U
PCB-185	ng/kg dw	23 J	66	46	54 J	54	68	35	39	25	21	40	8.3	230	390	420	8.1	5
PCB-186	ng/kg dw	0.38 U	0.16 U	0.66 U	0.63 U	0.89 U	0.48 U	0.49 U	0.44 U	0.47 U	0.28 U	0.95 U	0.67 U	0.45 U	0.85 U	1.5 U	0.53 U	0.48 U
PCB-187	ng/kg dw	580	1,500	980	1,100	1,100	1,600	660	870	620	510	780	150	3,100	7,200	7,400	180	110
PCB-188	ng/kg dw	0.98	1.2	1.4	0.93 J	0.69 U	1.2 J	0.75 J	0.73 J	0.97 J	0.51	0.76 U	0.57 U	2.4	4.7	5.3	0.45 U	0.4 U
PCB-189	ng/kg dw	16	44	34	31	33	48	22	27	19	16	21	3.4	58	170	190	4.4	2.7
PCB-190	ng/kg dw	83	190	160	160	160	220	110	120	85	76	110	19	330	880	910	23	15
PCB-191	ng/kg dw	17	43	32	35	36	43	20	26	20	15	20	4.6	77	200	220	5.7	3.3
PCB-192	ng/kg dw	0.77 U	0.77 U	1.3 U	1.1 U	2 U	0.88 U	0.92 U	0.78 U	0.78 U	0.54 U	1.7 U	0.66 U	1.2 U	1.9 U	3 U	0.77 U	0.51 U
PCB-194	ng/kg dw	270	940	500	490	500	810	330	420	260	260	370	50	950	2,600	3,100	56	32
PCB-195	ng/kg dw	95	280	190	180	200	300	120	150	91	92	140	19	380	980	1,100	21	13
PCB-196	ng/kg dw	110	330	220	240	220	350	140	160	110	100	160	23	390	1,000	1,200	24	14
PCB-197	ng/kg dw	7.9	20	13 J	17	16	23	10	9.4	7.6	6.9	12	1.3 J	31	67	65	1.7	0.89 J
PCB-198, 199	ng/kg dw	300	1,100	540	560	540	960	360	440	270	270	420	59	940	2,600	2,800	60	36
PCB-199	ng/kg dw	34	110	59	65	59	97	41	45	30	29	47	7.3	150	330	350	7.3	4.3
PCB-201	ng/kg dw	29	92	53	62	58	91	35	45	25	29	46	6.4	130	340	340	7.6	4.3
PCB-202	ng/kg dw	43	210	75	81	78	140	52	61	36	39	62	9.6	200	450	490	9.8	6.1
PCB-203	ng/kg dw	150	780	280	310	280	470	190	210	130	140	220	29	490	1,300	1,400	30	18
PCB-204	ng/kg dw	0.44 U	0.27 U	1.3 U	1.1 U	1.3 U	0.51 U	0.77 U	0.42 U	0.5 U	0.35 U	1.8 U	0.62 U	0.82 U	2	1.8 U	0.7 U	0.45 U
PCB-205	ng/kg dw	11	33	21	23	22	35	15	19	12	11	16 J	2.4	40	110	130	2.8	1.7
PCB-206	ng/kg dw	85	310	110	130	100	320	67	79	59	58	100	14	230	630	520	15	9.1
PCB-207	ng/kg dw	15	63	22	22	23	66	15	17	9.7	12	23	2	33	86	100	1.8 J	1.2
PCB-208	ng/kg dw	36	200	52	46	59	220	35	39	20	26	51	3.5	51	140	180	3.7	2.3
PCB-209	ng/kg dw	120	210	120	89	150	440	78	88	38	64	150	4.8	31	130	160	3.5	3.4
Total PCBs, Congeners	ng/kg dw	14,000	37,000	27,000	80,000	26,000	39,000	18,000	22,000	17,000	13,000	23,000	3,400	59,000	140,000	140,000	4,100	2,500
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	0.36	1.1	0.71	0.73	0.62	1.2	0.54	0.6	0.49	0.36	0.052	0.025	1.4	4	4.5	0.12	0.073
Other																		
Total TEQ	ng/kg dw	5.91	16.1	10.3	11.4	10.9	15.3	9.48	9.26	15.4	5.93	11.6	0.803	8.47	53	47	0.724	0.451

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		LP-07-SD	LP-08-SD	MD-03-SD	MD-04-SD	MD-05-SD	MD-06-SD	MD-07-SD	MD-08-SD	MD-09-SD	MD-10-SD	MD-11-SD	MD-12-SD	MD-13-SD	MD-14-SD	MD-15-SD	MD-16-SD	MD-17-SD
Sample ID		LP-07-SS	LP-08-SS	MD-03-SS	MD-04-SS	MD-05-SS	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS	MD-15-SS	MD-16-SS	MD-17-SS
Sample Date		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/29/2006	9/29/2006	9/30/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Conventionals																		
Acid-Volatile Sulfide	mg/kg dw	340	79															
Sulfides	mg/kg dw	450	200															
Total Organic Carbon	%	7.17	21.2	0.575	0.37	0.359	0.648	0.938	1.22	0.839	1.03	0.886	0.889	1.51	1.25	0.909	0.755	3.01
Total Solids	%	48.9	38.9	73.5	71.1	70.7	73.6	73.9	72.1	69.2	60.7	71.9	73	70.3	59.8	71.6	77.7	58.5
Total Solids, Preserved	%	48	40															
Total Volatile Solids	%	26.3	50.2	2.44	2.26	2.25	2.31	2.44	2.93	3.79	5.22	2.7	2.58	3.61	5.29	2.72	1.52	8.62
Particle/Grain Size																		
Percent Gravel	%	7.8	9.3	0.2	0.1	0.1	1.3	0.4	0.3	4.4	0.4	0.6	2.6	0.8	1.9	2.7	10	5.4
Phi Class 10.00+	%	3.4	5.5	2.8	2.7	2.6	1.5	3	3	3.2	5	3.5	2.4	3.6	7.2	2.2	1.3	3.6
Phi Class 9.00+ to 10.00	%	0.4	0.3	0.8	0.7	0.9	0.4	1.2	1.2	1.1	1.8	1.4	0.9	1.1	2.4	0.8	0.4	1.4
Phi Class 8.00+ to 9.00	%	0.3	0.5	0.8	0.7	0.6	0.4	1.2	1.2	1.2	1.9	1.5	0.9	1.1	2.3	0.8	0.4	1.5
Phi Class 7.00+ to 8.00	%	0.8	0.8	1.6	1.1	0.8	0.7	1.4	1.3	1.5	3.2	1.8	1.3	1.6	3.7	1.1	0.5	2.1
Phi Class 6.00+ to 7.00	%	1.1	1.4	2.1	1.8	1.8	0.7	1.9	2.1	2.3	4.5	2.3	1.5	2	5.1	1.5	0.8	3.4
Phi Class 5.00+ to 6.00	%	2.4	2.4	5	4.7	3.7	1.2	2.8	3.6	4.4	11	3.3	3.1	3.2	9.4	2.8	1.4	6.2
Phi Class 4.00+ to 5.00	%	7.8	3.8	18	21	19	3.9	6.1	9.8	13	30	6.3	8	8.9	23	3.5	2.8	11
Phi Class 3.00+ to 4.00	%	19	14	48	47	52	15	19	20	24	35	21	20	15	25	17	4.4	17
Phi Class 2.00+ to 3.00	%	13	18	15	14	15	34	29	29	22	4.8	32	26	27	7.2	21	15	19
Phi Class 1.00+ to 2.00	%	24	22	4.1	4.6	1.5	33	28	24	16	1.5	21	24	26	7.6	26	38	21
Phi Class 0.00+ to 1.00	%	14	14	1.3	0.6	0.6	5.9	5.4	4.7	5	0.6	4.4	7.7	7.2	3.4	16	17	5.9
Phi Class -1.00+ to 0.00	%	5.9	8.2	0.4	0.2	0.2	2.5	0.8	0.7	1.8	0.8	1.5	2.6	2.8	1.7	6.1	7.1	2.2
Percent Fines (clay & silt)	%	16	15	32	33	30	8.8	18	22	27	57	20	18	21	53	13	7.7	30
Dioxins/Furans																		
2,3,7,8-TCDD	ng/kg dw	0.978	0.946	0.413 J	0.383 J	0.281 J	0.132 U	0.272 J	0.251 J	0.477	0.648 J	0.29 J	0.353 J	0.783	0.693	0.451 J	0.116 U	0.681
1,2,3,7,8-PeCDD	ng/kg dw	2.82	2.91	0.754 J	0.812 J	0.84 J	0.271 J	0.696 J	0.864 J	1.55 J	2.14 J	1.08 J	0.99 J	1.92 J	2.39 J	1.3 J	0.172 U	1.79 J
1,2,3,4,7,8-HxCDD	ng/kg dw	2.31 J	2.54	0.77 J	1.09 J	0.745 J	0.254 U	0.71 J	1.04 J	1.63 J	2.06 J	1.03 J	1.13 J	2.01 J	3.08	1.11 J	0.259 U	1.87 J
1,2,3,6,7,8-HxCDD	ng/kg dw	5	6.09	1.45 J	2.24 J	1.36 J	0.511 J	1.8 J	2.76	4.24	4.97	2.96	3.1	4.73	6.89	2.78	0.943 J	5.2
1,2,3,7,8,9-HxCDD	ng/kg dw	2.95	3.46	1.17 J	1.49 J	1.08 J	0.336 J	1.13 J	1.47 J	2.63	2.7 J	1.55 J	1.72 J	3	4.55	1.65 J	0.457 J	2.63
1,2,3,4,6,7,8-HpCDD	ng/kg dw	63.8	95.2	21.7	62.7	22.4	5.32	20.2	29.9	50.7	81.9	26.3	63.2	61	79.9	28.1	11.7	147
Total OCDD	ng/kg dw	539	793	152	310	168	35.6	127	194	321	617	142	578	420	512	192	76.5	1,500
2,3,7,8-TCDF	ng/kg dw	5.13	6.32	1.01	1.13	0.964	0.327 J	0.853	1.49	2.9	9.64	1.48	1.62	4.53	3.33	1.94	0.457 J	3.12
1,2,3,7,8-PeCDF	ng/kg dw	2.79	3.42	0.56 J	0.791 J	0.431 J	0.233 U	0.423 J	0.926 J	1.3 J	2.16 J	0.867 J	0.778 J	1.81 J	1.59 J	1.06 J	0.276 J	1.6 J
2,3,4,7,8-PeCDF	ng/kg dw	3.78	5.77	0.767 J	1.12 J	0.738 J	0.233 U	0.723 J	1.34 J	1.89 J	3.3	1.18 J	1.08 J	2.69	2.52	1.56 J	0.392 J	2.45
1,2,3,4,7,8-HxCDF	ng/kg dw	1.99 J	3.53	0.436 J	0.582 J	0.408 J	0.233 U	0.542 J	0.817 J	1.24 J	2.06 J	0.795 J	0.557 J	1.64 J	2.43 J	0.802 J	0.259 J	1.84 J
1,2,3,6,7,8-HxCDF	ng/kg dw	1.47 J	1.96 J	0.344 J	0.515 J	0.401 J	0.0954 U	0.448 J	0.725 J	0.968 J	1.67 J	0.547 J	0.546 J	1.19 J	1.33 J	0.666 J	0.26 J	1.23 J
1,2,3,7,8,9-HxCDF	ng/kg dw	0.456 J	0.548 J	0.105 U	0.257 U	0.201 U	0.121 U	0.114 U	0.0927 U	0.335 J	0.395 J	0.119 U	0.123 U	0.481 J	0.388 J	0.24 U	0.139 U	0.453 J
2,3,4,6,7,8-HxCDF	ng/kg dw	1.87 J	2.58	0.518 J	0.481 J	0.498 J	0.233 U	0.558 J	0.892 J	1.18 J	1.74 J	0.72 J	0.665 J	1.52 J	1.69 J	0.876 J	0.24 U	1.51 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw	12.1	23.2	4.12	2.97	2.92	0.824 J	4.47	5.53	9.86	11.9	5.74	8.4	12.1	16.6	5.85	2.32	17.5
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.719 J	1.24 J	0.126 U	0.2 U	0.104 U	0.122 U	0.407 U	0.356 J	0.595 J	0.908 J	0.365 J	0.536 J	0.788 J	1.38 J	0.4 J	0.175 U	1.04 J
Total OCDF	ng/kg dw	68.5	107	17.3	7.32	9.7	2.02 J	11.5	17.7	45.8	30.8	13.2	84.4	43.7	61.1	23.8	7.55	64.1
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	8.08	9.86	2.29	3.06	2.21	0.461	2.09	2.89	4.87	7.51	3.03	3.54	6.35	7.41	3.64	0.529	7.16
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	8.08	9.86	2.3	3.07	2.22	0.613	2.1	2.89	4.87	7.51	3.03	3.55	6.35	7.41	3.65	0.706	7.16

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		LP-07-SD	LP-08-SD	MD-03-SD	MD-04-SD	MD-05-SD	MD-06-SD	MD-07-SD	MD-08-SD	MD-09-SD	MD-10-SD	MD-11-SD	MD-12-SD	MD-13-SD	MD-14-SD	MD-15-SD	MD-16-SD	MD-17-SD
Sample ID		LP-07-SS	LP-08-SS	MD-03-SS	MD-04-SS	MD-05-SS	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS	MD-15-SS	MD-16-SS	MD-17-SS
Sample Date		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/29/2006	9/29/2006	9/30/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (PCBs)																		
PCB-1	ng/kg dw	40	82	10	15	39	17	9.3	11	21	18	9.6	9.4	34	18	11	5.8	33
PCB-2	ng/kg dw	36	56	9.9	9.3	14	12	9.9	11	22	16	10	11	26	16	15	7.6	22
PCB-3	ng/kg dw	61	93	8.6	10	12	4.4	12	15	31	29	14	15	55	26	19	7.9	35
PCB-4	ng/kg dw	26	48	7.6	17	38	19	8.3	9.7	15	13	11	8.4	22	16	11	3.5	25
PCB-5	ng/kg dw	5.6	15	2	4.2	18	9.3	1.2	1.7	3.6	3.2	1.7	1.2	3.4	3.4	1.6	0.61	3
PCB-6	ng/kg dw	21	31	3.2	6.5	6.2	4.3	4.4	4.9	9.9	8.4	4.8	4.5	14	9.5	5.4	2.7	16
PCB-7	ng/kg dw	5.6	9.7	1.7	2.1	3.2	1.8	1.4	2	3	3.2	1.7	1.9	4.1	3	1.9	0.79	4.7
PCB-8	ng/kg dw	85	130	14	31	20	11	22	28	42	42	26	25	81	46	28	9.8	62
PCB-9	ng/kg dw	7.3	15	1.8	3	3.9	2.7	1.2	1.6	3	3.2	1.6	1.6	4.3	3.6	1.9	0.77	6.9
PCB-10	ng/kg dw	1.6	2.6	0.68 U	0.62 U	0.87 U	1 U	0.85 U	0.57	1	0.59	0.47	0.57	1.2	0.83	0.71	0.29 U	1.9
PCB-11	ng/kg dw	43	48	19	16	12	200	24	39	71	31	18	16	22	22	17	13	110
PCB-12, 13	ng/kg dw	32	54	7.4	12	24	10	5.9	8.3	16	15	8.3	8.5	21	18	11	3.5	19
PCB-14	ng/kg dw	3	3.7	1.6 U	1.1 U	1.4 U	1.3 U	0.59	0.83	1.7	1.2	0.7	0.88	1.9	1.1	1.3	0.35	1.7
PCB-15	ng/kg dw	70	110	13	15	12	7.2	18	21	36	44	20	20	75	44	22	7.7	47
PCB-16	ng/kg dw	47	110	9.2	20	23	11	9.5	13	24	21	12	11	43	28	24	4.2	36
PCB-17	ng/kg dw	43	87	9.7	17	14	6.7	15	20	28	21	18	17	43	26	25	5	38
PCB-18, 30	ng/kg dw	99	210	18	37	24	13	22	28	53	46	26	24	92	58	53	9.3	91
PCB-19	ng/kg dw	8.4	19	2.1	3.9	5.3	2.8 J	4.5	5.4	7.4	4.7	5.1	5.3	10	6.1	8.4	1.3 J	9.3
PCB-20, 28	ng/kg dw	220	400	42	58	43	28	52	66	120	110	61	63	180	150	91	26	160
PCB-21, 33	ng/kg dw	90	180	18	35	47	26	19	26	49	47	24	23	74	61	37	9.1	64
PCB-22	ng/kg dw	68	120	11	17	13	9.2	13	18	34	34	16	16	55	46	26	6.6	48
PCB-23	ng/kg dw	0.74 U	1.5 J	0.89 U	0.95 U	1.3	1.5 U	0.33 U	0.34 U	0.49 U	0.6 J	0.29 U	0.28 U	0.63	0.68	0.31 U	0.44 U	0.97 U
PCB-24	ng/kg dw	1.5	5	0.84	1.5	3.9	1.8	0.46	0.55	1.1	1.2	0.52	0.45	1.7	1.6	0.82	0.22	1.2
PCB-25	ng/kg dw	15	26	2.8	4.1	3.6	2.3	3.9	4.8	8.4	8.2	4.5	4.6	13	11	6.2	1.8	13
PCB-26, 29	ng/kg dw	38	73	7.8	13	16	9	8.1	11	20	20	9.4	9.3	29	26	14	3.7	29
PCB-27	ng/kg dw	7.8	15	1.9	3.1	1.6	0.78 J	2.2	2.8	5.8	4.6	2.6	2.5	8.7	6.9	4.5	0.95	8.4
PCB-31	ng/kg dw	160	300	25	41	28	20	32	40	81	78	38	40	130	110	65	16	120
PCB-32	ng/kg dw	34	66	6.4	11	5	2.8	12	15	21	15	13	13	35	21	21	3.9	28
PCB-34	ng/kg dw	1.3	1.7 J	0.94 U	1 U	1.1 U	1.6 U	0.34 U	0.38	0.82	0.86	0.3 U	0.33	1.2	0.94	0.75	0.45 U	1.3
PCB-35	ng/kg dw	15	26	2.7	3.7	3.6	3.6	2.8	3.8	7.3	7.4	3.9	4.4	11	9.6	5.3	1.6	20
PCB-36	ng/kg dw	3.2	4.8	0.84 U	0.9 U	1 U	3.7	0.93	1.2	1.7	1.7	0.98	1.1	2.1	2	1.2	0.42 U	7.6
PCB-37	ng/kg dw	82	150	13	15	12	8.3	18	22	39	42	22	22	67	56	31	8.1	52
PCB-38	ng/kg dw	1.9	3.5	0.87 U	0.93 U	2.8	1.5 U	0.38 J	0.66	1.3	1.4	0.67 J	0.62	1.4	1.7	0.92	0.42 U	0.92 U
PCB-39	ng/kg dw	0.69 U	1.4 U	0.86 U	0.91 U	1 U	1.4 U	0.35 J	0.33 U	0.58	0.91	0.6 J	0.63	1.1	1	0.74	0.45 U	0.9 U
PCB-40, 41, 71	ng/kg dw	130	430	20	40	35	18	32	43	74	66	34	36	91	81	57	12	91
PCB-41	ng/kg dw	25	75	7	15	45	22	5.6	9	14	15	6.7	5.8	16	22	11	2.4	13
PCB-42	ng/kg dw	73	230	11	20	17	9.3	14	20	38	36	15	17	52	47	30	6.3	58
PCB-43	ng/kg dw	14	42	2.2	4.9	13	6.7	2.7	3.8	6.6	6.1	3	3	8.8	9	5.5	0.95 J	7
PCB-44, 47, 65	ng/kg dw	460	2,100	51	120	90	49	67	100	200	190	70	85	280	260	170	29	350
PCB-45	ng/kg dw	20	58	4.2	11	28	17	4.9	7.6	14	12	6.3	5.9	18	17	13	2.4	17
PCB-46	ng/kg dw	9.9	27	1.5	3.6	3.5	2	2.9	4.1	6.9	5	3.5	3.9	8.7	6.5	7.2	1.3	9
PCB-48	ng/kg dw	53	180	15	34	91	44	17	24	39	34	20	18	41	47	27	5.8	31
PCB-49, 69	ng/kg dw	230	980	38	75	60	31	38	60	140	140	40	47	180	170	91	18	240
PCB-50, 53	ng/kg dw	30	96	5	11	11	6.1	9.8	13	20	16	11	13	24	19	21	4.2	31
PCB-51	ng/kg dw	8	20	1.2	2.3	2.1	1	2.4	3.1	4.4	4.8	2.6	3	5.9	5.6	4.3	0.9	6.7

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		LP-07-SD	LP-08-SD	MD-03-SD	MD-04-SD	MD-05-SD	MD-06-SD	MD-07-SD	MD-08-SD	MD-09-SD	MD-10-SD	MD-11-SD	MD-12-SD	MD-13-SD	MD-14-SD	MD-15-SD	MD-16-SD	MD-17-SD
Sample ID		LP-07-SS	LP-08-SS	MD-03-SS	MD-04-SS	MD-05-SS	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS	MD-15-SS	MD-16-SS	MD-17-SS
Sample Date		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/29/2006	9/29/2006	9/30/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-52	ng/kg dw	920	4,500	92	240	170	90	100	170	410	420	100	130	590	660	340	51	820
PCB-54	ng/kg dw	0.67	1.2	0.36 U	0.37 U	0.48	0.4 U	1.1	1.5	2.2	0.81	1.4	2.2	1.9	0.75	2.6	0.6	1.5
PCB-55	ng/kg dw	6.1	15	1.2	2.1	2.1	1.1	1.2	1.6	3.6	3.4	1.5	1.7	6.1	5.6	2.6	0.61	3.8
PCB-56	ng/kg dw	140	440	25	46	42	22	27	36	75	80	31	34	120	120	60	13	110
PCB-57	ng/kg dw	2	6.9	0.51 U	0.71	0.85 U	0.82 U	0.4	0.63	0.95	0.73 J	0.41	0.54	1.9	1.8	0.82	0.27 U	0.72 U
PCB-58	ng/kg dw	1.3	3.7	0.59 U	0.72 U	0.98 U	0.95 U	0.39	0.46 U	0.5 U	0.64	0.29 U	0.35	1.1	1.5	0.46	0.31 U	0.85 U
PCB-59, 62, 75	ng/kg dw	22	56	3.5	6.2	6.3	3.7	4.7	6.3	12	11	5.1	5.7	16	14	9.7	2	16
PCB-60	ng/kg dw	65	200	11	18	12	6.9	14	18	34	34	15	17	58	55	28	6.7	46
PCB-61, 70, 74, 76	ng/kg dw	880	4,100	120	260	180	89	130	190	400	430	140	160	680	660	320	63	700
PCB-63	ng/kg dw	10	39	1.8	3.2	2.7	1.4	2.1	2.7	5.5	5.8	2.3	2.4	9.6	8.4	4.3	1	8.5
PCB-64	ng/kg dw	140	610	15	35	23	14	21	30	62	58	22	25	93	90	51	9.3	100
PCB-66	ng/kg dw	300	1,200	55	96	66	35	62	82	170	180	71	76	280	270	130	30	270
PCB-67	ng/kg dw	14	34	2.5	3.9	5	2.2	2.8	3.9	7.2	7.3	3.2	3.5	11	12	5.2	1.4	8.9
PCB-68	ng/kg dw	1.8	2.9	0.96	1.1	1.4	0.81 U	0.55	0.68	1.9	2.4	0.68	0.76	2.2	2.5	0.96	0.41	2.9
PCB-72	ng/kg dw	5.7	12	1.4	1.9	2.3	0.81 U	1.2	1.7	4.1	4.6	1.2	1.5	5.6	6.9	1.9	0.61	6.3
PCB-73	ng/kg dw	0.53	0.45 U	0.31 U	0.43 U	0.47 U	0.7 U	0.17 U	0.18	0.46	0.44	0.15	0.16	0.3	0.24 J	0.27	0.15 U	0.44 U
PCB-77	ng/kg dw	47	82	7.8	11	8.7	4.5	10	14	26	29	12	14	41	46	22	5.1	40
PCB-78	ng/kg dw	0.69 U	1.5 U	0.57 U	0.7 U	0.95 U	0.92 U	0.27 U	0.48 U	0.52 U	0.47 U	0.33 U	0.25 U	0.64	0.41 U	0.36 U	0.35 U	0.81 U
PCB-79	ng/kg dw	15	50	2.7	5.7	6.5	2.3	2.4	4.1	10	12	2.7	3.9	14	16	7.2	1.2	14
PCB-80	ng/kg dw	0.61 U	1.3 U	0.51 U	0.62 U	0.85 U	0.82 U	0.23 U	0.41 U	0.45 U	0.4 U	0.27 U	0.21 U	0.31 U	0.34 U	0.3 U	0.29 U	0.71 U
PCB-81	ng/kg dw	2.9	5.1	0.59 U	0.72 U	0.98 U	0.94 U	0.6 J	0.52 U	1.1	1.4	0.74 J	0.62 J	2	1.9	1.4	0.37 U	1
PCB-82	ng/kg dw	200	760	17	47	37	17	22	33	70	94	22	30	120	140	66	9.2	120
PCB-83	ng/kg dw	79	280	8.6	17	16	8.9	7.8	14	34	55	8.7	13	53	74	27	4.8	66
PCB-84	ng/kg dw	380	1,500	34	90	68	34	38	63	160	190	40	55	260	310	150	19	290
PCB-85, 116, 117	ng/kg dw	240	1,100	21	57	39	18	27	42	95	130	29	37	170	150	74	12	140
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	1,300	4,800	140	330	280	130	150	240	610	750	170	220	990	1,400	500	74	1,000
PCB-88	ng/kg dw	0.64 U	0.71 U	0.69 U	0.97 U	5.3	1.2 U	0.51	0.74 U	0.28 U	0.37 U	0.21 U	0.71 U	0.2 U	0.3 U	0.68 U	0.26 U	1.2 U
PCB-89	ng/kg dw	14	18	2.3 J	5.7	8.3	3.1 J	2.4	3.9	9.7	11	2.8	3.1	14	18	5.3	1.2	12
PCB-90, 101, 113	ng/kg dw	3,100	9,800	450	820	750	340	440	760	2,400	2,600	550	720	3,300	6,000	1,300	260	3,300
PCB-91	ng/kg dw	180	760	22	51	42	24	19	32	70	100	19	25	110	130	59	11	180
PCB-92	ng/kg dw	480	1,600	74	140	150	69	64	110	380	440	78	100	500	900	200	38	500
PCB-93, 98, 100, 102	ng/kg dw	9.1	29	4.5	8	22	11	2	3.7	9	15	3	3.1	9.4	24	4.9	1.9	31
PCB-94	ng/kg dw	5.3	18	1.1	2.1 J	3.1	1.8	1.4	2.2	4.9	4.5	1.6	2	6.7	7.7	3.2	0.59 J	5.7
PCB-95	ng/kg dw	2,200	7,000	220	420	380	190	240	440	1,400	1,400	280	400	1,900	3,300	780	130	1,800
PCB-96	ng/kg dw	6.3	24	1.1	2.5	2.6 J	1.4	1.9	2.8	6.3	5.5	2.4	2.8	7.9	8.4	5.3	1	9.9
PCB-98	ng/kg dw	1.8	7.3	0.73 U	1 U	2.1	1.3 U	0.34	1.4	3.3	3.3	0.23 U	1.1	4.5	2.6	2.3	0.28 U	6.1
PCB-99	ng/kg dw	700	3,200	160	300	280	130	120	200	550	710	130	180	790	970	350	73	920
PCB-102	ng/kg dw	29	110	5.8	13	16	8.4	8.5	12	23	23	10	11	29	36	17	3.7	28
PCB-103	ng/kg dw	11	27	9.2	12	17	7.3	5.3	9.3	38	40	6.5	9.8	36	44	14	4.1	55
PCB-104	ng/kg dw	0.26 U	0.34 U	0.31 U	0.28 U	0.25 U	0.35 U	0.11 U	0.085 U	0.15 U	0.2 U	0.1 U	0.083 U	0.094 U	0.17 U	0.12 U	0.13 U	0.38 U
PCB-105	ng/kg dw	800	3,300	66	160	88	37	75	110	220	350	82	110	480	510	230	36	430
PCB-106	ng/kg dw	0.6 U	0.67 U	0.53 U	0.74 U	1.2	0.92 U	0.16 U	0.61 U	0.93	1.2	0.43	0.59 U	1 J	2.1	0.64	0.21 U	0.78 U
PCB-107, 124	ng/kg dw	78	270	6.9	17	10	4.7	8.1	12	27	39	9.1	12	54	68	28	3.9	52
PCB-109	ng/kg dw	96	330	15	29	24	11	14	20	51	70	18	23	92	130	43	8	86
PCB-110	ng/kg dw	2,600	9,200	280	590	440	210	260	440	1,200	1,400	330	450	2,100	3,100	910	150	2,000

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		LP-07-SD	LP-08-SD	MD-03-SD	MD-04-SD	MD-05-SD	MD-06-SD	MD-07-SD	MD-08-SD	MD-09-SD	MD-10-SD	MD-11-SD	MD-12-SD	MD-13-SD	MD-14-SD	MD-15-SD	MD-16-SD	MD-17-SD
Sample ID		LP-07-SS	LP-08-SS	MD-03-SS	MD-04-SS	MD-05-SS	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS	MD-15-SS	MD-16-SS	MD-17-SS
Sample Date		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/29/2006	9/29/2006	9/30/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-111	ng/kg dw	1.5	3.1	0.73	0.63 J	1.7 J	1.1	0.41	0.71	2.1	3.3	0.46	0.68	2.2	5.7	0.8	0.19 U	2.3
PCB-112	ng/kg dw	0.64 U	0.71 U	0.58 U	0.82 U	0.71 U	1 U	0.22	0.61 U	0.24 U	0.31 U	0.17 U	0.57 U	0.16 U	2	0.55 U	0.21 U	0.83 U
PCB-114	ng/kg dw	40	180	3.3	8.5	5.7	2.6	3.8	6	13	16	4.9	6.1	27	35	13	1.8	24
PCB-115	ng/kg dw	19	100	1.3	5.1	2.4	1.3 J	1.6	4	6.7	8.8	2.2	2.5	12	12	7.5	1	8.4
PCB-117	ng/kg dw	36	130	3.8	8.1	4.1	2.5	4.3	6.9	11	17	3.9	5.7	18	29	12	1.6	29
PCB-118	ng/kg dw	1,900	8,000 J	190	410	260	110	200	310	760	1,000	240	320	1,500	2,000	650	110	1,300
PCB-120	ng/kg dw	7.1	14	3	3.6	6.7	3	1.8	3.1	11	15	2.2	0.58 U	11	28	3.8	1.4	13
PCB-121	ng/kg dw	0.55 U	0.62 U	0.53 U	0.74 U	0.64 U	0.92 U	0.15 U	0.56 U	0.21 U	0.28 U	0.15 U	0.5 U	0.35	0.21 U	0.48 U	0.18 U	0.72 U
PCB-122	ng/kg dw	20	72	2	4.7	4.1	1.7 J	2.1	3.2	6.8	9.2	2.7	3.3	13	15	6	1.1	11
PCB-123	ng/kg dw	31	130	3	7.2	4.3	1.5	3.6	5.1	12	16	3.9	5.4	22	25	9.3	1.9	17
PCB-126	ng/kg dw	10	17	1.7	2.6	1.9	1.2 U	1.7	3.3	6.4	9.3	2.4	2.8	8.4	19	4.4	1.3	15
PCB-127	ng/kg dw	0.55 U	0.59 U	0.55 U	0.76 U	0.62 U	0.93 U	0.16 U	0.61 U	0.23 U	0.32 U	0.19 U	0.62 U	0.19 U	0.27 U	0.59 U	0.22 U	0.73 U
PCB-128, 166	ng/kg dw	650	1,800	69	130	110	43	74	130	350	440	140	120	550	1,100	220	39	470
PCB-130	ng/kg dw	270	670	40	61	55	24	38	77	250	270	79	69	290	760	120	25	270
PCB-131	ng/kg dw	47	130	6	11	10	4.5	6.3	13	39	41	12	11	46	100	21	3.9	40
PCB-132	ng/kg dw	1,600	4,200	210	320	310	140	190	420	1,400	1,500	400	350	1,600	4,000	590	130	1,500
PCB-133	ng/kg dw	61	150	15	20	31	14	11	23	78	95	23	20	82	230	31	7.9	81
PCB-134	ng/kg dw	270	740	36	60	65	29	37	80	270	290	74	66	300	770	120	23	260
PCB-135, 151	ng/kg dw	2,300	6,300	360	510	630	260	330	740	2,600	2,600	720	620	2,800	7,200	940	230	2,500
PCB-136	ng/kg dw	880	2,800	100	150	160	68	110	210	810	820	200	200	1,100	2,400	320	72	1,000
PCB-137	ng/kg dw	110	330	6.5	18	9.7	4.2	9.8	19	40	56	14	15	63	110	43	4.7	59
PCB-139, 140	ng/kg dw	41	130	9.3	16	20	9.5	6.3	13	36	53	9.9	11	38	82	22	4.9	52
PCB-141	ng/kg dw	1,400	3,600	140	220	230	100	160	350	1,200	1,300	440	300	1,500	4,100	500	110	1,400
PCB-142	ng/kg dw	1.7 J	5.6	0.9	1.5	6.2	2.9	0.19 U	0.83 J	1.8 J	2.8	1.1	0.47	1.6	4.8	0.91	0.27 U	0.65 U
PCB-143	ng/kg dw	6.9	20	3.1	5.2	6.4	2.5	1.9	3.9	12	12	2.8	2.6	22	33	5.3	1.8	11
PCB-144	ng/kg dw	380	1,000	54	82	85	35	58	130	420	400	130	110	460	1,200	170	37	400
PCB-145	ng/kg dw	1	3	0.28 U	0.28 U	0.82	0.4 U	0.2 J	0.39	1	0.98	0.39	0.37	1.5	2.3	0.68	0.15 U	1
PCB-146	ng/kg dw	810	2,000	170	230	290	130	140	310	1,000	1,100	320	260	1,100	2,900	410	100	1,100
PCB-147, 149	ng/kg dw	4,900	13,000	750	1,100	1,200	520	680	1,500	5,100	5,300	1,500	1,300	5,800	15,000	2,000	480	5,400
PCB-148	ng/kg dw	3.1	5.5	2.8 J	4.3	8.8	4	1.5	3.2	12	17	2.1	2.7	7.9	20	3.6	1.4	14
PCB-150	ng/kg dw	4.6	8.6	3.1	3.9	4.9	2.1	1.7	2.8	9.4	14	2.2	3	9.5	23	4	2	33
PCB-152	ng/kg dw	2.3	6.1	0.7	1.3 J	1.6	0.74	0.37	0.69	3.3	4.4	0.61	0.62	4.7	8.7	1.4	0.32 J	5.1
PCB-153, 168	ng/kg dw	5,700	15,000	940	1,300	1,300	530	910	1,900	6,200	6,500	2,300	1,700	7,400	19,000	2,700	650	6,900
PCB-154	ng/kg dw	30	62	23	27	43	19	11	24	81	100	16	21	67	160	32	11	120
PCB-155	ng/kg dw	0.41 U	0.51 U	0.29 U	0.29 U	0.3 U	0.42 U	0.13 U	0.11 U	0.19 U	0.42	0.11 U	0.11 U	0.23 J	0.85	0.17 U	0.15 U	1.6
PCB-156, 157	ng/kg dw	570	1,600	64	110	87	35	66	110	330	430	150	110	540	1,200	210	38	460
PCB-158	ng/kg dw	590	1,600	74	120	99	41	82	160	510	560	200	150	650	1,600	260	55	610
PCB-159	ng/kg dw	110	260	18	27	36	13	19	35	130	160	62	34	170	480	59	13	130
PCB-160	ng/kg dw	0.49 U	0.6 U	0.37 U	0.35 U	0.46 U	0.67 U	0.15 U	0.47	0.26 U	0.35 U	0.75	0.14 U	1.2	4.7	0.24 U	0.23 U	0.46 U
PCB-161	ng/kg dw	0.41 U	0.51 U	0.33 U	0.32 U	0.42 U	0.62 U	0.12 U	0.13 U	0.22 U	0.3 U	0.14 U	0.12 U	0.13 U	0.26 U	0.2 U	0.19 U	0.41 U
PCB-162	ng/kg dw	13	33	2.1	3.2	2.3	1 U	2.5	3.2	9.2	11	4	3.7	12	24	5.8	1.3	12
PCB-163, 164	ng/kg dw	5,900	16,000	870	1,200	1,100	470	840	1,700	5,500	5,900	2,000	1,600	7,000	18,000	2,600	580	6,600
PCB-164	ng/kg dw	370	960	56	79	76	33	51	110	350	380	120	96	430	1,100	150	35	400
PCB-165	ng/kg dw	1.9	3.4	0.76 J	0.86 J	1.2	0.72 U	0.78	1.2	3.2	2.7	1.1	1.2	2.3	3.1	1.1	0.38	1.6
PCB-167	ng/kg dw	200	530	27	42	34	14	28	45	140	170	62	46	210	480	84	17	200

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		LP-07-SD	LP-08-SD	MD-03-SD	MD-04-SD	MD-05-SD	MD-06-SD	MD-07-SD	MD-08-SD	MD-09-SD	MD-10-SD	MD-11-SD	MD-12-SD	MD-13-SD	MD-14-SD	MD-15-SD	MD-16-SD	MD-17-SD
Sample ID		LP-07-SS	LP-08-SS	MD-03-SS	MD-04-SS	MD-05-SS	MD-06-SS	MD-07-SS	MD-08-SS	MD-09-SS	MD-10-SS	MD-11-SS	MD-12-SS	MD-13-SS	MD-14-SS	MD-15-SS	MD-16-SS	MD-17-SS
Sample Date		9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/28/2006	9/29/2006	9/29/2006	9/30/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/29/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-169	ng/kg dw	18	40	2.6	1 U	4.6	1.4 U	3.6	7.6	23	27	13	6.2	0.81 U	93	13	2.4	21
PCB-170	ng/kg dw	1,700	4,500	330	420	470	170	290	610	2,100	2,400	1,100	550	2,500	8,900	1,100	210	2,300
PCB-171, 173	ng/kg dw	630	1,600	110	140	170	65	100	220	740	840	380	200	880	2,900	370	76	770
PCB-172	ng/kg dw	320	790	59	74	86	31	54	120	380	440	200	100	450	1,600	190	39	410
PCB-174	ng/kg dw	2,400	6,200	420	550	770	260	370	820	2,900	3,300	1,200	650	3,100	10,000	1,200	250	2,800
PCB-175	ng/kg dw	110	280	19	26	36	13	19	41	130	140	62	33	140	450	59	13	120
PCB-176	ng/kg dw	240	670	36	51	63	22	40	71	290	340	120	71	380	1,100	120	26	360
PCB-177	ng/kg dw	1,300	3,500	250	320	410	150	240	520	1,700	2,000	800	430	1,900	6,200	770	170	1,600
PCB-178	ng/kg dw	400	1,100	68	87	110	37	76	130	470	600	220	130	650	1,900	220	49	650
PCB-179	ng/kg dw	940	2,700	150	210	280	98	160	290	1,100	1,400	460	280	1,500	4,000	470	100	1,500
PCB-180, 193	ng/kg dw	4,100	11,000	740	960	1,200	400	660	1,400	4,800	5,800	2,700	1,300	6,000	21,000	2,600	490	5,500
PCB-181	ng/kg dw	9.5	22	1.4	2.2	2.4	1.4 U	1	2.3	6.6	9	3.9	1.9	8.1	27	4.3	0.82	8.6
PCB-182	ng/kg dw	5.3	10	2.9	3.5	5.7	2.3	1.6	3.6	12	15	2.9	3	9.7	38	4.4	1.1	9.8
PCB-183	ng/kg dw	1,200	3,000	180	250	360	110	190	420	1,400	1,600	650	350	1,500	4,900	670	130	1,500
PCB-184	ng/kg dw	0.55 U	1.6	0.4 U	0.43 U	0.56 U	0.77 U	0.19 U	0.42	1.2 J	1.8	0.35	0.39 J	1.3	3.2	0.55	0.21 U	2.1
PCB-185	ng/kg dw	160	420	31	42	47	15	20	46	220	270	110	38	200	680	71	19	140
PCB-186	ng/kg dw	0.58 U	0.64 U	0.41 U	0.44 U	0.58 U	0.8 U	0.19 U	0.17 U	0.95	0.43 U	0.18 U	0.14 U	1.6	3.4	0.26 U	0.21 U	0.55 U
PCB-187	ng/kg dw	2,800	7,100	560	770	1,100	350	500	1,100	3,400	4,100	1,500	850	3,700	12,000	1,500	340	3,500
PCB-188	ng/kg dw	1.7	2.6	1.3	1.7	1.8	0.71 U	0.49	1	3.7	5.8	0.81	0.97	3.9	10	1.2	0.71	10
PCB-189	ng/kg dw	73	180	15	19	19	7.7	14	24	82	96	48	23	110	390	48	8.8	110
PCB-190	ng/kg dw	380	1,000	72	91	110	39	62	130	510	550	280	120	600	2,200	260	50	520
PCB-191	ng/kg dw	85	220	15	19	23	7.8	14	29	100	120	54	28	130	430	55	11	120
PCB-192	ng/kg dw	1.5 U	1.6 U	0.66 U	0.77 U	1 U	1.4 U	0.36 U	0.39 U	0.76 U	0.74 U	0.44 U	0.35 U	0.61 U	1.9 U	0.66 U	0.58 U	1.2 U
PCB-194	ng/kg dw	1,400	2,900	220	310	410	120	220	410	1,300	2,000	780	380	1,700	7,200	800	140	1,700
PCB-195	ng/kg dw	430	1,100	80	110	160	46	80	150	500	710	310	130	610	2,600	300	50	620
PCB-196	ng/kg dw	460	1,200	86	110	150	42	78	140	510	720	290	150	720	3,000	330	55	700
PCB-197	ng/kg dw	28	67	6.6	9.9	13	3.4	6	11	34	49	16	8.5	38	160	16	3.2	35
PCB-198, 199	ng/kg dw	1,400	2,800	230	320	420	120	210	370	1,200	1,800	710	370	1,700	7,100	770	140	1,600
PCB-199	ng/kg dw	160	350	27	40	58	16	24	44	150	220	81	42	190	760	88	16	180
PCB-201	ng/kg dw	150	360	22	32	52	15	20	37	140	210	84	41	210	830	94	16	200
PCB-202	ng/kg dw	260	480	38	61	82	24	32	61	190	310	97	53	240	890	100	21	240
PCB-203	ng/kg dw	780	1,500	120	170	220	65	92	180	600	930	380	170	880	3,700	410	68	890
PCB-204	ng/kg dw	0.74 U	0.75 U	0.42 U	0.53 U	0.61 U	0.93 U	0.19 U	0.25 U	0.41 U	0.49 U	0.22 U	0.21 U	0.55	1.4	0.36 U	0.29 U	0.6 U
PCB-205	ng/kg dw	49	120	9.9	13	19	5.7	9.4	16	57	81	35	16	73	320	36	6.4	74
PCB-206	ng/kg dw	1,100	510	82	160	170	52	46	120	200	470	130	71	250	1,200	130	30	250
PCB-207	ng/kg dw	100	78	11	20	22	7.6	6.6	16	35	72	19	10	42	180	20	4.2	42
PCB-208	ng/kg dw	270	120	19	39	34	15	12	30	53	110	27	17	72	230	29	7	64
PCB-209	ng/kg dw	170	57	17	39	14	9.2	14	26	40	54	19	17	62	79	23	8.1	49
Total PCBs, Congeners	ng/kg dw	64,000	180,000	9,700	15,000	16,000	6,700	9,300	18,000	57,000	66,000	23,000	16,000	72,000	190,000	29,000	6,000	68,000
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	1.7	3.4	0.26	0.28	0.34	0.0067	0.29	0.58	1.4	1.8	0.66	0.49	0.93	4.8	0.86	0.21	2.2
Other																		
Total TEQ	ng/kg dw	9.76	13.2	2.55	3.36	2.56	0.62	2.39	3.47	6.26	9.32	3.7	4.04	7.28	12.2	4.52	0.912	9.4

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		MD-18-SD	MD-21-SD	MD-22-SD	MD-23-SD	MD-24-SD	WP-01-SD	WP-02-SD	WP-03-SD	WP-04-SD	WP-05-SD	WP-06-SD	WP-07-SD	WP-08-SD	WP-09-SD	WP-10-SD	WP-11-SD
Sample ID		MD-18-SS	MD-21-SS	MD-22-SS	MD-23-SS	MD-24-SS	WP-01-SS	WP-02-SS	WP-03-SS	WP-04-SS	WP-05-SS	WP-06-SS	WP-07-SS	WP-08-SS	WP-09-SS	WP-10-SS	WP-11-SS
Sample Date		9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/30/2006	9/30/2006	9/30/2006	10/1/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	WPAH015	WPAH008	WPAH013	No	No	No	WPAH006
Analyte	**Units**																
Conventionals																	
Acid-Volatile Sulfide	mg/kg dw																
Sulfides	mg/kg dw																
Total Organic Carbon	%	4.05	2.41	2.56	0.816	0.83	4.74	10	3.71	5.55	3.02	6.04	4.39	2.53	6.32	3.67	6.81
Total Solids	%	40.6	72	52.4	68.3	68.4	32	27.5	38.9	37.1	40.5	30.7	30.8	47.4	31.1	33.3	26.7
Total Solids, Preserved	%																
Total Volatile Solids	%	14.5	4.12	27.4	5.05	3.47	17.2	16.7	11.7	12.7	10.9	18.7	16.8	9.21	19.9	14.4	32.1
Particle/Grain Size																	
Percent Gravel	%	1.9	3.7	13	1.4	0.8	0.5	0.8	2.1	0.5	0.1	1.6	0.2	1.3	5.9	3.7	14
Phi Class 10.00+	%	9	1.3	3.1	2.2	3.3	12	13	9.7	11	9.7	12	12	9.6	11	11	9.4
Phi Class 9.00+ to 10.00	%	1.8	0.3	0.4	0.2	0.6	4.1	5.8	4.5	4.6	3.8	4.1	4.6	3.9	4.5	4.4	2.1
Phi Class 8.00+ to 9.00	%	2	0.5	0.7	0.7	0.7	3.8	5.8	4.4	4.8	4.3	3.6	5.2	4.1	4.5	4.7	2
Phi Class 7.00+ to 8.00	%	3.4	0.8	0.9	0.9	1	6.1	8.4	7.4	7.6	6.6	7.7	8.6	6.4	7.6	7.6	3.4
Phi Class 6.00+ to 7.00	%	5.9	1	1.2	0.9	1.7	12	13	11	11	10	11	13	9.6	13	11	6.2
Phi Class 5.00+ to 6.00	%	13	2.2	2.3	1.2	3.5	14	18	14	16	14	15	15	14	18	14	16
Phi Class 4.00+ to 5.00	%	26	4	9.4	3.3	16	12	13	15	15	17	12	11	17	13	14	10
Phi Class 3.00+ to 4.00	%	15	9.2	30	18	36	12	5.2	11	11	16	12	6.5	18	5.5	7.4	11
Phi Class 2.00+ to 3.00	%	9.1	20	20	42	17	6.5	3.3	5.2	5.3	6.1	6.1	4.7	7.2	3.5	4	7.8
Phi Class 1.00+ to 2.00	%	5.8	35	12	20	10	5.7	4.8	6	5.1	5.6	5.5	7.4	3	4.4	6.9	6.3
Phi Class 0.00+ to 1.00	%	4.6	16	4	5.4	6.6	4.4	3.5	4.2	3.3	3.3	4.9	5.4	2.7	4.4	5.3	5.5
Phi Class -1.00+ to 0.00	%	3	6.6	4.1	4	2.8	6.5	5.2	4.6	4.2	4	5	7.7	3.3	4.9	5.3	7.2
Percent Fines (clay & silt)	%	61	10	18	9.4	27	64	77	67	70	65	65	68	65	71	67	49
Dioxins/Furans																	
2,3,7,8-TCDD	ng/kg dw	1.38	0.33 J	0.45 J	0.24 J	0.206 J	1.86	1.39	1.37	2.6	1.17 J	1.73	2	1.65	0.869	0.96 J	1.31
1,2,3,7,8-PeCDD	ng/kg dw	4.22	1.08 J	1.29 J	0.762 J	0.409 J	5.03	4.06	3.64	5.23	3.25	5.5	5.56	5.01	2.77	2.56	3.15
1,2,3,4,7,8-HxCDD	ng/kg dw	5.2	0.93 J	1.22 J	1.01 J	0.382 J	6.06	5.33	3.92	6.89	3.16	6.81	6.13	5.89	3.62	2.65	9.73
1,2,3,6,7,8-HxCDD	ng/kg dw	15.4	1.92 J	2.84	2.91	1.02 J	50.1	37.5	29.1	38.1	16.6	52.6	53.7	22.2	15.7	19.8	37.4
1,2,3,7,8,9-HxCDD	ng/kg dw	7.03	1.28 J	1.67 J	1.15 J	0.644 J	18.2	11.7	9.54	14.5	5.8	15.4	14.5	8.61	6.65	5.71	10.1
1,2,3,4,6,7,8-HpCDD	ng/kg dw	793	20.6	37.2	140	17	841	635	1,060	544	262	761	1,100	241	235	403	1,100
Total OCDD	ng/kg dw	7,680	129	258	1,150	135	6,200	4,780	15,000 J	4,010	2,430	6,080	8,890	1,650	2,070	4,020	9,530
2,3,7,8-TCDF	ng/kg dw	4.71	1.81	2.65	2.27	0.632	8.23	5.63	6.02	6.22	5.19	7.87	7.65	5.85	3.24	3.45	5.41
1,2,3,7,8-PeCDF	ng/kg dw	2.41 J	0.893 J	1.1 J	0.489 J	0.333 J	3.04	2.29 J	2.63	2.77	2.26 J	3	3.76	3.41	1.67 J	1.51 J	15.9
2,3,4,7,8-PeCDF	ng/kg dw	3.81	1.47 J	1.47 J	0.944 J	0.458 J	5.75	4.84	4.78	5.47	4.44	6.17	7.17	6.04	3.33	2.95	11.5
1,2,3,4,7,8-HxCDF	ng/kg dw	2.97	0.662 J	1.03 J	3.15	0.415 J	8.14	6.6	6.24	6.03	4.07	7.61	8.5	5.93	2.5	3.43	57.7
1,2,3,6,7,8-HxCDF	ng/kg dw	1.85 J	0.593 J	0.899 J	0.694 J	0.248 U	4.89	3.87	3.53	4.24	2.8	4.89	5.26	4.67	2.1 J	2.09 J	26.8
1,2,3,7,8,9-HxCDF	ng/kg dw	0.779 J	0.228 U	0.266 J	0.284 J	0.0692 U	2.3 J	1.46 J	2.1 J	1.88 J	1.03 J	2.11 J	1.6 J	1.44 J	0.761 J	0.64 J	16.6
2,3,4,6,7,8-HxCDF	ng/kg dw	2.57	0.725 J	0.961 J	1.08 J	0.314 J	9.2	6.43	6.92	6.95	3.92	7.97	7.92 J	6.11	3.18	3.25	20
1,2,3,4,6,7,8-HpCDF	ng/kg dw	34.2	3.83	7.35	13.3	3.11	236	202	281	154	91.6	229	337	94.2	47.1	115	363
1,2,3,4,7,8,9-HpCDF	ng/kg dw	1.52 J	0.228 U	0.517 J	1.59 J	0.315 J	10.5	7.06	12.4	7.18	3.33	7.48	12.1	4.29	2.13 J	3.6	154
Total OCDF	ng/kg dw	142	10.5	12.4	53.2	6.29	724	486	3,150	483	239	553	1,650	214	150	415	1,590
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	21.5	2.96	3.9	4.46	1.35	32.4	24.8	32.2	26.4	14.4	31.7	38	18.6	12	15.1	46.3
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	21.5	2.97	3.9	4.46	1.37	32.4	24.8	32.2	26.4	14.4	31.7	38	18.6	12	15.1	46.3

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		MD-18-SD	MD-21-SD	MD-22-SD	MD-23-SD	MD-24-SD	WP-01-SD	WP-02-SD	WP-03-SD	WP-04-SD	WP-05-SD	WP-06-SD	WP-07-SD	WP-08-SD	WP-09-SD	WP-10-SD	WP-11-SD
Sample ID		MD-18-SS	MD-21-SS	MD-22-SS	MD-23-SS	MD-24-SS	WP-01-SS	WP-02-SS	WP-03-SS	WP-04-SS	WP-05-SS	WP-06-SS	WP-07-SS	WP-08-SS	WP-09-SS	WP-10-SS	WP-11-SS
Sample Date		9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/30/2006	9/30/2006	9/30/2006	10/1/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	WPAH015	WPAH008	WPAH013	No	No	No	WPAH006
Analyte	**Units**																
Polychlorinated Biphenyls (PCBs)																	
PCB-1	ng/kg dw	130	14	41	93	28	700	650	670	310	1,300	1,000	210	260	39	67	760
PCB-2	ng/kg dw	68	24	31	34	9.1	130	130	140	92	190	170	130	93	27	49	170
PCB-3	ng/kg dw	72	28	44	41	10	780	700	740	350	830	1,100	300	280	50	77	400
PCB-4	ng/kg dw	110	6.3	35	82	29	490	380	340	230	210	420	140	300	30	54	4,000
PCB-5	ng/kg dw	91	1.2	15	51	12	160	70	66	48	35	89	21	18	5.5	6.2	250
PCB-6	ng/kg dw	37	6.9	19	27	6.5	360	270	240	170	150	370	110	150	23	37	1,400
PCB-7	ng/kg dw	23	1.4	7.5	10	3	120	89	88	61	56	120	33	33	7.2	10	240
PCB-8	ng/kg dw	140	22	64	67	23	2,200	1,500	1,500	1,100	790	2,100	600	830	130	200	6,700
PCB-9	ng/kg dw	31	1.8	9.7	17	4.5	120	90	84	56	59	130	34	43	7.9	13	510
PCB-10	ng/kg dw	4.6	0.33	1.7	3.5	0.92	26	21	20	12	13	24	8	11	1.6	2.9	150
PCB-11	ng/kg dw	53	27	43	33	18	190	140	90	120	68	160	110	57	57	79	120
PCB-12, 13	ng/kg dw	150	11	46	110	23	330	210	210	140	110	260	120	76	25	37	710
PCB-14	ng/kg dw	4.7	0.91	2.9 U	3.5	1.2 U	2.7	1.9	2.8	3.2	2.8	2.2	3.8	3.2	1.3	1.9	9.6
PCB-15	ng/kg dw	74	18	37	32	14	1,700	940	910	730	360	1,400	440	340	120	150	3,300
PCB-16	ng/kg dw	320	11	57	76	25	2,000	1,600	1,200	730	340	1,800	450	420	73	120	7,100
PCB-17	ng/kg dw	200	11	37	37	15	1,900	1,500	1,000	830	340	1,800	440	390	77	130	6,300
PCB-18, 30	ng/kg dw	690	26	98	92	36	5,100	4,400	3,300	2,100	940	5,400	1,200	950	180	330	16,000
PCB-19	ng/kg dw	68	2.1	11	14	5.1	320	290	190	130	64	290	85	75	16	24	2,200
PCB-20, 28	ng/kg dw	740	58	140	130	65	9,300	6,300	6,100	4,400	1,800	8,100	2,200	1,500	470	550	19,000
PCB-21, 33	ng/kg dw	590	23	120	210	59	4,100	2,900	2,700	1,800	810	3,500	950	690	190	230	9,700
PCB-22	ng/kg dw	270	17	50	41	21	3,200	2,100	2,000	1,300	590	2,700	730	480	150	180	6,800
PCB-23	ng/kg dw	7.6	0.54 U	2.3	6.2	2 U	8.6	3.5	3.6	3	1.9 U	4.2	2.2 U	1.5	1 U	4.2 U	52
PCB-24	ng/kg dw	18	0.54	6.5	15	3.6	38	18	17	14	7.4	22	8.5	10	2.5	3.3	300
PCB-25	ng/kg dw	43	4.1	10	11	5	510	300	250	230	89	370	120	84	28	33	1,300
PCB-26, 29	ng/kg dw	170	9.5	43	84	23	1,200	730	640	460	210	900	270	180	59	70	3,100
PCB-27	ng/kg dw	28	2.2	6.7	5.3	2.1	320	260	180	140	65	290	91	70	16	26	990
PCB-31	ng/kg dw	830	43	110	93	45	8,000	5,600	5,600	3,500	1,600	7,300	1,900	1,200	350	430	16,000
PCB-32	ng/kg dw	180	8.1	25	19	7.5	1,600	1,300	1,000	660	310	1,500	380	310	60	100	4,400
PCB-34	ng/kg dw	4	0.56 U	2.4 U	4.4 U	2 U	30	19	16	22	5.6	20	7.7	5.3	1.6	4.3 U	65
PCB-35	ng/kg dw	23	4.7	11	13	4.9	150	76	67	69	28	86	47	27	13	16	340
PCB-36	ng/kg dw	2.1 U	1.1	2.1 U	3.9 U	1.8 U	4.1	3.9	1.9 U	3.5 J	4	3.3 U	4.4	3.8	2.6	4 U	6.9 U
PCB-37	ng/kg dw	190	20	46	34	17	2,900	1,600	1,600	1,000	460	2,200	630	360	160	4.5 U	6,800
PCB-38	ng/kg dw	30	0.51 U	5.5	19	3.3	9.8	5.1	8.7	3.8	2.8 J	7.4 J	3.3	2.8	0.98 U	4 U	59
PCB-39	ng/kg dw	2.2 U	0.88 J	2.2 U	4.2 U	1.9 U	3.2 U	3.8 U	2 U	2.4 U	1.7 U	3.3 U	2 U	1.7 U	0.94 U	4 U	7.3 U
PCB-40, 41, 71	ng/kg dw	1,500	24	120	150	45	3,400	3,700	3,300	1,900	950	4,300	1,100	750	290	390	8,800
PCB-41	ng/kg dw	440	4	78	170	42	800	660	650	320	180	920	170	120	58	61	2,700
PCB-42	ng/kg dw	770	15	62	61	24	2,500	2,400	2,100	1,400	580	3,000	700	440	180	260	5,600
PCB-43	ng/kg dw	170	1.8	22	39	12	390	380	320	190	76	440	97	59	25	35	1,200
PCB-44, 47, 65	ng/kg dw	2,900	83	480	500	120	8,200	8,500	6,900	4,600	2,000	10,000	2,500	1,600	650	1,000	21,000
PCB-45	ng/kg dw	490	4.2	46	85	28	790	1,100	810	490	260	1,200	300	190	71	91	3,000
PCB-46	ng/kg dw	200	2.2	12	13	5	380	490	410	210	110	520	120	82	30	41	1,100
PCB-48	ng/kg dw	930	8.7	160	350	91	1,600	1,600	1,400	840	380	2,000	430	280	120	170	4,800
PCB-49, 69	ng/kg dw	1,500	51	220	240	76	5,100	4,900	3,800	3,200	1,200	6,000	1,500	940	420	610	11,000
PCB-50, 53	ng/kg dw	450	6.2	35	39	14	850	1,100	890	530	260	1,200	310	190	72	100	2,400
PCB-51	ng/kg dw	130	2	6.9	8.5	2.7	330	380	310	180	72	370	84	57	21	35	790

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		MD-18-SD	MD-21-SD	MD-22-SD	MD-23-SD	MD-24-SD	WP-01-SD	WP-02-SD	WP-03-SD	WP-04-SD	WP-05-SD	WP-06-SD	WP-07-SD	WP-08-SD	WP-09-SD	WP-10-SD	WP-11-SD
Sample ID		MD-18-SS	MD-21-SS	MD-22-SS	MD-23-SS	MD-24-SS	WP-01-SS	WP-02-SS	WP-03-SS	WP-04-SS	WP-05-SS	WP-06-SS	WP-07-SS	WP-08-SS	WP-09-SS	WP-10-SS	WP-11-SS
Sample Date		9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/30/2006	9/30/2006	9/30/2006	10/1/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	WPAH015	WPAH008	WPAH013	No	No	No	WPAH006
Analyte	**Units**																
Polychlorinated Biphenyls (cont.)																	
PCB-52	ng/kg dw	3,300	180	1,000	1,000	230	10,000	10,000	7,700	5,700	2,500	12,000	3,300	2,000	830	1,400	38,000
PCB-54	ng/kg dw	11	0.13 U	0.95 U	1.3	0.64 U	20	19	22	7.8	3.6	20	4.4	2.6	1	1.4	66
PCB-55	ng/kg dw	39	0.38 U	6	10	2.8	240	130	110	84	31	180	40	25	12	12	470
PCB-56	ng/kg dw	1,400	37	140	210	57	4,800	4,100	3,700	2,400	930	5,200	1,200	690	280	310	8,600
PCB-57	ng/kg dw	12	0.32 U	1.6 U	2.7 U	1.2 U	44	31	28	15	7.2	36	8.1	5.8	2.8	2.7 J	82
PCB-58	ng/kg dw	5.9	0.36 U	1.9 U	3.1 U	1.4 U	18	13	13	14	3.2	19	6.2	3.2	1.7	2.2	36
PCB-59, 62, 75	ng/kg dw	200	4.3	20	25	8.8	640	600	500	350	160	740	190	130	53	72	1,700
PCB-60	ng/kg dw	690	18	53	62	18	2,600	2,000	2,000	1,100	490	2,700	620	340	140	160	5,000
PCB-61, 70, 74, 76	ng/kg dw	5,100	210	850	1,200	250	18,000	15,000	13,000	8,900	3,500	18,000	4,900	2,800	1,100	1,300	34,000
PCB-63	ng/kg dw	98	2.7	8.4	11	3.2	330	270	260	160	60	340	81	48	19	22	590
PCB-64	ng/kg dw	1,200	26	130	130	35	3,200	3,100	2,700	1,800	820	3,900	920	610	250	150	7,100
PCB-66	ng/kg dw	2,400	81	260	340	93	9,500	8,000	7,500	4,900	1,900	10,000	2,600	1,500	590	660	16,000
PCB-67	ng/kg dw	80	3	13	22	6.4	320	230	190	150	51	270	75	41	18	19	660
PCB-68	ng/kg dw	7	0.62 J	1.6 U	2.7 U	1.2 U	21	14	15	18	5.1	17	7.2	5.6	2.6	1.7 U	28
PCB-72	ng/kg dw	17	1.5	3.5	3.6	2.6	50	37	36	36	9.7	42	17	10	4	5.1	63
PCB-73	ng/kg dw	2.9	0.18 U	1.1 U	1.5 U	0.75 U	7.3	0.91 U	5.9	4.4	0.93 U	0.73 U	2.5	0.68 U	0.6 U	0.69 U	13
PCB-77	ng/kg dw	240	12	30	37	13	1,100	700	730	460	180	980	260	140	79	71	2,200
PCB-78	ng/kg dw	2.7 U	0.36 U	2 U	3.3 U	1.5 U	3.1 U	4 U	4.1 U	4.9 U	2.6 U	3.8 U	2.2 U	1.7 U	1.3 U	1.8 U	2.8 U
PCB-79	ng/kg dw	69	2.8	21	49	8.4	130	71	69	50	28	87	28	25	13	13	600
PCB-80	ng/kg dw	2.2 U	2.5	1.7 U	2.7 U	1.2 U	2.6 U	3.4 U	3.4 U	4.2 U	2.2 U	3.3 U	1.9 U	1.5 U	1.1 U	1.6 U	2.4 U
PCB-81	ng/kg dw	14	0.67 J	2.1 U	3.4 U	1.5 U	55	36	40	20	8.2	46	9.8	7.2	3.4	4.8	130
PCB-82	ng/kg dw	680	27	190	380	59	1,900	1,600	1,200	870	320	1,600	570	290	150	160	6,600
PCB-83	ng/kg dw	230	0.5 U	70	120	29	650	500	340	350	110	510	190	91	58	61	3,100
PCB-84	ng/kg dw	1,000	55	400	640	120	2,900	2,500	1,800	1,500	530	2,400	950	470	230	270	17,000
PCB-85, 116, 117	ng/kg dw	750	35	210	460	60	2,300	1,800	1,400	1,100	430	1,700	710	360	170	210	6,000
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	3,400	250	1,300	2,500	440	9,700	7,300	4,800	4,200	1,600	7,100	3,000	1,400	720	900	62,000
PCB-88	ng/kg dw	2.1 U	0.52 U	1.7 U	2.1 U	1.2 U	1.8 U	2 U	0.95 U	2.2 U	4 U	1.7 U	1.6 U	1.3 U	1 U	1.6 U	1.4 U
PCB-89	ng/kg dw	130	2	25	60	13	170	170	170	88	31	170	49	27	13	14	380
PCB-90, 101, 113	ng/kg dw	6,600	900	3,200	5,100	1,300	16,000	9,600	6,100	6,700	2,300	9,600	4,500	2,200	1,100	1,500	120,000
PCB-91	ng/kg dw	630	30	180	380	88	1,500	1,100	1,000	650	250	1,000	410	220	110	110	4,300
PCB-92	ng/kg dw	1,100	130	470	750	230	2,900	1,800	1,200	1,300	410	1,800	800	400	200	250	20,000
PCB-93, 98, 100, 102	ng/kg dw	220	5.5	37	120	30	94	75	73	45	18	81	24	15	7.9	7.1	410
PCB-94	ng/kg dw	36	1.1 J	8.1	17	4.3	54	52	48	29	11	53	18	8.7 J	4.4	4.6	120
PCB-95	ng/kg dw	4,500	480	2,500	3,700	850	9,500	6,100	4,000	3,900	1,500	5,900	2,700	1,400	670	860	72,000
PCB-96	ng/kg dw	62	1.6	8.8	16	5.1	97	94	110	49	17	100	30	15	6.9	9.4	250
PCB-98	ng/kg dw	8.8	0.75	1.8 U	2.2 U	1.7	21	16	13	19	3.8	18	6.9	4.6	2	1.7	51
PCB-99	ng/kg dw	2,300	200	730	1,600	410	6,400	4,700	3,500	3,400	1,100	4,900	2,100	1,000	560	640	23,000
PCB-102	ng/kg dw	210	5.5	49	120	27	270	270	240	150	64	280	92	57	27	28	640
PCB-103	ng/kg dw	89	7.6	18	35	25	68	53	39	54	13	56	28	16	8.6	9	170
PCB-104	ng/kg dw	0.77 U	0.18 U	0.71 U	0.86 U	0.61 U	0.88 U	1 U	0.68 U	0.92 U	0.64 U	0.79 U	0.87 U	0.46 U	0.37 U	0.47 U	3.1 J
PCB-105	ng/kg dw	1,400	110	470	1,000	130	5,500 J	4,000 J	3,000	2,500	950	4,500 J	1,800	860	460	630	33,000 J
PCB-106	ng/kg dw	22	0.39 U	4.2	9.8	0.99 U	1.6 U	6.7	0.86 U	1.6 U	2.6 U	1.1 U	1.1 U	0.86 U	0.66 U	1 U	1 U
PCB-107, 124	ng/kg dw	130	13	57	110	17	570	380	250	230	81	390	170	76	42	55	4,400
PCB-109	ng/kg dw	230	20	80	150	34	760	540	370	370	120	570	250	130	68	81	4,700
PCB-110	ng/kg dw	4,300	570	2,100	3,600	750	14,000	10,000	6,300	6,600	2,600	10,000	4,600	2,500	1,200	1,500	120,000

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		MD-18-SD	MD-21-SD	MD-22-SD	MD-23-SD	MD-24-SD	WP-01-SD	WP-02-SD	WP-03-SD	WP-04-SD	WP-05-SD	WP-06-SD	WP-07-SD	WP-08-SD	WP-09-SD	WP-10-SD	WP-11-SD
Sample ID		MD-18-SS	MD-21-SS	MD-22-SS	MD-23-SS	MD-24-SS	WP-01-SS	WP-02-SS	WP-03-SS	WP-04-SS	WP-05-SS	WP-06-SS	WP-07-SS	WP-08-SS	WP-09-SS	WP-10-SS	WP-11-SS
Sample Date		9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/30/2006	9/30/2006	9/30/2006	10/1/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	WPAH015	WPAH008	WPAH013	No	No	No	WPAH006
Analyte	**Units**																
Polychlorinated Biphenyls (cont.)																	
PCB-111	ng/kg dw	7.8	0.73	1.8	1.6 U	1.7	1.5 U	1.3 U	0.81 U	1.4 U	2.6 U	0.98 U	1 U	0.88 U	0.67 U	0.92 U	1 U
PCB-112	ng/kg dw	15	0.41 U	1.5	1.7 U	2.1	1.6 U	18	0.87 U	1.7 U	3 U	1.2 U	1.2 U	1 U	0.78 U	1.1 U	78
PCB-114	ng/kg dw	110	5.6	30	65	7.1	320	230	190	110	50	250	93	44	21	33	1,600
PCB-115	ng/kg dw	45	0.73	18	41	6.6	280	200	120	110	37	210	68	23	18	17	640
PCB-117	ng/kg dw	59	4.4	26	52	9.4	340	280	160	190	52	310	90	40	36	28	1,100
PCB-118	ng/kg dw	3,000	360	1,300	2,500	420	13,000 J	8,300 J	5,800 J	5,700 J	2,000	9,200 J	4,000 J	1,900	1,000	1,400	110,000 J
PCB-120	ng/kg dw	31	2.9	6.2	8.7	7.6	23	13	13	19	4.8 J	13	9.2	6.2	3.6	4.1	51
PCB-121	ng/kg dw	1.6 U	0.36 U	1.3 U	1.6 U	0.87 U	1.5 U	1.3 U	0.8 U	1.5 U	2.7 U	1 U	1 U	0.89 U	0.68 U	0.94 U	0.95 U
PCB-122	ng/kg dw	75	2.6	19	45	6.1	170	130	99	77	29	150	51	25	15	18	710
PCB-123	ng/kg dw	67	4.1	21	45	5.9	230	180	150	110	40	180	81	35	22	28	910
PCB-126	ng/kg dw	30	2.6	9.5	16	4.4	44	16	16	13	8.4	20	12	7.4	6.2	4.7	100
PCB-127	ng/kg dw	1.7 U	0.35 U	1.4 U	1.7 U	0.99 U	1.7 U	1.3 U	0.85 U	1.5 U	2.4 U	1 U	0.96 U	0.83 U	0.6 U	0.94 U	1.1 U
PCB-128, 166	ng/kg dw	950	110	480	990	200	3,200	1,500	810	1,200	360	1,500	770	350	230	310	42,000
PCB-130	ng/kg dw	520	78	230	370	94	1,600	600	350	450	130	540	310	160	98	120	16,000
PCB-131	ng/kg dw	94	0.33 U	46	73	15	270	130	59	92	25	110	62	30	17	19	2,600
PCB-132	ng/kg dw	3,300	490	1,600	2,300	540	6,700	2,700	1,500	2,100	610	2,300	1,400	710	430	530	63,000
PCB-133	ng/kg dw	190	24	61	90	34	280	98	62	89	27	96	62	32	20	24	2,500
PCB-134	ng/kg dw	670	98	310	460	110	1,200	570	270	450	120	440	290	140	82	89	13,000
PCB-135, 151	ng/kg dw	7,400	890	2,700	3,800	920	6,800	2,400	1,600	2,100	680	2,100	1,600	830	490	620	62,000
PCB-136	ng/kg dw	2,400	280	950	1,400	350	3,100	990	680	840	270	970	560	310	180	290	33,000
PCB-137	ng/kg dw	120	11	76	180	28	570	360	180	220	86	340	170	86	46	59	6,900
PCB-139, 140	ng/kg dw	110	12	40	84	22	260	160	71	120	32	140	75	36	23	25	2,000
PCB-141	ng/kg dw	3,400	490	1,400	2,200	470	5,100	1,300	970	950	310	1,200	800	370	230	340	50,000
PCB-142	ng/kg dw	150	0.36 U	7.8	43	3.3	2 U	2.3 U	1 U	2 U	1.5 U	1.4 U	1.6 U	0.85 U	0.85 U	1.1 U	140
PCB-143	ng/kg dw	84	1.7	17	51	9.4	40	32	12 J	20	7.7	26	20	6	3.8	6.6	140
PCB-144	ng/kg dw	990	140	430	610	140	1,300	430	270	360	110	380	260	140	81	100	13,000
PCB-145	ng/kg dw	8.9	0.25 U	2.4	6.3	1.2	5.7	3.9	2.4	3	0.85 U	3.1	1.6	0.52 U	0.46 U	0.67 U	34
PCB-146	ng/kg dw	2,300	330	820	1,300	400	3,100	1,100	750	990	300	1,000	690	370	230	290	30,000
PCB-147, 149	ng/kg dw	14,000	1,800	5,500	7,900	2,000	16,000	5,800	3,700	5,000	1,500	5,100	3,500	1,800	1,100	1,400	150,000
PCB-148	ng/kg dw	32	2.8	5.5	7.5	7.2	10	6.4	3.4	7.2	1.3 U	5.6	4 J	3.3	2.1	1.7	54
PCB-150	ng/kg dw	37	3.9	6.4	13	8.3	17	8.8	4.9	8	2	7.8	4.6	2.9	1.8	2.4	110
PCB-152	ng/kg dw	23	0.93	4.7	15	2.8	13	7.5	4.5	6.3	2	6.9	4.1	1.6 J	1.1	1.5 J	82
PCB-153, 168	ng/kg dw	17,000	2,200	5,800	9,800	2,200	18,000	6,600	4,500	5,700	1,800	6,000	4,100	2,100	1,300	1,800	210,000
PCB-154	ng/kg dw	210	24	41	71	45	120	71	39	85	21	64	50	29	19	19	730
PCB-155	ng/kg dw	1.9	0.24 U	0.96 U	0.99 U	0.63 U	1.3 U	1.3 U	0.68 U	1.1 U	0.87 U	0.79 U	0.73 U	0.53 U	0.47 U	0.67 U	1.1 U
PCB-156, 157	ng/kg dw	860	140	400	920	170	2,900	1,100	610	790	260	1,100	610	270	170	250	45,000 J
PCB-158	ng/kg dw	1,200	200	530	950	200	2,700	990	550	710	220	930	520	260	170	210	31,000
PCB-159	ng/kg dw	710	29	140	400	60	250	4.5 U	73	4.7 U	26	5.5 U	3.3 U	2.7 U	1.8 U	2.9 U	3,300
PCB-160	ng/kg dw	6.8	0.28 U	1.4 U	1.4 U	0.83 U	1.6 U	1.6 U	0.83 U	1.4 U	1 U	1 U	1.1 U	0.59 U	0.59 U	0.77 U	1 U
PCB-161	ng/kg dw	0.99 U	0.24 U	1.2 U	1.1 U	0.67 U	1.4 U	1.5 U	0.69 U	1.3 U	0.93 U	0.91 U	1 U	0.54 U	0.54 U	0.69 U	0.93 U
PCB-162	ng/kg dw	23	2.7 J	9	20	4.9	71	28	14	25	8.6	28	16	9.2	5.5	6.6	850
PCB-163, 164	ng/kg dw	13,000	2,100	5,600	9,100	2,100	25,000	8,800	5,700	6,900	2,300	8,200	5,100	2,800	1,700	2,200	290,000
PCB-164	ng/kg dw	860	140	370	580	140	1,800	530	340	410	120	460	300	150	98	120	16,000
PCB-165	ng/kg dw	7.1	0.29 U	1.4 U	1.3 U	0.79 U	1.6 U	1.8 U	0.82 U	1.5 U	1.1 U	1.1 U	1.2 U	0.64 U	0.64 U	0.83 U	1.1 U
PCB-167	ng/kg dw	350	56	150	330	70	1,000	350	200	270	90	360	200	93	62	86	14,000 J

Table C.5
Phase 2 Addendum Remedial Investigation for the Marine Environment near the Former Rayonier Site (2006)

Station ID		MD-18-SD	MD-21-SD	MD-22-SD	MD-23-SD	MD-24-SD	WP-01-SD	WP-02-SD	WP-03-SD	WP-04-SD	WP-05-SD	WP-06-SD	WP-07-SD	WP-08-SD	WP-09-SD	WP-10-SD	WP-11-SD
Sample ID		MD-18-SS	MD-21-SS	MD-22-SS	MD-23-SS	MD-24-SS	WP-01-SS	WP-02-SS	WP-03-SS	WP-04-SS	WP-05-SS	WP-06-SS	WP-07-SS	WP-08-SS	WP-09-SS	WP-10-SS	WP-11-SS
Sample Date		9/29/2006	9/29/2006	9/29/2006	9/29/2006	9/30/2006	9/30/2006	9/30/2006	10/1/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/30/2006	9/28/2006
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	WPAH015	WPAH008	WPAH013	No	No	No	WPAH006
Analyte	**Units**																
Polychlorinated Biphenyls (cont.)																	
PCB-169	ng/kg dw	150	3.9	20	62	7.6	11 U	5.9 U	5.7 U	5.7 U	4.6 U	6.7 U	4 U	0.89 J	2.1 U	3.6 U	18 U
PCB-170	ng/kg dw	6,600	740	1,900	5,800	780	6,500	1,400	1,400	1,300	480	1,300	1,100	580	430	620	84,000
PCB-171, 173	ng/kg dw	2,300	250	720	1,900	280	2,200	500	480	560	190	460	410	210	160	230	26,000
PCB-172	ng/kg dw	1,400	130	350	1,000	140	1,100	240	260	260	81	210	220	100	71	120	14,000
PCB-174	ng/kg dw	14,000	890	2,900	7,300	1,100	6,100	1,600	1,600	1,700	620	1,500	1,400	740	520	790	71,000
PCB-175	ng/kg dw	500	32	120	320	44	340	78	78	84	29	72	67	33	24	35	5,000
PCB-176	ng/kg dw	1,400	91	300	820	130	620	150 J	160	210	68	190	150	74	59	99	11,000
PCB-177	ng/kg dw	6,100	520	1,600	3,900	590	3,800	980	990	1,100	370	860	860	450	320	470	43,000
PCB-178	ng/kg dw	2,900	160	440	1,400	230	1,000	250	280	290	110	270	240	130	100	170	17,000
PCB-179	ng/kg dw	7,900	380	1,200	3,300	500	2,000	590	600	760	280	720	570	290 J	220	400	32,000
PCB-180, 193	ng/kg dw	29,000	1,700	4,900	16,000	1,900	12,000	3,000	3,200	3,100	1,000	2,700	2,500	1,200	920	1,500	180,000
PCB-181	ng/kg dw	43	2.2	9.4	33	4.5	65	17	9.2	12	4.9	15	10	4.3 J	1.4 U	3.6	900
PCB-182	ng/kg dw	41	1.9	7.1	23	5.4	26	7.8	5	11	3.4	7.2	5.1	3.4	2.7 J	2.3 J	320
PCB-183	ng/kg dw	7,000	460	1,400	3,900	480	3,400	900	840	1,000	340	830	780	410	300	430	47,000
PCB-184	ng/kg dw	5.1	0.16 U	1.6 U	2.5	1 U	4.1	2.2 U	1 U	2.1 U	1.4 U	1.6 U	1.1 U	0.97 U	0.83 U	1.2 U	59
PCB-185	ng/kg dw	1,200	58	250	710	92	370	150	150	100	37	100	91	42	32	65	6,600
PCB-186	ng/kg dw	19	0.17 U	1.8 U	6.6	1.1 U	1.5 U	2.3 U	1.1 U	2.2 U	1.4 U	1.7 U	1.2 U	0.96 U	0.82 U	1.2 U	20
PCB-187	ng/kg dw	23,000	1,000	3,400	9,100	1,300	6,300	2,000	2,000	2,300	740	1,800	1,800	930	660	970	84,000
PCB-188	ng/kg dw	15	1.4	2.8	7.2	2.7	4.7	1.8 U	0.98 U	1.8 U	1.1 U	2.6 J	0.97 U	0.79 U	0.68 U	0.95 U	61
PCB-189	ng/kg dw	220	31	72	280	38	350	61	62	57	22	58	47	24	17	28	4,900 J
PCB-190	ng/kg dw	1,900	160	450	1,500	190	1,400	270	310	280	100	270	250	120	87	140	22,000
PCB-191	ng/kg dw	320	35	95	280	38	330	64	62	69	20	63	55	26	19	31	5,000
PCB-192	ng/kg dw	5.3 U	0.57 U	3.2 U	3.8 U	1.2 U	4.2 U	3.8 U	3.5 U	3.1 U	2.3 U	2.7 U	2.6 U	1.5 U	1.3 U	1.7 U	11 U
PCB-194	ng/kg dw	20,000	400	1,300	7,000	590	2,500	880	1,100	940	380	780	820	390	320	540	57,000
PCB-195	ng/kg dw	5,500	160	560	2,900	250	980	340	380	380	150	300	330	160	120	220	23,000
PCB-196	ng/kg dw	8,500	170	570	2,800	230	1,100	310	410	360	140	320	280	150	110	240	33,000
PCB-197	ng/kg dw	570	11	40	190	19	79	23 J	28	27	9.1	27	25	12	7.9	20	2,300
PCB-198, 199	ng/kg dw	30,000	410	1,400	6,700	580	2,500	880	1,000	790 J	360	830	750	420	320	630	65,000
PCB-199	ng/kg dw	3,200	47	170	840	71	280	120	110	120	46	110	100	53	38	74	7,800
PCB-201	ng/kg dw	3,100	47	170	860	67	300	110	110	120	31 J	98	96	39	31	73	7,800
PCB-202	ng/kg dw	5,600	59	240	1,100	93	370	170	150	150 J	62	150	130	73	59	100	9,000
PCB-203	ng/kg dw	17,000	220	780	4,000	320	1,400	430	530	480	200	480	380	220	180	340	44,000
PCB-204	ng/kg dw	9.4	0.2 U	1.6 U	2.1 U	1.1 U	2.6 U	4 U	2.1 U	3.6 U	2.3 U	2.2 U	1.3 U	1.9 U	0.78 U	1.4 U	38
PCB-205	ng/kg dw	630	18	57	330	27	130	36	48	41	17	35	37	17	13	24	3,900
PCB-206	ng/kg dw	14,000	77	340	2,100	150	620	340	290	310	150	310	270	170	130	180	23,000
PCB-207	ng/kg dw	1,900	9.9	47	290	21	83	47	39	47	20	43	40	24	16	25	3,200
PCB-208	ng/kg dw	3,300	18	72	380	34	170	120	77	99	53	100	83	53	35	51	4,600
PCB-209	ng/kg dw	760	19	35	110	48	260	250	150	400	140	260	170	170	70	82	1,300 J
Total PCBs, Congeners	ng/kg dw	340,000	20,000	66,000	150,000	25,000	350,000	210,000	170,000	140,000	56,000	230,000	91,000	51,000 J	25,000	34,000	2,600,000
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	7.9	0.4	1.6	3.6	0.69	5.2	2.1	2	1.7	0.96	2.6	1.4	0.88	0.68	0.55	16
Other																	
Total TEQ	ng/kg dw	29.4	3.36	5.53	8.03	2.06	37.6	26.9	34.2	28.1	15.4	34.3	39.4	19.5	12.7	15.6	62.7

Notes:

Source: Malcolm Pirnie. 2007. *Phase 2 Addendum Remedial Investigation for the Marine Environment Near the Former Rayonier Mill Site, Port Angeles, Washington.* Prepared for Rayonier. February.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ and dioxin-like PCB congener TEQ (Van den Berg et al. 2006).

5 Calculated using detected congener concentrations.

Abbreviations:

cm Centimeters
DL Detection limit
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
mg/kg dw Milligrams per kilogram dry weight
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalent

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_BA01A	PA_BA02A	PA_BL01A	PA_BL02A	PA_BL03A	PA_BL04A	PA_BL05A	PA_BL06A	PA_BL07A	PA_BL08A	PA_CO01A	PA_CO02A	PA_CO03A	PA_CO04A	PA_CO05A	PA_DO01A	PA_DO02A	PA_DO03A	PA_DO04A	PA_DO05A	PA_EC01A	PA_EC02A
Sample ID		BA01A	BA02A	BL01A	BL02A	BL03A	BL04A	BL05A	BL06A	BL07A	BL08A	CO01A	CO02A	CO03A	CO04A	CO05A	DO01A	DO02A	DO03A	DO04A	DO05A	EC01A	EC02A
Sample Date		6/7/2008	6/7/2008	6/19/2008	6/13/2008	6/13/2008	6/13/2008	6/9/2008	6/11/2008	6/9/2008	6/9/2008	6/22/2008	6/22/2008	6/21/2008	6/20/2008	6/20/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/21/2008	6/21/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH044	No	WPAH033	No	WPAH034	WPAH035	No	WPAH041	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Conventionals																							
Sulfides	mg/kg dw	700		2,200 J	1,700	2,200	120		340 J		500 J	0.0088 U	810	14	32	170	13	5.1	46	14	1.8	0.0095 U	0.0095 U
Total Organic Carbon	%	2.04	1.82	5.03	2.72	2.51	0.64	2.46	1.89	2.48	1.46	0.588	2	0.314	0.182	0.885	0.423	0.681	0.542	0.438	0.495	0.469	0.239
Total Solids	%	46.8	46.4	38.5	48.5	43.8	81	46.2	53	50.5	55.9	91.3	56	78.3	90.6	70.3	76.7	70.7	67	68.7	68.8	80.1	82.4
Nutrients																							
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	12		12	18	43	7.3		24		35	0.72	9.8	5.3	3.3	13	17	0.47	17	12	12	7.8	0.64
Particle/Grain Size																							
Percent Fines (clay & silt)	%	72	83	57	56	71	5.6	67	62	69	62	2.2	40	1.8	0.3	20	10	21	31	27	22	1.5	0.1
Phi Class 10.00+	%	13	15	7.6	7	9.1	1.1	11	10	11	9		4			2.9	2.2	4.2	5.9	5.5	4.6		
Phi Class 9.00+ to 10.00	%	4.6	5.8	1.6	2.5	3.1	0.4	5.5	4.2	5.5	4.2		1.4			0.6	0.8	1.5	1.9	1.7	1.6		
Phi Class 8.00+ to 9.00	%	5	6.4	1.7	2.5	3.7	0.5	5.6	3.3	5.3	4.2		1.2			0.7	0.8	1.4	2.2	1.6	1		
Phi Class 7.00+ to 8.00	%	6.7	8.3	2.4	3.9	4.9	0.7	7.1	6.4	6.5	5.1		1.5			1.3	0.9	1.9	2.6	2	1.5		
Phi Class 6.00+ to 7.00	%	10	12	5.6	10	13	1.2	10	10	10	8.3		3.6			1.8	0.9	2.2	3.2	2.6	2		
Phi Class 5.00+ to 6.00	%	15	19	24	15	23	1.3	15	12	16	14		6.5			2.8	1.6	2.7	4.1	3.2	2.6		
Phi Class 4.00+ to 5.00	%	17	16	14	15	14	0.3	13	16	14	17		22			10	3.1	6.9	11	10	8.5		
Phi Class 3.00+ to 4.00	%	13	9.8	17	21	11	0.6	11	22	16	23	1	22	1.4	0.3	28	9.6	35	45	51	53	1.5	0.2
Phi Class 2.00+ to 3.00	%	2.8	2.7	11	16	4.9	0.9	8.8	10	8.2	11	3.7	12	8.8	1.7	24	17	26	19	21	23	3	8.5
Phi Class 1.00+ to 2.00	%	3.7	2.3	5.1	3.9	5.3	4.6	5.3	2.7	4	2.1	5.2	8.9	17	9.2	12	36	12	3.1	1.2	1.6	7.8	23
Phi Class 0.00+ to 1.00	%	2.5	1.5	4.2	1.6	2.2	12	3.5	1.4	2.3	1.4	6.1	5.4	9.7	10	7.7	17	3.1	0.7	0.5	0.5	12	13
Phi Class -1.00+ to 0.00	%	4.1	1.1	3.4	1.2	2.5	12	2.6	1.1	1.3	0.6	11	4.2	8.7	14	4.5	6.6	2	0.3	0.2	0.1	15	12
Phi Class < -1.00	%	2.5	0.1 U	2.7	0.4	3.3	64	1.2	0.1 U	0.2	0.1	71	8.3	52	65	3.3	3.2	1.4	0.2	0.1 U	0.1 U	60	44
Biochemical Measures																							
12-Chlorodehydroabietic acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
14-Chlorodehydroabietic acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
1-Phenanthrenecarboxylic acid	µg/kg dw	98 U		6,300 J	2,400	99 U						290 U	3,200	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
3,4,5-Trichloroguaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
3,4,6-Trichloroguaiacol (Ac)	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
3,4-Dichloroguaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
4,5,6-Trichloroguaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
4,5-Dichloroguaiacol	µg/kg dw	19 UJ		20 U	20 U	20 UJ						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
4,6-Dichloroguaiacol	µg/kg dw	19 UJ		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ
4-Chloroguaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
9,10-Dichlorostearic Acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Abietic Acid	µg/kg dw	98 U		19,000 J	1,600	99 U						290 U	5,700	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	100	98 U
Dichlorodehydroabietic Acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Guaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
Isopimaric Acid	µg/kg dw	98 U		1,500	540	99 U						290 U	510	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Linolenic Acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Neoabietic Acid	µg/kg dw			300 U	490 U							290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Oleic Acid	µg/kg dw	180		340	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	2,300	690	97 U	98 U
Palustric Acid	µg/kg dw			340 J	490 U							290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Pimaric Acid	µg/kg dw	98 U		300 U	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Sandaracopimaric Acid	µg/kg dw	98 U		530	490 U	99 U						290 U	490 U	290 U	290 U	490 U	490 U	290 U	490 U	500 U	300 U	97 U	98 U
Tetrachloroguaiacol	µg/kg dw	19 U		20 U	20 U	20 U						20 UJ	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U
Metals																							
Antimony	mg/kg dw	0.45 U	0.43 U	0.17 JQ	0.2 JQ	0.28 JQ	0.13 JQ	0.51 U	0.26		0.43 U	0.23 U	0.37 U	0.0018 U	0.0018 U	0.0027 U	0.0022 U	0.003 U	0.0027 U	0.28 U	0.23 U	0.0021 U	0.0023 U
Arsenic	mg/kg dw	7.6	8.2	5	4.9	7.3	3.5	9.2	7.6		6.8	2.4	7.3	2.7	2.2	4.5	2.8	4.5	3.3	3.2	3.2	2.8	5.9
Barium	mg/kg dw	39	39	17	21	31	9.9	29	33		29	18	23	11	9.3	20	13	18	22	19	17	53	21
Cadmium	mg/kg dw	0.47	0.46	0.87	0.73	0.91	0.19 JQ	0.6	0.57		0.34	0.0036 JQ	0.57	0.00042 U	0.00042 U	0.054 JQ	0.078 JQ	0.13 JQ	0.059 JQ	0.054 JQ	0.072 JQ	0.00048 U	0.00052 U
Chromium	mg/kg dw	38	37	20	28	37 J	15	39	33		34	21	38	27	37	34	19	23	27	24	26	40	33
Copper	mg/kg dw	34	34	23	30	42	15	39	29		30	25	35	36	29	31	11	15	17	16	16	47	40
Lead	mg/kg dw	12	13	6.1	7.9	14	3.6	14	12		12	7.2	14	3.2	2.6	4.5	3.3	5.3	5.9	5.1	5.4	3.2	3.2
Mercury	mg/kg dw	0.11	0.13	0.09	0.063	0.12	0.022	0.22	0.11	0.21	0.13	0.016 JQ	0.06	0.026	0.024	0.028	0.016 JQ	0.028	0.04	0.018 JQ	0.026	0.02 JQ	0.019 JQ

Table C.6
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Station ID		PA_BA01A	PA_BA02A	PA_BL01A	PA_BL02A	PA_BL03A	PA_BL04A	PA_BL05A	PA_BL06A	PA_BL07A	PA_BL08A	PA_CO01A	PA_CO02A	PA_CO03A	PA_CO04A	PA_CO05A	PA_DO01A	PA_DO02A	PA_DO03A	PA_DO04A	PA_DO05A	PA_EC01A	PA_EC02A
Sample ID		BA01A	BA02A	BL01A	BL02A	BL03A	BL04A	BL05A	BL06A	BL07A	BL08A	CO01A	CO02A	CO03A	CO04A	CO05A	DO01A	DO02A	DO03A	DO04A	DO05A	EC01A	EC02A
Sample Date		6/7/2008	6/7/2008	6/19/2008	6/13/2008	6/13/2008	6/13/2008	6/9/2008	6/11/2008	6/9/2008	6/9/2008	6/22/2008	6/22/2008	6/21/2008	6/20/2008	6/20/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/21/2008	6/21/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH044	No	WPAH033	No	WPAH034	WPAH035	No	WPAH041	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Metals (cont.)																							
Nickel	mg/kg dw	30	30	18	27	34	31	32	27		29	24	34	33	43	38	20	22	24	22	24	62	43
Silver	mg/kg dw	0.13 JQ	0.15 JQ	0.076 JQ	0.1 JQ	0.16 JQ	0.037 JQ	0.16 JQ	0.14 JQ		0.12 JQ	0.039 JQ	0.086 JQ	0.049 JQ	0.04 JQ	0.084 JQ	0.039 JQ	0.059 JQ	0.056 JQ	0.047 JQ	0.047 JQ	0.057 JQ	0.07 JQ
Zinc	mg/kg dw	80	83	49	61	97	31	90	82		77	37	55	41	37	48	29	44	53	50	52	80	45
Butyltins																							
Butyltin	µg/kg dw			4 U	4.1 U	3.9 U	4 U																
Dibutyltin	µg/kg dw			3.1 U	3.2 U	3.1 U	3.1 U																
Tributyltin	µg/kg dw			1.7 U	1.8 U	12	8.7																
Pesticides																							
4,4'-DDD	µg/kg dw			0.57 UJ	0.48 U							0.29 U	2.2 JQ	0.37 JQ	0.29 U	1.5 JQ						0.31 U	0.31 U
4,4'-DDE	µg/kg dw			0.48 UJ	2.5 JQ							0.25 U	0.35 U	0.24 U	0.24 U	0.29 U						0.26 U	0.26 U
4,4'-DDT	µg/kg dw			0.56 UJ	6.6 J							0.28 U	3.7 J	0.28 U	0.28 U	0.34 U						0.3 U	0.3 U
Aldrin	µg/kg dw			0.23 UJ	1.1 JQ							0.25 JQ	0.16 U	1.6	0.12 U	0.14 U						0.73 U	0.97 JQ
alpha-Endosulfan	µg/kg dw			0.25 UJ	0.21 U							0.13 U	0.18 U	0.13 U	0.13 U	0.15 U						0.14 U	0.14 U
alpha-Hexachlorocyclohexane	µg/kg dw			0.23 UJ	0.19 U							0.6 U	1.8 J	0.12 U	0.12 U	0.14 U						0.12 U	0.77 U
beta-Endosulfan	µg/kg dw			0.56 UJ	0.47 U							0.28 U	0.4 U	0.28 U	0.28 U	0.71 JQ						0.3 U	0.3 U
beta-Hexachlorocyclohexane	µg/kg dw			0.27 UJ	2.6 J							0.14 U	0.93 JQ	0.38 JQ	0.14 U	1 U						0.51 U	0.25 JQ
Cis-chlordane	µg/kg dw			0.25 UJ	4.4 J							0.13 U	0.18 U	0.13 U	0.13 U	0.15 U						0.14 U	0.14 U
delta-Hexachlorocyclohexane	µg/kg dw			0.25 UJ	0.21 U							0.13 U	0.18 U	0.13 U	0.5 U	2.9 U						3.7 U	0.14 U
Dieldrin	µg/kg dw			0.47 UJ	1.5 JQ							0.24 U	9.3 J	0.24 U	0.24 U	0.29 U						0.25 U	1.2 JQ
Endosulfan Sulfate	µg/kg dw			0.72 UJ	0.61 U							0.37 U	0.52 U	0.37 U	0.37 U	0.44 U						0.39 U	0.39 U
Endrin	µg/kg dw			0.89 UJ	0.75 U							0.45 U	3.6 J	0.45 U	0.45 U	0.54 U						0.48 U	0.48 U
Endrin Aldehyde	µg/kg dw			0.53 UJ	0.45 U							0.27 U	1.8 JQ	0.27 U	0.27 U	0.32 U						0.29 U	0.41 JQ
Endrin Ketone	µg/kg dw			0.53 UJ	0.45 U							0.27 U	0.39 U	0.27 U	0.27 U	0.32 U						0.29 U	0.29 U
gamma-Chlordane	µg/kg dw			0.25 UJ	0.38 JQ							0.13 U	6.6 J	0.13 U	0.13 U	0.15 U						0.14 U	0.14 U
gamma-Hexachlorocyclohexane	µg/kg dw			0.25 UJ	2 J							0.13 U	3.6 J	0.12 U	0.13 U	0.61 JQ						0.13 U	0.13 U
Heptachlor	µg/kg dw			0.28 UJ	0.24 U							0.14 U	0.21 U	0.14 U	0.14 U	0.98 JQ						0.15 U	0.3 JQ
Heptachlor Epoxide	µg/kg dw			0.27 UJ	1.4 JQ							0.24 JQ	7 J	0.14 U	0.14 U	2.5 J						0.14 U	0.15 U
Methoxychlor	µg/kg dw			2.8 UJ	2.4 U							1.4 U	3.3 JQ	1.4 U	1.4 U	1.7 U						1.5 U	1.5 U
Toxaphene	µg/kg dw			21 UJ	18 U							11 U	15 U	11 U	11 U	13 U						11 U	11 U
Dioxins/Furans																							
2,3,7,8-TCDD	ng/kg dw			0.401	0.355 J	0.855 J	0.18 J		0.598 J		0.588 J	0.156	0.717	0.065 JQ	0.059 J	0.147	0.141	0.205	0.22	0.204	0.209	0.091 JQ	0.044 J
1,2,3,7,8-PeCDD	ng/kg dw			1.2	0.829 J	1.45 J	0.27 J		1.66 J		1.68 J	0.427 JQ	1.6	0.081 JQ	0.062 J	0.347 JQ	0.433 JQ	0.577 JQ	0.488 JQ	0.473 JQ	0.435 JQ	0.124 JQ	0.045 JQ
1,2,3,4,7,8-HxCDD	ng/kg dw			1.43	0.991 J	1.56 J	0.262 J		1.56 J		2.1 J	0.482 JQ	1.76	0.058 JQ	0.039 J	0.296 JQ	0.347 JQ	0.456 JQ	0.491 JQ	0.388 JQ	0.345 JQ	0.076 JQ	0.0252 U
1,2,3,6,7,8-HxCDD	ng/kg dw			7.14	4.9 J	8.4 J	1.47 J		7.89 J		8.1 J	0.976	5.29	0.206 JQ	0.114 JQ	0.729	1.11	2.2	2.21	2.14	1.79	0.17 JQ	0.07 JQ
1,2,3,7,8,9-HxCDD	ng/kg dw			4.01	2.9 J	5.39 J	0.961 J		4.87 J		5.34 J	0.921	3.75	0.203 JQ	0.131 JQ	0.692	0.948	1.44	1.61	1.51	1.17	0.258 JQ	0.075 JQ
1,2,3,4,6,7,8-HpCDD	ng/kg dw			116	90.7 J	179 J	22.8 J		81.9 J		99.8 J	12.5	95.9	3.65	2.87	10.1	10.9	17.8	32.5	20.1	12.8	2.1	0.754
Total OCDD	ng/kg dw			1,040	723 J	2,060 J	177 J		602 J		850 J	112	949	31.3	28.3	75.6	82.7	102	438	201	64.7	14.7	5.2
2,3,7,8-TCDF	ng/kg dw			1.26	0.756 J	1.54	0.336		2.16		2.03	0.509	2.91	0.118 JQ	0.0571 U	0.465	0.499	0.731	0.709	1.02	0.596	0.046 JQ	0.0252 U
1,2,3,7,8-PeCDF	ng/kg dw			0.629	0.425 J	0.831 J	0.162 J		0.885 J		0.882 J	0.306 JQ	1.25	0.053 JQ	0.034 J	0.272 JQ	0.337 JQ	0.326 JQ	0.259 JQ	0.267 JQ	0.208 JQ	0.031 JQ	0.0252 U
2,3,4,7,8-PeCDF	ng/kg dw			0.78	0.612 J	1.14 J	0.224 J		1.22 J		1.2 J	0.496 JQ	2.14	0.088 JQ	0.06 JQ	0.32 JQ	0.424 JQ	0.457 JQ	0.359 JQ	0.35 JQ	0.338 JQ	0.063 JQ	0.031 JQ
1,2,3,4,7,8-HxCDF	ng/kg dw			1.34	0.83 J	1.73 J	0.319 J		1.51 J		1.61 J	0.362 JQ	3.63	0.158 JQ	0.062 U	0.376 JQ	0.47 JQ	0.0249 U	0.447 JQ	0.447 JQ	0.345 JQ	0.04 JQ	0.0252 U
1,2,3,6,7,8-HxCDF	ng/kg dw			0.864	0.607 J	1.17 J	0.191 J		1.03 J		0.984 J	0.203 JQ	1.22	0.054 JQ	0.035 JQ	0.229 JQ	0.398 JQ	0.301 JQ	0.228 J	0.245 JQ	0.204 JQ	0.034 JQ	0.0252 U
1,2,3,7,8,9-HxCDF	ng/kg dw			0.089 U	0.046 J	0.102 J	0.0238 UJ		0.099 J		0.096 J	0.0624 U	0.161 JQ	0.0247 U	0.0245 U	0.035 J	0.042 JQ	0.032 J	0.028 JQ	0.033 JQ	0.0241 U	0.0243 U	0.0252 U
2,3,4,6,7,8-HxCDF	ng/kg dw			0.799	0.582 J	1.13 J	0.202 J		0.922 J		0.928 J	0.194 JQ	1.38	0.041 JQ	0.032 JQ	0.178 JQ	0.324 JQ	0.285 JQ	0.268 JQ	0.248 JQ	0.223 JQ	0.032 JQ	0.0252 U
1,2,3,4,6,7,8-HpCDF	ng/kg dw			20.8	16.1 J	24.7 J	4.2 J		23.8 J		23 J	2.2	16	0.721	0.321 JQ	1.81	2.73	7	3.49	3.88	2.5	0.33 JQ	0.095 JQ
1,2,3,4,7,8,9-HpCDF	ng/kg dw			0.986	0.747 J	1.52 J	0.205 J		1.2 J		1.4 J	0.156 U	0.843	0.0454 U	0.036 JQ	0.152 JQ	0.18 JQ	0.243 JQ	0.219 JQ	0.228 JQ	0.16 JQ	0.0419 U	0.0252 U
Total OCDF	ng/kg dw			60.3	54.3 J	89 J	9.79 J		51.1 J		108 J	9.11	72.9	1.41	0.778 JQ	3.5	9.59	9.9	8.5	16.7	4.4	0.836 U	0.197 U
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw			5.25	3.85 J	7.47 J	1.22 J		5.92 J		6.3 J	1.29 J	6.44 J	0.311 J	0.216 J	1.04 J	1.29 J	1.76 J	1.92 J	1.7 J	1.39 J	0.329 J	0.123 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw			5.25	3.85 J	7.47 J	1.23 J		5.92 J		6.3 J	1.29 J	6.44 J	0.313 J	0.223 J	1.04 J	1.29 J	1.76 J	1.92 J	1.7 J	1.4 J	0.331 J	0.131 J

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_BA01A	PA_BA02A	PA_BL01A	PA_BL02A	PA_BL03A	PA_BL04A	PA_BL05A	PA_BL06A	PA_BL07A	PA_BL08A	PA_CO01A	PA_CO02A	PA_CO03A	PA_CO04A	PA_CO05A	PA_DO01A	PA_DO02A	PA_DO03A	PA_DO04A	PA_DO05A	PA_EC01A	PA_EC02A
Sample ID		BA01A	BA02A	BL01A	BL02A	BL03A	BL04A	BL05A	BL06A	BL07A	BL08A	CO01A	CO02A	CO03A	CO04A	CO05A	DO01A	DO02A	DO03A	DO04A	DO05A	EC01A	EC02A
Sample Date		6/7/2008	6/7/2008	6/19/2008	6/13/2008	6/13/2008	6/13/2008	6/9/2008	6/11/2008	6/9/2008	6/9/2008	6/22/2008	6/22/2008	6/21/2008	6/20/2008	6/20/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/21/2008	6/21/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH044	No	WPAH033	No	WPAH034	WPAH035	No	WPAH041	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Polychlorinated Biphenyls (PCBs)																							
Aroclor 1016	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	9.2 UJ	6.5 U	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1221	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	9.2 UJ	6.5 U	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1232	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	9.2 UJ	6.5 U	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1242	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	9.2 UJ	6.5 U	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1248	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	9.2 UJ	6.5 U	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1254	µg/kg dw			3.2 UJ	2.7 UJ	3 U	1.7 UJ	3.2 UJ	2.7 UJ	2.9 UJ	2.6 UJ	1.6 U	2.4 UJ	1.7 U	1.6 U	1.9 U						1.7 U	1.7 U
Aroclor 1260	µg/kg dw			3.2 UJ	2.7 UJ	3 U	1.7 UJ	3.2 UJ	2.7 UJ	2.9 UJ	2.6 UJ	1.6 U	25 J	42	1.6 U	1.9 U						1.7 U	1.7 U
Total PCBs, Aroclors	µg/kg dw			12 UJ	11 UJ	12 U	6.4 UJ	12 UJ	10 UJ	11 UJ	10 UJ	6 U	25 J	42	6.1 U	7.4 U						6.5 U	6.5 U
Aroclor 1016	mg/kg OC				0.4 UJ	0.48 U	1 UJ	0.49 UJ	0.53 UJ	0.44 UJ	0.68 UJ	1 U	0.46 UJ	2.1 U	3.4 U	0.84 U						1.4 U	2.7 U
Aroclor 1221	mg/kg OC				0.4 UJ	0.48 U	1 UJ	0.49 UJ	0.53 UJ	0.44 UJ	0.68 UJ	1 U	0.46 UJ	2.1 U	3.4 U	0.84 U						1.4 U	2.7 U
Aroclor 1232	mg/kg OC				0.4 UJ	0.48 U	1 UJ	0.49 UJ	0.53 UJ	0.44 UJ	0.68 UJ	1 U	0.46 UJ	2.1 U	3.4 U	0.84 U						1.4 U	2.7 U
Aroclor 1242	mg/kg OC				0.4 UJ	0.48 U	1 UJ	0.49 UJ	0.53 UJ	0.44 UJ	0.68 UJ	1 U	0.46 UJ	2.1 U	3.4 U	0.84 U						1.4 U	2.7 U
Aroclor 1248	mg/kg OC				0.4 UJ	0.48 U	1 UJ	0.49 UJ	0.53 UJ	0.44 UJ	0.68 UJ	1 U	0.46 UJ	2.1 U	3.4 U	0.84 U						1.4 U	2.7 U
Aroclor 1254	mg/kg OC				0.099 UJ	0.12 U	0.27 UJ	0.13 UJ	0.14 UJ	0.12 UJ	0.18 UJ	0.27 U	0.12 UJ	0.54 U	0.88 U	0.21 U						0.36 U	0.71 U
Aroclor 1260	mg/kg OC				0.099 UJ	0.12 U	0.27 UJ	0.13 UJ	0.14 UJ	0.12 UJ	0.18 UJ	0.27 U	1.3 J	13	0.88 U	0.21 U						0.36 U	0.71 U
Total PCBs, Aroclors	mg/kg OC				0.4 U	0.48 U	1 U	0.49 U	0.53 U	0.44 U	0.68 U	1 U	1.3 J	13	3.4 U	0.84 U						1.4 U	2.7 U
Other																							
Total TEQ	ng/kg dw			5.46	4.06	7.68	1.44		6.13		6.51	1.5	6.65	0.523	0.433	1.25	1.5	1.97	2.13	1.91	1.61	0.541	0.341
Aromatic Hydrocarbons																							
Total LPAH	µg/kg dw			120	200 J	130	20		140		44	32	330 J	20	8.7 U	19 J	8.8 U	8.8 U	8.8 U	8.9 U	8.9 U	18 J	8.8 U
Naphthalene	µg/kg dw			8.6 U	11 JQ	8.5 U	8.4 U		46		8.5 U	8.5 U	31	8.4 U	8.5 U	8.6 U	8.6 U	8.5 U	8.5 U	8.7 U	8.6 U	8.5 U	8.5 U
Acenaphthylene	µg/kg dw			8.6 U	8.5 U	8.5 U	8.4 U		8.5 U		8.5 U	8.5 U	16 JQ	8.4 U	8.5 U	8.6 U	8.5 U	8.5 U	8.5 U	8.6 U	8.6 U	8.4 U	8.5 U
Acenaphthene	µg/kg dw			8.2 U	11 JQ	8.1 U	8 U		8.1 U		8.1 U	8 U	16 JQ	8 U	8 U	8.1 U	8.1 U	8 U	8 U	8.2 U	8.1 U	8 U	8.1 U
Fluorene	µg/kg dw			8.9 U	22	8.8 U	8.7 U		8.8 U		8.8 U	8.8 U	24	8.7 U	8.7 U	8.9 U	8.8 U	8.8 U	8.8 U	8.9 U	8.9 U	8.7 U	8.8 U
Phenanthrene	µg/kg dw			83	87	84	20		69		44	32	180	20	8.2 U	19 JQ	8.3 U	8.2 U	8.2 U	8.4 U	8.3 U	18 JQ	8.2 U
Anthracene	µg/kg dw			34	64	49	7.5 U		22		7.6 U	7.6 U	62	7.5 U	7.6 U	7.6 U	7.6 U	7.6 U	7.6 U	7.7 U	7.7 U	7.5 U	7.6 U
2-Methylnaphthalene	µg/kg dw			8.2 U	13 JQ	8 U	8 U		8.1 U		8 U	8 U	11 JQ	8 U	8 U	8.1 U	8.1 U	8 U	8 U	8.2 U	8.1 U	8 U	8 U
Total HPAH	µg/kg dw			880	1,100	1,200	230		430 J		240 J	150 J	1,800 J	67 J	11 J	140 J	11 J	9.3 U	9.3 U	9.5 U	9.4 U	120 J	9.3 U
Fluoranthene	µg/kg dw			260	270	280	55		120		68	44	590	35	11 JQ	56	11 JQ	7.8 U	7.8 U	7.9 U	7.9 U	30	7.8 U
Pyrene	µg/kg dw			150	280	200	52		100		47	23	320	20	7.6 U	29	7.6 U	7.6 U	7.6 U	7.7 U	7.7 U	23	7.6 U
Benzo(a)anthracene	µg/kg dw			78	100	110	24		33		25	14 JQ	130	5.7 U	5.8 U	12 JQ	5.8 U	5.8 U	5.8 U	5.9 U	5.9 U	9.5 JQ	5.8 U
Chrysene	µg/kg dw			140	140	180	36		65		44	23	260	12 JQ	6.5 U	18 JQ	6.5 U	6.5 U	6.5 U	6.6 U	6.6 U	16 JQ	6.5 U
Total Benzofluoranthenes	µg/kg dw			190	200	250	47		85		57	33 J	300	9.2 U	9.3 U	29 J	9.4 U	9.3 U	9.3 U	9.5 U	9.4 U	29 J	9.3 U
Benzo(b)fluoranthene	µg/kg dw			70	96	150	26		47		28	19 JQ	170	9.2 U	9.3 U	17 JQ	9.4 U	9.3 U	9.3 U	9.5 U	9.4 U	14 JQ	9.3 U
Benzo(k)fluoranthene	µg/kg dw			120	100	100	21		38		29	14 JQ	130	9 U	9 U	12 JQ	9.1 U	9.1 U	9.1 U	9.2 U	9.2 U	15 JQ	9.1 U
Benzo(a)pyrene	µg/kg dw			62	75	100	20		27		8 U	15 JQ	100	7.9 U	8 U	8.1 U	8 U	8 U	8 U	8.1 U	8.1 U	12 JQ	8 U
Benzo(g,h,i)perylene	µg/kg dw			6.7 U	26	31	6.6 U		6.6 UJ		6.6 UJ	6.6 U	26	6.6 U	6.6 U	6.7 U	6.7 U	6.6 U	6.6 U	6.7 U	6.7 U	6.6 U	6.6 U
Indeno(1,2,3-cd)pyrene	µg/kg dw			8.6 U	26	37	8.4 U		8.5 UJ		8.4 UJ	8.4 U	25	8.3 U	8.4 U	8.5 U	8.5 U	8.4 U	8.4 U	8.6 U	8.5 U	8.4 U	8.4 U
Dibenzo(a,h)anthracene	µg/kg dw			8.5 U	8.4 U	8.4 U	8.3 U		8.4 UJ		8.4 UJ	8.4 U	10 JQ	8.3 U	8.4 U	8.5 U	8.4 U	8.4 U	8.4 U	8.5 U	8.5 U	8.3 U	8.4 U
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw			90	110	140	27		39 J		8.6 J	20 J	150 J	0.12 J		4.3 J						16 J	
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw			91	110	140	28		40 J		13 J	21 J	150 J	6.1 J	6.1 U	9.2 J	6.1 U	6.1 U	6.1 U	6.2 U	6.2 U	17 J	6.1 U
Total LPAH	mg/kg OC				7.2 J	5.3	3.1		7.2		3	5.4	16 J	6.4	4.8 U	2.1 J	2.1 U	1.3 U	1.6 U	2 U	1.8 U	3.8 J	3.7 U
Naphthalene	mg/kg OC				0.4 JQ	0.34 U	1.3 U		2.4		0.58 U	1.4 U	1.6	2.7 U	4.7 U	0.97 U	2 U	1.2 U	1.6 U	2 U	1.7 U	1.8 U	3.6 U
Acenaphthylene	mg/kg OC				0.31 U	0.34 U	1.3 U		0.45 U		0.58 U	1.4 U	0.8 JQ	2.7 U	4.7 U	0.97 U	2 U	1.2 U	1.6 U	2 U	1.7 U	1.8 U	3.6 U
Acenaphthene	mg/kg OC				0.4 JQ	0.32 U	1.3 U		0.43 U		0.55 U	1.4 U	0.8 JQ	2.5 U	4.4 U	0.92 U	1.9 U	1.2 U	1.5 U	1.9 U	1.6 U	1.7 U	3.4 U
Fluorene	mg/kg OC				0.81	0.35 U	1.4 U		0.47 U		0.6 U	1.5 U	1.2	2.8 U	4.8 U	1 U	2.1 U	1.3 U	1.6 U	2 U	1.8 U	1.9 U	3.7 U
Phenanthrene	mg/kg OC				3.2	3.3	3.1		3.7		3	5.4	9	6.4	4.5 U	2.1 JQ	2 U	1.2 U	1.5 U	1.9 U	1.7 U	3.8 JQ	3.4 U
Anthracene	mg/kg OC				2.4	2	1.2 U		1.2		0.52 U	1.3 U	3.1	2.4 U	4.2 U	0.86 U	1.8 U	1.1 U	1.4 U	1.8 U	1.6 U	1.6 U	3.2 U
2-Methylnaphthalene	mg/kg OC				0.48 JQ	0.32 U	1.3 U		0.43 U		0.55 U	1.4 U	0.55 JQ	2.5 U	4.4 U	0.92 U	1.9 U	1.2 U	1.5 U	1.9 U	1.6 U	1.7 U	3.3 U
Total HPAH	mg/kg OC				41	47	37		23 J		17 J	26 J	88 J	21 J	6 J	16 J	2.6 J	1.4 U	1.7 U	2.2 U	1.9 U	25 J	3.9 U
Fluoranthene	mg/kg OC				9.9	11	8.6		6.3		4.7	7.5	30	11	6 JQ	6.3	2.6 JQ	1.1 U	1.4 U	1.8 U	1.6 U	6.4	3.3 U
Pyrene	mg/kg OC				10	8	8.1		5.3		3.2	3.9	16	6.4	4.2 U	3.3	1.8 U	1.1 U	1.4 U	1.8 U	1.6 U	4.9	3.2 U
Benzo(a)anthracene	mg/kg OC				3.7	4.4	3.8		1.7		1.7	2.4 JQ	6.5	1.8 U	3.2 U	1.4 JQ	1.4 U	0.85 U	1.1 U	1.3 U	1.2 U	2 JQ	2.4 U

Table C.6
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Station ID		PA_BA01A	PA_BA02A	PA_BL01A	PA_BL02A	PA_BL03A	PA_BL04A	PA_BL05A	PA_BL06A	PA_BL07A	PA_BL08A	PA_CO01A	PA_CO02A	PA_CO03A	PA_CO04A	PA_CO05A	PA_DO01A	PA_DO02A	PA_DO03A	PA_DO04A	PA_DO05A	PA_EC01A	PA_EC02A
Sample ID		BA01A	BA02A	BL01A	BL02A	BL03A	BL04A	BL05A	BL06A	BL07A	BL08A	CO01A	CO02A	CO03A	CO04A	CO05A	DO01A	DO02A	DO03A	DO04A	DO05A	EC01A	EC02A
Sample Date		6/7/2008	6/7/2008	6/19/2008	6/13/2008	6/13/2008	6/13/2008	6/9/2008	6/11/2008	6/9/2008	6/9/2008	6/22/2008	6/22/2008	6/21/2008	6/20/2008	6/20/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/21/2008	6/21/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH044	No	WPAH033	No	WPAH034	WPAH035	No	WPAH041	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Aromatic Hydrocarbons (cont.)																							
Chrysene	mg/kg OC				5.1	7.2	5.6		3.4		3	3.9	13	3.8 JQ	3.6 U	2 JQ	1.5 U	0.95 U	1.2 U	1.5 U	1.3 U	3.4 JQ	2.7 U
Total Benzofluoranthenes	mg/kg OC				7.2	10	7.3		4.5		3.9	5.6 J	15	2.9 U	5.1 U	3.3 J	2.2 U	1.4 U	1.7 U	2.2 U	1.9 U	6.2 J	3.9 U
Benzo(b)fluoranthene	mg/kg OC				3.5	6	4.1		2.5		1.9	3.2 JQ	8.5	2.9 U	5.1 U	1.9 JQ	2.2 U	1.4 U	1.7 U	2.2 U	1.9 U	3 JQ	3.9 U
Benzo(k)fluoranthene	mg/kg OC				3.7	4	3.3		2		2	2.4 JQ	6.5	2.9 U	4.9 U	1.4 JQ	2.2 U	1.3 U	1.7 U	2.1 U	1.9 U	3.2 JQ	3.8 U
Benzo(a)pyrene	mg/kg OC				2.8	4	3.1		1.4		0.55 U	2.6 JQ	5	2.5 U	4.4 U	0.92 U	1.9 U	1.2 U	1.5 U	1.8 U	1.6 U	2.6 JQ	3.3 U
Benzo(g,h,i)perylene	mg/kg OC				0.96	1.2	1 U		0.35 UJ		0.45 UJ	1.1 U	1.3	2.1 U	3.6 U	0.76 U	1.6 U	0.97 U	1.2 U	1.5 U	1.4 U	1.4 U	2.8 U
Indeno(1,2,3-cd)pyrene	mg/kg OC				0.96	1.5	1.3 U		0.45 UJ		0.58 UJ	1.4 U	1.3	2.6 U	4.6 U	0.96 U	2 U	1.2 U	1.5 U	2 U	1.7 U	1.8 U	3.5 U
Dibenzo(a,h)anthracene	mg/kg OC				0.31 U	0.33 U	1.3 U		0.44 UJ		0.58 UJ	1.4 U	0.5 JQ	2.6 U	4.6 U	0.96 U	2 U	1.2 U	1.5 U	1.9 U	1.7 U	1.8 U	3.5 U
Carcinogenic PAH TEQ, 0 DL [4,5]	mg/kg OC				4	5.6	4.3		2.1 J		0.59 J	3.4 J	7.5 J	0.038 J		0.48 J						3.4 J	
Carcinogenic PAH TEQ, 1/2 DL [4,6]	mg/kg OC				4	5.7	4.4		2.1 J		0.92 J	3.5 J	7.5 J	1.9 J	3.3 U	1 J	1.4 U	0.89 U	1.1 U	1.4 U	1.2 U	3.6 J	2.5 U
Chlorinated Benzenes																							
1,2-Dichlorobenzene	µg/kg dw			7.8 U	7.7 U	7.7 U	7.7 U		7.7 U		7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.8 U	7.8 U	7.7 U	7.7 U	7.9 U	7.8 U	7.7 U	7.7 U
1,3-Dichlorobenzene	µg/kg dw			7.4 U	7.3 U	7.3 U	7.2 U		7.3 U		7.3 U	7.3 U	7.3 U	7.2 U	7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.4 U	7.4 U	7.3 U	7.3 U
1,4-Dichlorobenzene	µg/kg dw			7.3 U	7.2 U	7.2 U	7.1 U		7.2 U		7.2 U	7.2 U	7.2 U	7.1 U	7.2 U	7.3 U	7.3 U	7.2 U	7.2 U	7.3 U	7.3 U	7.2 U	7.2 U
1,2,4-Trichlorobenzene	µg/kg dw			9 U	8.9 U	8.9 U	8.8 U		8.9 U		8.9 U	8.9 U	8.9 U	8.8 U	8.9 U	9 U	9 U	8.9 U	8.9 U	9 U	9 U	8.6 U	8.9 U
Hexachlorobenzene	µg/kg dw			8 U	7.8 U	7.9 U	7.8 U		7.9 U		7.9 U	7.8 U	7.9 U	7.8 U	7.8 U	7.9 U	7.9 U	7.9 U	7.9 U	8 U	8 U	7.8 U	7.9 U
1,2-Dichlorobenzene	mg/kg OC				0.28 U	0.31 U	1.2 U		0.41 U		0.53 U	1.3 U	0.39 U	2.5 U	4.2 U	0.88 U	1.8 U	1.1 U	1.4 U	1.8 U	1.6 U	1.6 U	3.2 U
1,4-Dichlorobenzene	mg/kg OC				0.26 U	0.29 U	1.1 U		0.38 U		0.49 U	1.2 U	0.36 U	2.3 U	4 U	0.82 U	1.7 U	1.1 U	1.3 U	1.7 U	1.5 U	1.5 U	3 U
1,2,4-Trichlorobenzene	mg/kg OC				0.33 U	0.35 U	1.4 U		0.47 U		0.61 U	1.5 U	0.45 U	2.8 U	4.9 U	1 U	2.1 U	1.3 U	1.6 U	2.1 U	1.8 U	1.8 U	3.7 U
Hexachlorobenzene	mg/kg OC				0.29 U	0.31 U	1.2 U		0.42 U		0.54 U	1.3 U	0.4 U	2.5 U	4.3 U	0.89 U	1.9 U	1.2 U	1.5 U	1.8 U	1.6 U	1.7 U	3.3 U
Phthalate Esters																							
Dimethyl Phthalate	µg/kg dw			7.7 U	7.6 U	7.6 U	7.5 U		7.6 U		7.6 U	7.6 U	7.6 U	7.5 U	7.6 U	7.7 U	7.6 U	7.6 U	7.6 U	7.7 U	7.7 U	7.6 U	7.6 U
Diethyl Phthalate	µg/kg dw			16 U	16 U	16 U	16 U		16 U		16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U
Di-n-butyl Phthalate	µg/kg dw			12 U	12 U	12 U	12 U		12 U		12 U	12 U	24	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U
Butylbenzyl Phthalate	µg/kg dw			11 U	11 U	11 U	11 U		11 U		11 U	11 U	21	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
bis(2-ethylhexyl)phthalate	µg/kg dw			140	69	35	13 JQ		28		23	14 JQ	26	11 U	11 U	11 U	11 U	20	11 U	11 U	11 U	18 JQ	11 U
Di-n-octyl Phthalate	µg/kg dw			8.3 U	8.1 U	8.2 U	8.1 U		8.2 U		8.2 U	8.2 U	8.2 U	8.1 U	8.1 U	8.2 U	8.2 U	8.2 U	8.2 U	8.3 U	8.3 U	8.1 U	8.2 U
Dimethyl Phthalate	mg/kg OC				0.28 U	0.3 U	1.2 U		0.4 U		0.52 U	1.3 U	0.38 U	2.4 U	4.2 U	0.87 U	1.8 U	1.1 U	1.4 U	1.8 U	1.6 U	1.6 U	3.2 U
Diethyl Phthalate	mg/kg OC				0.59 U	0.64 U	2.5 U		0.85 U		1.1 U	2.7 U	0.8 U	5.1 U	8.8 U	1.8 U	3.8 U	2.3 U	3 U	3.7 U	3.2 U	3.4 U	6.7 U
Di-n-butyl Phthalate	mg/kg OC				0.44 U	0.48 U	1.9 U		0.63 U		0.82 U	2 U	1.2	3.8 U	6.6 U	1.4 U	2.8 U	1.8 U	2.2 U	2.7 U	2.4 U	2.6 U	5 U
Butylbenzyl Phthalate	mg/kg OC				0.4 U	0.44 U	1.7 U		0.58 U		0.75 U	1.9 U	1.1	3.5 U	6 U	1.2 U	2.6 U	1.6 U	2 U	2.5 U	2.2 U	2.3 U	4.6 U
bis(2-ethylhexyl)phthalate	mg/kg OC				2.5	1.4	2 JQ		1.5		1.6	2.4 JQ	1.3	3.5 U	6 U	1.2 U	2.6 U	2.9	2 U	2.5 U	2.2 U	3.8 JQ	4.6 U
Di-n-octyl Phthalate	mg/kg OC				0.3 U	0.33 U	1.3 U		0.43 U		0.56 U	1.4 U	0.41 U	2.6 U	4.5 U	0.93 U	1.9 U	1.2 U	1.5 U	1.9 U	1.7 U	1.7 U	3.4 U
Miscellaneous Nonionizable Organic Compounds																							
Dibenzofuran	µg/kg dw			7.5 U	18 JQ	7.4 U	7.3 U		7.4 U		7.4 U	7.4 U	18 JQ	7.3 U	7.4 U	7.5 U	7.5 U	7.4 U	7.4 U	7.5 U	7.5 U	7.4 U	7.4 U
Hexachlorobutadiene	µg/kg dw			8.1 U	7.9 U	8 U	7.9 U		8 U		8 U	7.9 U	8 U	7.9 U	7.9 U	8 U	8 U	8 U	8 U	8.1 U	8 U	7.9 U	8 U
N-nitrosodiphenylamine	µg/kg dw			8.6 U	8.5 U	8.5 U	8.4 U		8.5 U		8.5 U	8.5 U	8.5 U	8.4 U	8.5 U	8.6 U	8.6 U	8.5 U	8.5 U	8.7 U	8.6 U	8.5 U	8.5 U
Dibenzofuran	mg/kg OC				0.66 JQ	0.29 U	1.1 U		0.39 U		0.51 U	1.3 U	0.9 JQ	2.3 U	4.1 U	0.85 U	1.8 U	1.1 U	1.4 U	1.7 U	1.5 U	1.6 U	3.1 U
Hexachlorobutadiene	mg/kg OC				0.29 U	0.32 U	1.2 U		0.42 U		0.55 U	1.3 U	0.4 U	2.5 U	4.3 U	0.9 U	1.9 U	1.2 U	1.5 U	1.8 U	1.6 U	1.7 U	3.3 U
N-nitrosodiphenylamine	mg/kg OC				0.31 U	0.34 U	1.3 U		0.45 U		0.58 U	1.4 U	0.43 U	2.7 U	4.7 U	0.97 U	2 U	1.2 U	1.6 U	2 U	1.7 U	1.8 U	3.6 U
Ionizable Organic Compounds																							
Phenol	µg/kg dw			14 U	13 U	95	22		47		40	13 U	72	13 U	13 U	14 U	24	36	21	76	110	13 U	13 U
2-Methylphenol	µg/kg dw			14 U	14 U	14 U	14 U		14 U		14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U
4-Methylphenol	µg/kg dw			13 U	12 U	13 JQ	12 U		13 U		80	13 U	120	12 U	12 U	13 U	13 JQ	46	13 U	26	95	12 U	13 U
2,4-Dimethylphenol	µg/kg dw			15 U	14 U	15 U	14 U		15 U		15 U	14 U	15 U	14 U	14 U	15 U	15 U	14 U	14 U	15 U	15 U	14 U	15 U
Pentachlorophenol	µg/kg dw			47 U	46 U	47 U	46 U		47 U		47 U	47 U	47 U	46 U	46 U	47 U	47 U	47 U	47 U	47 U	47 U	46 U	47 U
Benzyl Alcohol	µg/kg dw			14 UJ	14 U	14 U	14 U		14 U		14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U
Benzoic Acid	µg/kg dw			110 UJ	110 U	110 UJ	110 UJ		110 UJ		110 UJ	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U
Other Semivolatile Organic Compounds																							
1-Methylnaphthalene	µg/kg dw			7.2 U	7 U	7.1 U	7 U		7.1 U		7.1 U	7 U	7.1 U	7 U	7 U	7.1 U	7.1 U	7.1 U	7.1 U	7.2 U	7.1 U	7 U	7.1 U
2,2'-Oxybis(1-chloropropane)	µg/kg dw			7.9 U	7.8 U	7.8 U	7.8 U		7.8 U		7.8 U	7.8 U	7.8 U	7.7 U	7.8 U	7.9 U	7.9 U	7.8 U	7.8 U	8 U	7.9 U	7.8 U	7.8 U
2,4,5-Trichlorophenol	µg/kg dw			45 U	44 U	44 U	44 U		44 U		44 U	44 U	44 U	43 U	44 U	44 U	44 U	44 U	44 U	45 U	44 U	44 U	44 U
2,4,6-Trichlorophenol	µg/kg dw			46 U	45 U	45 U	45 U		45 U		45 U	45 U	45 U	45 U	45 U	46 U	46 U	45 U	45 U	46 U	46 U	45 U	45 U

Table C.6
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Station ID		PA_BA01A	PA_BA02A	PA_BL01A	PA_BL02A	PA_BL03A	PA_BL04A	PA_BL05A	PA_BL06A	PA_BL07A	PA_BL08A	PA_CO01A	PA_CO02A	PA_CO03A	PA_CO04A	PA_CO05A	PA_DO01A	PA_DO02A	PA_DO03A	PA_DO04A	PA_DO05A	PA_EC01A	PA_EC02A
Sample ID		BA01A	BA02A	BL01A	BL02A	BL03A	BL04A	BL05A	BL06A	BL07A	BL08A	CO01A	CO02A	CO03A	CO04A	CO05A	DO01A	DO02A	DO03A	DO04A	DO05A	EC01A	EC02A
Sample Date		6/7/2008	6/7/2008	6/19/2008	6/13/2008	6/13/2008	6/13/2008	6/9/2008	6/11/2008	6/9/2008	6/9/2008	6/22/2008	6/22/2008	6/21/2008	6/20/2008	6/20/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/19/2008	6/21/2008	6/21/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH044	No	WPAH033	No	WPAH034	WPAH035	No	WPAH041	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Other Semivolatile Organic Compounds (cont.)																							
2,4-Dichlorophenol	µg/kg dw			41 U	40 U	40 U	40 U		40 U		40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	41 U	40 U	40 U	40 U
2,4-Dinitrophenol	µg/kg dw			110 U	110 UJ	110 U	110 U		110 U		110 U	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ
2,4-Dinitrotoluene	µg/kg dw			38 U	38 U	38 U	37 U		38 U		38 U	38 U	38 U	37 U	37 U	38 U	38 U	38 U	38 U	38 U	38 U	37 U	38 U
2,6-Dinitrotoluene	µg/kg dw			54 U	53 U	53 U	52 U		53 U		53 U	53 U	53 U	52 U	52 U	53 U	53 U	53 U	53 U	54 U	53 U	52 U	53 U
2-Chloronaphthalene	µg/kg dw			7.9 U	7.8 U	7.8 U	7.7 U		7.8 U		7.8 U	7.8 U	7.8 U	7.7 U	7.8 U	7.9 U	7.8 U	7.8 U	7.8 U	7.9 U	7.9 U	7.8 U	7.8 U
2-Chlorophenol	µg/kg dw			7.4 U	7.3 U	7.3 U	7.3 U		7.4 U		7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.4 U	7.4 U	7.3 U	7.3 U	7.5 U	7.4 U	7.3 U	7.3 U
2-Methyl-4,6-dinitrophenol	µg/kg dw			84 UJ	82 U	82 UJ	82 UJ		83 UJ		82 UJ	82 U	82 U	82 U	82 U	83 U	83 U	82 U	82 U	84 U	83 U	82 U	82 U
2-Nitroaniline	µg/kg dw			42 U	41 U	41 U	41 U		41 U		41 U	41 U	41 U	41 U	41 U	41 U	41 U	41 U	41 U	42 U	41 U	41 U	41 U
2-Nitrophenol	µg/kg dw			40 U	39 U	39 U	39 U		39 U		39 U	39 U	39 U	39 U	39 U	39 U	39 U	39 U	39 U	40 U	39 U	39 U	39 U
3,3'-Dichlorobenzidine	µg/kg dw			49 U	48 U	48 U	47 U					48 U	48 U	47 U	48 UJ	48 U	48 U	48 U	48 U	49 U	48 U	48 U	48 U
3-Nitroaniline	µg/kg dw			76 U	74 U	75 UJ	74 UJ					75 U	75 U	74 U	74 U	8.6 U	75 U	75 U	75 U	75 U	76 U	72 U	75 U
4-Bromophenyl-phenyl Ether	µg/kg dw			9.6 U	9.4 U	9.4 U	9.3 U		9.5 U		9.4 U	9.4 U	9.4 U	9.3 U	9.4 U	9.5 U	9.5 U	9.4 U	9.4 U	9.6 U	9.5 U	9.4 U	9.4 U
4-Chloro-3-methylphenol	µg/kg dw			8.4 U	8.2 U	8.2 U	8.2 U		8.3 U		8.2 U	8.2 U	8.2 U	8.2 U	8.2 U	8.3 U	8.3 U	8.2 U	8.2 U	8.3 U	8.3 U	8.2 U	8.2 U
4-Chloroaniline	µg/kg dw			35 U	34 U							34 U	34 U	34 U	34 UJ	34 U	34 U	34 U	34 U	35 U	34 U	34 U	34 U
4-Chlorophenyl-phenyl Ether	µg/kg dw			8.4 U	8.2 U	8.2 U	8.2 U		8.3 U		8.2 U	8.2 U	8.2 U	8.2 U	8.2 U	8.3 U	8.3 U	8.2 U	8.2 U	8.4 U	8.3 U	8.2 U	8.2 U
4-Nitroaniline	µg/kg dw			51 U	50 U	50 U	50 U		50 U		50 U	50 U	50 U	50 U	50 U	51 U	50 U	50 U	50 U	51 U	51 U	50 U	50 U
4-Nitrophenol	µg/kg dw			66 U	65 U	65 U	64 U		98 U		98 U	65 U	65 U	64 U	65 U	65 U	65 U	65 U	65 U	66 U	66 U	65 U	65 U
bis(2-chloroethoxy)methane	µg/kg dw			8.8 U	8.7 U	8.7 U	8.6 U		8.7 U		8.7 U	8.7 U	8.7 U	8.6 U	8.6 U	8.8 U	8.7 U	8.7 U	8.7 U	8.8 U	8.8 U	8.6 U	8.7 U
bis(2-chloroethyl)ether	µg/kg dw			7.4 U	7.3 U	7.3 U	7.3 U		7.4 U		7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.4 U	7.4 U	7.3 U	7.3 U	7.5 U	7.4 U	7.3 U	7.3 U
Carbazole	µg/kg dw			6.6 U	17 JQ	22	6.4 U		6.5 U		6.5 U	6.5 U	29	6.4 U	6.5 U	6.6 U	6.5 U	6.5 U	6.5 U	6.6 U	6.6 U	6.5 U	6.5 U
Hexachloroethane	µg/kg dw			7.2 U	7 U	7.1 U	7 U		7.1 U		7.1 U	7 U	7.1 U	7 U	7 U	7.1 U	7.1 U	7.1 U	7.1 U	7.2 U	7.1 U	7 U	7.1 U
Hexachlorocyclopentadiene	µg/kg dw			44 U	43 U	43 U	43 U		43 UJ		43 UJ	43 U	43 U	43 U	43 U	43 U	43 U	43 U	43 U	44 U	44 U	43 U	43 U
Isophorone	µg/kg dw			8.2 U	8.1 U	8.1 U	8 U		8.1 U		8.1 U	8.1 U	8.1 U	8 U	8.1 U	8.2 U	8.2 U	8.1 U	8.1 U	8.3 U	8.2 U	7.9 U	8.1 U
Nitrobenzene	µg/kg dw			8.8 U	8.6 U	8.6 U	8.5 U		8.7 U		8.6 U	8.6 U	8.6 U	8.5 U	8.6 U	8.7 U	8.7 U	8.6 U	8.6 U	8.8 U	8.7 U	8.6 U	8.6 U
N-nitroso-di-n-propylamine	µg/kg dw			36 U	35 U	35 U	35 U		35 U		35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	36 U	35 U	35 U	35 U
Retene	µg/kg dw	8.6 U		86	46	16						8.7 U	1,400	8.7 U	8.7 U	10	8.8 U	8.8 U	8.8 U	8.9 U	8.9 U	8.7 U	8.8 U
Total Petroleum Hydrocarbons																							
#2 Diesel	mg/kg dw	12 U	12 U	83	66	50	14 JQ					17 U	80	10 U	6.6 JQ	16 JQ						15 U	6.6 U
Motor Oil	mg/kg dw	19 JQ	13 JQ	320	280	150	39 JQ					150	210	16 JQ	6.4 U	63 JQ						51 JQ	6.5 U

Notes:

Source: Exponent, Inc. 2008. *Environmental Baseline Investigation, DNR Lease 22-077766: Nippon Paper Industries USA Co., Ltd., Port Angeles, Washington.* Prepared for Nippon Paper Industries USA Co., Ltd. October.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EC03A	PA_EC04A	PA_EC05A	PA_ED01A	PA_ED02A	PA_ED03A	PA_ED04A	PA_ED05A	PA_EE01A	PA_EE02A	PA_EE03A	PA_EE04A	PA_EE05A	PA_EH01A	PA_EH02A	PA_EH03A	PA_EH04A	PA_EI01A	PA_EI02A	PA_EI03A	PA_EI04A
Sample ID		EC03A	EC04A	EC05A	ED01A	ED02A	ED03A	ED04A	ED05A	EE01A	EE02A	EE03A	EE04A	EE05A	EH01A	EH02A	EH03A	EH04A	EI01A	EI02A	EI03A	EI04A
Sample Date		6/20/2008	6/20/2008	6/21/2008	6/21/2008	6/19/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/8/2008	6/7/2008	6/8/2008	6/6/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH047	No	No	No	No	No	No
Analyte	**Units**																					
Conventionals																						
Sulfides	mg/kg dw	94	63	0.0095 U	190	720	1,400	3,200	110							3.6			16	3.5	0.0086 U	22
Total Organic Carbon	%	1.06 J	1.35	0.216	1.59	2.22	4.23	5.13	1.32	0.232	0.311	0.176	0.197	0.222	1.59	0.62	0.832	0.662	0.198	0.182	0.459	0.172
Total Solids	%	62.2	68.5	80.9	56.8	48.2	43.8	28.7	69.3	90.1	78.1	74.9	87.2	89.1	40.3	74.1	66.5	66.6	73	75.3	81.8	72.3
Nutrients																						
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	14	13	0.88	19	28	39	400	7.9							5.1			3.7	7.8	9.1	8.2
Particle/Grain Size																						
Percent Fines (clay & silt)	%	34	18	0.4	47	68	72	77	17	0.2	5.6	1.4	1.4	1.1	5.4	9.7	29	32	7.8	8.3	2.8	5.9
Phi Class 10.00+	%	3.6	3		5.4	7.2	7.5	12	2.5		0.9				1.5	2.3	6.3	6.5	1	1		1.2
Phi Class 9.00+ to 10.00	%	0.7	0.6		1.5	2.4	2.1	1.7	0.5		0.1				0.5	0.7	1.9	2.2	0.1	0.1		0.1
Phi Class 8.00+ to 9.00	%	0.9	1		2.5	2.8	3.1	1.9	0.9		0.2				0.4	0.7	2	2.2	0.2	0.2		0.2
Phi Class 7.00+ to 8.00	%	1	1		2.5	3.9	4.1	2.9	1.3		0.3				0.4	0.9	2.6	3	0.2	0.1		0.1
Phi Class 6.00+ to 7.00	%	1.6	1.6		4.3	6.9	8.8	6.9	1.6		0.4				0.5	1.1	3.3	3.6	0.3	0.2		0.2
Phi Class 5.00+ to 6.00	%	4.5	3.3		9.7	19	22	29	2.5		0.7				0.5	1.6	5.1	5.5	0.4	0.4		0.3
Phi Class 4.00+ to 5.00	%	22	7.8		21	26	24	23	7.3		2.9				1.5	2.4	7.8	9.2	5.7	6.3		3.8
Phi Class 3.00+ to 4.00	%	46	19	1.9	20	13	10	5.7	25	0.2	4.1	10	1.6	2.3	3.9	12	39	41	31	32	7.9	53
Phi Class 2.00+ to 3.00	%	13	28	17	14	9	5.9	4.6	41	5	14	48	11	9.7	49	63	28	25	49	43	9.2	39
Phi Class 1.00+ to 2.00	%	3.5	26	13	9.8	6.5	5.6	5	15	15	44	37	5.8	3.3	24	13	1.9	1.4	11	17	36	1.9
Phi Class 0.00+ to 1.00	%	1.8	5.6	5.3	2.9	3	4.2	7	2.3	15	16	3.3	4.4	2.3	6.2	2	0.8	0.6	1.1	0.6	9	0.3
Phi Class -1.00+ to 0.00	%	1	2.2	6.1	1.2	0.7	1.4	0.9	0.6	18	9.6	0.3	15	14	4	0.4	0.2	0.1	0.1	0.1	6.7	0.1
Phi Class < -1.00	%	0.4	1.5	56	4.8	0.3	1.3	0.1	0.1	46	6.8	0.1 U	62	67	8	0.1	0.9	0.1 U	0.1	0.1	29	0.1 U
Biochemical Measures																						
12-Chlorodehydroabietic acid	µg/kg dw	490 U	480 U	99 U																		
14-Chlorodehydroabietic acid	µg/kg dw	490 U	480 U	99 U																		
1-Phenanthrenecarboxylic acid	µg/kg dw	820	480 U	99 U																		
3,4,5-Trichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
3,4,6-Trichloroguaiacol (Ac)	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
3,4-Dichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
4,5,6-Trichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
4,5-Dichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
4,6-Dichloroguaiacol	µg/kg dw	20 UJ	19 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ														
4-Chloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
9,10-Dichlorostearic Acid	µg/kg dw	490 U	480 U	99 U																		
Abietic Acid	µg/kg dw	760	480 U	99 U																		
Dichlorodehydroabietic Acid	µg/kg dw	490 U	480 U	99 U																		
Guaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
Isopimaric Acid	µg/kg dw	490 U	480 U	99 U																		
Linolenic Acid	µg/kg dw	490 U	480 U	99 U																		
Neoabietic Acid	µg/kg dw	490 U	480 U	99 U																		
Oleic Acid	µg/kg dw	490 U	480 U	99 U																		
Palustric Acid	µg/kg dw	490 U	480 U	99 U																		
Pimaric Acid	µg/kg dw	490 U	480 U	99 U																		
Sandaracopimaric Acid	µg/kg dw	490 U	480 U	99 U																		
Tetrachloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	20 U	20 U	20 U														
Metals																						
Antimony	mg/kg dw	0.0026 U	0.0023 U	0.16 U	0.29 U	0.47 U	0.32 U	0.0055 U	0.0027 U	0.16 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0019 U	0.0025 U	0.41 U	0.48 U	0.0022 U	0.0023 U	0.0017 U	0.0019 U
Arsenic	mg/kg dw	5.5	3.9	2.8	5.7	7.6	9.2	11	4.8	2.8	3.3	2.1	1.1	2.1	2.3	3	5.6	4.4	1.7	1.9	2.7	1.7
Barium	mg/kg dw	20	19	13	23	27	30	32	26	12	14	12	6.6	7.5	7.1	11	20	18	10	11	7.4	12
Cadmium	mg/kg dw	0.26	0.027 JQ	0.00038 U	0.26	0.51	1	1.5	0.095 JQ	0.00034 U	0.00043 U	0.00046 U	0.00039 U	0.00039 U	0.035 JQ	0.02 JQ	0.24	0.078 JQ	0.0098 JQ	0.0032 JQ	0.014 JQ	0.021 JQ
Chromium	mg/kg dw	29	37	31	33	41	42	48	36	29	31	24	12	17	18	23	28	25	23	18	38	25
Copper	mg/kg dw	29	32	28	28	40	42	52	30	29	25	19	13	26	17	21	20	17	10	10	9.7	9.3
Lead	mg/kg dw	8.1	4.2	3.3	10	14	14	16	5.5	2.9	3.6	3.4	1.7	2.2	3.6	6.1	6.9	6	2.6	2.7	2.2	2
Mercury	mg/kg dw	0.046	0.026 JQ	0.049	0.07	0.11	0.095	0.22	0.037	0.0096 U	0.01 U	0.011 JQ	0.014 JQ	0.0096 U	0.011 U	0.019 JQ	0.049	0.029	0.0095 U	0.013 JQ	0.018 JQ	0.01 U

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Station ID		PA_EC03A	PA_EC04A	PA_EC05A	PA_ED01A	PA_ED02A	PA_ED03A	PA_ED04A	PA_ED05A	PA_EE01A	PA_EE02A	PA_EE03A	PA_EE04A	PA_EE05A	PA_EH01A	PA_EH02A	PA_EH03A	PA_EH04A	PA_EI01A	PA_EI02A	PA_EI03A	PA_EI04A
Sample ID		EC03A	EC04A	EC05A	ED01A	ED02A	ED03A	ED04A	ED05A	EE01A	EE02A	EE03A	EE04A	EE05A	EH01A	EH02A	EH03A	EH04A	EI01A	EI02A	EI03A	EI04A
Sample Date		6/20/2008	6/20/2008	6/21/2008	6/21/2008	6/19/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/8/2008	6/7/2008	6/8/2008	6/6/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH047	No	No	No	No	No	No
Analyte	**Units**																					
Metals (cont.)																						
Nickel	mg/kg dw	28	41	41	32	39	40	45	41	35	33	28	15	28	17	22	24	21	22	21	20	22
Silver	mg/kg dw	0.084 JQ	0.08 JQ	0.041 JQ	0.11 JQ	0.16 JQ	0.15 JQ	0.18 JQ	0.08 JQ	0.039 JQ	0.058 JQ	0.044 JQ	0.024 JQ	0.037 JQ	0.03 JQ	0.043 JQ	0.063 JQ	0.054 JQ	0.031 JQ	0.037 JQ	0.02 JQ	0.029 JQ
Zinc	mg/kg dw	45	47	37	58	66	72	83	51	37	41	32	22	31	33	44	61	50	28	28	29	27
Butyltins																						
Butyltin	µg/kg dw																					
Dibutyltin	µg/kg dw																					
Tributyltin	µg/kg dw																					
Pesticides																						
4,4'-DDD	µg/kg dw	6.7 J	0.36 U	0.71 JQ						0.28 U	0.46 JQ	0.31 U	0.27 U	0.28 U					0.32 U	0.32 U	0.29 U	0.3 U
4,4'-DDE	µg/kg dw	0.75 JQ	0.42 JQ	0.24 U						0.24 U	0.26 U	0.27 U	0.23 U	0.24 U					0.27 U	0.27 U	0.25 U	0.26 U
4,4'-DDT	µg/kg dw	10 J	0.35 U	0.28 U						0.28 U	0.3 U	0.31 U	0.27 U	0.28 U					0.32 U	0.31 U	0.29 U	0.3 U
Aldrin	µg/kg dw	1.4 JQ	0.14 U	0.68 JQ						0.44 U	0.12 U	0.13 U	0.35 U	0.11 U					0.13 U	0.13 U	0.56 U	0.12 U
alpha-Endosulfan	µg/kg dw	0.61 JQ	0.16 U	0.13 U						0.13 U	0.13 U	0.14 U	0.12 U	0.12 U					0.14 U	0.14 U	0.13 U	0.13 U
alpha-Hexachlorocyclohexane	µg/kg dw	0.48 U	0.15 U	1.1 U						0.47 JQ	0.55 JQ	0.56 JQ	0.11 U	0.11 U					0.13 U	0.13 U	0.12 U	0.12 U
beta-Endosulfan	µg/kg dw	2.8 J	0.35 U	0.28 U						0.28 U	0.3 U	0.31 U	0.27 U	0.28 U					0.32 U	0.31 U	0.29 U	0.3 U
beta-Hexachlorocyclohexane	µg/kg dw	0.18 U	0.17 U	0.14 U						0.46 U	0.37 U	0.15 U	0.13 U	0.52 U					0.4 U	0.35 U	0.22 U	0.35 U
Cis-chlordane	µg/kg dw	0.53 JQ	0.16 U	0.19 JQ						0.13 U	0.13 U	0.14 U	0.12 U	0.13 U					0.22 JQ	0.14 U	0.22 JQ	0.14 U
delta-Hexachlorocyclohexane	µg/kg dw	0.17 U	0.16 U	0.13 U						2.2 U	0.13 U	3.4 U	0.12 U	2.6 U					0.85 U	4.2 U	0.13 U	0.14 U
Dieldrin	µg/kg dw	0.31 U	0.3 U	0.24 U						0.24 U	0.25 U	0.26 U	0.23 U	0.23 U					0.27 U	0.26 U	0.24 U	0.25 U
Endosulfan Sulfate	µg/kg dw	4.7 J	0.46 U	0.36 U						0.36 U	0.39 U	0.4 U	0.35 U	0.36 U					0.41 U	0.41 U	0.38 U	0.39 U
Endrin	µg/kg dw	0.59 U	0.57 U	0.45 U						0.45 U	0.48 U	0.5 U	0.43 U	0.44 U					0.51 U	0.5 U	0.46 U	0.48 U
Endrin Aldehyde	µg/kg dw	0.35 U	0.34 U	0.27 U						0.27 U	0.45 JQ	0.84 JQ	0.57 JQ	0.26 U					0.3 U	0.3 U	0.28 U	0.29 U
Endrin Ketone	µg/kg dw	0.35 U	0.34 U	0.27 U						0.27 U	0.28 U	0.3 U	0.26 U	0.26 U					0.3 U	0.3 U	0.28 U	0.29 U
gamma-Chlordane	µg/kg dw	1.9	0.16 U	0.6 JQ						0.13 U	0.13 U	0.14 U	0.12 U	0.17 JQ					0.14 U	0.14 U	0.13 U	0.14 U
gamma-Hexachlorocyclohexane	µg/kg dw	1.7 J	0.16 U	1.1 J						0.12 U	0.23 JQ	0.16 JQ	0.12 U	0.12 U					0.22 JQ	0.14 U	0.13 U	0.13 U
Heptachlor	µg/kg dw	1.5 J	0.18 U	0.14 U						0.14 U	0.15 U	0.16 U	0.14 U	0.49 JQ					0.16 U	0.16 U	0.15 U	0.15 U
Heptachlor Epoxide	µg/kg dw	2.2	0.86 JQ	0.14 U						0.13 U	0.67 JQ	0.15 U	0.13 U	0.13 U					0.66 JQ	0.15 U	0.14 U	0.14 U
Methoxychlor	µg/kg dw	1.9 U	1.8 U	1.4 U						1.4 U	1.5 U	1.6 U	1.4 U	1.4 U					1.6 U	1.6 U	1.5 U	1.5 U
Toxaphene	µg/kg dw	14 U	13 U	11 U						11 U	11 U	12 U	10 U	10 U					12 U	12 U	11 U	11 U
Dioxins/Furans																						
2,3,7,8-TCDD	ng/kg dw	0.472	0.127	0.101 J	0.63	1.13	0.8	1.26	0.219	0.047 J	0.092 JQ	0.075 J	0.045 J	0.041 J						0.077 J		0.045 J
1,2,3,7,8-PeCDD	ng/kg dw	0.891	0.272 JQ	0.066 JQ	1.54	2.72	2.23	2.78	0.409 JQ	0.042 JQ	0.147 JQ	0.094 JQ	0.041 JQ	0.047 J						0.072 JQ		0.085 J
1,2,3,4,7,8-HxCDD	ng/kg dw	0.954	0.266 JQ	0.045 J	1.68	3.21	2.64	3.06	0.427 JQ	0.034 JQ	0.104 JQ	0.062 JQ	0.0241 U	0.0234 U						0.045 JQ		0.052 JQ
1,2,3,6,7,8-HxCDD	ng/kg dw	2.85	0.816	0.111 JQ	6.23	9.95	7.32	10.9	1.47	0.081 JQ	0.273 JQ	0.217 JQ	0.082 JQ	0.088 JQ						0.225 JQ		0.203 JQ
1,2,3,7,8,9-HxCDD	ng/kg dw	2.26	0.607	0.155 JQ	5.19	7.86	5.62	6.84	1.13	0.104 JQ	0.265 JQ	0.214 JQ	0.066 J	0.082 JQ						0.191 JQ		0.156 JQ
1,2,3,4,6,7,8-HpCDD	ng/kg dw	48.6	17.1	1.52	122	147	145	212	29.5	1.1	3.13	2.44	0.753	0.418 JQ						1.94		1.93
Total OCDD	ng/kg dw	607	200	10.6	1,120	1,200	1,340	1,680	263	7.85	22.3	13.5	6.08	1.68						13.7		14.1
2,3,7,8-TCDF	ng/kg dw	2.56	0.357	0.0243 U	2.88	5.17	3.52	3.66	0.935	0.052 JQ	0.105 J	0.082 JQ	0.032 JQ	0.0234 U						0.067 JQ		0.082 JQ
1,2,3,7,8-PeCDF	ng/kg dw	0.778	0.15 JQ	0.0243 U	1.14	2.14	1.4	1.81	0.31 JQ	0.029 JQ	0.058 JQ	0.06 J	0.0241 U	0.0234 U						0.025 J		0.041 JQ
2,3,4,7,8-PeCDF	ng/kg dw	1.4	0.23 JQ	0.049 JQ	1.68	3.06	2.15	2.71	0.465 JQ	0.037 J	0.09 JQ	0.078 JQ	0.034 JQ	0.028 JQ						0.054 J		0.066 JQ
1,2,3,4,7,8-HxCDF	ng/kg dw	2.94	0.227 JQ	0.117 JQ	1.39	3.09	2.09	2.71	0.876	0.065 U	0.088 U	0.115 U	0.042 U	0.035 U						0.042 JQ		0.06 U
1,2,3,6,7,8-HxCDF	ng/kg dw	0.839	0.138 JQ	0.035 JQ	0.879	1.67	1.24	1.62	0.307 JQ	0.028 J	0.054 JQ	0.058 J	0.0241 U	0.0234 U						0.025 J		0.04 JQ
1,2,3,7,8,9-HxCDF	ng/kg dw	0.064 JQ	0.0242 U	0.0243 U	0.067 JQ	0.156 JQ	0.094 JQ	0.17 JQ	0.0306 U	0.0249 U	0.0251 U	0.0246 U	0.0241 U	0.0234 U						0.0248 U		0.0251 U
2,3,4,6,7,8-HxCDF	ng/kg dw	1.16	0.125 JQ	0.031 JQ	0.811	1.55	1.11	1.5	0.281 JQ	0.0249 U	0.051 JQ	0.048 J	0.0241 U	0.0234 U						0.0248 U		0.037 JQ
1,2,3,4,6,7,8-HpCDF	ng/kg dw	11.7	2.47	0.444 JQ	13.2	21	22	31.1	3.6	0.161 U	0.677	0.487 JQ	0.176 JQ	0.11 U						0.405 JQ		0.412 JQ
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.984	0.132 JQ	0.0542 U	0.74	1.13	1.05	1.62	0.351 JQ	0.037 J	0.05 JQ	0.041 JQ	0.0241 U	0.0234 U						0.035 J		0.051 J
Total OCDF	ng/kg dw	60.6	26.8	0.714 U	108	84.2	75.9	78.8	9.26	0.385 JQ	1.21	0.887 JQ	0.429 JQ	0.15 U						0.882 JQ		0.839 JQ
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	3.98 J	0.991 J	0.254 J	6.35 J	10.2 J	8.19 J	10.9 J	1.74 J	0.145 J	0.399 J	0.296 J	0.125 J	0.118 J						0.254 J		0.236 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	3.98 J	0.992 J	0.257 J	6.35 J	10.2 J	8.19 J	10.9 J	1.74 J	0.151 J	0.404 J	0.303 J	0.133 J	0.127 J						0.256 J		0.241 J

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Sample ID		EC03A	EC04A	EC05A	ED01A	ED02A	ED03A	ED04A	ED05A	EE01A	EE02A	EE03A	EE04A	EE05A	EH01A	EH02A	EH03A	EH04A	EI01A	EI02A	EI03A	EI04A
Sample Date		6/20/2008	6/20/2008	6/21/2008	6/21/2008	6/19/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/8/2008	6/7/2008	6/8/2008	6/6/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH047	No	No	No	No	No	No
Analyte	**Units**																					
Polychlorinated Biphenyls (PCBs)																						
Aroclor 1016	µg/kg dw	8.6 UJ	7.6 U	5.8 U	9 UJ	11 UJ	11 UJ	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1221	µg/kg dw	8.6 UJ	7.6 U	5.8 U	9 UJ	11 UJ	11 UJ	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1232	µg/kg dw	8.6 UJ	7.6 U	5.8 U	9 UJ	11 UJ	11 UJ	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1242	µg/kg dw	8.6 UJ	7.6 U	5.8 U	9 UJ	11 UJ	11 UJ	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1248	µg/kg dw	8.6 UJ	7.6 U	5.8 U	9 UJ	11 UJ	11 UJ	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1254	µg/kg dw	2.2 UJ	2 U	1.5 U	2.3 UJ	2.8 UJ	120 J	4.6 U	1.9 UJ	1.6 U	1.8 U	1.8 U	1.5 U	1.5 U					1.8 U	1.7 U	1.6 U	1.8 U
Aroclor 1260	µg/kg dw	55 J	2 U	1.5 U	10 J	2.8 UJ	3 UJ	4.6 U	1.9 UJ	1.6 U	1.8 U	1.8 U	1.5 U	1.5 U					1.8 U	1.7 U	1.6 U	1.8 U
Total PCBs, Aroclors	µg/kg dw	55 J	7.6 U	5.8 U	10 J	11 UJ	120 J	18 U	7.2 UJ	6 U	6.9 U	7 U	5.8 U	5.9 U					6.8 U	6.7 U	6.2 U	7.1 U
Aroclor 1016	mg/kg OC	0.81 UJ	0.56 U	2.7 U	0.57 UJ	0.5 UJ			0.55 UJ	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Aroclor 1221	mg/kg OC	0.81 UJ	0.56 U	2.7 U	0.57 UJ	0.5 UJ			0.55 UJ	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Aroclor 1232	mg/kg OC	0.81 UJ	0.56 U	2.7 U	0.57 UJ	0.5 UJ			0.55 UJ	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Aroclor 1242	mg/kg OC	0.81 UJ	0.56 U	2.7 U	0.57 UJ	0.5 UJ			0.55 UJ	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Aroclor 1248	mg/kg OC	0.81 UJ	0.56 U	2.7 U	0.57 UJ	0.5 UJ			0.55 UJ	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Aroclor 1254	mg/kg OC	0.21 UJ	0.15 U	0.69 U	0.14 UJ	0.13 UJ			0.14 UJ	0.69 U	0.58 U	1 U	0.76 U	0.68 U					0.91 U	0.93 U	0.35 U	1 U
Aroclor 1260	mg/kg OC	5.2 J	0.15 U	0.69 U	0.63 J	0.13 UJ			0.14 UJ	0.69 U	0.58 U	1 U	0.76 U	0.68 U					0.91 U	0.93 U	0.35 U	1 U
Total PCBs, Aroclors	mg/kg OC	5.2 J	0.56 U	2.7 U	0.63 J	0.5 U			0.55 U	2.6 U	2.2 U	4 U	2.9 U	2.7 U					3.4 U	3.7 U	1.4 U	4.1 U
Other																						
Total TEQ	ng/kg dw	4.19	1.2	0.467	6.56	10.4	8.4	11.1	1.95	0.361	0.614	0.513	0.343	0.337						0.466		0.451
Aromatic Hydrocarbons																						
Total LPAH	µg/kg dw	85	8.7 U	8.9 U	150	370	380	410	94	8.8 U	8.7 U	8.7 U	8.7 U	8.7 U					19 J	8.8 U	8.7 U	8.8 U
Naphthalene	µg/kg dw	8.5 U	8.4 U	8.6 U	30	58	35	29	8.4 U	8.6 U	8.4 U	8.4 U	8.4 U	8.5 U					8.5 U	8.6 U	8.4 U	8.5 U
Acenaphthylene	µg/kg dw	8.5 U	8.4 U	8.6 U	8.6 U	31	26	30	8.4 U	8.5 U	8.4 U	8.4 U	8.4 U	8.5 U					8.5 U	8.5 U	8.4 U	8.5 U
Acenaphthene	µg/kg dw	8.1 U	8 U	8.2 U	8.2 U	8.2 U	8.2 U	8.1 U	8 U	8.1 U	8 U	8 U	8 U	8 U					8 U	8.1 U	8 U	8 U
Fluorene	µg/kg dw	8.8 U	8.7 U	8.9 U	8.9 U	22	30	30	8.7 U	8.8 U	8.7 U	8.7 U	8.7 U	8.7 U					8.8 U	8.8 U	8.7 U	8.8 U
Phenanthrene	µg/kg dw	61	8.2 U	8.3 U	84	180	180	200	72	8.3 U	8.1 U	8.2 U	8.2 U	8.2 U					19 JQ	8.3 U	8.1 U	8.2 U
Anthracene	µg/kg dw	24	7.5 U	7.7 U	38	83	110	120	22	7.6 U	7.5 U	7.5 U	7.5 U	7.6 U					7.6 U	7.6 U	7.5 U	7.6 U
2-Methylnaphthalene	µg/kg dw	8 U	8 U	8.1 U	8.1 U	8.2 U	8.2 U	8.1 U	8 U	8.1 U	8 U	8 U	8 U	8 U					8 U	8.1 U	8 U	8 U
Total HPAH	µg/kg dw	640	100	9.4 U	1,000	1,800	2,100 J	2,300 J	880 J	99 J	23 J	9.2 U	9.3 U	9.3 U					29 J	9.4 U	9.2 U	9.3 U
Fluoranthene	µg/kg dw	190	50	7.9 U	230	500	590	660	300	41	13 JQ	7.7 U	7.7 U	7.7 U					19 JQ	7.8 U	7.7 U	7.7 U
Pyrene	µg/kg dw	100	30	7.7 U	150	280	300 J	320 J	180	26	10 JQ	7.5 U	7.5 U	7.6 U					10 JQ	7.6 U	7.5 U	7.6 U
Benzo(a)anthracene	µg/kg dw	53	5.7 U	5.9 U	97	140	170 J	160 J	67	15 JQ	5.7 U	5.7 U	5.8 U	5.8 U					5.8 U	5.8 U	5.7 U	5.8 U
Chrysene	µg/kg dw	110	21	6.6 U	170	310	340 J	380 J	120	17 JQ	6.4 U	6.4 U	6.5 U	6.5 U					6.5 U	6.5 U	6.4 U	6.5 U
Total Benzofluoranthenes	µg/kg dw	140	9.2 U	9.4 U	210	420	500	540	130	9.4 U	9.2 U	9.2 U	9.3 U	9.3 U					9.3 U	9.4 U	9.2 U	9.3 U
Benzo(b)fluoranthene	µg/kg dw	78	9.2 U	9.4 U	130	150	280	250	73	9.4 U	9.2 U	9.2 U	9.3 U	9.3 U					9.3 U	9.4 U	9.2 U	9.3 U
Benzo(k)fluoranthene	µg/kg dw	58	9 U	9.2 U	84	270	220	290	54	9.1 U	9 U	9 U	9 U	9 U					9.1 U	9.1 U	9 U	9.1 U
Benzo(a)pyrene	µg/kg dw	46	7.9 U	8.1 U	87	130	160	170	48	8 U	7.9 U	7.9 U	7.9 U	8 U					8 U	8 U	7.9 U	8 U
Benzo(g,h,i)perylene	µg/kg dw	6.6 U	6.6 U	6.7 U	23	28	25	28	18 JQ	6.7 U	6.6 U	6.6 U	6.6 U	6.6 U					6.6 U	6.7 U	6.6 U	6.6 U
Indeno(1,2,3-cd)pyrene	µg/kg dw	8.4 U	8.3 U	8.5 U	25	28	29	28	17 JQ	8.5 U	8.3 U	8.3 U	8.4 U	8.4 U					8.4 U	8.5 U	8.3 U	8.4 U
Dibenzo(a,h)anthracene	µg/kg dw	8.4 U	8.3 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.3 U	8.4 U	8.3 U	8.3 U	8.3 U	8.4 U					8.4 U	8.4 U	8.3 U	8.4 U
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	66	0.21		120	190	230 J	250 J	70 J	1.7 J												
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	67	6.2	6.2 U	120	190	230 J	250 J	71 J	7.4 J	6 U	6 U	6 U	6.1 U					6.1 U	6.1 U	6 U	6.1 U
Total LPAH	mg/kg OC	8	0.64 U	4.1 U	9.6	17			7.1	3.8 U	2.8 U	4.9 U	4.4 U	3.9 U					9.6 J	4.8 U	1.9 U	5.1 U
Naphthalene	mg/kg OC	0.8 U	0.62 U	4 U	1.9	2.6			0.64 U	3.7 U	2.7 U	4.8 U	4.3 U	3.8 U					4.3 U	4.7 U	1.8 U	4.9 U
Acenaphthylene	mg/kg OC	0.8 U	0.62 U	4 U	0.54 U	1.4			0.64 U	3.7 U	2.7 U	4.8 U	4.3 U	3.8 U					4.3 U	4.7 U	1.8 U	4.9 U
Acenaphthene	mg/kg OC	0.76 U	0.59 U	3.8 U	0.52 U	0.37 U			0.61 U	3.5 U	2.6 U	4.5 U	4.1 U	3.6 U					4 U	4.5 U	1.7 U	4.7 U
Fluorene	mg/kg OC	0.83 U	0.64 U	4.1 U	0.56 U	0.99			0.66 U	3.8 U	2.8 U	4.9 U	4.4 U	3.9 U					4.4 U	4.8 U	1.9 U	5.1 U
Phenanthrene	mg/kg OC	5.8	0.61 U	3.8 U	5.3	8.1			5.5	3.6 U	2.6 U	4.7 U	4.2 U	3.7 U					9.6 JQ	4.6 U	1.8 U	4.8 U
Anthracene	mg/kg OC	2.3	0.56 U	3.6 U	2.4	3.7			1.7	3.3 U	2.4 U	4.3 U	3.8 U	3.4 U					3.8 U	4.2 U	1.6 U	4.4 U
2-Methylnaphthalene	mg/kg OC	0.75 U	0.59 U	3.8 U	0.51 U	0.37 U			0.61 U	3.5 U	2.6 U	4.5 U	4.1 U	3.6 U					4 U	4.5 U	1.7 U	4.7 U
Total HPAH	mg/kg OC	60	7.5	4.4 U	63	83			66 J	43 J	7.4 J	5.2 U	4.7 U	4.2 U					15 J	5.2 U	2 U	5.4 U
Fluoranthene	mg/kg OC	18	3.7	3.7 U	14	23			23	18	4.2 JQ	4.4 U	3.9 U	3.5 U					9.6 JQ	4.3 U	1.7 U	4.5 U
Pyrene	mg/kg OC	9.4	2.2	3.6 U	9.4	13			14	11	3.2 JQ	4.3 U	3.8 U	3.4 U					5.1 JQ	4.2 U	1.6 U	4.4 U
Benzo(a)anthracene	mg/kg OC	5	0.42 U	2.7 U	6.1	6.3			5.1	6.5 JQ	1.8 U	3.2 U	2.9 U	2.6 U					2.9 U	3.2 U	1.2 U	3.4 U

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EC03A	PA_EC04A	PA_EC05A	PA_ED01A	PA_ED02A	PA_ED03A	PA_ED04A	PA_ED05A	PA_EE01A	PA_EE02A	PA_EE03A	PA_EE04A	PA_EE05A	PA_EH01A	PA_EH02A	PA_EH03A	PA_EH04A	PA_EI01A	PA_EI02A	PA_EI03A	PA_EI04A
Sample ID		EC03A	EC04A	EC05A	ED01A	ED02A	ED03A	ED04A	ED05A	EE01A	EE02A	EE03A	EE04A	EE05A	EH01A	EH02A	EH03A	EH04A	EI01A	EI02A	EI03A	EI04A
Sample Date		6/20/2008	6/20/2008	6/21/2008	6/21/2008	6/19/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/8/2008	6/7/2008	6/8/2008	6/6/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH047	No	No	No	No	No	No
Analyte	**Units**																					
Aromatic Hydrocarbons (cont.)																						
Chrysene	mg/kg OC	10	1.6	3.1 U	11	14			9.1	7.3 JQ	2.1 U	3.6 U	3.3 U	2.9 U					3.3 U	3.6 U	1.4 U	3.8 U
Total Benzofluoranthenes	mg/kg OC	13	0.68 U	4.4 U	13	19			9.6	4.1 U	3 U	5.2 U	4.7 U	4.2 U					4.7 U	5.2 U	2 U	5.4 U
Benzo(b)fluoranthene	mg/kg OC	7.4	0.68 U	4.4 U	8.2	6.8			5.5	4.1 U	3 U	5.2 U	4.7 U	4.2 U					4.7 U	5.2 U	2 U	5.4 U
Benzo(k)fluoranthene	mg/kg OC	5.5	0.67 U	4.3 U	5.3	12			4.1	3.9 U	2.9 U	5.1 U	4.6 U	4.1 U					4.6 U	5 U	2 U	5.3 U
Benzo(a)pyrene	mg/kg OC	4.3	0.59 U	3.8 U	5.5	5.9			3.6	3.4 U	2.5 U	4.5 U	4 U	3.6 U					4 U	4.4 U	1.7 U	4.7 U
Benzo(g,h,i)perylene	mg/kg OC	0.62 U	0.49 U	3.1 U	1.4	1.3			1.4 JQ	2.9 U	2.1 U	3.8 U	3.4 U	3 U					3.3 U	3.7 U	1.4 U	3.8 U
Indeno(1,2,3-cd)pyrene	mg/kg OC	0.79 U	0.61 U	3.9 U	1.6	1.3			1.3 JQ	3.7 U	2.7 U	4.7 U	4.3 U	3.8 U					4.2 U	4.7 U	1.8 U	4.9 U
Dibenzo(a,h)anthracene	mg/kg OC	0.79 U	0.61 U	3.9 U	0.53 U	0.38 U			0.63 U	3.6 U	2.7 U	4.7 U	4.2 U	3.8 U					4.2 U	4.6 U	1.8 U	4.9 U
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC	6.2	0.016		7.7	8.6			5.3 J	0.72 J												
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC	6.3	0.46	2.9 U	7.7	8.7			5.4 J	3.2 J	1.9 U	3.4 U	3.1 U	2.7 U					3.1 U	3.3 U	1.3 U	3.5 U
Chlorinated Benzenes																						
1,2-Dichlorobenzene	µg/kg dw	7.7 U	7.7 U	7.8 U	7.8 U	7.8 U	7.9 U	7.8 U	7.7 U	7.8 U	7.6 U	7.6 U	7.7 U	7.7 U					7.7 U	7.8 U	7.6 U	7.7 U
1,3-Dichlorobenzene	µg/kg dw	7.3 U	7.2 U	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U	7.2 U	7.3 U	7.2 U	7.2 U	7.2 U	7.3 U					7.3 U	7.3 U	7.2 U	7.3 U
1,4-Dichlorobenzene	µg/kg dw	7.2 U	7.1 U	7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.1 U	7.3 U	7.1 U	7.1 U	7.2 U	7.2 U					7.2 U	7.3 U	7.1 U	7.2 U
1,2,4-Trichlorobenzene	µg/kg dw	8.9 U	8.8 U	9 U	9 U	9 U	9 U	9 U	8.8 U	9 U	8.8 U	8.8 U	8.8 U	8.9 U					8.9 U	9 U	8.8 U	8.9 U
Hexachlorobenzene	µg/kg dw	7.9 U	7.8 U	8 U	8 U	8 U	8 U	7.9 U	7.8 U	7.9 U	7.8 U	7.8 U	7.8 U	7.8 U					7.9 U	7.9 U	7.8 U	7.8 U
1,2-Dichlorobenzene	mg/kg OC	0.73 U	0.57 U	3.6 U	0.49 U	0.35 U			0.58 U	3.4 U	2.4 U	4.3 U	3.9 U	3.5 U					3.9 U	4.3 U	1.7 U	4.5 U
1,4-Dichlorobenzene	mg/kg OC	0.68 U	0.53 U	3.4 U	0.46 U	0.33 U			0.54 U	3.1 U	2.3 U	4 U	3.7 U	3.2 U					3.6 U	4 U	1.5 U	4.2 U
1,2,4-Trichlorobenzene	mg/kg OC	0.84 U	0.65 U	4.2 U	0.57 U	0.41 U			0.67 U	3.9 U	2.8 U	5 U	4.5 U	4 U					4.5 U	4.9 U	1.9 U	5.2 U
Hexachlorobenzene	mg/kg OC	0.75 U	0.58 U	3.7 U	0.5 U	0.36 U			0.59 U	3.4 U	2.5 U	4.4 U	4 U	3.5 U					4 U	4.3 U	1.7 U	4.5 U
Phthalate Esters																						
Dimethyl Phthalate	µg/kg dw	26	7.5 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.5 U	7.7 U	7.5 U	7.5 U	7.5 U	7.6 U					7.6 U	7.6 U	7.5 U	7.6 U
Diethyl Phthalate	µg/kg dw	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U					16 U	16 U	16 U	16 U
Di-n-butyl Phthalate	µg/kg dw	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U					12 U	12 U	12 U	12 U
Butylbenzyl Phthalate	µg/kg dw	11 U	11 U	11 U	11 U	11 U	11 UJ	11 UJ	11 U	11 U	11 U	11 U	11 U	11 U					11 U	11 U	11 U	11 U
bis(2-ethylhexyl)phthalate	µg/kg dw	70	11 U	130	11 U	45	47	270 J	11 U	11 U	11 U	11 U	11 U	11 U					11 U	11 U	11 U	11 U
Di-n-octyl Phthalate	µg/kg dw	8.2 U	8.1 U	8.3 U	8.3 U	8.3 U	8.3 U	88 J	8.1 U	8.2 U	8.1 U	8.1 U	8.1 U	8.1 U					8.2 U	8.2 U	8.1 U	8.2 U
Dimethyl Phthalate	mg/kg OC	2.5	0.56 U	3.6 U	0.48 U	0.35 U			0.57 U	3.3 U	2.4 U	4.3 U	3.8 U	3.4 U					3.8 U	4.2 U	1.6 U	4.4 U
Diethyl Phthalate	mg/kg OC	1.5 U	1.2 U	7.4 U	1 U	0.72 U			1.2 U	6.9 U	5.1 U	9.1 U	8.1 U	7.2 U					8.1 U	8.8 U	3.5 U	9.3 U
Di-n-butyl Phthalate	mg/kg OC	1.1 U	0.89 U	5.6 U	0.75 U	0.54 U			0.91 U	5.2 U	3.9 U	6.8 U	6.1 U	5.4 U					6.1 U	6.6 U	2.6 U	7 U
Butylbenzyl Phthalate	mg/kg OC	1 U	0.81 U	5.1 U	0.69 U	0.5 U			0.83 U	4.7 U	3.5 U	6.3 U	5.6 U	5 U					5.6 U	6 U	2.4 U	6.4 U
bis(2-ethylhexyl)phthalate	mg/kg OC	6.6	0.81 U	60	0.69 U	2			0.83 U	4.7 U	3.5 U	6.3 U	5.6 U	5 U					5.6 U	6 U	2.4 U	6.4 U
Di-n-octyl Phthalate	mg/kg OC	0.77 U	0.6 U	3.8 U	0.52 U	0.37 U			0.61 U	3.5 U	2.6 U	4.6 U	4.1 U	3.6 U					4.1 U	4.5 U	1.8 U	4.8 U
Miscellaneous Nonionizable Organic Compounds																						
Dibenzofuran	µg/kg dw	7.4 U	7.3 U	7.5 U	7.5 U	22	7.5 U	21	7.3 U	7.5 U	7.3 U	7.3 U	7.4 U	7.4 U					7.4 U	7.5 U	7.3 U	7.4 U
Hexachlorobutadiene	µg/kg dw	8 U	7.9 U	8.1 U	8.1 U	8.1 U	8.1 U	8 U	7.9 U	8 U	7.9 U	7.9 U	7.9 U	7.9 U					7.9 U	8 U	7.9 U	7.9 U
N-nitrosodiphenylamine	µg/kg dw	8.5 U	8.4 U	8.6 U	8.6 U	8.6 U	8.6 U	8.6 U	8.4 U	8.6 U	8.4 U	8.4 U	8.4 U	8.5 U					8.5 U	8.6 U	8.4 U	8.5 U
Dibenzofuran	mg/kg OC	0.7 U	0.54 U	3.5 U	0.47 U	0.99			0.55 U	3.2 U	2.3 U	4.1 U	3.8 U	3.3 U					3.7 U	4.1 U	1.6 U	4.3 U
Hexachlorobutadiene	mg/kg OC	0.75 U	0.59 U	3.8 U	0.51 U	0.36 U			0.6 U	3.4 U	2.5 U	4.5 U	4 U	3.6 U					4 U	4.4 U	1.7 U	4.6 U
N-nitrosodiphenylamine	mg/kg OC	0.8 U	0.62 U	4 U	0.54 U	0.39 U			0.64 U	3.7 U	2.7 U	4.8 U	4.3 U	3.8 U					4.3 U	4.7 U	1.8 U	4.9 U
Ionizable Organic Compounds																						
Phenol	µg/kg dw	13 U	13 U	14 U	42	22	14 U	230	19 JQ	14 U	13 U	13 U	13 U	43					13 U	14 U	13 U	13 U
2-Methylphenol	µg/kg dw	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U					14 U	14 U	14 U	14 U
4-Methylphenol	µg/kg dw	72	12 U	13 U	37	110	400	41,000	33	13 U	12 U	12 U	12 U	12 U					13 U	13 U	12 U	13 U
2,4-Dimethylphenol	µg/kg dw	15 U	14 U	15 U	15 U	15 U	15 U	15 U	14 U	15 U	14 U	14 U	14 U	14 U					14 U	15 U	14 U	14 U
Pentachlorophenol	µg/kg dw	47 U	46 U	47 U	47 U	47 U	47 U	47 U	46 U	47 U	46 U	46 U	46 U	46 U					47 U	47 U	46 U	47 U
Benzyl Alcohol	µg/kg dw	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U						14 U	14 U	14 U
Benzoic Acid	µg/kg dw	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U					110 U	110 U	110 U	110 U
Other Semivolatile Organic Compounds																						
1-Methylnaphthalene	µg/kg dw	7.1 U	7 U	7.1 U	7.1 U	7.2 U	7.2 U	7.1 U	7 U	7.1 U	7 U	7 U	7 U	7 U					7 U	7.1 U	7 U	7 U
2,2'-Oxybis(1-chloropropane)	µg/kg dw	7.8 U	7.7 U	7.9 U	7.9 U	7.9 U	8 U	7.9 U	7.7 U	7.9 U	7.7 U	7.7 U	7.8 U	7.8 U					7.8 U	7.9 U	7.7 U	7.8 U
2,4,5-Trichlorophenol	µg/kg dw	44 U	43 U	44 U	44 U	45 U	45 U	44 U	43 U	44 U	43 U	43 U	44 U	44 U					44 U	44 U	43 U	44 U
2,4,6-Trichlorophenol	µg/kg dw	45 U	45 U	46 U	46 U	46 U	46 U	46 U	45 U	46 U	45 U	45 U	45 U	45 U					45 U	46 U	45 U	45 U

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EC03A	PA_EC04A	PA_EC05A	PA_ED01A	PA_ED02A	PA_ED03A	PA_ED04A	PA_ED05A	PA_EE01A	PA_EE02A	PA_EE03A	PA_EE04A	PA_EE05A	PA_EH01A	PA_EH02A	PA_EH03A	PA_EH04A	PA_EI01A	PA_EI02A	PA_EI03A	PA_EI04A
Sample ID		EC03A	EC04A	EC05A	ED01A	ED02A	ED03A	ED04A	ED05A	EE01A	EE02A	EE03A	EE04A	EE05A	EH01A	EH02A	EH03A	EH04A	EI01A	EI02A	EI03A	EI04A
Sample Date		6/20/2008	6/20/2008	6/21/2008	6/21/2008	6/19/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/20/2008	6/8/2008	6/7/2008	6/8/2008	6/6/2008	6/19/2008	6/18/2008	6/18/2008	6/18/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH047	No	No	No	No	No	No
Analyte	**Units**																					
Other Semivolatile Organic Compounds (cont.)																						
2,4-Dichlorophenol	µg/kg dw	40 U	40 U	40 U	40 U	41 U	41 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U					40 U	40 U	40 U	40 U
2,4-Dinitrophenol	µg/kg dw	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ					110 UJ	110 UJ	110 UJ	110 UJ
2,4-Dinitrotoluene	µg/kg dw	38 U	37 U	38 U	38 U	38 U	38 U	38 U	37 U	38 U	37 U	37 U	37 U	37 U					38 U	38 U	37 U	38 U
2,6-Dinitrotoluene	µg/kg dw	53 U	52 U	53 U	53 U	54 U	54 U	53 U	52 U	53 U	52 U	52 U	52 U	52 U					53 U	53 U	52 U	53 U
2-Chloronaphthalene	µg/kg dw	7.8 U	7.7 U	7.9 U	7.9 U	7.9 U	7.9 U	7.9 U	7.7 U	7.9 U	7.7 U	7.7 U	7.7 U	7.8 U					7.8 U	7.8 U	7.7 U	7.8 U
2-Chlorophenol	µg/kg dw	7.3 U	7.3 U	7.4 U	7.4 U	7.5 U	7.5 U	7.4 U	7.3 U	7.4 U	7.3 U	7.3 U	7.3 U	7.3 U					7.3 U	7.4 U	7.3 U	7.3 U
2-Methyl-4,6-dinitrophenol	µg/kg dw	82 U	82 U	83 U	83 U	84 U	84 U	83 U	82 U	83 U	81 U	82 U	82 U	82 U					82 U	83 U	81 U	82 U
2-Nitroaniline	µg/kg dw	41 U	41 U	41 U	41 U	42 U	42 U	41 U	41 U	41 U	41 U	41 U	41 U	41 U					41 U	41 U	41 U	41 U
2-Nitrophenol	µg/kg dw	39 U	39 U	39 U	39 U	40 U	40 U	39 U	39 U	39 U	39 U	39 U	39 U	39 U					39 U	39 U	39 U	39 U
3,3'-Dichlorobenzidine	µg/kg dw	48 U	47 U	48 U	48 U	49 U	49 UJ	48 UJ	47 UJ	48 UJ	47 UJ	47 UJ	47 UJ	48 UJ						48 UJ	47 UJ	48 UJ
3-Nitroaniline	µg/kg dw	75 U	74 U	76 U	76 U	76 U	76 U	75 U	74 U	75 U	74 U	74 U	74 U	41 U					75 U	75 U	74 U	74 U
4-Bromophenyl-phenyl Ether	µg/kg dw	9.4 U	9.3 U	9.5 U	9.5 U	9.6 U	9.6 U	9.5 U	9.3 U	9.5 U	9.3 U	9.3 U	9.4 U	9.4 U					9.4 U	9.5 U	9.3 U	9.4 U
4-Chloro-3-methylphenol	µg/kg dw	8.2 U	8.2 U	8.3 U	8.3 U	8.4 U	8.4 U	8.3 U	8.2 U	8.3 U	8.1 U	8.2 U	8.2 U	8.2 U					8.2 U	8.3 U	8.1 U	8.2 U
4-Chloroaniline	µg/kg dw	34 U	34 U	35 U	35 U	35 U	35 U	34 U	34 U	34 U	34 U	34 U	34 U	34 U					34 UJ	34 U	34 U	34 U
4-Chlorophenyl-phenyl Ether	µg/kg dw	8.2 U	8.2 U	8.3 U	8.3 U	8.4 U	8.4 U	8.3 U	8.2 U	8.3 U	8.1 U	8.2 U	8.2 U	8.2 U					8.2 U	8.3 U	8.1 U	8.2 U
4-Nitroaniline	µg/kg dw	50 U	50 U	51 U	51 U	51 U	51 U	51 U	50 U	50 U	50 U	50 U	50 U	50 U					50 U	50 U	50 U	50 U
4-Nitrophenol	µg/kg dw	65 U	64 U	66 U	66 U	66 U	66 U	65 U	64 U	65 U	64 U	64 U	64 U	65 U					65 U	65 U	64 U	65 U
bis(2-chloroethoxy)methane	µg/kg dw	8.7 U	8.6 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.6 U	8.7 U	8.6 U	8.6 U	8.6 U	8.6 U					8.7 U	8.7 U	8.6 U	8.7 U
bis(2-chloroethyl)ether	µg/kg dw	7.3 U	7.3 U	7.4 U	7.4 U	7.5 U	7.5 U	7.4 U	7.3 U	7.4 U	7.3 U	7.3 U	7.3 U	7.3 U					7.3 U	7.4 U	7.3 U	7.3 U
Carbazole	µg/kg dw	6.5 U	6.4 U	6.6 U	6.6 U	35	31	43	14 JQ	6.5 U	6.4 U	6.4 U	6.5 U	6.5 U					6.5 U	6.5 U	6.4 U	6.5 U
Hexachloroethane	µg/kg dw	7.1 U	7 U	7.1 U	7.1 U	7.2 U	7.2 U	7.1 U	7 U	7.1 U	7 U	7 U	7 U	7 U					7 U	7.1 U	7 U	7 U
Hexachlorocyclopentadiene	µg/kg dw	43 U	43 U	44 U	44 U	44 U	44 U	44 U	43 U	43 U	43 U	43 U	43 U	43 U					43 UJ	43 U	43 U	43 U
Isophorone	µg/kg dw	8.1 U	8 U	8.2 U	8.2 U	8.2 U	8.3 U	8.2 U	8 U	8.2 U	8 U	8 U	8.1 U	8.1 U					8.1 U	8.2 U	8 U	8.1 U
Nitrobenzene	µg/kg dw	8.6 U	8.5 U	8.7 U	8.7 U	8.8 U	8.8 U	8.7 U	8.5 U	8.7 U	8.5 U	8.5 U	8.6 U	8.6 U					8.6 U	8.7 U	8.5 U	8.6 U
N-nitroso-di-n-propylamine	µg/kg dw	35 U	35 U	36 U	36 U	36 U	36 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U					35 U	35 U	35 U	35 U
Retene	µg/kg dw	140	20	8.9 U	87	130	130	150	21	8.8 U	8.7 U	8.7 U	8.7 U	8.7 U					8.8 U	8.8 U	8.7 U	8.7 U
Total Petroleum Hydrocarbons																						
#2 Diesel	mg/kg dw	55 J	14 JQ	8.9 U	27 U	52	34 JQ	110	19 JQ	6.5 U	14 U	8.7 U	6.2 U	6.2 U	7.3 U	7.8 U	8.6 U					
Motor Oil	mg/kg dw	170 J	64	6.3 U	59 JQ	100	140	240	52 JQ	6.4 U	24 JQ	11 JQ	6.1 U	6.2 U	7.3 U	7.8 U	8.5 U					

Notes:

Source: Exponent, Inc. 2008. *Environmental Baseline Investigation, DNR Lease 22-077766: Nippon Paper Industries USA Co., Ltd., Port Angeles, Washington.* Prepared for Nippon Paper Industries USA Co., Ltd. October.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EI06A	PA_EI07A	PA_FP01A	PA_FP02A	PA_FP03A	PA_FT01A	PA_FT02A	PA_FT04A	PA_FT05A	PA_FT06A	PA_FT07A	PA_FT08A	PA_FT09A	PA_FT10A	PA_FT11A	PA_FT12A	PA_FT13A	PA_IE03A	PA_IE04A	PA_IE05A	PA_IE06A	PA_IE07A	PA_IE08A	PA_IE09A
Sample ID		EI06A	EI07A	FP01A	FP02A	FP03A	FT01A	FT02A	FT04A	FT05A	FT06A	FT07A	FT08A	FT09A	FT10A	FT11A	FT12A	FT13A	IE03A	IE04A	IE05A	IE06A	IE07A	IE08A	IE09A
Sample Date		6/18/2008	6/18/2008	6/7/2008	6/7/2008	6/8/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/11/2008	6/7/2008	6/8/2008	6/7/2008	6/8/2008	6/16/2008	6/13/2008	6/16/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH046	No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH043	WPAH039	No	WPAH028	WPAH027	No	WPAH026
Analyte	**Units**																								
Conventionals																									
Sulfides	mg/kg dw	1.5	380	33			860		82		280					150	69		990	1,100	1,300	2,300	1,400	1,700	1,500
Total Organic Carbon	%	0.162	0.628	1.03	1.45	1.9	2.44	2.61	1.12	1.85	1.47	1.26	1.43	1.48	1.38	2.4	0.708	0.879	6.48	4.81	5.93	33.2	15.4	8.76	3.33
Total Solids	%	71.5	74.6	68	74.8	51.9	49.9	47.7	60	53.7	60.3	65.3	61.2	64.2	63.6	62.3	69.2	67.6	31.3	31.9	25.9	22.8	36	29	24.4
Nutrients																									
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	4.5	14	7.3			8.3		12		22					14			18	25	21	31	22	20	14
Particle/Grain Size																									
Percent Fines (clay & silt)	%	4	16	10	7.8	69	69	67	50	64	52	40	55	43	41	45	27	27	66	68	65	43	18	71	67
Phi Class 10.00+	%	1.1	2.6	2.9	1.7	12	7.1	6.9	3.7	9.6	8.6	6.7	9.4	4.5	6.4	7.8	5.3	5.2	13	14	15	14	5.7	13	15
Phi Class 9.00+ to 10.00	%	0.1 U	0.6	1	0.5	4	2.6	1.9	0.9	4	3.2	2.3	3.2	1.5	2.6	2.9	1.8	1.6	4.7	4.8	4.3	2	0.7	4.6	5
Phi Class 8.00+ to 9.00	%	0.1	1	0.9	0.5	4.3	3	3	1.1	4.7	3.9	2.9	3.9	2.1	3	3.4	1.6	1.8	5.2	5.5	4.7	3.3	0.8	5	4.9
Phi Class 7.00+ to 8.00	%	0.2	1.2	1	0.6	6.1	4.6	5	1.6	6	5	3.5	4.4	2.3	3.8	3.9	2.3	2.2	8.6	8.5	7.4	4.5	1.1	8.2	8.6
Phi Class 6.00+ to 7.00	%	0.1	2.2	1.1	0.7	9.1	7.9	9.7	2.2	11	7.4	4.8	7.3	5.1	6.3	7	3.2	3	11	11	11	8	2.3	15	12
Phi Class 5.00+ to 6.00	%	0.2	3	1.4	0.8	11	18	20	8.2	15	11	7.7	11	12	7.4	8.8	3.7	4.6	14	14	12	8.2	6.8	18	14
Phi Class 4.00+ to 5.00	%	2.4	5.4	2	3	23	26	20	32	14	13	12	16	15	12	11	8.7	8.6	8.4	10	9.6	2.9	0.5	7.1	6.5
Phi Class 3.00+ to 4.00	%	60	17	28	10	20	18	14	37	15	23	35	31	14	16	24	44	39	5.3	6.1	6.3	5.5	2.9	4.6	4.6
Phi Class 2.00+ to 3.00	%	33	44	57	27	4	6.4	8.2	9.1	10	18	23	12	13	22	23	27	31	3.8	4.5	7.3	7.7	15	4.1	5.2
Phi Class 1.00+ to 2.00	%	2.9	14	3	23	4.5	2.7	5.6	2.6	7.3	5.1	1	1.1	21	18	6.9	1.6	1.1	5.2	4.7	7.4	8.6	19	5.7	8
Phi Class 0.00+ to 1.00	%	0.3	4.1	0.8	18	1.9	1.8	2.6	1.2	2.9	1.4	0.5	0.7	7.6	2.3	1.2	0.5	0.5	5.1	4.3	5.7	9.6	15	5	5.7
Phi Class -1.00+ to 0.00	%	0.1 U	1.7	0.3	6.9	0.1	1.2	2.2	0.5	0.9	0.4	0.2	0.3	1.3	0.6	0.5	0.2	0.2	5.2	4.1	5.4	13	9.8	6.6	9.1
Phi Class < -1.00	%	0.1 U	2.9	0.3	6.8	0.1	0.6	0.4	0.1	0.1	0.1	0.7	0.1	0.1 U	0.1 U	0.1 U	0.3	0.4	9.9	8.3	3.4	13	21	2.8	1
Biochemical Measures																									
12-Chlorodehydroabietic acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
14-Chlorodehydroabietic acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
1-Phenanthrenecarboxylic acid	µg/kg dw							99 U	1,300	180	110			420	96 U	97 U		110	5,100	1,300	2,200	5,400	1,100	1,100	1,000
3,4,5-Trichloroguaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
3,4,6-Trichloroguaiacol (Ac)	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
3,4-Dichloroguaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
4,5,6-Trichloroguaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
4,5-Dichloroguaiacol	µg/kg dw							20 U	20 U	20 UJ	20 UJ			20 UJ	19 UJ	19 UJ		20 U	20 UJ	20 UJ	20 UJ	20 UJ	20 U	20 U	20 U
4,6-Dichloroguaiacol	µg/kg dw							20 U	20 U	20 UJ	20 UJ			20 UJ	19 UJ	19 U		20 U	20 UJ	20 UJ	20 UJ	20 UJ	20 U	20 U	20 U
4-Chloroguaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
9,10-Dichlorostearic Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
Abietic Acid	µg/kg dw							150	930	300	160			730	96 U	97 U		84 JQ	6,400	1,300	4,400	13,000	1,700	1,800	1,100
Dichlorodehydroabietic Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
Guaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Isopimaric Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	100	500 U	910	290 U	300 U	300 U
Linolenic Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
Neoabietic Acid	µg/kg dw								490 U									100 U							
Oleic Acid	µg/kg dw							160	970 J	220	400			180	96 U	120		74 JQ	500 U	200	500 U	490 U	350 J	300 U	300 U
Palustric Acid	µg/kg dw								490 U									100 U							
Pimaric Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	490 U	290 U	300 U	300 U
Sandaracopimaric Acid	µg/kg dw							99 U	490 U	98 U	99 U			99 U	96 U	97 U		100 U	500 U	98 U	500 U	570	290 U	300 U	300 U
Tetrachloroguaiacol	µg/kg dw							20 U	20 U	20 U	20 U			20 U	19 U	19 U		20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Metals																									
Antimony	mg/kg dw	0.0017 U	0.3	0.18 U	0.0025 U	0.35 U	0.55	0.46	0.34 U	0.0041 U	0.0039 U				0.22 JQ	0.22 JQ		0.17 JQ	0.75 U	0.0068 U	0.84 U	0.75 U	0.28 JQ		0.6 JQ
Arsenic	mg/kg dw	1.8	4.2	3	3.6	6.1	8.8	8.6	7.2	6.1	5.2				4.9	5.8		4.8	9.8	9.6	12	13	13		12
Barium	mg/kg dw	12	16	8.7	8.5	33	30	30	26	25	24				21	25		16	37	41	31	27	24		33
Cadmium	mg/kg dw	0.0004 U	0.024 JQ	0.12 JQ	0.13 JQ	0.32	0.98	0.66	0.47	0.43	0.32 JQ				0.29 JQ	0.33		0.21 JQ	0.91	0.97	1.8	2.2	2		5
Chromium	mg/kg dw	24	31	21	21	30	35	33	26	28	28				24	30 J		24	36	41	36	31	25		33
Copper	mg/kg dw	13	19	14	15	26	42	35	24	26	22				18	22		15	36	40	45	44	28		60
Lead	mg/kg dw	2	3.8	4.3	4.4	10	35	20	13	12	9.1				8.8	10		6.3	13	15	24	20	12		42
Mercury	mg/kg dw	0.016 JQ	0.024	0.032	0.021 JQ	0.1	0.24	0.11	0.077		0.092					0.076	0.03	0.041	0.075	0.13	0.13	0.19	0.33	0.17	1.2

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EI06A	PA_EI07A	PA_FP01A	PA_FP02A	PA_FP03A	PA_FT01A	PA_FT02A	PA_FT04A	PA_FT05A	PA_FT06A	PA_FT07A	PA_FT08A	PA_FT09A	PA_FT10A	PA_FT11A	PA_FT12A	PA_FT13A	PA_IE03A	PA_IE04A	PA_IE05A	PA_IE06A	PA_IE07A	PA_IE08A	PA_IE09A
Sample ID		EI06A	EI07A	FP01A	FP02A	FP03A	FT01A	FT02A	FT04A	FT05A	FT06A	FT07A	FT08A	FT09A	FT10A	FT11A	FT12A	FT13A	IE03A	IE04A	IE05A	IE06A	IE07A	IE08A	IE09A
Sample Date		6/18/2008	6/18/2008	6/7/2008	6/7/2008	6/8/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/11/2008	6/7/2008	6/8/2008	6/7/2008	6/8/2008	6/16/2008	6/13/2008	6/16/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH046	No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH043	WPAH039	No	WPAH028	WPAH027	No	WPAH026
Analyte	**Units**																								
Metals (cont.)																									
Nickel	mg/kg dw	23	29	18	18	25	30	30	25	23	23				22	26		22	29	32	26	22	21		26
Silver	mg/kg dw	0.037 JQ	0.05 JQ	0.13 JQ	0.04 JQ	0.1 JQ	0.24 JQ	0.18 JQ	0.22 JQ	0.12 JQ	0.1 JQ				0.09 JQ	0.11 JQ		0.063 JQ	0.16 JQ	0.18 JQ	0.16 JQ	0.14 JQ	0.098 JQ		0.18 JQ
Zinc	mg/kg dw	31	44	45	46	66	93	79	69	63	60				48	65		56	80	83	90	100	90		860
Butyltins																									
Butyltin	µg/kg dw																								
Dibutyltin	µg/kg dw																								
Tributyltin	µg/kg dw																								
Pesticides																									
4,4'-DDD	µg/kg dw	0.33 U	1 JQ	0.36 U	0.36 U	0.47 U	4.7 J	3.5 J	6 J	0.47 UJ	0.45 UJ				0.43 UJ	0.41 UJ		0.37 U							
4,4'-DDE	µg/kg dw	0.28 U	0.28 U	0.31 U	0.3 U	0.4 U	2.5 J	1.2 JQ	2.2 JQ	0.4 UJ	0.39 UJ				0.37 UJ	0.35 UJ		0.32 JQ							
4,4'-DDT	µg/kg dw	0.33 U	0.33 U	0.35 U	0.35 U	0.47 U	4.4 J	0.49 UJ	0.37 U	0.47 UJ	0.45 UJ				0.42 UJ	0.41 UJ		0.37 U							
Aldrin	µg/kg dw	0.13 U	0.13 U	0.14 U	0.14 U	0.19 U	1.4 UJ	1.9 J	0.15 U	0.19 UJ	0.18 UJ				0.17 UJ	0.17 UJ		0.64 JQ							
alpha-Endosulfan	µg/kg dw	0.15 U	0.15 U	0.16 U	0.16 U	0.21 U	0.21 UJ	0.22 UJ	0.17 U	0.21 UJ	0.2 UJ				0.19 UJ	0.18 UJ		0.16 U							
alpha-Hexachlorocyclohexane	µg/kg dw	0.13 U	0.13 U	0.54 JQ	0.15 U	0.29 JQ	0.93 J	0.92 J	0.15 U	0.19 UJ	0.18 UJ				0.17 UJ	0.17 UJ		0.66 JQ							
beta-Endosulfan	µg/kg dw	0.33 U	0.33 U	0.35 U	0.35 U	0.47 U	0.47 UJ	0.49 UJ	1 JQ	0.58 UJ	0.45 UJ				0.48 UJ	0.57 UJ		0.37 U							
beta-Hexachlorocyclohexane	µg/kg dw	0.34 U	1.1 U	40	0.17 U	0.23 U	0.23 UJ	2.7 J	0.86 U	0.23 UJ	0.22 UJ				0.21 UJ	0.2 UJ		1.5 J							
Cis-chlordane	µg/kg dw	0.15 U	0.15 U	0.22 JQ	0.16 U	0.21 U	0.21 UJ	0.22 UJ	0.17 U	0.21 UJ	0.2 UJ				0.19 UJ	0.18 UJ		1.4 JQ							
delta-Hexachlorocyclohexane	µg/kg dw	0.15 U	7.3 U	0.16 U	0.16 U	0.21 U	0.21 UJ	0.22 UJ	0.17 U	0.21 UJ	0.2 UJ				0.19 UJ	0.18 UJ		0.35 JQ							
Dieldrin	µg/kg dw	0.28 U	0.27 U	0.3 U	0.3 U	0.39 U	0.39 UJ	0.41 UJ	0.32 U	0.39 UJ	0.38 UJ				0.36 UJ	0.34 UJ		0.31 U							
Endosulfan Sulfate	µg/kg dw	0.42 U	0.42 U	0.46 U	0.46 U	0.6 U	0.6 UJ	0.64 UJ	1.4 JQ	0.6 UJ	0.58 UJ				0.55 UJ	0.53 UJ		0.47 U							
Endrin	µg/kg dw	0.52 U	0.52 U	0.57 U	0.56 U	0.75 U	0.75 UJ	0.79 UJ	0.6 U	0.75 UJ	0.72 UJ				0.68 UJ	0.65 UJ		0.59 U							
Endrin Aldehyde	µg/kg dw	0.73 JQ	0.31 U	0.38 JQ	0.34 U	0.45 U	0.45 UJ	0.47 UJ	0.36 U	0.44 UJ	0.43 UJ				0.41 UJ	0.39 UJ		0.35 U							
Endrin Ketone	µg/kg dw	0.31 U	0.39 JQ	0.34 U	0.34 U	0.45 U	0.45 UJ	0.47 UJ	0.36 U	0.44 UJ	0.43 UJ				0.41 UJ	0.39 UJ		0.35 U							
gamma-Chlordane	µg/kg dw	0.15 U	0.15 U	0.16 U	0.16 U	0.21 U	1.4 J	0.87 JQ	2.3 J	0.21 UJ	0.2 UJ				0.19 UJ	0.18 UJ		0.79 JQ							
gamma-Hexachlorocyclohexane	µg/kg dw	0.14 U	0.62 JQ	0.22 JQ	0.16 U	0.21 U	0.58 J	1.5 J	0.82 JQ	0.21 UJ	0.2 UJ				0.19 UJ	0.18 UJ		1.1 JQ							
Heptachlor	µg/kg dw	0.17 U	0.17 U	0.18 U	0.18 U	0.24 U	0.24 UJ	0.52 J	0.19 U	0.24 UJ	0.23 UJ				0.22 UJ	0.21 UJ		0.19 U							
Heptachlor Epoxide	µg/kg dw	0.26 JQ	0.16 U	0.31 JQ	0.17 U	0.22 U	0.79 J	0.24 UJ	0.75 JQ	0.22 UJ	0.21 UJ				0.2 UJ	0.2 UJ		0.6 JQ							
Methoxychlor	µg/kg dw	1.7 U	1.6 U	1.8 U	1.8 U	2.4 U	2.4 UJ	2.5 UJ	1.9 U	2.4 UJ	2.3 UJ				2.1 UJ	2.1 UJ		1.9 U							
Toxaphene	µg/kg dw	12 U	12 U	13 U	13 U	18 U	18 UJ	19 UJ	14 U	18 UJ	17 UJ				16 UJ	15 UJ		14 U							
Dioxins/Furans																									
2,3,7,8-TCDD	ng/kg dw		0.091 J				0.978		0.343		0.478 J				0.657		0.208	0.28 J	0.469 J	0.484 J	0.851 J	0.692 J	0.743		2.61
1,2,3,7,8-PeCDD	ng/kg dw		0.158 JQ				3.27		0.867		1.6 J				2.23 J		0.496 JQ	0.644 J	1.54 J	1.52 J	2.69 J	2.72 J	2.39		5.19
1,2,3,4,7,8-HxCDD	ng/kg dw		0.129 JQ				3.11		0.848		1.68 J				2.18 J		0.448 JQ	0.548 J	1.23 J	1.21 J	2.56 J	3.03 J	2.68		6.18
1,2,3,6,7,8-HxCDD	ng/kg dw		0.428 JQ				14.4		3.17		7.1 J				7.98 J		1.7	2.15 J	5.56 J	6.08 J	12.4 J	13.7 J	10.1		103
1,2,3,7,8,9-HxCDD	ng/kg dw		0.348 JQ				9.26		2.42		4.84 J				5.96 J		1.2	1.57 J	4.07 J	4.17 J	8.28 J	7.74 J	6.16		23.8
1,2,3,4,6,7,8-HpCDD	ng/kg dw		3.96				248		66.8		68.1 J				63.7 J		14.6	19.4 J	55.2 J	53.5 J	158 J	140 J	118		2,360
Total OCDD	ng/kg dw		26.1				2,260		589		536 J				408 J		95.5	122 J	436 J	404 J	1,480 J	1,110 J	950		17,300
2,3,7,8-TCDF	ng/kg dw		0.177				3.95		0.956		1.84				2.69		0.694	0.73 J	1.91	1.9	3.61	3.48	2.85		5.03
1,2,3,7,8-PeCDF	ng/kg dw		0.075 JQ				1.86		0.45 JQ		0.795 J				1.25 J		0.291 JQ	0.317 J	0.692 J	0.643 J	1.54 J	1.37 J	1.23		3.55
2,3,4,7,8-PeCDF	ng/kg dw		0.121 JQ				2.75		0.691		1.16 J				1.59 J		0.428 JQ	0.472 J	0.904 J	0.815 J	2.17 J	2.02 J	1.69		4.52
1,2,3,4,7,8-HxCDF	ng/kg dw		0.098 U				3.37		0.661		1.29 J				1.48 J		0.438 JQ	0.475 J	1.02 J	1.05 J	2.55 J	2.77 J	2.61		18.7
1,2,3,6,7,8-HxCDF	ng/kg dw		0.067 JQ				2.16		0.508 JQ		0.863 J				1.1 J		0.28 JQ	0.303 J	0.697 J	0.625 J	1.75 J	1.82 J	1.64		8.85
1,2,3,7,8,9-HxCDF	ng/kg dw		0.0248 U				0.209 JQ		0.041 J		0.085 J				0.103 J		0.029 JQ	0.037 J	0.057 J	0.072 J	0.153 J	0.158 J	0.152 JQ		1.05 J
2,3,4,6,7,8-HxCDF	ng/kg dw		0.067 JQ				2.06		0.468 JQ		0.858 J				1.07 J		0.274 JQ	0.312 J	0.639 J	0.62 J	1.96 J	1.98 J	1.67		8.7
1,2,3,4,6,7,8-HpCDF	ng/kg dw		0.789				35.5		7.26		15.1 J				15.3 J		3.71	4.84 J	11 J	11.4 J	31.3 J	33.1 J	36.5		651
1,2,3,4,7,8,9-HpCDF	ng/kg dw		0.059 JQ				2.1		0.44 JQ		0.893 J				0.877 J		0.207 JQ	0.292 J	0.597 J	0.598 J	1.48 J	1.57 J	1.54		19
Total OCDF	ng/kg dw		2.05				111		21		43.5 J				36.4 J		7.21	9.12 J	32.7 J	27.3 J	79.1 J	77.1 J	74		2,190
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw		0.466 J				12.5 J		3.27 J		5.32 J				6.59 J		1.56 J	1.97 J	4.63 J	4.62 J	9.94 J	9.63 J	8.33 J		62.9 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw		0.472 J				12.5 J		3.27 J		5.32 J				6.59 J		1.56 J	1.97 J	4.63 J	4.62 J	9.94 J	9.63 J	8.33 J		62.9 J

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_EI06A	PA_EI07A	PA_FP01A	PA_FP02A	PA_FP03A	PA_FT01A	PA_FT02A	PA_FT04A	PA_FT05A	PA_FT06A	PA_FT07A	PA_FT08A	PA_FT09A	PA_FT10A	PA_FT11A	PA_FT12A	PA_FT13A	PA_IE03A	PA_IE04A	PA_IE05A	PA_IE06A	PA_IE07A	PA_IE08A	PA_IE09A
Sample ID		EI06A	EI07A	FP01A	FP02A	FP03A	FT01A	FT02A	FT04A	FT05A	FT06A	FT07A	FT08A	FT09A	FT10A	FT11A	FT12A	FT13A	IE03A	IE04A	IE05A	IE06A	IE07A	IE08A	IE09A
Sample Date		6/18/2008	6/18/2008	6/7/2008	6/7/2008	6/8/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/11/2008	6/7/2008	6/8/2008	6/7/2008	6/8/2008	6/16/2008	6/13/2008	6/16/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH046	No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH043	WPAH039	No	WPAH028	WPAH027	No	WPAH026
Analyte	**Units**																								
Polychlorinated Biphenyls (PCBs)																									
Aroclor 1016	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	10 U	11 UJ	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1221	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	10 U	11 U	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1232	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	10 U	11 U	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1242	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	10 U	11 U	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1248	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	10 U	11 U	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1254	µg/kg dw	1.7 U	1.8 U	1.9 U	2.1 U	2.7 UJ	48	2.8 U	2.1 U		2.6 UJ				2.3 UJ	2.3 UJ		1.9 U	4.9 UJ	4.3 UJ	5.6 UJ	5.7 UJ	4.4 UJ		5.7 UJ
Aroclor 1260	µg/kg dw	1.7 U	1.8 U	1.9 U	2.1 U	2.7 UJ	2.7 U	2.8 U	2.1 U		2.6 UJ				2.3 UJ	2.3 UJ		1.9 U	4.9 UJ	4.3 UJ	5.6 UJ	5.7 UJ	4.4 UJ		5.7 UJ
Total PCBs, Aroclors	µg/kg dw	6.7 U	7 U	7.4 U	8 U	10 UJ	48	11 U	8 U		10 UJ				9 UJ	9 UJ		7.4 U	19 UJ	17 UJ	22 UJ	22 UJ	17 UJ		22 UJ
Aroclor 1016	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 UJ	0.41 U	0.42 UJ	0.71 U		0.68 UJ				0.65 UJ	0.38 UJ		0.84 U							0.66 UJ
Aroclor 1221	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 UJ	0.41 U	0.42 U	0.71 U		0.68 UJ				0.65 UJ	0.38 UJ		0.84 U							0.66 UJ
Aroclor 1232	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 UJ	0.41 U	0.42 U	0.71 U		0.68 UJ				0.65 UJ	0.38 UJ		0.84 U							0.66 UJ
Aroclor 1242	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 UJ	0.41 U	0.42 U	0.71 U		0.68 UJ				0.65 UJ	0.38 UJ		0.84 U							0.66 UJ
Aroclor 1248	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 UJ	0.41 U	0.42 U	0.71 U		0.68 UJ				0.65 UJ	0.38 UJ		0.84 U							0.66 UJ
Aroclor 1254	mg/kg OC	1 U	0.29 U	0.18 U	0.14 U	0.14 UJ	2	0.11 U	0.19 U		0.18 UJ				0.17 UJ	0.096 UJ		0.22 U							0.17 UJ
Aroclor 1260	mg/kg OC	1 U	0.29 U	0.18 U	0.14 U	0.14 UJ	0.11 U	0.11 U	0.19 U		0.18 UJ				0.17 UJ	0.096 UJ		0.22 U							0.17 UJ
Total PCBs, Aroclors	mg/kg OC	4.1 U	1.1 U	0.72 U	0.55 U	0.53 U	2	0.42 U	0.71 U		0.68 U				0.65 U	0.38 U		0.84 U							0.66 U
Other																									
Total TEQ	ng/kg dw		0.682				12.8		3.48		5.53				6.8		1.77	2.18	4.84	4.83	10.2	9.84	8.54		63.2
Aromatic Hydrocarbons																									
Total LPAH	µg/kg dw	8.9 U	8.8 U				540	970	410 J	400	140				83	97		20	8.9 U	8.8 U	40	26	340 J		250 J
Naphthalene	µg/kg dw	8.6 U	8.5 U				47	42	23	78	43				29	41		8.7 U	8.6 U	8.6 U	8.6 U	8.6 U	8.5 U		10 JQ
Acenaphthylene	µg/kg dw	8.6 U	8.5 U				52	87	8.5 U	29	8.5 U				8.4 U	8.4 U		8.6 U	8.6 U	8.5 U	8.6 U	8.6 U	10 JQ		20
Acenaphthene	µg/kg dw	8.2 U	8.1 U				20	29	16 JQ	21	8.1 U				7.9 U	7.9 U		8.2 U	8.2 U	8.1 U	8.2 U	8.1 U	8.1 U		8.2 U
Fluorene	µg/kg dw	8.9 U	8.8 U				33	57	22	29	8.8 U				8.7 U	8.6 U		8.9 U	8.9 U	8.8 U	8.9 U	8.9 U	14 JQ		20
Phenanthrene	µg/kg dw	8.4 U	8.3 U				240	510	290	180	76				54	56		20	8.3 U	8.3 U	40	26	200		120
Anthracene	µg/kg dw	7.7 U	7.6 U				150	240	63	65	22				7.5 U	7.5 U		7.7 U	7.7 U	7.6 U	7.7 U	7.7 U	120		81
2-Methylnaphthalene	µg/kg dw	8.2 U	8.1 U				18 JQ	18 JQ	8 U	22	8 U				7.9 U	7.9 U		8.2 U	8.1 U	8.1 U	8.1 U	8.1 U	8.1 U		11 JQ
Total HPAH	µg/kg dw	9.5 U	9.4 U				4,000 J	8,000	3,000	1,600 J	610 J				350 J	310 J		110 J	80 J	9.4 U	400 J	410 J	1,100 J		1,900 J
Fluoranthene	µg/kg dw	7.9 U	7.8 U				790	2,500	690	380	170				100	92		29	32	7.8 U	120	120	290		440
Pyrene	µg/kg dw	7.7 U	7.6 U				660	1,400	490	320	130				79	72		25	25	7.6 U	88	88	180		420
Benzo(a)anthracene	µg/kg dw	5.9 U	5.8 U				310	610	250	120	47				28	26		10 JQ	5.9 U	5.8 U	23	32	60		170
Chrysene	µg/kg dw	6.6 U	6.5 U				620	1,100	370	220	75				44	41		20	23	6.5 U	73	70	180		330
Total Benzofluoranthenes	µg/kg dw	9.5 U	9.4 U				1,100	1,700	640	340	120				74	60		13	9.5 U	9.4 U	72	77	210		320
Benzo(b)fluoranthene	µg/kg dw	9.5 U	9.4 U				690	960	400	200	81				42	26		13 JQ	9.5 U	9.4 U	41	47	100		170
Benzo(k)fluoranthene	µg/kg dw	9.2 U	9.1 U				390	730	240	140	40				32	34		9.2 U	9.2 U	9.1 U	31	30	110		150
Benzo(a)pyrene	µg/kg dw	8.1 U	8 U				400	530	290	120	45				26	21		10 JQ	8.1 U	8 U	23	21	80		140
Benzo(g,h,i)perylene	µg/kg dw	6.7 U	6.6 U				75	78	96	39 J	20 J				6.5 UJ	6.5 UJ		6.7 U	6.7 UJ	6.7 UJ	6.7 UJ	6.7 UJ	39		50
Indeno(1,2,3-cd)pyrene	µg/kg dw	8.6 U	8.5 U				80	94	100	39 J	8.4 UJ				8.3 UJ	8.3 UJ		8.6 U	8.5 UJ	8.5 UJ	8.5 UJ	8.5 UJ	38		52
Dibenzo(a,h)anthracene	µg/kg dw	8.5 U	8.4 U				19 JQ	25	24	8.5 UJ	8.4 UJ				8.3 UJ	8.3 UJ		8.5 U	8.5 UJ	8.4 UJ	8.5 UJ	8.5 UJ	10 JQ		13 JQ
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw						560 J	780	400	170 J	63 J				37 J	30 J		13 J	0.23 J		33 J	33 J	110 J		200 J
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	6.2 U	6.1 U				560 J	780	400	170 J	63 J				37 J	31 J		14 J	6.4 J	6.1 U	34 J	33 J	110 J		200 J
Total LPAH	mg/kg OC	5.5 U	1.4 U				22	37	37 J	22	9.6				6	4		2.3							7.5 J
Naphthalene	mg/kg OC	5.3 U	1.4 U				1.9	1.6	2.1	4.2	2.9				2.1	1.7		0.99 U							0.3 JQ
Acenaphthylene	mg/kg OC	5.3 U	1.4 U				2.1	3.3	0.76 U	1.6	0.58 U				0.61 U	0.35 U		0.98 U							0.6
Acenaphthene	mg/kg OC	5.1 U	1.3 U				0.82	1.1	1.4 JQ	1.1	0.55 U				0.57 U	0.33 U		0.93 U							0.25 U
Fluorene	mg/kg OC	5.5 U	1.4 U				1.4	2.2	2	1.6	0.6 U				0.63 U	0.36 U		1 U							0.6
Phenanthrene	mg/kg OC	5.2 U	1.3 U				9.8	20	26	9.7	5.2				3.9	2.3		2.3							3.6
Anthracene	mg/kg OC	4.8 U	1.2 U				6.1	9.2	5.6	3.5	1.5				0.54 U	0.31 U		0.88 U							2.4
2-Methylnaphthalene	mg/kg OC	5.1 U	1.3 U				0.74 JQ	0.69 JQ	0.71 U	1.2	0.54 U				0.57 U	0.33 U		0.93 U							0.33 JQ
Total HPAH	mg/kg OC	5.9 U	1.5 U				170 J	310	260	85 J	41 J				25 J	13 J		12 J							58 J
Fluoranthene	mg/kg OC	4.9 U	1.2 U				32	96	62	21	12				7.2	3.8		3.3							13
Pyrene	mg/kg OC	4.8 U	1.2 U				27	54	44	17	8.8				5.7	3		2.8							13
Benzo(a)anthracene	mg/kg OC	3.6 U	0.92 U				13	23	22	6.5	3.2				2	1.1		1.1 JQ							5.1

Table C.6
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Station ID		PA_EI06A	PA_EI07A	PA_FP01A	PA_FP02A	PA_FP03A	PA_FT01A	PA_FT02A	PA_FT04A	PA_FT05A	PA_FT06A	PA_FT07A	PA_FT08A	PA_FT09A	PA_FT10A	PA_FT11A	PA_FT12A	PA_FT13A	PA_IE03A	PA_IE04A	PA_IE05A	PA_IE06A	PA_IE07A	PA_IE08A	PA_IE09A
Sample ID		EI06A	EI07A	FP01A	FP02A	FP03A	FT01A	FT02A	FT04A	FT05A	FT06A	FT07A	FT08A	FT09A	FT10A	FT11A	FT12A	FT13A	IE03A	IE04A	IE05A	IE06A	IE07A	IE08A	IE09A
Sample Date		6/18/2008	6/18/2008	6/7/2008	6/7/2008	6/8/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/11/2008	6/7/2008	6/8/2008	6/7/2008	6/8/2008	6/16/2008	6/13/2008	6/16/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH046	No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH043	WPAH039	No	WPAH028	WPAH027	No	WPAH026
Analyte	**Units**																								
Aromatic Hydrocarbons (cont.)																									
Chrysene	mg/kg OC	4.1 U	1 U				25	42	33	12	5.1				3.2	1.7		2.3							9.9
Total Benzofluoranthenes	mg/kg OC	5.9 U	1.5 U				44	65	57	18	8.2				5.4	2.5		1.5							9.6
Benzo(b)fluoranthene	mg/kg OC	5.9 U	1.5 U				28	37	36	11	5.5				3	1.1		1.5 JQ							5.1
Benzo(k)fluoranthene	mg/kg OC	5.7 U	1.4 U				16	28	21	7.6	2.7				2.3	1.4		1 U							4.5
Benzo(a)pyrene	mg/kg OC	5 U	1.3 U				16	20	26	6.5	3.1				1.9	0.88		1.1 JQ							4.2
Benzo(g,h,i)perylene	mg/kg OC	4.1 U	1.1 U				3.1	3	8.6	2.1 J	1.4 J				0.47 UJ	0.27 UJ		0.76 U							1.5
Indeno(1,2,3-cd)pyrene	mg/kg OC	5.3 U	1.4 U				3.3	3.6	8.9	2.1 J	0.57 UJ				0.6 UJ	0.35 UJ		0.98 U							1.6
Dibenzo(a,h)anthracene	mg/kg OC	5.2 U	1.3 U				0.78 JQ	0.96	2.1	0.46 UJ	0.57 UJ				0.6 UJ	0.35 UJ		0.97 U							0.39 JQ
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC						23 J	30	35	9.3 J	4.3 J				2.7 J	1.3 J		1.4 J							6 J
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC	3.8 U	0.97 U				23 J	30	35	9.3 J	4.3 J				2.7 J	1.3 J		1.6 J							6 J
Chlorinated Benzenes																									
1,2-Dichlorobenzene	µg/kg dw	7.9 U	7.7 U				7.8 U	7.8 U	7.7 U	7.8 U	7.7 U				7.6 U	7.6 U		7.9 U	7.8 U	7.8 U	7.8 U	7.8 U	7.7 U		7.9 U
1,3-Dichlorobenzene	µg/kg dw	7.4 U	7.3 U				7.3 U	7.4 U	7.3 U	7.4 U	7.3 U				7.2 U	7.2 U		7.4 U	7.4 U	7.3 U	7.4 U	7.4 U	7.3 U		7.4 U
1,4-Dichlorobenzene	µg/kg dw	7.3 U	7.2 U				7.3 U	7.3 U	7.2 U	7.3 U	7.2 U				7.1 U	7.1 U		7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.2 U		7.4 U
1,2,4-Trichlorobenzene	µg/kg dw	9 U	8.9 U				9 U	9 U	8.9 U	9 U	8.9 U				8.8 U	8.8 U		9.1 U	9 U	8.9 U	9 U	9 U	8.9 U		9.1 U
Hexachlorobenzene	µg/kg dw	8 U	7.9 U				7.9 U	8 U	7.8 U	7.9 U	7.9 U				7.7 U	7.7 U		8 U	8 U	7.9 U	8 U	7.9 U	7.9 U		8 U
1,2-Dichlorobenzene	mg/kg OC	4.9 U	1.2 U				0.32 U	0.3 U	0.69 U	0.42 U	0.52 U				0.55 U	0.32 U		0.9 U							0.24 U
1,4-Dichlorobenzene	mg/kg OC	4.5 U	1.1 U				0.3 U	0.28 U	0.64 U	0.39 U	0.49 U				0.51 U	0.3 U		0.83 U							0.22 U
1,2,4-Trichlorobenzene	mg/kg OC	5.6 U	1.4 U				0.37 U	0.34 U	0.79 U	0.49 U	0.61 U				0.64 U	0.37 U		1 U							0.27 U
Hexachlorobenzene	mg/kg OC	4.9 U	1.3 U				0.32 U	0.31 U	0.7 U	0.43 U	0.54 U				0.56 U	0.32 U		0.91 U							0.24 U
Phthalate Esters																									
Dimethyl Phthalate	µg/kg dw	7.7 U	7.6 U				7.7 U	7.7 U	7.6 U	7.7 U	7.6 U				7.5 U	7.5 U		7.7 U	7.7 U	7.6 U	7.7 U	7.7 U	7.6 U		7.8 U
Diethyl Phthalate	µg/kg dw	16 U	16 U				16 U	16 U	16 U	16 U	16 U				16 U	16 U		16 U	16 U	16 U	20	16 U	16 U		16 U
Di-n-butyl Phthalate	µg/kg dw	12 U	12 U				17 JQ	12 U	15 JQ	12 U	12 U				12 U	12 U		12 U	12 U	12 U	12 U	12 U	12 U		12 U
Butylbenzyl Phthalate	µg/kg dw	11 U	11 U				11 U	38	11 U	11 U	11 U				11 U	11 U		11 U	11 U	11 U	11 U	52	11 U		11 U
bis(2-ethylhexyl)phthalate	µg/kg dw	11 U	11 U				130	200	380	73	25				19	11 U		11 U	24	11 U	24	23	11 U		22
Di-n-octyl Phthalate	µg/kg dw	8.3 U	8.2 U				8.2 U	28	8.2 U	8.2 U	8.2 U				8.1 U	8 U		8.3 U	8.3 U	8.2 U	8.3 U	8.3 U	8.2 U		8.3 U
Dimethyl Phthalate	mg/kg OC	4.8 U	1.2 U				0.32 U	0.3 U	0.68 U	0.42 U	0.52 U				0.54 U	0.31 U		0.88 U							0.23 U
Diethyl Phthalate	mg/kg OC	9.9 U	2.5 U				0.66 U	0.61 U	1.4 U	0.86 U	1.1 U				1.2 U	0.67 U		1.8 U							0.48 U
Di-n-butyl Phthalate	mg/kg OC	7.4 U	1.9 U				0.7 JQ	0.46 U	1.3 JQ	0.65 U	0.82 U				0.87 U	0.5 U		1.4 U							0.36 U
Butylbenzyl Phthalate	mg/kg OC	6.8 U	1.8 U				0.45 U	1.5	0.98 U	0.59 U	0.75 U				0.8 U	0.46 U		1.3 U							0.33 U
bis(2-ethylhexyl)phthalate	mg/kg OC	6.8 U	1.8 U				5.3	7.7	34	3.9	1.7				1.4	0.46 U		1.3 U							0.66
Di-n-octyl Phthalate	mg/kg OC	5.1 U	1.3 U				0.34 U	1.1	0.73 U	0.44 U	0.56 U				0.59 U	0.33 U		0.94 U							0.25 U
Miscellaneous Nonionizable Organic Compounds																									
Dibenzofuran	µg/kg dw	7.5 U	7.4 U				25	34	15 JQ	26	7.4 U				7.3 U	7.3 U		7.5 U	7.5 U	7.4 U	7.5 U	7.5 U	10 JQ		12 JQ
Hexachlorobutadiene	µg/kg dw	8.1 U	8 U				8 U	8.1 U	7.9 U	8 U	8 U				7.8 U	7.8 U		8.1 U	8.1 U	8 U	8.1 U	8 U	8 U		8.1 U
N-nitrosodiphenylamine	µg/kg dw	8.6 U	8.5 U				8.6 U	8.6 U	8.5 U	8.6 U	8.5 U				8.4 U	8.4 U		8.7 U	8.6 U	8.6 U	8.6 U	8.6 U	8.5 U		8.7 U
Dibenzofuran	mg/kg OC	4.6 U	1.2 U				1	1.3	1.3 JQ	1.4	0.5 U				0.53 U	0.3 U		0.85 U							0.36 JQ
Hexachlorobutadiene	mg/kg OC	5 U	1.3 U				0.33 U	0.31 U	0.71 U	0.43 U	0.54 U				0.57 U	0.33 U		0.92 U							0.24 U
N-nitrosodiphenylamine	mg/kg OC	5.3 U	1.4 U				0.35 U	0.33 U	0.76 U	0.46 U	0.58 U				0.61 U	0.35 U		0.99 U							0.26 U
Ionizable Organic Compounds																									
Phenol	µg/kg dw	14 U	56				14 U	14 JQ	13 U	130	190				110	23		20 JQ	68	14 U	24	23	210		16 JQ
2-Methylphenol	µg/kg dw	14 U	14 U				14 U	14 U	14 U	14 U	14 U				14 U	14 U		14 U	14 U	14 U	14 U	14 U	14 U		14 U
4-Methylphenol	µg/kg dw	13 U	32				15 JQ	29	22	13 U	13 U				32	12 U		13 U	13 U	13 U	13 U	13 U	18 JQ		23
2,4-Dimethylphenol	µg/kg dw	15 U	15 U				15 U	15 U	14 U	15 U	14 U				14 U	14 U		15 U	15 U	15 U	15 U	15 U	15 U		15 U
Pentachlorophenol	µg/kg dw	47 U	47 U				47 U	47 U	47 U	47 U	47 U				46 U	46 U		47 U	47 U	47 U	47 U	47 U	47 U		48 U
Benzyl Alcohol	µg/kg dw	14 U	14 U				14 U	14 U	14 U	14 U	14 U				14 U	14 UJ		14 UJ	14 U	14 U	14 U	14 U	14 U		14 U
Benzoic Acid	µg/kg dw	110 U	110 U				110 U	110 U	110 U	110 UJ	110 UJ				110 UJ	110 UJ		110 U	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ		110 UJ
Other Semivolatile Organic Compounds																									
1-Methylnaphthalene	µg/kg dw	7.2 U	7.1 U				13 JQ	13 JQ	7 U	7.1 U	7.1 U				7 U	6.9 U		7.2 U	7.2 U	7.1 U	7.2 U	7.1 U	7.1 U		7.2 U
2,2'-Oxybis(1-chloropropane)	µg/kg dw	8 U	7.8 U				7.9 U	7.9 U	7.8 U	7.9 U	7.8 U				7.7 U	7.7 U		8 U	7.9 U	7.9 U	7.9 U	7.9 U	7.8 U		8 U
2,4,5-Trichlorophenol	µg/kg dw	45 U	44 U				44 U	45 U	44 U	44 U	44 U				43 U	43 U		45 U	44 U	44 U	45 U	44 U	44 U		45 U
2,4,6-Trichlorophenol	µg/kg dw	46 U	45 U				46 U	46 U	45 U	46 U	45 U				45 U	45 U		46 U	46 U	46 U	46 U	46 U	45 U		46 U

Table C.6
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Station ID		PA_EI06A	PA_EI07A	PA_FP01A	PA_FP02A	PA_FP03A	PA_FT01A	PA_FT02A	PA_FT04A	PA_FT05A	PA_FT06A	PA_FT07A	PA_FT08A	PA_FT09A	PA_FT10A	PA_FT11A	PA_FT12A	PA_FT13A	PA_IE03A	PA_IE04A	PA_IE05A	PA_IE06A	PA_IE07A	PA_IE08A	PA_IE09A
Sample ID		EI06A	EI07A	FP01A	FP02A	FP03A	FT01A	FT02A	FT04A	FT05A	FT06A	FT07A	FT08A	FT09A	FT10A	FT11A	FT12A	FT13A	IE03A	IE04A	IE05A	IE06A	IE07A	IE08A	IE09A
Sample Date		6/18/2008	6/18/2008	6/7/2008	6/7/2008	6/8/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/12/2008	6/12/2008	6/12/2008	6/11/2008	6/11/2008	6/7/2008	6/8/2008	6/7/2008	6/8/2008	6/16/2008	6/13/2008	6/16/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH046	No	No	No	No	No	No	No	No	No	No	No	No	No	No	WPAH043	WPAH039	No	WPAH028	WPAH027	No	WPAH026
Analyte	**Units**																								
Other Semivolatile Organic Compounds (cont.)																									
2,4-Dichlorophenol	µg/kg dw	41 U	40 U				40 U	41 U	40 U	40 U	40 U				39 U	39 U		41 U	41 U	40 U	41 U	40 U	40 U		41 U
2,4-Dinitrophenol	µg/kg dw	110 UJ	110 UJ				110 UJ	110 UJ	110 UJ	110 U	110 U				110 U	110 U		110 UJ	110 U	110 U	110 U	110 U	110 U		110 U
2,4-Dinitrotoluene	µg/kg dw	38 U	38 U				38 U	38 U	38 U	38 U	38 U				37 U	37 U		38 U	38 U	38 U	38 U	38 U	38 U		38 U
2,6-Dinitrotoluene	µg/kg dw	54 U	53 U				53 U	53 U	53 U	53 U	53 U				52 U	52 U		54 U	53 U	53 U	53 U	53 U	53 U		54 U
2-Chloronaphthalene	µg/kg dw	7.9 U	7.8 U				7.9 U	7.9 U	7.8 U	7.9 U	7.8 U				7.7 U	7.7 U		7.9 U	7.9 U	7.8 U	7.9 U	7.9 U	7.8 U		8 U
2-Chlorophenol	µg/kg dw	7.5 U	7.4 U				7.4 U	7.4 U	7.3 U	7.4 U	7.3 U				7.2 U	7.2 U		7.5 U	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U		7.5 U
2-Methyl-4,6-dinitrophenol	µg/kg dw	84 U	83 U				83 U	83 U	82 U	83 UJ	82 UJ				81 UJ	81 UJ		84 U	83 UJ	83 UJ	83 UJ	83 UJ	83 UJ		84 UJ
2-Nitroaniline	µg/kg dw	42 U	41 U				41 U	42 U	41 U	41 U	41 U				40 U	40 U		42 U	42 U	41 U	42 U	41 U	41 U		42 U
2-Nitrophenol	µg/kg dw	40 U	39 U				39 U	40 U	39 U	39 U	39 U				38 U	38 U		40 U	40 U	39 U	40 U	39 U	39 U		40 U
3,3'-Dichlorobenzidine	µg/kg dw	49 UJ	48 UJ				48 UJ	48 UJ	48 UJ									49 UJ					48 U		49 U
3-Nitroaniline	µg/kg dw	76 U	75 U				75 U	76 U	75 U									76 UJ					75 UJ		76 UJ
4-Bromophenyl-phenyl Ether	µg/kg dw	9.6 U	9.5 U				9.5 U	9.6 U	9.4 U	9.5 U	9.4 U				9.3 U	9.3 U		9.6 U	9.6 U	9.5 U	9.6 U	9.5 U	9.5 U		9.6 U
4-Chloro-3-methylphenol	µg/kg dw	8.4 U	8.3 U				8.3 U	8.3 U	8.2 U	8.3 U	8.2 U				8.1 U	8.1 U		8.4 U	8.3 U	8.3 U	8.3 U	8.3 U	8.3 U		8.4 U
4-Chloroaniline	µg/kg dw	35 U	34 U				34 U	35 U	34 U																
4-Chlorophenyl-phenyl Ether	µg/kg dw	8.4 U	8.3 U				8.3 U	8.3 U	8.2 U	8.3 U	8.2 U				8.1 U	8.1 U		8.4 U	8.3 U	8.3 U	8.3 U	8.3 U	8.3 U		8.4 U
4-Nitroaniline	µg/kg dw	51 U	50 U				51 U	51 U	50 U	51 U	50 U				49 U	49 U		51 U	51 U	50 U	51 U	51 U	50 U		51 U
4-Nitrophenol	µg/kg dw	66 U	65 U				65 U	66 U	65 U	99 U	98 U				97 U	96 U		66 U	99 U	98 U	99 U	99 U	65 U		66 U
bis(2-chloroethoxy)methane	µg/kg dw	8.8 U	8.7 U				8.7 U	8.8 U	8.7 U	8.8 U	8.7 U				8.6 U	8.5 U		8.8 U	8.8 U	8.7 U	8.8 U	8.8 U	8.7 U		8.8 U
bis(2-chloroethyl)ether	µg/kg dw	7.5 U	7.4 U				7.4 U	7.4 U	7.3 U	7.4 U	7.3 U				7.2 U	7.2 U		7.5 U	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U		7.5 U
Carbazole	µg/kg dw	6.6 U	6.5 U				56	110	39	23	6.5 U				6.4 U	6.4 U		6.6 U	6.6 U	6.5 U	6.6 U	6.6 U	37		26
Hexachloroethane	µg/kg dw	7.2 U	7.1 U				7.1 U	7.2 U	7 U	7.1 U	7.1 U				7 U	6.9 U		7.2 UJ	7.2 U	7.1 U	7.2 U	7.1 U	7.1 U		7.2 U
Hexachlorocyclopentadiene	µg/kg dw	44 U	43 U				43 U	44 U	43 U	43 UJ	43 UJ				42 UJ	42 UJ		44 UJ	44 UJ	43 UJ	44 UJ	44 UJ	43 U		44 U
Isophorone	µg/kg dw	8.3 U	8.1 U				8.2 U	8.2 U	8.1 U	8.2 U	8.1 U				8 U	8 U		8.3 U	8.2 U	8.2 U	8.2 U	8.2 U	8.1 U		8.3 U
Nitrobenzene	µg/kg dw	8.8 U	8.7 U				8.7 U	8.7 U	8.6 U	8.7 U	8.6 U				8.5 U	8.5 U		8.8 U	8.7 U	8.7 U	8.7 U	8.7 U	8.7 U		8.8 U
N-nitroso-di-n-propylamine	µg/kg dw	36 U	35 U				35 U	36 U	35 U	35 U	35 U				35 U	35 U		36 U	36 U	35 U	36 U	35 U	35 U		36 U
Retene	µg/kg dw	8.9 U	8.8 U				36	160	31	83	38			69	27	32		8.9 U	8.9 U	8.8 U	8.9 U	8.8 U	38	49	170
Total Petroleum Hydrocarbons																									
#2 Diesel	mg/kg dw			14 JQ	11 JQ	11 U	62	47	41									11 JQ	38 JQ	69 JQ	80 JQ	100	58	20 U	120
Motor Oil	mg/kg dw			19 JQ	15 JQ	13 JQ	200	110	140									17 JQ	87 JQ	230	320	290	250	70	790

Notes:

Source: Exponent, Inc. 2008. *Environmental Baseline Investigation, DNR Lease 22-077766: Nippon Paper Industries USA Co., Ltd., Port Angeles, Washington.* Prepared for Nippon Paper Industries USA Co., Ltd. October.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
2 Calculated using detected dioxin/furan concentrations.
3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.
4 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.
5 Calculated using detected cPAH concentrations.
6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_IE10A	PA_IE11A	PA_IE12A	PA_IE13A	PA_IE14A	PA_IE15A	PA_IE16A	PA_IH01A	PA_IH02A	PA_IH03A	PA_IH04A	PA_IH05A	PA_IH06A	PA_KP01A	PA_KP02A	PA_KP03A	PA_KP04A	PA_KP05A	PA_KP06A	PA_KP07A	PA_KP08A	PA_LA01A	PA_LA02A	PA_LA03A
Sample ID		IE10A	IE11A	IE12A	IE13A	IE14A	IE15A	IE16A	IH01A	IH02A	IH03A	IH04A	IH05A	IH06A	KP01A	KP02A	KP03A	KP04A	KP05A	KP06A	KP07A	KP08A	LA01A	LA02A	LA03A
Sample Date		6/8/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/17/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/11/2008	6/11/2008	6/12/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH052	WPAH012	WPAH040	WPAH029	WPAH014	WPAH050	WPAH022	WPAH023	No	No	WPAH024	WPAH036	WPAH037	No	No	WPAH042	WPAH045	No	No	WPAH048	WPAH021	WPAH051
Analyte	**Units**																								
Conventionals																									
Sulfides	mg/kg dw	1,700 J	1,600	1,500 J	5,300 J	1,500	520 J	1,100 J	1,000	770	3,100	550	260	740	730	760	130		400	510 J			480	1,100	1,200
Total Organic Carbon	%	1.64	6.08	2.72	8.29	2.79	2.48	4.9	17.2	25.4	11.7	2.91	1.8	2.09	4.21	5.31	1.8	1.65	1.09	1.72	1.65	2.37	11.7	10.3	9.17
Total Solids	%	44.1	39.6	38.6	27.6	38.9	44.4	30.5	18.4	8.7	28.1	48.9	60.5	45.5	44.8	42	62.3	61.1	62.4	55.6	60.4	51.4	22.6	29.2	26.7
Nutrients																									
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	37	11	42	17	19	38	11	8.4	36	24	9.7	8.7	28	20	14	8.1		19	29			23	20	38
Particle/Grain Size																									
Percent Fines (clay & silt)	%	81	72	72	60	78	75	67	31	62	43	35	30	46	71	61	24	65	71	61	57	45	45	70	50
Phi Class 10.00+	%	15	14	12	13	15	13	12	13	14	9.7	5.8	3.9	7.2	9.7	9.5	3.9	5.9	11	9.4	8.5	7.3	10	14	13
Phi Class 9.00+ to 10.00	%	6	5.7	8.3	5.3	5.6	6.2	5.3	1.3	3.7	0.7	1.5	0.9	2.5	3.4	3.1	1.1	1.8	5	3.9	3	2.7	2.8	6.2	3.5
Phi Class 8.00+ to 9.00	%	6.9	6.2	6.9	4.6	5.9	5.8	4.8	0.1	3.8	1.2	0.5	0.8	2.4	3.6	3.4	1.2	2	5.5	3.5	2.8	3.6	1.7	4.6	2.5
Phi Class 7.00+ to 8.00	%	10	8.6	10	8.2	8.8	8.6	7.5	2.6	6.7	2.3	3.3	1.7	4.2	7.1	6.7	1.9	3.6	9.2	5.4	4.3	4.5	3.4	8.5	4.7
Phi Class 6.00+ to 7.00	%	14	13	13	11	13	11	10	2.7	13	5.6	5.4	2.3	6.9	11	9.2	2.3	7	11	8.8	6.9	7.1	12	11	7
Phi Class 5.00+ to 6.00	%	18	13	15	13	16	14	14	2.6	15	16	6.1	3.9	9.8	18	16	3	14	16	13	11	11	7.7	13	8.1
Phi Class 4.00+ to 5.00	%	12	12	7	4.7	15	16	13	8.6	5.7	7	12	17	13	17	14	10	31	13	17	21	9	7	12	11
Phi Class 3.00+ to 4.00	%	4.7	5	2.6	2.3	6.6	11	8.4	4.4	3.8	6.4	37	50	23	13	15	27	27	9.6	24	30	7.8	6	8	7.8
Phi Class 2.00+ to 3.00	%	1.6	2.3	1.2	2	2.5	3.7	2.9	7.2	4.3	7.2	15	16	18	7.2	9.7	33	5.5	6.6	10	9.7	7.9	8.1	6.2	9.8
Phi Class 1.00+ to 2.00	%	3.7	5.4	2.4	3	4.6	3.6	5	14	6.7	8.7	5	1.8	6	4	5.4	13	1.6	7.1	2	1.5	10	12	6.8	12
Phi Class 0.00+ to 1.00	%	3.5	6.2	3.2	3.2	4.5	3	5.1	11	5.9	9	3	1.2	3.5	3	3.8	2.9	0.8	3.2	0.9	0.9	4.9	12	4.9	19
Phi Class -1.00+ to 0.00	%	4.6	7.2	6.6	5.8	3.6	2.8	11	11	6.4	7.5	1.8	0.4	3.4	2.3	2.7	1.1	0.5	2.2	0.8	0.3	3.1	12	4.1	2.2
Phi Class < -1.00	%	0.8	1.9	12	24	0.1 U	0.9	1.5	21	11	18	2.9	0.5	0.4	0.3	1.9	0.2	0.2	0.4	1	0.1	21	4.6	0.3	0.1
Biochemical Measures																									
12-Chlorodehydroabietic acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	98 U	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
14-Chlorodehydroabietic acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	98 U	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
1-Phenanthrenecarboxylic acid	µg/kg dw	100	470		410	140	320	560	1,800	620	14,000 J	3,700	360	310	370	910	890	490 U	110		490 U		5,000	2,200	2,900
3,4,5-Trichloroguaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
3,4,6-Trichloroguaiacol (Ac)	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
3,4-Dichloroguaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
4,5,6-Trichloroguaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
4,5-Dichloroguaiacol	µg/kg dw	20 UJ	20 UJ	20 U	20 UJ	20 UJ	20 UJ	20 UJ	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
4,6-Dichloroguaiacol	µg/kg dw	20 UJ	20 UJ	20 U	20 UJ	20 UJ	20 UJ	20 UJ	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
4-Chloroguaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
9,10-Dichlorostearic Acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	98 U	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Abietic Acid	µg/kg dw	160	640		1,200	160	480	1,300	4,200	1,200	46,000 J	3,500	670	850	840	550	630	490 U	160 J		490 U		4,800	1,200	1,800
Dichlorodehydroabietic Acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	98 U	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Guaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
Isopimaric Acid	µg/kg dw	100 U	99 U		150	98 U	98 U	110	510	130	8,100 J	550	110	300 U	98 U	300	490 U	490 U	99 U		490 U		1,400	490 U	500 U
Linolenic Acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	110	97 U	300 U	98 U	120	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Neoabietic Acid	µg/kg dw										720 J						490 U	490 U			490 U		680 J		
Oleic Acid	µg/kg dw	280	460		100 U	180	120	160	500	150	420 J	140	180	300 U	200	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Palustric Acid	µg/kg dw										1,700 J						490 U	490 U			490 U		640 J	490 UJ	500 UJ
Pimaric Acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	300 U	98 U	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Sandaracopimaric Acid	µg/kg dw	100 U	99 U		100 U	98 U	98 U	99 U	340 U	98 U	1,000 J	150	97 U	300 U	98 U	99 U	490 U	490 U	99 U		490 U		500 U	490 U	500 U
Tetrachloroguaiacol	µg/kg dw	20 U	20 U	20 U	20 U	20 U	20 U	20 U	78 U	20 U	20 U	20 U	19 U	20 U	20 U	20 U	20 U	20 U	20 U		20 U		20 U	20 U	20 U
Metals																									
Antimony	mg/kg dw		0.7 U	0.56 U	0.83 U	0.62 U	0.66	0.17 JQ	0.9 JQ	0.59 JQ	0.2 JQ	0.37	0.16 JQ	0.22 JQ	0.26 JQ	0.32 JQ	0.0023 U	0.24 U	0.37 JQ		0.21	0.26 JQ	0.59 JQ		
Arsenic	mg/kg dw		8.3	11	10	8.4	11	9.7	8.3	69	8.2	5.6	5.2	8.1	8.6	9.9	3.9	6	9.5		6.2	6.3	9.9		
Barium	mg/kg dw		39	49	34	46	36	35	13	26	20	13	12	19	21	22	16	22	34		29	19	16		
Cadmium	mg/kg dw		0.73	1.2	4.4	0.76	0.94	2.4	7.4	4.1	1.7	0.78	0.66	1.5	1.1	1.3	0.22	0.42	0.78		0.42	0.56	5.9		
Chromium	mg/kg dw		37	44	37	42	39	39	21	29	19 J	16	19 J	26	26	29	26	30	38 J		28	22	29		
Copper	mg/kg dw		35	45	70	39	39	53	95	60	34	24	20	32	32	34	24	28	39		22	24	61		
Lead	mg/kg dw		13	16	34	15	16	23	57	27	10	11	17	15	12	12	7.2	11	16		9	10	84		
Mercury	mg/kg dw	0.087	0.1	0.15	1.9	0.15	0.38	1.3	3.5	1.3	0.16	0.15	0.079	0.19	0.16	0.11	0.036	0.089	0.1	0.096	0.065	0.14	0.45	0.59	0.59

Table C.6
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Station ID		PA_IE10A	PA_IE11A	PA_IE12A	PA_IE13A	PA_IE14A	PA_IE15A	PA_IE16A	PA_IH01A	PA_IH02A	PA_IH03A	PA_IH04A	PA_IH05A	PA_IH06A	PA_KP01A	PA_KP02A	PA_KP03A	PA_KP04A	PA_KP05A	PA_KP06A	PA_KP07A	PA_KP08A	PA_LA01A	PA_LA02A	PA_LA03A
Sample ID		IE10A	IE11A	IE12A	IE13A	IE14A	IE15A	IE16A	IH01A	IH02A	IH03A	IH04A	IH05A	IH06A	KP01A	KP02A	KP03A	KP04A	KP05A	KP06A	KP07A	KP08A	LA01A	LA02A	LA03A
Sample Date		6/8/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/17/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/11/2008	6/11/2008	6/12/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH052	WPAH012	WPAH040	WPAH029	WPAH014	WPAH050	WPAH022	WPAH023	No	No	WPAH024	WPAH036	WPAH037	No	No	WPAH042	WPAH045	No	No	WPAH048	WPAH021	WPAH051
Analyte	**Units**																								
Metals (cont.)																									
Nickel	mg/kg dw		29	34	30	33	31	29	15	23	16	15	17	21	22	25	26	28	31		24	18	38		
Silver	mg/kg dw		0.16 JQ	0.19 JQ	0.2 JQ	0.16 JQ	0.18 JQ	0.17 JQ	0.11 JQ	0.17 JQ	0.081 JQ	0.053 JQ	0.055 JQ	0.13 JQ	0.12 JQ	0.12 JQ	0.075 JQ	0.13 JQ	0.18 JQ		0.1 JQ	0.093 JQ	0.18 JQ		
Zinc	mg/kg dw		82	110	610	96	130	290	1,600	460	84	62	47	91	80	77	58	63	90		67	58	320		
Butyltins																									
Butyltin	µg/kg dw														3.9 U	4 U		3.7 U	3.9 UJ		3.9 UJ	4 UJ			
Dibutyltin	µg/kg dw														3.1 U	3.1 U		2.9 U	3 U		3.1 U	3.1 U			
Tributyltin	µg/kg dw														40	9.3		1.6 U	5		1.7 U	9.8			
Pesticides																									
4,4'-DDD	µg/kg dw														0.54 UJ	0.57 UJ	0.36 U	0.39 U	0.53 UJ		0.39 U		1.2 U		
4,4'-DDE	µg/kg dw														0.46 UJ	0.48 UJ	1.5 JQ	0.34 U	0.46 UJ		0.42 JQ		1.1 U		
4,4'-DDT	µg/kg dw														0.54 UJ	0.56 UJ	1.3 JQ	0.39 U	0.53 UJ		0.38 U		1.2 U		
Aldrin	µg/kg dw														0.22 UJ	0.23 UJ	0.87 JQ	0.16 U	0.22 UJ		0.74 JQ		2.1 JQ		
alpha-Endosulfan	µg/kg dw														0.24 UJ	0.25 UJ	0.16 U	2.9 J	0.24 UJ		0.17 U		0.55 U		
alpha-Hexachlorocyclohexane	µg/kg dw														0.22 UJ	0.23 UJ	0.15 U	0.86 U	0.22 UJ		1.4 JQ		0.51 U		
beta-Endosulfan	µg/kg dw														0.85 UJ	0.69 UJ	0.36 U	0.39 U	0.72 UJ		0.38 U		1.6 JQ		
beta-Hexachlorocyclohexane	µg/kg dw														0.26 UJ	0.27 UJ	0.17 U	1.1 JQ	0.26 UJ		0.19 U		4.5 JQ		
Cis-chlordane	µg/kg dw														0.24 UJ	0.25 UJ	0.34 JQ	22 J	0.24 UJ		0.53 JQ		0.56 U		
delta-Hexachlorocyclohexane	µg/kg dw														0.24 UJ	0.25 UJ	0.16 U	0.18 U	0.24 UJ		0.26 JQ		2.8 JQ		
Dieldrin	µg/kg dw														0.45 UJ	0.47 UJ	1.5 JQ	3.3 J	0.45 UJ		0.32 U		1 U		
Endosulfan Sulfate	µg/kg dw														0.69 UJ	0.72 UJ	0.46 U	0.5 U	0.68 UJ		0.5 U		1.6 U		
Endrin	µg/kg dw														0.86 UJ	0.9 UJ	0.57 U	0.62 U	0.85 UJ		0.61 U		2 U		
Endrin Aldehyde	µg/kg dw														0.51 UJ	0.53 UJ	0.52 JQ	1.1 JQ	0.5 UJ		0.37 U		1.2 U		
Endrin Ketone	µg/kg dw														0.51 UJ	0.53 UJ	0.34 U	0.37 U	0.5 UJ		0.37 U		1.2 U		
gamma-Chlordane	µg/kg dw														0.24 UJ	0.25 UJ	0.56 JQ	0.18 U	0.24 UJ		0.81 JQ		0.56 U		
gamma-Hexachlorocyclohexane	µg/kg dw														0.24 UJ	0.25 UJ	0.16 U	8.4 J	0.23 UJ		2.6 J		0.54 U		
Heptachlor	µg/kg dw														0.27 UJ	0.29 UJ	0.95 JQ	0.2 U	0.27 UJ		0.66 JQ		0.63 U		
Heptachlor Epoxide	µg/kg dw														0.26 UJ	0.27 UJ	0.35 JQ	0.19 U	0.25 UJ		0.94 JQ		1.8 JQ		
Methoxychlor	µg/kg dw														2.7 UJ	2.8 UJ	1.8 U	2 U	2.7 UJ		1.9 U		6.2 U		
Toxaphene	µg/kg dw														20 UJ	21 UJ	13 U	15 U	20 UJ		14 U		47 U		
Dioxins/Furans																									
2,3,7,8-TCDD	ng/kg dw			0.475 J		0.383 J	0.652 J		3.72	1.76	0.915	0.53	0.267	0.628	1.28	1.02	0.427	0.619	0.68 J		0.432 J		20.6	10.5	44.3
1,2,3,7,8-PeCDD	ng/kg dw			1.39 J		1.15 J	1.96 J		7.44	5.44	2.91	1.88	0.854 J	2.12	3.48	2.88	0.705	1.42	2.29 J		1.04 J		11.3	12.7	14.4
1,2,3,4,7,8-HxCDD	ng/kg dw			1.19 J		0.998 J	1.61 J		11.9 J	5.63	3.69	1.73	0.954 J	2.39	3.32	2.61	0.589 JQ	1.55	2.09 J		1 J		14.2	17.6	15.3
1,2,3,6,7,8-HxCDD	ng/kg dw			7.28 J		5.78 J	14.4 J		191	72.1	38.9	17.9	6.58	19.6	17.4	10.9	2.28	5.44	9.92 J		4.17 J		56.5	67	76.1
1,2,3,7,8,9-HxCDD	ng/kg dw			4.6 J		3.65 J	6.71 J		31.9	21.5	12.9	6.78	3.4	8.91	11.4	8.09	1.67	4.07	6.92 J		2.59 J		32.9	38.5	37.2
1,2,3,4,6,7,8-HpCDD	ng/kg dw			104 J		64.5 J	200 J		5,090	1,420	511	217	117 J	297	350	190	29.7	72.3	145 J		42.4 J		820	854	1,020
Total OCDD	ng/kg dw			1,070 J		583 J	1,830 J		24,300	11,500	4,160	1,950	1,110 J	2,640	2,700	2,250	226	510	1,350 J		303 J		8,780	6,750	8,750
2,3,7,8-TCDF	ng/kg dw			1.77		1.64	2.68		7.18	5.34	3.95	2.34	0.923	2.39	4.04	3.6	0.857	1.62	2.89		1.48		6.69	10.7	8.36
1,2,3,7,8-PeCDF	ng/kg dw			0.696 J		0.538 J	0.978 J		5.96	2.96	1.59	0.991	0.444 JQ	0.908	2.27	2	0.5 JQ	0.876	1.26 J		0.565 J		3.41	5.04	4.17
2,3,4,7,8-PeCDF	ng/kg dw			0.973 J		0.777 J	1.35 J		7.18	3.25	2.15	1.2	0.531 J	1.19	3.63	3.18	0.821	1.39	1.92 J		0.844 J		4.57	6.25	4.91
1,2,3,4,7,8-HxCDF	ng/kg dw			1.39 J		1.17 J	2.31 J		37.3	11.9	4.84	2.65	1.07 J	2.79	4.42	2.57	0.588	1.4	2.28 J		0.899 J		11.7 JQ	11.9	12.5
1,2,3,6,7,8-HxCDF	ng/kg dw			0.718 J		0.677 J	1.35 J		15.1	6.31	3.07	1.69	0.644 J	1.71	2.71	1.99	0.49 JQ	1.07	1.34 J		0.584 J		10.5 JQ	9.19	9.25
1,2,3,7,8,9-HxCDF	ng/kg dw			0.079 J		0.066 J	0.15 J		1.25 JQ	1.88	0.341 J	0.24 JQ	0.077 JQ	0.138 JQ	0.271 JQ	0.259 J	0.053 JQ	0.097 JQ	0.149 J		0.058 J		0.769 JQ	0.7 J	0.966 JQ
2,3,4,6,7,8-HxCDF	ng/kg dw			0.888 J		0.652 J	1.33 J		15.9	5.8	3.42	1.81	0.59 J	1.69	2.69	2.2	0.541 JQ	1.03	1.42 J		0.566 J		11.4 JQ	10.1	10.7
1,2,3,4,6,7,8-HpCDF	ng/kg dw			24.5 J		16.9 J	58.5 J		1,430	420	128	61.2	21.2	67.8	52.1	30.6	4.65	15.9	27.4 J		10.9 J		262	259	278
1,2,3,4,7,8,9-HpCDF	ng/kg dw			0.945 J		0.775 J	2.55 J		36.7	13.2	4.58	2.61	0.92	2.66	2.57	1.88	0.312 JQ	0.882	1.65 J		0.496 J		8.42 JQ	10.4	9.65
Total OCDF	ng/kg dw			88.7 J		60.7 J	284 J		5,420	1,220	282	278	66.4 J	188	123	204	11.4	41.2	92.3 J		24.8 J		594	615	610
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw			5.61 J		4.26 J	9.35 J		119 J	43.7	19.4 J	9.79 J	4.46 J	11.6 J	15.4 J	11.1 J	2.52 J	5.17 J	8.46 J		3.51 J		61.6 J	55.2 J	93.2 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw			5.61 J		4.26 J	9.35 J		119 J	43.7	19.4 J	9.79 J	4.46 J	11.6 J	15.4 J	11.1 J	2.52 J	5.17 J	8.46 J		3.51 J		61.6 J	55.2 J	93.2 J

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_IE10A	PA_IE11A	PA_IE12A	PA_IE13A	PA_IE14A	PA_IE15A	PA_IE16A	PA_IH01A	PA_IH02A	PA_IH03A	PA_IH04A	PA_IH05A	PA_IH06A	PA_KP01A	PA_KP02A	PA_KP03A	PA_KP04A	PA_KP05A	PA_KP06A	PA_KP07A	PA_KP08A	PA_LA01A	PA_LA02A	PA_LA03A
Sample ID		IE10A	IE11A	IE12A	IE13A	IE14A	IE15A	IE16A	IH01A	IH02A	IH03A	IH04A	IH05A	IH06A	KP01A	KP02A	KP03A	KP04A	KP05A	KP06A	KP07A	KP08A	LA01A	LA02A	LA03A
Sample Date		6/8/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/17/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/11/2008	6/11/2008	6/12/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH052	WPAH012	WPAH040	WPAH029	WPAH014	WPAH050	WPAH022	WPAH023	No	No	WPAH024	WPAH036	WPAH037	No	No	WPAH042	WPAH045	No	No	WPAH048	WPAH021	WPAH051
Analyte	**Units**																								
Polychlorinated Biphenyls (PCBs)																									
Aroclor 1016	µg/kg dw		14 UJ	15 UJ	21 UJ	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	8.8 UJ	27 UJ		
Aroclor 1221	µg/kg dw		14 UJ	15 UJ	21 UJ	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	8.8 UJ	27 UJ		
Aroclor 1232	µg/kg dw		14 UJ	15 UJ	21 UJ	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	8.8 UJ	27 UJ		
Aroclor 1242	µg/kg dw		14 UJ	15 UJ	21 UJ	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	8.8 UJ	27 UJ		
Aroclor 1248	µg/kg dw		14 UJ	15 UJ	21 UJ	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	8.8 UJ	27 UJ		
Aroclor 1254	µg/kg dw		3.5 UJ	3.8 UJ	5.5 UJ	3.6 UJ	3.2 UJ	4.9 UJ	7.7 UJ	5.1 UJ	4.2 UJ	2.6 UJ	2.1 UJ	3.1 UJ	3 UJ	3.2 UJ	2.2 U		3 UJ		2.3 UJ	26	7 UJ		
Aroclor 1260	µg/kg dw		3.5 UJ	3.8 UJ	16 J	3.6 UJ	3.2 UJ	4.9 UJ	7.7 UJ	5.1 UJ	4.2 UJ	2.6 UJ	2.1 UJ	3.1 UJ	3 UJ	3.2 UJ	2.2 U		3 UJ		2.3 UJ	2.3 UJ	19 J		
Total PCBs, Aroclors	µg/kg dw		14 UJ	15 UJ	16 J	14 UJ	12 UJ	19 UJ	30 UJ	20 UJ	16 UJ	10 UJ	8.2 UJ	12 UJ	12 UJ	12 UJ	8.4 U		11 UJ		8.7 UJ	26	19 J		
Aroclor 1016	mg/kg OC			0.55 UJ		0.5 UJ	0.48 UJ					0.34 UJ	0.46 UJ	0.57 UJ			0.47 U		1 UJ		0.53 UJ	0.37 UJ			
Aroclor 1221	mg/kg OC			0.55 UJ		0.5 UJ	0.48 UJ					0.34 UJ	0.46 UJ	0.57 UJ			0.47 U		1 UJ		0.53 UJ	0.37 UJ			
Aroclor 1232	mg/kg OC			0.55 UJ		0.5 UJ	0.48 UJ					0.34 UJ	0.46 UJ	0.57 UJ			0.47 U		1 UJ		0.53 UJ	0.37 UJ			
Aroclor 1242	mg/kg OC			0.55 UJ		0.5 UJ	0.48 UJ					0.34 UJ	0.46 UJ	0.57 UJ			0.47 U		1 UJ		0.53 UJ	0.37 UJ			
Aroclor 1248	mg/kg OC			0.55 UJ		0.5 UJ	0.48 UJ					0.34 UJ	0.46 UJ	0.57 UJ			0.47 U		1 UJ		0.53 UJ	0.37 UJ			
Aroclor 1254	mg/kg OC			0.14 UJ		0.13 UJ	0.13 UJ					0.089 UJ	0.12 UJ	0.15 UJ			0.12 U		0.28 UJ		0.14 UJ	1.1			
Aroclor 1260	mg/kg OC			0.14 UJ		0.13 UJ	0.13 UJ					0.089 UJ	0.12 UJ	0.15 UJ			0.12 U		0.28 UJ		0.14 UJ	0.097 UJ			
Total PCBs, Aroclors	mg/kg OC			0.55 U		0.5 U	0.48 U					0.34 U	0.46 U	0.57 U			0.47 U		1 U		0.53 U	1.1 J			
Other																									
Total TEQ	ng/kg dw			5.82		4.47	9.56		119	43.9	19.6	10	4.67	11.8	15.6	11.3	2.73	5.38	8.67		3.72		61.8	55.4	93.4
Aromatic Hydrocarbons																									
Total LPAH	µg/kg dw				8.9 U	8.8 U	52	8.9 U	63 J	260 J	720	580	220 J	770	270 J	160 J	140 J	120 J	300		46 J	110	46 J	240 J	210 J
Naphthalene	µg/kg dw				8.6 U	8.6 U	23	8.6 U	34 U	17 JQ	8.5 U	48	8.3 U	8.5 U	10 JQ	8.6 U	12 JQ	20	46		19 JQ	22	15 JQ	84	14 JQ
Acenaphthylene	µg/kg dw				8.6 U	8.6 U	8.5 U	8.6 U	34 U	19 JQ	36	62	43	58	27	17 JQ	8.6 U	10 JQ	23		8.5 U	8.5 U	8.6 U	16 JQ	11 JQ
Acenaphthene	µg/kg dw				8.2 U	8.1 U	8.1 U	8.1 U	32 U	10 JQ	24	8.1 U	7.9 U	21	10 JQ	8.2 U	8.1 U	8.1 U	8.1 U		8 U	8.1 U	8.2 U	12 JQ	12 JQ
Fluorene	µg/kg dw				8.9 U	8.8 U	8.8 U	8.9 U	35 U	19 JQ	60	30	10 JQ	61	18 JQ	11 JQ	12 JQ	8.8 U	22		8.8 U	8.8 U	8.9 U	17 JQ	20 JQ
Phenanthrene	µg/kg dw				8.4 U	8.3 U	29	8.3 U	63 JQ	130	200	380	85	470	120	84	90	69	150		27	54	31	82	120
Anthracene	µg/kg dw				7.7 U	7.6 U	7.6 U	7.7 U	30 U	60	400	64	81	160	88	45	24	24	62		7.6 U	36	7.7 U	26	30
2-Methylnaphthalene	µg/kg dw				8.2 U	8.1 U	8.1 U	8.1 U	32 U	10 JQ	8 U	8.1 U	7.9 U	8 U	8.1 U	8.2 U	8.1 U	8.1 U	8.1 U		8 U	8.1 U	8.1 U	14 JQ	8.2 U
Total HPAH	µg/kg dw				9.5 U	20 J	130 J	50 J	430 J	1,400	3,000 J	2,600	3,700	6,500	2,000	1,200 J	520 J	700 J	1,500 J		180 J	920 J	260 J	640 J	1,000
Fluoranthene	µg/kg dw				7.9 U	20	44	23	180	290	1,000	670	920	2,000	340	240	120	180	360		52	140	65	150	200
Pyrene	µg/kg dw				7.7 U	7.7 U	39	27	130	270	390	530	630	1,100	370	220	120	140	320		38	260	58	120	180
Benzo(a)anthracene	µg/kg dw				5.9 U	5.8 U	5.8 U	5.9 U	45 JQ	110	220	160	420	690	180	100	45	54	120		15 JQ	67	20	60	89
Chrysene	µg/kg dw				6.6 U	6.6 U	22	6.6 U	78	230	390 J	300	490	890	330	180	60	88	190		22	120	34	120	140
Total Benzofluoranthenes	µg/kg dw				9.5 U	9.4 U	20	9.4 U	37 U	300	660	400	680	1,100	400	230	97	140	280		36	210	48	120	250
Benzo(b)fluoranthene	µg/kg dw				9.5 U	9.4 U	20	9.4 U	37 U	140	330	160	360	660	220	130	54	85	99		22	120	24	55	120
Benzo(k)fluoranthene	µg/kg dw				9.2 U	9.1 U	9.1 U	9.2 U	36 U	160	330	240	320	450	180	100	43	58	180		14 JQ	85	24	62	130
Benzo(a)pyrene	µg/kg dw				8.1 U	8.1 U	8 U	8.1 U	32 U	110	230	200	300	360	160	98	46	57	110		16 JQ	78	20	45	94
Benzo(g,h,i)perylene	µg/kg dw				6.7 UJ	6.7 UJ	6.7 UJ	6.7 UJ	26 U	48	60	160	91	120	79	64	15 JQ	20	47 J		6.6 U	24 J	11 JQ	16 JQ	33
Indeno(1,2,3-cd)pyrene	µg/kg dw				8.6 UJ	8.5 UJ	8.5 UJ	8.5 UJ	34 U	48	71	130	99	130	82	56	14 JQ	18 JQ	46 J		8.4 U	24 J	8.5 U	14 JQ	30
Dibenzo(a,h)anthracene	µg/kg dw				8.5 UJ	8.5 UJ	8.4 UJ	8.5 UJ	33 U	20	28	31	41	67	25	11 JQ	8.5 U	8.5 U	8.5 UJ		8.4 U	8.4 UJ	8.5 UJ	8.5 UJ	8.5 U
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw						2.2 J		5.3 J	160	330 J	280	430	570	230	140 J	62 J	79 J	160 J		21 J	110 J	27 J	65 J	130
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw				6.2 U	6.1 U	7.8 J	6.2 U	28 J	160	330 J	280	430	570	230	140 J	63 J	80 J	160 J		22 J	110 J	28 J	66 J	130
Total LPAH	mg/kg OC					0.32 U	2.1					20	12 J	37			7.7 J	7.5 J	28		2.8 J	4.7			
Naphthalene	mg/kg OC					0.31 U	0.93					1.6	0.46 U	0.41 U			0.67 JQ	1.2	4.2		1.2 JQ	0.93			
Acenaphthylene	mg/kg OC					0.31 U	0.34 U					2.1	2.4	2.8			0.48 U	0.61 JQ	2.1		0.52 U	0.36 U			
Acenaphthene	mg/kg OC					0.29 U	0.33 U					0.28 U	0.44 U	1			0.45 U	0.49 U	0.74 U		0.48 U	0.34 U			
Fluorene	mg/kg OC					0.32 U	0.35 U					1	0.56 JQ	2.9			0.67 JQ	0.53 U	2		0.53 U	0.37 U			
Phenanthrene	mg/kg OC					0.3 U	1.2					13	4.7	22			5	4.2	14		1.6	2.3			
Anthracene	mg/kg OC					0.27 U	0.31 U					2.2	4.5	7.7			1.3	1.5	5.7		0.46 U	1.5			
2-Methylnaphthalene	mg/kg OC					0.29 U	0.33 U					0.28 U	0.44 U	0.38 U			0.45 U	0.49 U	0.74 U		0.48 U	0.34 U			
Total HPAH	mg/kg OC					0.72 J	5 J					89	200	310			29 J	42 J	140 J		11 J	39 J			
Fluoranthene	mg/kg OC					0.72	1.8					23	51	96			6.7	11	33		3.2	5.9			
Pyrene	mg/kg OC					0.28 U	1.6					18	35	53			6.7	8.5	29		2.3	11			
Benzo(a)anthracene	mg/kg OC					0.21 U	0.23 U					5.5	23	33			2.5	3.3	11		0.91 JQ	2.8			

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_IE10A	PA_IE11A	PA_IE12A	PA_IE13A	PA_IE14A	PA_IE15A	PA_IE16A	PA_IH01A	PA_IH02A	PA_IH03A	PA_IH04A	PA_IH05A	PA_IH06A	PA_KP01A	PA_KP02A	PA_KP03A	PA_KP04A	PA_KP05A	PA_KP06A	PA_KP07A	PA_KP08A	PA_LA01A	PA_LA02A	PA_LA03A
Sample ID		IE10A	IE11A	IE12A	IE13A	IE14A	IE15A	IE16A	IH01A	IH02A	IH03A	IH04A	IH05A	IH06A	KP01A	KP02A	KP03A	KP04A	KP05A	KP06A	KP07A	KP08A	LA01A	LA02A	LA03A
Sample Date		6/8/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/17/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/11/2008	6/11/2008	6/12/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH052	WPAH012	WPAH040	WPAH029	WPAH014	WPAH050	WPAH022	WPAH023	No	No	WPAH024	WPAH036	WPAH037	No	No	WPAH042	WPAH045	No	No	WPAH048	WPAH021	WPAH051
Analyte	**Units**																								
Aromatic Hydrocarbons (cont.)																									
Chrysene	mg/kg OC					0.24 U	0.89					10	27	43			3.3	5.3	17		1.3	5.1			
Total Benzofluoranthenes	mg/kg OC					0.34 U	0.81					14	38	53			5.4	8.7	26		2.2	8.6			
Benzo(b)fluoranthene	mg/kg OC					0.34 U	0.81					5.5	20	32			3	5.2	9.1		1.3	5.1			
Benzo(k)fluoranthene	mg/kg OC					0.33 U	0.37 U					8.2	18	22			2.4	3.5	17		0.85 JQ	3.6			
Benzo(a)pyrene	mg/kg OC					0.29 U	0.32 U					6.9	17	17			2.6	3.5	10		0.97 JQ	3.3			
Benzo(g,h,i)perylene	mg/kg OC					0.24 UJ	0.27 UJ					5.5	5.1	5.7			0.83 JQ	1.2	4.3 J		0.4 U	1 J			
Indeno(1,2,3-cd)pyrene	mg/kg OC					0.3 UJ	0.34 UJ					4.5	5.5	6.2			0.78 JQ	1.1 JQ	4.2 J		0.51 U	1 J			
Dibenzo(a,h)anthracene	mg/kg OC					0.3 UJ	0.34 UJ					1.1	2.3	3.2			0.47 U	0.52 U	0.78 UJ		0.51 U	0.35 UJ			
Carcinogenic PAH TEQ, 0 DL [4,5]	mg/kg OC						0.09 J					9.5	24	27			3.5 J	4.8 J	14 J		1.3 J	4.6 J			
Carcinogenic PAH TEQ, 1/2 DL [4,6]	mg/kg OC					0.22 U	0.31 J					9.5	24	27			3.5 J	4.8 J	14 J		1.3 J	4.6 J			
Chlorinated Benzenes																									
1,2-Dichlorobenzene	µg/kg dw				7.8 U	7.8 U	7.8 U	7.8 U	31 U	7.8 U	7.7 U	7.8 U	7.6 U	7.7 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U		7.7 U	7.7 U	7.8 U	7.8 U	7.8 U
1,3-Dichlorobenzene	µg/kg dw				7.4 U	7.3 U	7.3 U	7.4 U	29 U	7.3 U	7.3 U	7.4 U	7.1 U	7.3 U	7.4 U	7.4 U	7.4 U	7.3 U	7.4 U		7.3 U	7.3 U	7.4 U	7.4 U	7.4 U
1,4-Dichlorobenzene	µg/kg dw				7.3 U	7.3 U	7.3 U	7.3 U	29 U	7.3 U	7.2 U	7.3 U	7.1 U	7.2 U	7.3 U	7.3 U	7.3 U	7.3 U	7.3 U		7.2 U	7.2 U	7.3 U	7.3 U	7.3 U
1,2,4-Trichlorobenzene	µg/kg dw				9 U	9 U	9 U	9 U	35 U	9 U	8.9 U	9 U	8.7 U	8.9 U	9 U	9 U	9 U	9 U	9 U		8.9 U	8.9 U	9 U	9 U	9 U
Hexachlorobenzene	µg/kg dw				8 U	7.9 U	7.9 U	7.9 U	31 U	7.9 U	7.8 U	7.9 U	7.7 U	7.8 U	7.9 U	8 U	7.9 U	7.9 U	7.9 U		7.8 U	7.9 U	8 U	7.9 U	8 U
1,2-Dichlorobenzene	mg/kg OC					0.28 U	0.31 U					0.27 U	0.42 U	0.37 U			0.43 U	0.47 U	0.72 U		0.47 U	0.32 U			
1,4-Dichlorobenzene	mg/kg OC					0.26 U	0.29 U					0.25 U	0.39 U	0.34 U			0.41 U	0.44 U	0.67 U		0.44 U	0.3 U			
1,2,4-Trichlorobenzene	mg/kg OC					0.32 U	0.36 U					0.31 U	0.48 U	0.43 U			0.5 U	0.55 U	0.83 U		0.54 U	0.38 U			
Hexachlorobenzene	mg/kg OC					0.28 U	0.32 U					0.27 U	0.43 U	0.37 U			0.44 U	0.48 U	0.72 U		0.47 U	0.33 U			
Phthalate Esters																									
Dimethyl Phthalate	µg/kg dw				7.7 U	7.7 U	7.6 U	7.7 U	30 U	7.7 U	7.6 U	7.7 U	7.4 U	7.6 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U		7.6 U	7.6 U	7.7 U	7.7 U	7.7 U
Diethyl Phthalate	µg/kg dw				16 U	16 U	28	16 U	93	16 U	16 U	31	19 JQ	21	19 JQ	16 U	16 U	16 U	20		16 U	16 U	16 U	16 U	19 JQ
Di-n-butyl Phthalate	µg/kg dw				12 U	12 U	12 U	12 U	48 U	12 U	12 U	12 U	12 U	16 JQ	12 U	12 U	12 U	12 U	12 U		12 U	12 U	12 U	12 U	12 U
Butylbenzyl Phthalate	µg/kg dw				11 U	11 U	11 U	11 U	44 U	11 U	31	11 U	11 U	12 JQ	11 U	11 U	11 U	11 U	11 U		11 U	11 U	11 U	11 U	73
bis(2-ethylhexyl)phthalate	µg/kg dw				11 U	11 U	11 U	11 U	43 U	11 U	26 J	11 U	21	37	48	45	33	29	48		11 JQ	27	11 U	39	41
Di-n-octyl Phthalate	µg/kg dw				8.3 U	8.2 U	8.2 U	8.3 U	33 U	8.2 U	8.2 U	8.3 U	8 U	8.1 U	8.2 U	8.3 U	8.2 U	8.2 U	8.2 U		8.2 U	8.2 U	8.3 U	8.3 U	8.3 U
Dimethyl Phthalate	mg/kg OC					0.28 U	0.31 U					0.26 U	0.41 U	0.36 U			0.43 U	0.47 U	0.71 U		0.46 U	0.32 U			
Diethyl Phthalate	mg/kg OC					0.57 U	1.1					1.1	1.1 JQ	1			0.89 U	0.97 U	1.8		0.97 U	0.68 U			
Di-n-butyl Phthalate	mg/kg OC					0.43 U	0.48 U					0.41 U	0.67 U	0.77 JQ			0.67 U	0.73 U	1.1 U		0.73 U	0.51 U			
Butylbenzyl Phthalate	mg/kg OC					0.39 U	0.44 U					0.38 U	0.61 U	0.57 JQ			0.61 U	0.67 U	1 U		0.67 U	0.46 U			
bis(2-ethylhexyl)phthalate	mg/kg OC					0.39 U	0.44 U					0.38 U	1.2	1.8			1.8	1.8	4.4		0.67 JQ	1.1			
Di-n-octyl Phthalate	mg/kg OC					0.29 U	0.33 U					0.29 U	0.44 U	0.39 U			0.46 U	0.5 U	0.75 U		0.5 U	0.35 U			
Miscellaneous Nonionizable Organic Compounds																									
Dibenzofuran	µg/kg dw				7.5 U	7.5 U	7.5 U	7.5 U	30 U	12 JQ	25	7.5 U	7.3 U	18 JQ	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U		7.4 U	7.4 U	7.5 U	16 JQ	10 JQ
Hexachlorobutadiene	µg/kg dw				8.1 U	8 U	8 U	8 U	32 U	8 U	7.9 U	8 U	7.8 U	7.9 U	8 U	8.1 U	8 U	8 U	8 U		7.9 U	8 U	8.1 U	8 U	8.1 U
N-nitrosodiphenylamine	µg/kg dw				8.6 U	8.6 U	8.6 U	8.6 U	34 U	8.6 U	8.5 U	8.6 U	8.3 U	8.5 U	8.6 U	8.6 U	8.6 U	8.6 U	8.6 U		8.5 U	8.5 U	8.6 U	8.6 U	8.6 U
Dibenzofuran	mg/kg OC					0.27 U	0.3 U					0.26 U	0.41 U	0.86 JQ			0.42 U	0.45 U	0.69 U		0.45 U	0.31 U			
Hexachlorobutadiene	mg/kg OC					0.29 U	0.32 U					0.27 U	0.43 U	0.38 U			0.44 U	0.48 U	0.73 U		0.48 U	0.34 U			
N-nitrosodiphenylamine	mg/kg OC					0.31 U	0.35 U					0.3 U	0.46 U	0.41 U			0.48 U	0.52 U	0.79 U		0.52 U	0.36 U			
Ionizable Organic Compounds																									
Phenol	µg/kg dw				66	14 U	62	14 U	54 U	51	34	71	88	86	44	20	14 U	130	36		15 JQ	57	31	41	28 U
2-Methylphenol	µg/kg dw				14 U	14 U	14 U	14 U	55 U	14 U	40 J	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U		14 U	14 U	14 U	14 U	14 U
4-Methylphenol	µg/kg dw				38	13 U	13 U	31	77 JQ	67	31 J	28	26	30	33	20 JQ	13 U	32	13 U		18 JQ	28	23	150	25
2,4-Dimethylphenol	µg/kg dw				15 U	15 U	15 U	15 U	58 U	15 U	14 U	15 U	14 U	14 U	15 U	15 U	15 U	15 U	15 U		14 U	15 U	15 U	15 U	15 U
Pentachlorophenol	µg/kg dw				47 U	47 U	47 U	47 U	190 U	47 U	47 U	47 U	46 U	47 U	47 U	47 U	47 U	47 U	47 U		47 U	47 U	47 U	47 U	47 U
Benzyl Alcohol	µg/kg dw				14 U	14 U	14 U	14 U	57 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 UJ		14 UJ	14 UJ	14 U	14 U	14 U
Benzoic Acid	µg/kg dw				110 UJ	110 UJ	110 UJ	110 UJ	450 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 U	110 U	110 UJ		110 U	110 UJ	110 U	110 U	110 U
Other Semivolatile Organic Compounds																									
1-Methylnaphthalene	µg/kg dw				7.2 U	7.1 U	7.1 U	7.1 U	28 U	7.1 U	7 U	7.1 U	6.9 U	7 U	7.1 U	7.2 U	7.1 U	7.1 U	7.1 U		7 U	7.1 U	7.1 U	10 JQ	7.2 U
2,2'-Oxybis(1-chloropropane)	µg/kg dw				7.9 U	7.9 U	7.9 U	7.9 U	31 U	7.9 U	7.8 U	7.9 U	7.7 U	7.8 U	7.9 U	7.9 U	7.9 U	7.9 U	7.9 U		7.8 U	7.8 U	7.9 U	7.9 U	7.9 U
2,4,5-Trichlorophenol	µg/kg dw				45 U	44 U	44 U	44 U	180 U	44 U	44 U	44 U	43 U	44 U	44 U	45 U	44 U	44 U	44 U		44 U	44 U	44 U	44 U	45 U
2,4,6-Trichlorophenol	µg/kg dw				46 U	46 U	46 U	46 U	180 U	46 U	45 U	46 U	44 U	45 U	46 U	46 U	46 U	46 U	46 U		45 U	45 U	46 U	46 U	46 U

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_IE10A	PA_IE11A	PA_IE12A	PA_IE13A	PA_IE14A	PA_IE15A	PA_IE16A	PA_IH01A	PA_IH02A	PA_IH03A	PA_IH04A	PA_IH05A	PA_IH06A	PA_KP01A	PA_KP02A	PA_KP03A	PA_KP04A	PA_KP05A	PA_KP06A	PA_KP07A	PA_KP08A	PA_LA01A	PA_LA02A	PA_LA03A
Sample ID		IE10A	IE11A	IE12A	IE13A	IE14A	IE15A	IE16A	IH01A	IH02A	IH03A	IH04A	IH05A	IH06A	KP01A	KP02A	KP03A	KP04A	KP05A	KP06A	KP07A	KP08A	LA01A	LA02A	LA03A
Sample Date		6/8/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/9/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/16/2008	6/17/2008	6/17/2008	6/17/2008	6/17/2008	6/12/2008	6/11/2008	6/11/2008	6/12/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	WPAH052	WPAH012	WPAH040	WPAH029	WPAH014	WPAH050	WPAH022	WPAH023	No	No	WPAH024	WPAH036	WPAH037	No	No	WPAH042	WPAH045	No	No	WPAH048	WPAH021	WPAH051
Analyte	**Units**																								
Other Semivolatile Organic Compounds (cont.)																									
2,4-Dichlorophenol	µg/kg dw				41 U	40 U	40 U	40 U	160 U	40 U	40 U	40 U	39 U	40 U	40 U	41 U	40 U	40 U	40 U		40 U	40 U	40 U	40 U	41 U
2,4-Dinitrophenol	µg/kg dw				110 U	110 U	110 U	110 U	430 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 UJ	110 UJ	110 U		110 UJ	110 U	110 UJ	110 UJ	110 UJ
2,4-Dinitrotoluene	µg/kg dw				38 U	38 U	38 U	38 U	150 U	38 U	38 U	38 U	37 U	38 U	38 U	38 U	38 U	38 U	38 U		38 U	38 U	38 U	38 U	38 U
2,6-Dinitrotoluene	µg/kg dw				54 U	53 U	53 U	53 U	210 U	53 U	53 U	53 U	52 U	53 U	53 U	54 U	53 U	53 U	53 U		53 U	53 U	53 U	53 U	54 U
2-Chloronaphthalene	µg/kg dw				7.9 U	7.9 U	7.8 U	7.9 U	31 U	7.9 U	7.8 U	7.9 U	7.6 U	7.8 U	7.9 U	7.9 U	7.9 U	7.9 U	7.9 U		7.8 U	7.8 U	7.9 U	7.9 U	7.9 U
2-Chlorophenol	µg/kg dw				7.4 U	7.4 U	7.4 U	7.4 U	29 U	7.4 U	7.3 U	7.4 U	7.2 U	7.3 UJ	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U		7.3 U	7.4 U	7.4 U	7.4 U	7.5 U
2-Methyl-4,6-dinitrophenol	µg/kg dw				84 UJ	83 UJ	83 UJ	83 UJ	330 UJ	83 UJ	82 UJ	83 UJ	81 UJ	82 UJ	83 UJ	84 UJ	83 U	83 U	83 UJ		82 U	83 UJ	83 U	83 U	84 UJ
2-Nitroaniline	µg/kg dw				42 U	41 U	41 U	41 U	160 U	41 U	41 U	41 U	40 U	41 U	41 U	42 U	41 U	41 U	41 U		41 U	41 U	41 U	41 U	42 U
2-Nitrophenol	µg/kg dw				40 U	39 U	39 U	39 U	160 U	39 U	39 U	39 U	38 U	39 U	39 U	40 U	39 U	39 U	39 U		39 U	39 U	39 U	39 U	40 U
3,3'-Dichlorobenzidine	µg/kg dw								190 U	48 U	48 UJ	48 U	47 U	48 U	48 U	49 U	48 U	48 U			48 U		48 UJ	48 UJ	49 UJ
3-Nitroaniline	µg/kg dw								300 UJ	75 UJ	75 UJ	75 UJ	73 UJ	74 UJ	75 UJ	76 UJ	75 U	75 U			75 UJ		76 U	75 U	76 U
4-Bromophenyl-phenyl Ether	µg/kg dw				9.6 U	9.5 U	9.5 U	9.5 U	38 U	9.5 U	9.4 U	9.5 U	9.2 U	9.4 U	9.5 U	9.6 U	9.5 U	9.5 U	9.5 U		9.4 U	9.5 U	9.5 U	9.5 U	9.6 U
4-Chloro-3-methylphenol	µg/kg dw				8.4 U	8.3 U	8.3 U	8.3 U	33 U	8.3 U	8.2 U	8.3 U	8.1 U	8.2 U	8.3 U	8.4 U	8.3 U	8.3 U	8.3 U		8.2 U	8.3 U	8.3 U	8.3 U	8.4 U
4-Chloroaniline	µg/kg dw																34 U	34 U					35 U	34 U	35 U
4-Chlorophenyl-phenyl Ether	µg/kg dw				8.4 U	8.3 U	8.3 U	8.3 U	33 U	8.3 U	8.2 U	8.3 U	8.1 U	8.2 U	8.3 U	8.4 U	8.3 U	8.3 U	8.3 U		8.2 U	8.3 U	8.3 U	8.3 U	8.4 U
4-Nitroaniline	µg/kg dw				51 U	51 U	50 U	51 U	200 U	51 U	50 U	51 U	49 U	50 U	51 U	51 U	51 U	51 U	51 U		50 U	50 U	51 U	51 U	51 UJ
4-Nitrophenol	µg/kg dw				100 U	99 U	99 U	99 U	260 U	65 U	65 U	66 U	64 U	65 U	65 U	66 U	65 U	65 U	99 U		65 U	65 U	66 U	66 U	66 U
bis(2-chloroethoxy)methane	µg/kg dw				8.8 U	8.7 U	8.7 U	8.8 U	35 U	8.7 U	8.7 U	8.8 U	8.5 U	8.7 U	8.8 U	8.8 U	8.8 U	8.7 U	8.8 U		8.7 U	8.7 U	8.8 U	8.8 U	8.8 U
bis(2-chloroethyl)ether	µg/kg dw				7.4 U	7.4 U	7.4 U	7.4 U	29 U	7.4 U	7.3 U	7.4 U	7.2 U	7.3 U	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U		7.3 U	7.4 U	7.4 U	7.4 U	7.5 U
Carbazole	µg/kg dw				6.6 U	6.6 U	6.5 U	6.6 U	26 U	27	100	29	38	65	31	20 JQ	6.6 U	6.6 U	21		6.5 U	6.5 U	6.6 U	6.6 U	12 JQ
Hexachloroethane	µg/kg dw				7.2 U	7.1 U	7.1 U	7.1 U	28 U	7.1 U	7 U	7.1 U	6.9 U	7 U	7.1 U	7.2 U	7.1 U	7.1 U	7.1 U		7 U	7.1 U	7.1 U	7.1 U	7.2 U
Hexachlorocyclopentadiene	µg/kg dw				44 UJ	43 UJ	43 UJ	44 UJ	170 U	43 U	43 U	44 U	42 U	43 U	43 U	44 U	44 U	43 U	43 UJ		43 U	43 UJ	44 U	44 U	44 U
Isophorone	µg/kg dw				8.2 U	8.2 U	8.2 U	8.2 U	32 U	8.2 U	8.1 U	8.2 U	7.9 U	8.1 U	8.2 U	8.2 U	8.2 U	8.2 U	8.2 U		8.1 U	8.1 U	8.2 U	8.2 U	8.2 U
Nitrobenzene	µg/kg dw				8.8 U	8.7 U	8.7 U	8.7 U	34 U	8.7 U	8.6 UJ	8.7 U	8.4 U	8.6 U	8.7 U	8.8 U	8.7 U	8.7 U	8.7 U		8.6 U	8.7 U	8.7 U	8.7 U	8.8 U
N-nitroso-di-n-propylamine	µg/kg dw				36 U	35 U	35 U	35 U	140 U	35 U	35 U	35 U	34 U	35 U	35 U	36 U	35 U	35 U	35 U		35 U	35 U	36 U	35 U	36 U
Retene	µg/kg dw	8.8 U	8.7 U	8.8 U	33	8.8 U	26	43	2,000	160	70	89	240	210	27	22	17	14	47		16		18 JQ	110	80
Total Petroleum Hydrocarbons																									
#2 Diesel	mg/kg dw								320	87 JQ	170	72	25 U	73	31 U	31 U	28 U						110 JQ	69 JQ	93 JQ
Motor Oil	mg/kg dw								1,700	490	830	370	86	280	66 JQ	97 JQ	120						330	280	370

Notes:

Source: Exponent, Inc. 2008. *Environmental Baseline Investigation, DNR Lease 22-077766: Nippon Paper Industries USA Co., Ltd., Port Angeles, Washington.* Prepared for Nippon Paper Industries USA Co., Ltd. October.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
2 Calculated using detected dioxin/furan concentrations.
3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.
4 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.
5 Calculated using detected cPAH concentrations.
6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.6
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Station ID		PA_LP01A	PA_LP03A	PA_LP04A	PA_LP05A	PA_MA01A	PA_MA02A	PA_MA03A	PA_MA04A	PA_MA05A	PA_MA06A	PA_MD01A	PA_MD02A	PA_MD03A	PA_MD04A	PA_MD05A	PA_OH01A-R	PA_OH02A	PA_OH03A	PA_RL01A	PA_RL02A	PA_RL03A	PA_WW01A
Sample ID		LP01A	LP03A	LP04A	LP05A	MA01A	MA02A	MA03A	MA04A	MA05A	MA06A	MD01A	MD02A	MD03A	MD04A	MD05A	OH01A-R	OH02A	OH03A	RL01A	RL02A	RL03A	WW01A
Sample Date		6/22/2008	6/22/2008	6/22/2008	6/22/2008	6/17/2008	6/13/2008	6/13/2008	6/12/2008	6/13/2008	6/11/2008	6/22/2008	6/21/2008	6/21/2008	6/22/2008	6/21/2008	6/18/2008	6/11/2008	6/11/2008	6/18/2008	6/18/2008	6/12/2008	6/19/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	WPAH025	WPAH032	WPAH017	WPAH018	WPAH031	WPAH030	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Conventionals																							
Sulfides	mg/kg dw	130	2.1	210	1,000	300	1,900			590	400	470	910	1,000	620	75 J	180	11 J	28 J	5.8	7.2		7.6 J
Total Organic Carbon	%	3.6	1.55	3.79	3.6	1.13	4.02	2.38	8.49	2.46	1.36	2.36	3.62	1.24	2.16	1.45	0.431	0.679	0.728	0.414	0.425	0.763	0.742
Total Solids	%	70.9	71.8	46.2	30.6	64.1	33.5	37	25.6	40.3	50.7	56.3	39.5	45.9	49	74.9	69.1	68.4	67.9	71.5	71.7	73.5	69.5
Nutrients																							
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	14	4.3	12	31	19	12			29		71	42	24	9	8.4	6.5	5.4	4	7.7	11		7.5
Particle/Grain Size																							
Percent Fines (clay & silt)	%	8.4	1.9	13	50	24	74	71	58	74	67	39	70	67	56	11	24	28	29	6.8	2.9	15	21
Phi Class 10.00+	%	1.2		3.4	9.3	4.3	13	13	12	11	12	4	8.2	3.9	6.2	1.7	4.8	5.7	5.9	1.3		1.8	4.1
Phi Class 9.00+ to 10.00	%	0.4		0.4	2.2	1.5	5.2	5.3	3.8	4.8	4.1	1.3	2.1	1.3	2.2	0.5	1.6	1.8	2	0.1		0.9	1.2
Phi Class 8.00+ to 9.00	%	0.3		0.6	2.2	1.9	6.7	6.5	4.3	6.1	5	1.4	2.9	2.1	2.4	0.6	1.4	1.9	2	0.2		1	1.4
Phi Class 7.00+ to 8.00	%	0.4		0.8	3.5	2.2	9.4	7.8	6.4	8.1	6.3	1.9	4	8.9	2.7	0.6	1.6	2.3	2.5	0.2		1.1	1.9
Phi Class 6.00+ to 7.00	%	0.5		1.2	6.2	2.8	14	12	12	12	11	3.4	8.3	8.1	5.3	0.9	2.2	3	3.3	0.3		1.5	2.3
Phi Class 5.00+ to 6.00	%	0.9		2.6	13	3.1	16	15	15	16	14	7.1	18	17	13	1.4	3.3	4	4.2	0.6		2.4	3.1
Phi Class 4.00+ to 5.00	%	4.7		3.6	14	8.1	9.4	11	5.4	16	15	20	26	26	24	5	9.1	9.3	9.4	4.2		5.7	6.9
Phi Class 3.00+ to 4.00	%	3.8	3.4	10	8.5	36	4.5	9.1	3.6	11	18	22	13	12	16	4.9	54	47	38	22	6.4	13	34
Phi Class 2.00+ to 3.00	%	9	9.1	10	8.8	36	3.3	5.1	3.4	5	8.9	9.4	5.3	7.6	9	10	20	23	30	53	62	30	26
Phi Class 1.00+ to 2.00	%	19	28	25	9.9	3.1	3.6	4.4	4.2	4.5	3.3	11	4.1	6.6	9.7	21	0.9	1.3	1.4	17	28	32	16
Phi Class 0.00+ to 1.00	%	7.6	22	18	8.1	0.8	4.1	3.7	5	3.2	1.9	8.4	3.4	3.4	4.2	17	0.4	0.6	0.6	0.6	0.8	7.4	2.4
Phi Class -1.00+ to 0.00	%	4.1	14	11	6.8	0.3	6	5.5	7.6	3	1.4	6.1	3.9	2.8	2.1	14	0.2	0.2	0.4	0.2	0.1	1.4	0.3
Phi Class < -1.00	%	48	22	12	7.5	0.1 U	4.3	1.1	18	0.3	0.2	4.6	1	0.3	3.9	22	0.1	0.1 U	0.2	0.5	0.1	2.2	0.1 U
Biochemical Measures																							
12-Chlorodehydroabietic acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	98 U	99 U	500 U	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	72 JQ	200 U				
14-Chlorodehydroabietic acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	98 U	99 U	500 U	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
1-Phenanthrenecarboxylic acid	µg/kg dw	1,400	1,400	2,900	9,500	290 U	3,300	99 U	46,000	180	200	1,200	2,400	1,300	1,400	300 U	99 U	1,100	190 JQ				
3,4,5-Trichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
3,4,6-Trichloroguaiacol (Ac)	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
3,4-Dichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
4,5,6-Trichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
4,5-Dichloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 UJ	20 U	20 UJ	20 UJ	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
4,6-Dichloroguaiacol	µg/kg dw	20 U	19 U	20 UJ	20 UJ	19 U	120 UJ	20 U	20 U	20 U	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 U	20 U	20 U	20 U				
4-Chloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
9,10-Dichlorostearic Acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	98 U	99 U	500 U	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Abietic Acid	µg/kg dw	320	1,700	3,600	11,000	320	7,000	210	110,000 J	260	380	1,700	2,300	1,400	1,500	300 U	99 U	1,500	230				
Dichlorodehydroabietic Acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	98 U	99 U	500 U	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Guaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
Isopimaric Acid	µg/kg dw	290 U	290 U	290 U	510 J	290 U	1,700	99 U	3,500	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	240 UJ	200 U				
Linolenic Acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	380	99 U	1,400	99 U	110	490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Neoabietic Acid	µg/kg dw	290 U	290 U	290 U	500 U				1,200 J			490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Oleic Acid	µg/kg dw	290 U	290 U	560 J	670 J	650	98 U	99 U	1,200	100	140	490 U	750 J	490 U	990 J	300 U	140	98 U	240				
Palustric Acid	µg/kg dw	290 U	290 U	290 U	500 U				1,900 J			490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Pimaric Acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	100	99 U	500 U	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	81 JQ	200 U				
Sandaracopimaric Acid	µg/kg dw	290 U	290 U	290 U	500 U	290 U	370	99 U	7,500	99 U	100 U	490 U	490 U	490 U	500 U	300 U	99 U	98 U	200 U				
Tetrachloroguaiacol	µg/kg dw	20 U	19 U	20 U	20 U	19 U	120 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U				
Metals																							
Antimony	mg/kg dw	0.0026 U	0.0021 U	0.0038 U	1.1 U	0.13 JQ	0.3 JQ	0.36 JQ	0.23 JQ	0.33 JQ		0.28 U	0.39 U	0.34 U	0.34 U	0.16 U	0.25 JQ	0.17	0.18	0.0027 U			
Arsenic	mg/kg dw	5.2	4.2	8.9	14	4	8.3	12	7.5	8.6		6	12	9.4	6.9	4.5	3.4	4.1	4.2	2.1			
Barium	mg/kg dw	14	14	12	22	12	33	37	33	30		16	27	24	21	9.7	15	18	17	7.1			
Cadmium	mg/kg dw	0.21 JQ	0.15 JQ	0.67	2	0.69	1.6	1.5	1.4	0.94		0.51	1.3	1.1	0.48	0.2	0.067 JQ	0.17	0.17	0.23 JQ			
Chromium	mg/kg dw	17	14	17	34	17	31	35	33	28		27	37	34	30	14	26	25	24	11			
Copper	mg/kg dw	9.1	9.3	16	44	29	38	42	40	31		25	39	36	27	11	17	17	17	6.8			
Lead	mg/kg dw	4.4	3.3	10	43	5.8	13	18	11	14		8.5	16	14	11	4.5	5.7	6.2	7	4.2			
Mercury	mg/kg dw	0.021 JQ	0.16	0.026 JQ	0.036 JQ	0.058	0.21	0.32	0.085	0.31	0.19	0.09	0.13	0.18	0.12	0.07	0.073	0.032	0.03	0.051	0.053	0.064	0.064

Table C.6
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Station ID		PA_LP01A	PA_LP03A	PA_LP04A	PA_LP05A	PA_MA01A	PA_MA02A	PA_MA03A	PA_MA04A	PA_MA05A	PA_MA06A	PA_MD01A	PA_MD02A	PA_MD03A	PA_MD04A	PA_MD05A	PA_OH01A-R	PA_OH02A	PA_OH03A	PA_RL01A	PA_RL02A	PA_RL03A	PA_WW01A
Sample ID		LP01A	LP03A	LP04A	LP05A	MA01A	MA02A	MA03A	MA04A	MA05A	MA06A	MD01A	MD02A	MD03A	MD04A	MD05A	OH01A-R	OH02A	OH03A	RL01A	RL02A	RL03A	WW01A
Sample Date		6/22/2008	6/22/2008	6/22/2008	6/22/2008	6/17/2008	6/13/2008	6/13/2008	6/12/2008	6/13/2008	6/11/2008	6/22/2008	6/21/2008	6/21/2008	6/22/2008	6/21/2008	6/18/2008	6/11/2008	6/11/2008	6/18/2008	6/18/2008	6/12/2008	6/19/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	WPAH025	WPAH032	WPAH017	WPAH018	WPAH031	WPAH030	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Metals (cont.)																							
Nickel	mg/kg dw	18	17	16	29	16	25	27	27	22		28	35	33	29	19	23	22	22	12			
Silver	mg/kg dw	0.048 JQ	0.032 JQ	0.045 JQ	0.16 JQ	0.055 JQ	0.15 JQ	0.17 JQ	0.14 JQ	0.14 JQ		0.073 JQ	0.12 JQ	0.13 JQ	0.11 JQ	0.047 JQ	0.044 JQ	0.055 JQ	0.056 JQ	0.027 JQ			
Zinc	mg/kg dw	23	20	31	80	48	99	120	84	90		46	69	64	53	26	54	58	56	21			
Butyltins																							
Butyltin	µg/kg dw					4 U	4 U	3.8 U	4 U	3.7 U													
Dibutyltin	µg/kg dw					3.1 U	3.1 U	5.5	3.1 U	2.9 U													
Tributyltin	µg/kg dw					8.3	1.7 U	7.1	1.7 U	4													
Pesticides																							
4,4'-DDD	µg/kg dw																			0.33 U			
4,4'-DDE	µg/kg dw																			0.28 U			
4,4'-DDT	µg/kg dw																			0.33 U			
Aldrin	µg/kg dw																			0.13 U			
alpha-Endosulfan	µg/kg dw																			0.15 U			
alpha-Hexachlorocyclohexane	µg/kg dw																			0.14 U			
beta-Endosulfan	µg/kg dw																			0.41 U			
beta-Hexachlorocyclohexane	µg/kg dw																			0.16 U			
Cis-chlordane	µg/kg dw																			0.15 U			
delta-Hexachlorocyclohexane	µg/kg dw																			0.15 U			
Dieldrin	µg/kg dw																			0.28 U			
Endosulfan Sulfate	µg/kg dw																			0.43 U			
Endrin	µg/kg dw																			0.53 U			
Endrin Aldehyde	µg/kg dw																			0.31 U			
Endrin Ketone	µg/kg dw																			0.31 U			
gamma-Chlordane	µg/kg dw																			0.15 U			
gamma-Hexachlorocyclohexane	µg/kg dw																			0.15 U			
Heptachlor	µg/kg dw																			0.17 U			
Heptachlor Epoxide	µg/kg dw																			0.16 U			
Methoxychlor	µg/kg dw																			1.7 U			
Toxaphene	µg/kg dw																			12 U			
Dioxins/Furans																							
2,3,7,8-TCDD	ng/kg dw	0.155	0.106 J	0.407	1.31	0.43	0.679	1.02	0.445	1.09		0.371	0.837	0.783	0.646	0.145	0.163	0.095 JQ	0.113 JQ	0.093 J			0.165
1,2,3,7,8-PeCDD	ng/kg dw	0.425 JQ	0.343 JQ	1.25	5.21	4.14	2.54	3.47	1.71	3.84		1.18	2.72	2.81	1.85	0.441 JQ	0.393 JQ	0.25 JQ	0.234 JQ	0.323 J			0.442 JQ
1,2,3,4,7,8-HxCDD	ng/kg dw	0.45 JQ	0.31 JQ	1.01	5.12	6.1	2.72	4	2.27	3.98		1.73	2.76	3.12	1.84	0.469 JQ	0.371 JQ	0.175 JQ	0.188 JQ	0.325 JQ			0.361 JQ
1,2,3,6,7,8-HxCDD	ng/kg dw	1.45	0.881	3.12	15.9	24.6	18.8	26.1	14.6	25.4		6.16	8.19	7.55	7.25	1.38	1.73	1.03	1	0.993			1.62
1,2,3,7,8,9-HxCDD	ng/kg dw	1.13	0.631	2.4	11.8	16.2	9.84	12.5	8.72	12.5		5.7	7.17	6.13	4.58	1.02	1.23	0.79	0.777	0.779			1.14
1,2,3,4,6,7,8-HpCDD	ng/kg dw	34	12.8 J	39	298	336	433	393	374	271		203	222	157	245	12.9	12.5	8.71	8.82	12.1			14.4
Total OCDD	ng/kg dw	323	166	329	3,540	2,410	5,000	3,590	4,090	1,960		1,690	2,750	1,810	3,750	82.3	69.6	56.5	58.8	93.8			91.7
2,3,7,8-TCDF	ng/kg dw	0.628	0.627	2.72	7.23	0.955	2.87	4.37	1.78	4.8		1.87	4.49	4.77	3.53	0.561	0.559	0.386	0.363 J	0.385			0.528
1,2,3,7,8-PeCDF	ng/kg dw	0.279 JQ	0.247 JQ	1.11	3.56	1.05	1.15	1.53	0.976	1.92		0.918	1.9	1.9	1.3	0.27 JQ	0.217 JQ	0.121 JQ	0.13 JQ	0.146			0.238 JQ
2,3,4,7,8-PeCDF	ng/kg dw	0.401 JQ	0.39 JQ	1.65	6.21	1.09	1.49	2.09	1.19	2.55		1.18	2.66	2.74	1.94	0.382 JQ	0.314 JQ	0.198 JQ	0.2 JQ	0.238 JQ			0.37 JQ
1,2,3,4,7,8-HxCDF	ng/kg dw	0.342 JQ	0.318 JQ	1.61	5.86	3.11	3.1	4.51	2.6	4.4		1.59	2.82	2.74	2.81	0.303 JQ	0.382 JQ	0.236 JQ	0.27 JQ	0.235			0.374 JQ
1,2,3,6,7,8-HxCDF	ng/kg dw	0.218 JQ	0.189 JQ	0.815	2.75	2.19	1.73	2.62	1.43	2.7		0.774	1.37	1.56	1.13	0.227 JQ	0.234 JQ	0.128 JQ	0.138 JQ	0.151			0.227 JQ
1,2,3,7,8,9-HxCDF	ng/kg dw	0.026 JQ	0.0243 U	0.076 JQ	0.308 JQ	0.187 JQ	0.152 J	0.286 JQ	0.204 J	0.251 JQ		0.101 JQ	0.147 JQ	0.155 JQ	0.102 JQ	0.03 JQ	0.027 J	0.0701 U	0.0414 U	0.025 U			0.024 U
2,3,4,6,7,8-HxCDF	ng/kg dw	0.21 JQ	0.158 JQ	0.783	2.86	2.3	1.82	2.6	1.51	2.54		0.812	1.32	1.44	1.24	0.229 JQ	0.233 JQ	0.127 JQ	0.132 JQ	0.148 U			0.231 JQ
1,2,3,4,6,7,8-HpCDF	ng/kg dw	3.24	2.32	9.11	63.4	52.5	86	112	53.8	82		16.4	28.3	26.9	52.3	2.62	2.82	2.03	2.22	2.51			3.26
1,2,3,4,7,8,9-HpCDF	ng/kg dw	0.232 JQ	0.161 JQ	0.55	2.95	2.44	3.76	5.15	2.38	3.8		0.887	1.51	1.47	2.36	0.156 JQ	0.171 JQ	0.086 JQ	0.138 JQ	0.212 JQ			0.188 JQ
Total OCDF	ng/kg dw	15.6	14.7	24.6	450	107	760	420	336	212		82.9	291	172	736	7.43	4.36	3.24	3.87	8.3			6.73
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	1.63 J	1.09 J	4.03 J	18.5 J	15.2 J	14.8 J	17.2 J	11.5 J	15.6 J		6.54 J	10.7 J	9.67 J	9.71 J	1.31 J	1.31 J	0.821 J	0.828 J	0.957 J			1.38 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	1.63 J	1.09 J	4.03 J	18.5 J	15.2 J	14.8 J	17.2 J	11.5 J	15.6 J		6.54 J	10.7 J	9.67 J	9.71 J	1.31 J	1.31 J	0.825 J	0.83 J	0.966 J			1.38 J

Table C.6
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Station ID		PA_LP01A	PA_LP03A	PA_LP04A	PA_LP05A	PA_MA01A	PA_MA02A	PA_MA03A	PA_MA04A	PA_MA05A	PA_MA06A	PA_MD01A	PA_MD02A	PA_MD03A	PA_MD04A	PA_MD05A	PA_OH01A-R	PA_OH02A	PA_OH03A	PA_RL01A	PA_RL02A	PA_RL03A	PA_WW01A
Sample ID		LP01A	LP03A	LP04A	LP05A	MA01A	MA02A	MA03A	MA04A	MA05A	MA06A	MD01A	MD02A	MD03A	MD04A	MD05A	OH01A-R	OH02A	OH03A	RL01A	RL02A	RL03A	WW01A
Sample Date		6/22/2008	6/22/2008	6/22/2008	6/22/2008	6/17/2008	6/13/2008	6/13/2008	6/12/2008	6/13/2008	6/11/2008	6/22/2008	6/21/2008	6/21/2008	6/22/2008	6/21/2008	6/18/2008	6/11/2008	6/11/2008	6/18/2008	6/18/2008	6/12/2008	6/19/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	WPAH025	WPAH032	WPAH017	WPAH018	WPAH031	WPAH030	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Polychlorinated Biphenyls (PCBs)																							
Aroclor 1016	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	12 UJ	11 UJ	10 UJ	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1221	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	12 UJ	11 UJ	10 UJ	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1232	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	12 UJ	11 UJ	10 UJ	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1242	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	12 UJ	11 UJ	10 UJ	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1248	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	12 UJ	11 UJ	10 UJ	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1254	µg/kg dw					2.2 UJ	4.2 U	3.8 UJ	5.8 UJ	3.3 UJ		2.2 UJ	3.1 UJ	2.9 UJ	2.6 UJ	1.6 U	2 UJ	1.9 UJ	2 U	1.8 U			
Aroclor 1260	µg/kg dw					2.2 UJ	4.2 U	3.8 UJ	5.8 UJ	3.3 UJ		2.2 UJ	49 J	17 J	45 J	1.6 U	2 UJ	1.9 UJ	2 U	1.8 U			
Total PCBs, Aroclors	µg/kg dw					8.6 UJ	16 U	15 UJ	22 UJ	13 UJ		8.3 UJ	49 J	17 J	45 J	6.4 U	7.7 UJ	7.5 UJ	7.7 U	7 U			
Aroclor 1016	mg/kg OC					0.76 UJ		0.63 UJ		0.53 UJ		0.35 UJ		0.89 UJ	0.46 UJ	0.44 U	1.8 UJ	1.1 UJ	1.1 U	1.7 U			
Aroclor 1221	mg/kg OC					0.76 UJ		0.63 UJ		0.53 UJ		0.35 UJ		0.89 UJ	0.46 UJ	0.44 U	1.8 UJ	1.1 UJ	1.1 U	1.7 U			
Aroclor 1232	mg/kg OC					0.76 UJ		0.63 UJ		0.53 UJ		0.35 UJ		0.89 UJ	0.46 UJ	0.44 U	1.8 UJ	1.1 UJ	1.1 U	1.7 U			
Aroclor 1242	mg/kg OC					0.76 UJ		0.63 UJ		0.53 UJ		0.35 UJ		0.89 UJ	0.46 UJ	0.44 U	1.8 UJ	1.1 UJ	1.1 U	1.7 U			
Aroclor 1248	mg/kg OC					0.76 UJ		0.63 UJ		0.53 UJ		0.35 UJ		0.89 UJ	0.46 UJ	0.44 U	1.8 UJ	1.1 UJ	1.1 U	1.7 U			
Aroclor 1254	mg/kg OC					0.19 UJ		0.16 UJ		0.13 UJ		0.093 UJ		0.23 UJ	0.12 UJ	0.11 U	0.46 UJ	0.28 UJ	0.27 U	0.43 U			
Aroclor 1260	mg/kg OC					0.19 UJ		0.16 UJ		0.13 UJ		0.093 UJ		1.4 J	2.1 J	0.11 U	0.46 UJ	0.28 UJ	0.27 U	0.43 U			
Total PCBs, Aroclors	mg/kg OC					0.76 U		0.63 U		0.53 U		0.35 U		1.4 J	2.1 J	0.44 U	1.8 U	1.1 U	1.1 U	1.7 U			
Other																							
Total TEQ	ng/kg dw	1.84	1.3	4.24	18.7	15.4	15	17.4	11.7	15.8		6.75	10.9	9.88	9.92	1.52	1.52	1.03	1.04	1.18			1.59
Aromatic Hydrocarbons																							
Total LPAH	µg/kg dw	76 J	55 J	380 J	610	180 J	260 J	180 J	470	84 J		620	420 J	420 J	350 J	29 J	8.9 U	120 J	16 J	30			
Naphthalene	µg/kg dw	13 JQ	14 JQ	49	74	8.3 U	51 U	8.5 U	8.6 U	15 JQ		41	45	34	45	12 JQ	8.6 U	26	8.6 U	8.5 U			
Acenaphthylene	µg/kg dw	10 JQ	8.4 U	12 JQ	25	21	51 U	13 JQ	8.6 U	8.5 U		20	26	26	25	8.6 U	8.6 U	8.5 U	8.6 U	8.4 U			
Acenaphthene	µg/kg dw	8 U	8 U	26	34	7.9 U	94 JQ	8.1 U	59	8.1 U		29	18 JQ	14 JQ	14 JQ	8.2 U	8.1 U	8.1 U	8.2 U	8 U			
Fluorene	µg/kg dw	10 JQ	8.7 U	25	51	14 JQ	53 U	14 JQ	56	8.8 U		57	32	25	22	8.9 U	8.9 U	12 JQ	8.9 U	8.7 U			
Phenanthrene	µg/kg dw	30	29	210	280	100	110 JQ	110	210	51		200	190	150	120	17 JQ	8.3 U	49	16 JQ	30			
Anthracene	µg/kg dw	13 JQ	12 JQ	53	150	45	59 JQ	38	140	18 JQ		270	110	170	120	7.7 U	7.7 U	29	7.7 U	7.5 U			
2-Methylnaphthalene	µg/kg dw	8 U	7.9 U	14 JQ	29	7.9 U	48 U	8 U	8.1 U	8.1 U		16 JQ	16 JQ	14 JQ	14 JQ	8.2 U	8.1 U	8 U	8.1 U	8 U			
Total HPAH	µg/kg dw	380	350	1,700 J	3,200	1,400 J	56 U	1,300 J	2,500 J	580 J		2,900 J	2,900 J	2,800 J	2,100 J	130 J	9.4 U	520	9.4 U	370 J			
Fluoranthene	µg/kg dw	130	84	740	770	340	47 UJ	370	930	130		560	760	480	350	34	7.8 U	84	7.9 U	87			
Pyrene	µg/kg dw	69	47	370	520	300	46 U	240	530	110		460	440	350	310	28	7.7 U	200	7.7 U	72			
Benzo(a)anthracene	µg/kg dw	25	38	110	290	83	35 U	120	250	51		280	290	330	150	10 JQ	5.9 U	36	5.9 U	27			
Chrysene	µg/kg dw	47	47	160	520	230	39 UJ	200	300	90		640	440	560	410	16 JQ	6.6 U	55	6.6 U	45			
Total Benzofluoranthenes	µg/kg dw	84	100	250	730	250	56 UJ	240	380	120		670	710	740	590	30 J	9.4 U	110	9.4 U	65			
Benzo(b)fluoranthene	µg/kg dw	46	54	95	340	150	56 UJ	150	180	63		410	330	440	370	17 JQ	9.4 U	54	9.4 U	30			
Benzo(k)fluoranthene	µg/kg dw	38	46	150	390	100	55 UJ	94	200	55		260	380	300	220	13 JQ	9.2 U	59	9.2 U	35			
Benzo(a)pyrene	µg/kg dw	23	31	76	230	81	48 UJ	82	120	44		170	210	220	190	11 JQ	8.1 U	36	8.1 U	29			
Benzo(g,h,i)perylene	µg/kg dw	6.6 U	6.5 U	14 JQ	40	48	40 U	28	6.7 UJ	20		24	26	28	28	6.7 U	6.7 U	6.6 U	6.7 U	21			
Indeno(1,2,3-cd)pyrene	µg/kg dw	8.4 U	8.3 U	14 JQ	42	47	51 U	29	24 J	18 JQ		30	32	32	34	8.6 U	8.5 U	8.4 U	8.5 U	19 JQ			
Dibenzo(a,h)anthracene	µg/kg dw	8.3 U	8.3 U	8.4 U	21	10 JQ	50 U	10 JQ	8.5 UJ	8.4 U		17 JQ	15 JQ	11 JQ	10 JQ	8.5 U	8.5 U	8.4 U	8.5 U	8.3 U			
Carcinogenic PAH TEQ, 0 DL[4,5]	µg/kg dw	34	45	110 J	340	120 J		120 J	190 J	64 J		280 J	320 J	340 J	270 J	15 J		51		41 J			
Carcinogenic PAH TEQ, 1/2 DL[4,6]	µg/kg dw	35	46	110 J	340	120 J	37 U	120 J	190 J	64 J		280 J	320 J	340 J	270 J	16 J	6.2 U	52	6.2 U	41 J			
Total LPAH	mg/kg OC		3.5 J			16 J		7.4 J		3.4 J		26		34 J	16 J	2 J	2.1 U	17 J	2.2 J	7.2			
Naphthalene	mg/kg OC		0.9 JQ			0.73 U		0.36 U		0.61 JQ		1.7		2.7	2.1	0.83 JQ	2 U	3.8	1.2 U	2.1 U			
Acenaphthylene	mg/kg OC		0.54 U			1.9		0.55 JQ		0.35 U		0.85		2.1	1.2	0.59 U	2 U	1.3 U	1.2 U	2 U			
Acenaphthene	mg/kg OC		0.52 U			0.7 U		0.34 U		0.33 U		1.2		1.1 JQ	0.65 JQ	0.57 U	1.9 U	1.2 U	1.1 U	1.9 U			
Fluorene	mg/kg OC		0.56 U			1.2 JQ		0.59 JQ		0.36 U		2.4		2	1	0.61 U	2.1 U	1.8 JQ	1.2 U	2.1 U			
Phenanthrene	mg/kg OC		1.9			8.8		4.6		2.1		8.5		12	5.6	1.2 JQ	1.9 U	7.2	2.2 JQ	7.2			
Anthracene	mg/kg OC		0.77 JQ			4		1.6		0.73 JQ		11		14	5.6	0.53 U	1.8 U	4.3	1.1 U	1.8 U			
2-Methylnaphthalene	mg/kg OC		0.51 U			0.7 U		0.34 U		0.33 U		0.68 JQ		1.1 JQ	0.65 JQ	0.57 U	1.9 U	1.2 U	1.1 U	1.9 U			
Total HPAH	mg/kg OC		22			120 J		56 J		24 J		120 J		220 J	96 J	8.9 J	2.2 U	77	1.3 U	88 J			
Fluoranthene	mg/kg OC		5.4			30		16		5.3		24		39	16	2.3	1.8 U	12	1.1 U	21			
Pyrene	mg/kg OC		3			27		10		4.5		19		28	14	1.9	1.8 U	29	1.1 U	17			
Benzo(a)anthracene	mg/kg OC		2.5			7.3		5		2.1		12		27	6.9	0.69 JQ	1.4 U	5.3	0.81 U	6.5			

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_LP01A	PA_LP03A	PA_LP04A	PA_LP05A	PA_MA01A	PA_MA02A	PA_MA03A	PA_MA04A	PA_MA05A	PA_MA06A	PA_MD01A	PA_MD02A	PA_MD03A	PA_MD04A	PA_MD05A	PA_OH01A-R	PA_OH02A	PA_OH03A	PA_RL01A	PA_RL02A	PA_RL03A	PA_WW01A
Sample ID		LP01A	LP03A	LP04A	LP05A	MA01A	MA02A	MA03A	MA04A	MA05A	MA06A	MD01A	MD02A	MD03A	MD04A	MD05A	OH01A-R	OH02A	OH03A	RL01A	RL02A	RL03A	WW01A
Sample Date		6/22/2008	6/22/2008	6/22/2008	6/22/2008	6/17/2008	6/13/2008	6/13/2008	6/12/2008	6/13/2008	6/11/2008	6/22/2008	6/21/2008	6/21/2008	6/22/2008	6/21/2008	6/18/2008	6/11/2008	6/11/2008	6/18/2008	6/18/2008	6/12/2008	6/19/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	WPAH025	WPAH032	WPAH017	WPAH018	WPAH031	WPAH030	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Aromatic Hydrocarbons (cont.)																							
Chrysene	mg/kg OC		3			20		8.4		3.7		27		45	19	1.1 JQ	1.5 U	8.1	0.91 U	11			
Total Benzofluoranthenes	mg/kg OC		6.5			22		10		4.8		28		60	27	2.1 J	2.2 U	17	1.3 U	16			
Benzo(b)fluoranthene	mg/kg OC		3.5			13		6.3		2.6		17		35	17	1.2 JQ	2.2 U	8	1.3 U	7.2			
Benzo(k)fluoranthene	mg/kg OC		3			8.8		3.9		2.2		11		24	10	0.9 JQ	2.1 U	8.7	1.3 U	8.5			
Benzo(a)pyrene	mg/kg OC		2			7.2		3.4		1.8		7.2		18	8.8	0.76 JQ	1.9 U	5.3	1.1 U	7			
Benzo(g,h,i)perylene	mg/kg OC		0.42 U			4.2		1.2		0.81		1		2.3	1.3	0.46 U	1.6 U	0.97 U	0.92 U	5.1			
Indeno(1,2,3-cd)pyrene	mg/kg OC		0.54 U			4.2		1.2		0.73 JQ		1.3		2.6	1.6	0.59 U	2 U	1.2 U	1.2 U	4.6 JQ			
Dibenzo(a,h)anthracene	mg/kg OC		0.54 U			0.88 JQ		0.42 JQ		0.34 U		0.72 JQ		0.89 JQ	0.46 JQ	0.59 U	2 U	1.2 U	1.2 U	2 U			
Carcinogenic PAH TEQ, 0 DL[4,5]	mg/kg OC		2.9			11 J		5.2 J		2.6 J		12 J		27 J	13 J	1 J		7.6		9.8 J			
Carcinogenic PAH TEQ, 1/2 DL[4,6]	mg/kg OC		3			11 J		5.2 J		2.6 J		12 J		27 J	13 J	1.1 J	1.4 U	7.7	0.85 U	9.9 J			
Chlorinated Benzenes																							
1,2-Dichlorobenzene	µg/kg dw	7.7 U	7.6 U	7.7 U	7.8 U	7.5 U	46 U	7.7 U	7.8 U	7.7 U		7.7 U	7.8 U	7.8 U	7.8 U	7.9 U	7.8 U	7.7 U	7.8 U	7.7 U			
1,3-Dichlorobenzene	µg/kg dw	7.2 U	7.2 U	7.3 U	7.4 U	7.1 U	44 U	7.3 U	7.4 U	7.3 U		7.3 U	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U	7.3 U	7.4 U	7.3 U			
1,4-Dichlorobenzene	µg/kg dw	7.2 U	7.1 U	7.2 U	7.3 U	7 U	43 U	7.2 U	7.3 U	7.2 U		7.2 U	7.3 U	7.3 U	7.3 U	7.3 U	7.3 U	7.2 U	7.3 U	7.2 U			
1,2,4-Trichlorobenzene	µg/kg dw	8.8 U	8.8 U	8.9 U	9 U	8.7 U	54 U	8.9 U	9 U	8.9 U		8.9 U	9 U	9 U	9 U	9.1 U	9 U	8.9 U	9 U	8.8 U			
Hexachlorobenzene	µg/kg dw	7.8 U	7.8 U	7.9 U	8 U	7.7 U	47 U	7.9 U	8 U	7.9 U		7.8 U	7.9 U	8 U	8 U	8 U	7.9 U	7.9 U	8 U	7.8 U			
1,2-Dichlorobenzene	mg/kg OC		0.49 U			0.66 U		0.32 U		0.31 U		0.33 U		0.63 U	0.36 U	0.54 U	1.8 U	1.1 U	1.1 U	1.9 U			
1,4-Dichlorobenzene	mg/kg OC		0.46 U			0.62 U		0.3 U		0.29 U		0.31 U		0.59 U	0.34 U	0.5 U	1.7 U	1.1 U	1 U	1.7 U			
1,2,4-Trichlorobenzene	mg/kg OC		0.57 U			0.77 U		0.37 U		0.36 U		0.38 U		0.73 U	0.42 U	0.63 U	2.1 U	1.3 U	1.2 U	2.1 U			
Hexachlorobenzene	mg/kg OC		0.5 U			0.68 U		0.33 U		0.32 U		0.33 U		0.65 U	0.37 U	0.55 U	1.8 U	1.2 U	1.1 U	1.9 U			
Phthalate Esters																							
Dimethyl Phthalate	µg/kg dw	7.6 U	7.5 U	7.6 U	7.7 U	7.4 U	46 U	7.6 U	7.7 U	7.6 U		7.6 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.6 U	7.7 U	7.6 U			
Diethyl Phthalate	µg/kg dw	20	16 U	16 U	16 U	16 U	97 U	20	16 U	16 U		16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U	16 U			
Di-n-butyl Phthalate	µg/kg dw	13 JQ	12 U	40 J	12 U	12 U	73 UJ	12 U	12 U	12 U		12 U	24	27 J	21 J	12 U	12 U	12 U	12 U	12 U			
Butylbenzyl Phthalate	µg/kg dw	11 U	11 U	27 J	11 U	11 U	66 U	11 U	670	11 U		11 U	22 J	11 U	11 U	11 U	11 U	11 U	11 U	11 U			
bis(2-ethylhexyl)phthalate	µg/kg dw	20	14 JQ	25	75	560	65 UJ	41	44	20		25	52	28	20	11 U	11 U	11 U	11 U	17 JQ			
Di-n-octyl Phthalate	µg/kg dw	9.7 JQ	8.1 U	8.2 U	8.3 U	8 U	49 UJ	8.2 U	8.3 U	8.2 U		8.1 U	8.2 U	8.3 U	8.3 U	8.3 U	8.2 U	8.2 U	8.3 U	8.1 U			
Dimethyl Phthalate	mg/kg OC		0.48 U			0.65 U		0.32 U		0.31 U		0.32 U		0.62 U	0.36 U	0.53 U	1.8 U	1.1 U	1.1 U	1.8 U			
Diethyl Phthalate	mg/kg OC		1 U			1.4 U		0.84		0.65 U		0.68 U		1.3 U	0.74 U	1.1 U	3.7 U	2.4 U	2.2 U	3.9 U			
Di-n-butyl Phthalate	mg/kg OC		0.77 U			1.1 U		0.5 U		0.49 U		0.51 U		2.2 J	0.97 J	0.83 U	2.8 U	1.8 U	1.6 U	2.9 U			
Butylbenzyl Phthalate	mg/kg OC		0.71 U			0.97 U		0.46 U		0.45 U		0.47 U		0.89 U	0.51 U	0.76 U	2.6 U	1.6 U	1.5 U	2.7 U			
bis(2-ethylhexyl)phthalate	mg/kg OC		0.9 JQ			50		1.7		0.81		1.1		2.3	0.93	0.76 U	2.6 U	1.6 U	1.5 U	4.1 JQ			
Di-n-octyl Phthalate	mg/kg OC		0.52 U			0.71 U		0.34 U		0.33 U		0.34 U		0.67 U	0.38 U	0.57 U	1.9 U	1.2 U	1.1 U	2 U			
Miscellaneous Nonionizable Organic Compounds																							
Dibenzofuran	µg/kg dw	10 JQ	7.3 U	27	39	7.2 U	45 U	7.4 U	32	7.4 U		40	27	20	23	7.5 U	7.5 U	10 JQ	7.5 U	7.4 U			
Hexachlorobutadiene	µg/kg dw	7.9 U	7.9 U	7.9 U	8.1 U	7.8 U	48 U	8 U	8.1 U	8 U		7.9 U	8 U	8 U	8.1 U	8.1 U	8 U	8 U	8.1 U	7.9 U			
N-nitrosodiphenylamine	µg/kg dw	8.5 U	8.4 U	8.5 U	8.6 U	8.3 U	51 U	8.5 U	8.6 U	8.5 U		8.5 U	8.6 U	8.6 U	8.6 U	8.7 U	8.6 U	8.5 U	8.6 U	8.5 U			
Dibenzofuran	mg/kg OC		0.47 U			0.64 U		0.31 U		0.3 U		1.7		1.6	1.1	0.52 U	1.7 U	1.5 JQ	1 U	1.8 U			
Hexachlorobutadiene	mg/kg OC		0.51 U			0.69 U		0.34 U		0.33 U		0.33 U		0.65 U	0.38 U	0.56 U	1.9 U	1.2 U	1.1 U	1.9 U			
N-nitrosodiphenylamine	mg/kg OC		0.54 U			0.73 U		0.36 U		0.35 U		0.36 U		0.69 U	0.4 U	0.6 U	2 U	1.3 U	1.2 U	2.1 U			
Ionizable Organic Compounds																							
Phenol	µg/kg dw	70	15 JQ	13 U	100	14 JQ	81 UJ	610	740	22		13 U	14 U	14 U	760	17 JQ	27	18 JQ	19 JQ	13 U			
2-Methylphenol	µg/kg dw	14 U	14 U	14 U	14 U	14 U	84 UJ	14 U	14 UJ	14 U		14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U			
4-Methylphenol	µg/kg dw	26	12 U	68	280	12 U	76 U	67	50	16 JQ		52	93	71	220	13 U	13 U	20	13 U	12 U			
2,4-Dimethylphenol	µg/kg dw	14 U	14 U	14 U	15 U	14 U	87 UJ	15 U	15 U	15 U		14 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	14 U			
Pentachlorophenol	µg/kg dw	46 U	46 U	47 U	47 U	46 U	280 U	47 U	47 U	47 U		46 U	47 U	47 U	47 U	48 U	47 U	47 U	47 U	46 U			
Benzyl Alcohol	µg/kg dw	14 UJ	14 UJ	14 UJ	14 UJ	14 U	86 UJ	14 U	14 UJ	14 U		14 UJ	14 UJ	14 UJ	14 UJ	14 UJ	14 UJ	14 U	14 U	14 U			
Benzoic Acid	µg/kg dw	110 U	110 U	110 U	110 U	110 UJ	680 UJ	110 UJ	110 UJ	110 UJ		110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 U	110 UJ			
Other Semivolatile Organic Compounds																							
1-Methylnaphthalene	µg/kg dw	7 U	7 U	7 U	20	6.9 U	42 U	7.1 U	7.2 U	7.1 U		11 JQ	10 JQ	7.1 U	7.1 U	7.2 U	7.1 U	7.1 U	7.1 U	7 U			
2,2'-Oxybis(1-chloropropane)	µg/kg dw	7.8 U	7.7 U	7.8 U	7.9 U	7.6 U	47 U	7.8 U	7.9 U	7.8 U		7.8 U	7.9 U	7.9 U	7.9 U	8 U	7.9 U	7.8 U	7.9 U	7.8 U			
2,4,5-Trichlorophenol	µg/kg dw	44 U	43 U	44 U	44 U	43 U	260 U	44 U	44 U	44 U		44 U	44 U	44 U	44 U	45 U	44 U	44 U	44 U	44 U			
2,4,6-Trichlorophenol	µg/kg dw	45 U	45 U	45 U	46 U	44 U	270 U	45 U	46 U	45 U		45 U	46 U	46 U	46 U	46 U	46 U	45 U	46 U	45 U			

Table C.6
Port Angeles Harbor Sediment Characterization Study, Sediment Investigation Report

Station ID		PA_LP01A	PA_LP03A	PA_LP04A	PA_LP05A	PA_MA01A	PA_MA02A	PA_MA03A	PA_MA04A	PA_MA05A	PA_MA06A	PA_MD01A	PA_MD02A	PA_MD03A	PA_MD04A	PA_MD05A	PA_OH01A-R	PA_OH02A	PA_OH03A	PA_RL01A	PA_RL02A	PA_RL03A	PA_WW01A
Sample ID		LP01A	LP03A	LP04A	LP05A	MA01A	MA02A	MA03A	MA04A	MA05A	MA06A	MD01A	MD02A	MD03A	MD04A	MD05A	OH01A-R	OH02A	OH03A	RL01A	RL02A	RL03A	WW01A
Sample Date		6/22/2008	6/22/2008	6/22/2008	6/22/2008	6/17/2008	6/13/2008	6/13/2008	6/12/2008	6/13/2008	6/11/2008	6/22/2008	6/21/2008	6/21/2008	6/22/2008	6/21/2008	6/18/2008	6/11/2008	6/11/2008	6/18/2008	6/18/2008	6/12/2008	6/19/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	WPAH025	WPAH032	WPAH017	WPAH018	WPAH031	WPAH030	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**																						
Other Semivolatile Organic Compounds (cont.)																							
2,4-Dichlorophenol	µg/kg dw	40 U	39 U	40 U	40 U	39 U	240 U	40 U	41 U	40 U		40 U	40 U	40 U	41 U	41 U	40 U	40 U	40 U	40 U			
2,4-Dinitrophenol	µg/kg dw	110 UJ	110 UJ	110 UJ	110 UJ	110 U	650 U	110 U	110 U	110 U		110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 UJ	110 U			
2,4-Dinitrotoluene	µg/kg dw	37 U	37 U	38 U	38 U	37 U	230 U	38 U	38 U	38 U		38 U	38 U	38 U	38 U	38 U	38 U	38 U	38 U	37 U			
2,6-Dinitrotoluene	µg/kg dw	52 U	52 U	53 U	53 U	52 U	320 U	53 U	53 U	53 U		53 U	53 U	53 U	53 U	54 U	53 U	53 U	53 U	52 U			
2-Chloronaphthalene	µg/kg dw	7.7 U	7.7 U	7.8 U	7.9 U	7.6 U	47 UJ	7.8 U	7.9 U	7.8 U		7.8 U	7.9 U	7.9 U	7.9 U	7.9 U	7.9 U	7.8 U	7.9 U	7.8 U			
2-Chlorophenol	µg/kg dw	7.3 U	7.2 U	7.3 U	7.4 U	7.2 U	44 U	7.3 U	7.4 U	7.4 U		7.3 U	7.4 U	7.4 U	7.4 U	7.5 U	7.4 U	7.3 U	7.4 U	7.3 U			
2-Methyl-4,6-dinitrophenol	µg/kg dw	82 U	81 U	82 U	83 U	80 UJ	500 UJ	82 UJ	83 UJ	83 UJ		82 U	83 U	83 U	83 U	84 U	83 U	82 U	83 U	82 UJ			
2-Nitroaniline	µg/kg dw	41 U	40 U	41 U	41 U	40 U	250 U	41 U	42 U	41 U		41 U	41 U	41 U	42 U	42 U	41 U	41 U	41 U	41 U			
2-Nitrophenol	µg/kg dw	39 U	39 U	39 U	39 U	38 U	230 U	39 U	40 U	39 U		39 U	39 U	39 U	40 U	40 U	39 U	39 U	39 U	39 U			
3,3'-Dichlorobenzidine	µg/kg dw	48 U	47 U	48 U	48 U	47 U	290 UJ	48 U		48 U		48 U	48 U	48 U	48 U	49 U	48 U	48 U	48 U	48 U			
3-Nitroaniline	µg/kg dw	74 U	74 U	75 U	76 U	73 UJ	450 UJ	75 UJ		75 UJ		74 U	75 U	76 U	76 U	76 U	75 U	75 U	76 U	74 UJ			
4-Bromophenyl-phenyl Ether	µg/kg dw	9.4 U	9.3 U	9.4 U	9.5 U	9.2 U	57 U	9.4 U	9.6 U	9.5 U		9.4 U	9.5 U	9.5 U	9.6 U	9.6 U	9.5 U	9.4 U	9.5 U	9.4 U			
4-Chloro-3-methylphenol	µg/kg dw	8.2 U	8.1 U	8.2 U	8.3 U	8 U	50 U	8.2 U	8.3 U	8.3 U		8.2 U	8.3 U	8.3 U	8.3 U	8.4 U	8.3 U	8.2 U	8.3 U	8.2 U			
4-Chloroaniline	µg/kg dw	34 U	34 U	34 U	35 U							34 U	34 U	34 U	35 U	35 U	34 U	34 U	35 U				
4-Chlorophenyl-phenyl Ether	µg/kg dw	8.2 U	8.1 U	8.2 U	8.3 U	8 U	50 U	8.2 U	8.3 U	8.3 U		8.2 U	8.3 U	8.3 U	8.3 U	8.4 U	8.3 U	8.2 U	8.3 U	8.2 U			
4-Nitroaniline	µg/kg dw	50 U	50 U	50 U	51 U	49 U	300 U	50 U	51 U	50 U		50 U	51 U	51 U	51 U	51 U	51 U	50 U	51 U	50 U			
4-Nitrophenol	µg/kg dw	64 U	64 U	65 UJ	66 UJ	63 U	390 U	65 U	66 U	65 U		65 UJ	65 UJ	66 UJ	66 UJ	66 U	65 U	65 U	66 U	65 U			
bis(2-chloroethoxy)methane	µg/kg dw	8.6 U	8.6 U	8.7 U	8.8 U	8.5 U	52 U	8.7 U	8.8 U	8.7 U		8.7 U	8.8 U	8.8 U	8.8 U	8.8 U	8.8 U	8.7 U	8.8 U	8.6 U			
bis(2-chloroethyl)ether	µg/kg dw	7.3 U	7.2 U	7.3 U	7.4 U	7.2 U	44 UJ	7.3 U	7.4 UJ	7.4 U		7.3 U	7.4 U	7.4 U	7.4 U	7.5 U	7.4 U	7.3 U	7.4 U	7.3 U			
Carbazole	µg/kg dw	14 JQ	6.4 U	30	51	24	39 U	21	26	10 JQ		36	30	37	27	6.6 U	6.6 U	6.5 U	6.6 U	6.5 U			
Hexachloroethane	µg/kg dw	7 U	7 U	7 U	7.1 U	6.9 U	42 U	7.1 U	7.2 U	7.1 U		7 U	7.1 U	7.1 U	7.1 U	7.2 U	7.1 U	7.1 U	7.1 U	7 U			
Hexachlorocyclopentadiene	µg/kg dw	43 U	43 U	43 U	44 U	42 U	260 UJ	43 U	44 UJ	43 U		43 U	43 U	44 U	44 U	44 U	44 U	43 U	44 U	43 U			
Isophorone	µg/kg dw	8.1 U	8 U	8.1 U	8.2 U	7.9 U	49 U	8.1 U	8.2 U	8.1 U		8.1 U	8.2 U	8.2 U	8.2 U	8.3 U	8.2 U	8.1 U	8.2 U	8.1 U			
Nitrobenzene	µg/kg dw	8.6 U	8.5 U	8.6 U	8.7 U	8.4 U	52 UJ	8.6 U	8.7 U	8.7 U		8.6 U	8.7 U	8.7 U	8.7 U	8.8 U	8.7 U	8.6 U	8.7 U	8.6 U			
N-nitroso-di-n-propylamine	µg/kg dw	35 U	35 U	35 U	36 U	34 U	210 U	35 U	36 U	35 U		35 U	35 U	35 U	36 U	36 U	35 U	35 U	36 U	35 U			
Retene	µg/kg dw	70	120	690	1,100	17	53 U	42	100	32	54	160	670	290	190	13	8.8 U	47	10				
Total Petroleum Hydrocarbons																							
#2 Diesel	mg/kg dw						54 JQ					49	42 JQ	200	38 JQ	14 U	18 JQ	8 U	7.7 U	13 JQ	15 JQ		9.8 J
Motor Oil	mg/kg dw						160					160	120	290	96	20 JQ	8 U	9.4 JQ	7.6 U	31 JQ	9 JQ		7.8 J

Notes:

Source: Exponent, Inc. 2008. *Environmental Baseline Investigation, DNR Lease 22-077766: Nippon Paper Industries USA Co., Ltd., Port Angeles, Washington.* Prepared for Nippon Paper Industries USA Co., Ltd. October.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

5 Calculated using detected cPAH concentrations.

6 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethylene
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.7
Nippon Environmental Baseline Investigation, DNR Lease 22-077766

Station ID		NPI-L1	NPI-L2	NPI-L3	NPI-PA1	NPI-PA2	NPI-PA3	NPI-PA4	NPI-PA5	NPI-PA6		NPI-PA8	NPI-PA9	NPI-PA10		LA01A-01	LA02A-01	LA03A-01
Sample ID		LP-1/ NPI-L1-01	LP-2/ NPI-L2-01	LP-3/ NPI-L3-01	PA-1/ NPI-PA1-01	PA-2/ NPI-PA2-01	PA-3/ NPI-PA3-01	PA-4/ NPI-PA4-01	PA-5/ NPI-PA5-01	PA-6/ NPI-PA6-01	PA-6/ NPI-PA6-02	PA-8/ NPI-PA8-01	PA-9/ NPI-PA9-01	PA-10/ NPI-PA10-01	PA-10/ NPI-PA10-02	LA01A-1	LA02A-1	LA03A-1
Sample Date		2/28/2008	2/27/2008	2/27/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	3/17/2008	3/17/2008	3/17/2008	3/17/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH002	No	No	WPAH049	No	WPAH009	WPAH010	No	WPAH011	WPAH011	WPAH004	WPAH005	WPAH007	WPAH007	No	WPAH001	No
Analyte	**Units**																	
Conventionals																		
Sulfides	mg/kg dw	520	0.16 J	390	3,600	7,100	1,500	770	2,300	830	1,000	930	1,400	870	780	390	380	560
Total Organic Carbon	%	14.6	2.15	3.43	13.1	23.8	14.1	12	8	8.44	8.69	18.3	11.1	11	10.8	18.8	12.6	16.3
Total Solids	%	25.5	74.1	51.2	17.9	11.7	20.4	22.7	24.7	25.1	24.9	25.1	26.7	29.4	29.5	22.7	28.8	26.9
Total Volatile Solids	%	30.6	4.89	9.24	29.9	42	33.4	27.6	20.9	20.3	20.2	44.4	24.4	24.4	25.4			
Particle/Grain Size																		
Percent Clay	%	24	2.5	10	29	44	26	25	21	25	25	15	16	13	14			
Percent Silt	%	34	4	28	28	28	32	38	57	47	43	30	48	36	37			
Percent Gravel	%	6.4	22	1.3	7.8	14	11	12	7.3	8.6	12	16	2.7	3	6			
Phi Class -1.00+ to 0.00	%	5.3	12	6.9	7.2	3.4	8.2	4.8	6.4	3	2.9	8.8	5.1	4.5	5.4			
Phi Class 0.00+ to 1.00	%	7.8	11	11	6.1	1.8	4.8	4.6	3.2	2.4	3.1	4.1	7.7	4.9	6.9			
Phi Class 1.00+ to 2.00	%	8.9	18	15	8.3	1.3	5.8	4.7	2.6	4.1	3	4.5	9.1	10	8.4			
Phi Class 2.00+ to 3.00	%	8.1	11	18	6.2	1.6	3.8	3.7	1.6	2.6	2.2	4.5	7.9	9.8	9.7			
Phi Class 3.00+ to 4.00	%	2.6	1.4	4.7	1.8	0.34	0.94	0.82	0.68	1.1	1.1	1.8	2.9	5.2	4.6			
Metals																		
Arsenic	mg/kg dw	11	2.4	3.8	14	11	15	11	8.6	11	10	16	14	11	12			
Cadmium	mg/kg dw	6	0.23	1.2	4.5	2.9	8.1	6.9	1.6	4.3	4.2	3.7	4.3	2.9	3	6.4	7.6	5.7
Copper	mg/kg dw	51	17	27	52	32	67	63	27	45	44	39	46	43	46			
Mercury	mg/kg dw	0.61	0.052	0.1	0.54	0.43	1.5	2.7	0.26	1.3	1.3	0.67	1.1	0.66	0.56	0.57	0.59	0.59
Zinc	mg/kg dw	410	39	74	240	140	1,700	1,300	110	370	360	240	330	250	280	340	370	390
Dioxins/Furans																		
2,3,7,8-TCDD	ng/kg dw	13.6	0.564	2.41	3.38	1.86	3.83	4.18	0.875	2	2.11	1.81	2.2	1.61	1.62	16.6	11.1	10
1,2,3,7,8-PeCDD	ng/kg dw	16.3	1.21	3.84	7.56	5.51	8.16	12.9	2.68	6.31	5.65	4.71	5.98	4.56	4.5	15.3	17.1	14.7
1,2,3,4,7,8-HxcDD	ng/kg dw	19	1.31 J	4.81	12	5.7	9.14	11.7	2.55	5.99	5.41	5.5	6.57	5.51	5.29	21.9	22.1	21
1,2,3,6,7,8-HxCDD	ng/kg dw	95.7	6.68	13.7	70.1	44.3	133	157	16.2	60	58.8	54.5	63.2	52	50.7	70.8	71.1	79.9
1,2,3,7,8,9-HxCDD	ng/kg dw	34.5	2.94	8.21	22.3	10	23.1	30.6	6.16	14	13.2	12	14	13.1	13.1	32.6	31.5	33.6
1,2,3,4,6,7,8-HpCDD	ng/kg dw	1,280	79.2	206	1,760	651	3,420	3,680	305	1,400	1,280	1,410	1,570	1,180	1,140	1,270	1,230	1,270
Total OCDD	ng/kg dw	8,770	504	1,300	17,900	4,940	29,000	26,900	2,280	12,700	9,580	14,000	15,100	8,720	9,930	11,900	8,660	10,800
2,3,7,8-TCDF	ng/kg dw	13.6	0.915	3.59	8.09	6.09	8.86	11	2.88	6.29	6.6	4.59	5.51	5.73	5.65	11	19.4	14.2
1,2,3,7,8-PeCDF	ng/kg dw	7.26	0.562	2.03	4.25	3.99	6.46	6.67	1.47	3.44	3.62	2.83	3.39	2.68	2.59	6.53	9.28	7.52
2,3,4,7,8-PeCDF	ng/kg dw	14.9	1.14	3.36	9.86	7.12	16.2	14.3	2.61	7.07	7.09	6.64	7.65	5.85	5.38	12.1	16.1	14.8
1,2,3,4,7,8-HxCDF	ng/kg dw	15.4	1.35	3.29	13.1	7.03	28.5	24	2.89	10.1	10.2	8.26	10.6	8.11	7.59	14.3	15.4	14.4
1,2,3,6,7,8-HxCDF	ng/kg dw	13.4	1.04	3.25	8.87	5.12	13	13.5	1.75 J	5.66	5.6	5.15	6.45	5.12	4.82	13.5	12.2	12.2
1,2,3,7,8,9-HxCDF	ng/kg dw	21.9	1.61	4.7	15.3	7.84	20.7	21.1	2.81	8.63	8.65	8.74	10.4	7.84	7.95	19.5	18.3	18.7
2,3,4,6,7,8-HxCDF	ng/kg dw	3.62	0.424	0.762	3.26	1.48	5.61	4.51	0.726 J	1.88	1.66	1.96	2.26	2.15	1.77	2.94	3.18	3.3
1,2,3,4,6,7,8-HpCDF	ng/kg dw	385	20.4	63.1	346	212	879	1,010	78.1	390	376	292	409	252	262	324	842	319
1,2,3,4,7,8,9-HpCDF	ng/kg dw	12.4	0.953	2.63	15.3	4.37	29.3	28.5	2.7	11.1	11	8.5	12.1	7.3	8.15	9.58	11.9	10.6
Total OCDF	ng/kg dw	661	36	114	1,330	378	2,810	3,300	214	1,820	1,150	782	1,760	650	1,000	1,000	3,140	922
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	75.9	4.93	14.7	56.3	28.7	94.1	105	12.6	44.2	40.9	40.2	47.4	35.2	34.9	74.3	77	68.6
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	75.9	4.93	14.7	56.3	28.7	94.1	105	12.6	44.2	40.9	40.2	47.4	35.2	34.9	74.3	77	68.6
Polychlorinated Biphenyls (PCBs)																		
Aroclor 1016	µg/kg dw	3.4 U	1.7 U	1.7 U	4.8 U	7.3 U	4.2 U	3.8 U	3.5 U	3.4 U	3.5 U	9.3 U	12 U	2.9 U	2.9 U	2.9 U	2.3 U	2.5 U
Aroclor 1221	µg/kg dw	3.4 U	1.7 U	1.7 U	4.8 U	7.3 U	4.2 U	3.8 U	3.5 U	3.4 U	3.5 U	40 U	20 U	2.9 U	2.9 U	2.9 U	2.3 U	2.5 U
Aroclor 1232	µg/kg dw	3.4 U	1.7 U	1.7 U	4.8 U	7.3 U	4.2 U	3.8 U	3.5 U	3.4 U	3.5 U	39 U	21 U	2.9 U	2.9 U	2.9 U	2.3 U	2.5 U

Table C.7
Nippon Environmental Baseline Investigation, DNR Lease 22-077766

Station ID		NPI-L1	NPI-L2	NPI-L3	NPI-PA1	NPI-PA2	NPI-PA3	NPI-PA4	NPI-PA5	NPI-PA6		NPI-PA8	NPI-PA9	NPI-PA10		LA01A-01	LA02A-01	LA03A-01
Sample ID		LP-1/ NPI-L1-01	LP-2/ NPI-L2-01	LP-3/ NPI-L3-01	PA-1/ NPI-PA1-01	PA-2/ NPI-PA2-01	PA-3/ NPI-PA3-01	PA-4/ NPI-PA4-01	PA-5/ NPI-PA5-01	PA-6/ NPI-PA6-01	PA-6/ NPI-PA6-02	PA-8/ NPI-PA8-01	PA-9/ NPI-PA9-01	PA-10/ NPI-PA10-01	PA-10/ NPI-PA10-02	LA01A-1	LA02A-1	LA03A-1
Sample Date		2/28/2008	2/27/2008	2/27/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	3/17/2008	3/17/2008	3/17/2008	3/17/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH002	No	No	WPAH049	No	WPAH009	WPAH010	No	WPAH011	WPAH011	WPAH004	WPAH005	WPAH007	WPAH007	No	WPAH001	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
Aroclor 1242	µg/kg dw	5.8 J	6.6 U	7.4 U	19 J	7.3 U	17 U	19 J	3.5 U	10 J	9.2 J	8.7 U	12 U	16 J	9.3 J	2.9 U	2.3 U	2.5 U
Aroclor 1248	µg/kg dw	3.4 U	1.7 U	1.7 U	4.8 U	7.3 U	4.2 U	3.8 U	3.5 U	3.4 U	3.5 U	3.4 U	3.2 U	2.9 U	2.9 U	2.9 U	2.3 U	2.5 U
Aroclor 1254	µg/kg dw	45	8	9.7 J	55	7.3 U	31	40	11 J	18 J	26	17 J	33	37	32	36	23	68
Aroclor 1260	µg/kg dw	3.4 U	1.7 U	1.7 U	4.8 U	7.3 U	4.2 U	3.8 U	3.5 U	3.4 U	3.5 U	3.4 U	25 J	15 J	12 J	2.9 U	2.3 U	2.5 U
Total PCBs, Aroclors	µg/kg dw	51 J	8	9.7 J	74 J	7.3 U	31	59 J	11 J	28 J	35 J	17 J	58	68 J	53 J	36	23	68
Aroclor 1016	mg/kg OC		0.079 U	0.05 U														
Aroclor 1221	mg/kg OC		0.079 U	0.05 U														
Aroclor 1232	mg/kg OC		0.079 U	0.05 U														
Aroclor 1242	mg/kg OC		0.31 U	0.22 U														
Aroclor 1248	mg/kg OC		0.079 U	0.05 U														
Aroclor 1254	mg/kg OC		0.37	0.28 J														
Aroclor 1260	mg/kg OC		0.079 U	0.05 U														
Total PCBs, Aroclors	mg/kg OC		0.37	0.28 J														
PCB-1	ng/kg dw											10,000 U	9,400 U	8,500 U	8,500 U			
PCB-5	ng/kg dw											1,000 U	230 U	850 U	850 U			
PCB-8	ng/kg dw	1,200 U	190 U	390 U	1,400 U	2,200 U	1,300 U	1,100 U	2,000 U	380 U	1,100 U					1,100 U	870 U	930 U
PCB-18	ng/kg dw	970 J	240 U	240 U	1,400 U	1,600 U	590 U	790 U	490 U	480 U	490 U	1,000 U	610 J	810 J	720 J	530 U	420 U	680 J
PCB-28	ng/kg dw	1,000	710	590	1,800	360 U	1,700	1,700	420 J	910 J	1,000 J					1,100	1,300	1,300
PCB-31	ng/kg dw											1,100 U	1,000	1,100	970			
PCB-44	ng/kg dw	980 J	740	240 J	1,400	420 U	1,400	1,800	200 U	540 J	520 J	570 J	980	1,300	1,100	1,200	770 J	2,300
PCB-52	ng/kg dw	2,000	900	380 J	2,500	850 U	2,400 J	2,700	560 J	970 J	980 J	1,200	1,600	1,800	1,600	2,300	1,800	4,000
PCB-60	ng/kg dw	1,800 U	400 U	410 J	3,000 U	600 U	2,100 U	2,300 U	1,100 U	1,100 U	890 U					310 U	870 U	930 U
PCB-66	ng/kg dw	1,400 J	400 J	330 J	1,700 J	350 U	2,000 J	2,000 J	790 U	820 J	700 J	1,100 J	2,000 J	1,400 J	1,100 J	1,200 J	1,300 J	2,500 J
PCB-77	ng/kg dw	990 U	160 U	160 U	1,400 U	1,200 U	1,300 U	1,100 U	330 U	320 U	330 U					1,100 U	870 U	1,100 U
PCB-81	ng/kg dw	5,100	880	1,100	4,300 U	1,100 U	3,700 U	4,300 U	1,100	2,000 U	2,200 U					3,300 J	2,800	8,000 J
PCB-87	ng/kg dw	1,500 J	230 J	300 J	2,900 J	650 U	1,300 U	1,300 U	370 J	1,000 U	1,100 U	790 J	1,400	1,600	1,400	1,400	1,100 J	3,500
PCB-90	ng/kg dw	1,300 U	250 U	490 U	3,800 U	730 U	1,500 U	1,900 U	330 U	590 U	670 U					860 J	780 J	2,000 U
PCB-101	ng/kg dw	4,400	550	850	4,200	820 J	2,900	3,800	910 J	1,600	1,700	1,600	3,000	3,400	3,300	3,100	2,700 U	7,400
PCB-105	ng/kg dw	1,700	280 J	340 J	1,700	560 U	1,100 J	1,200	300 J	580 J	580 J					1,000 J	930	2,800 J
PCB-110	ng/kg dw											1,500	2,500	3,100	2,800			
PCB-114	ng/kg dw	160 U	77 U	77 U	220 U	330 U	190 U	170 U	160 U	160 U	160 U					170 U	140 U	210 J
PCB-118	ng/kg dw	3,600	570	820	4,000	560 U	2,100	2,700	900 J	1,400	1,500					2,300	1,800	6,300
PCB-123	ng/kg dw	990 U	130 U	130 U	1,400 U	560 U	320 U	290 U	270 U	260 U	270 U					1,100 U	230 U	1,100 J
PCB-126	ng/kg dw	690 U	350 U	350 U	970 U	1,500 U	860 U	770 U	710 U	700 U	710 U					770 U	610 U	660 U
PCB-128	ng/kg dw	1,100	270 J	180 J	1,500	600 U	1,000 J	1,000 J	290 U	440 J	590 J					640 J	550 J	1,500
PCB-138	ng/kg dw	4,100	850	840	5,300	780 J	3,000	3,300	930 J	1,700	2,200	1,200	5,400	2,800	2,500	2,900	2,700	7,100
PCB-141	ng/kg dw											200 U	850 J	460 J	470 J			
PCB-151	ng/kg dw											260 J	690 J	490 J	540 J			
PCB-153	ng/kg dw	4,100	770	850	3,400	770 U	3,300	4,400 J	1,100 J	2,300 J	2,600 J	1,400 J	5,400	2,900	1,900	1,800 J	1,500 J	4,100
PCB-156	ng/kg dw	430 J	150 J	490 U	1,100 J	330 U	240 J	270 J	160 U	170 J	280 J					540 J	420 U	1,300
PCB-157	ng/kg dw	280 U	140 U	140 U	390 U	600 U	350 U	310 U	290 U	280 U	290 U					310 U	250 U	270 U
PCB-158	ng/kg dw	650 J	170 U	170 U	770 J	730 U	420 U	580 J	350 U	340 U	350 U					380 U	300 U	870 J
PCB-166	ng/kg dw	710 U	360 U	360 U	1,000 U	1,600 U	890 U	790 U	730 U	720 U	730 U					790 U	630 U	670 U

Table C.7
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Station ID		NPI-L1	NPI-L2	NPI-L3	NPI-PA1	NPI-PA2	NPI-PA3	NPI-PA4	NPI-PA5	NPI-PA6		NPI-PA8	NPI-PA9	NPI-PA10		LA01A-01	LA02A-01	LA03A-01
Sample ID		LP-1/ NPI-L1-01	LP-2/ NPI-L2-01	LP-3/ NPI-L3-01	PA-1/ NPI-PA1-01	PA-2/ NPI-PA2-01	PA-3/ NPI-PA3-01	PA-4/ NPI-PA4-01	PA-5/ NPI-PA5-01	PA-6/ NPI-PA6-01	PA-6/ NPI-PA6-02	PA-8/ NPI-PA8-01	PA-9/ NPI-PA9-01	PA-10/ NPI-PA10-01	PA-10/ NPI-PA10-02	LA01A-1	LA02A-1	LA03A-1
Sample Date		2/28/2008	2/27/2008	2/27/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	3/17/2008	3/17/2008	3/17/2008	3/17/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH002	No	No	WPAH049	No	WPAH009	WPAH010	No	WPAH011	WPAH011	WPAH004	WPAH005	WPAH007	WPAH007	No	WPAH001	No
Analyte	**Units**																	
Polychlorinated Biphenyls (cont.)																		
PCB-167	ng/kg dw	820 U	180 U	300 J	1,200 U	490 U	660 U	810 U	230 U	490 U	610 U					870 U	690 U	1,300 J
PCB-169	ng/kg dw	300 U	150 U	150 U	420 U	650 U	370 U	330 U	310 U	300 U	310 U					330 U	260 U	280 U
PCB-170	ng/kg dw	690 J	220 J	350 J	860 J	690 U	670 U	800 J	330 U	400 J	540 J	330 J	1,800	1,400 J	1,600 J	860 J	610 J	840 J
PCB-180	ng/kg dw	1,400	320 J	300 J	1,700	460 J	1,400	1,800	500 J	910 J	1,200	670 J	3,200	1,400	1,400	1,600	1,400	2,400
PCB-183	ng/kg dw	590 J	100 J	150 J	540 U	340 U	570 U	790 J	160 U	260 U	380 U	160 U	1,200	710 J	650 J	1,100 U	870 U	500 U
PCB-184	ng/kg dw	990 U	340 U	280 J	1,400 U	810 U	170 U	880 J	140 U	1,000 U	1,100 U					1,100 U	870 U	930 U
PCB-187	ng/kg dw	880 J	270 U	400 J	920 J	1,200 U	810 J	1,100	550 U	540 U	720 J	540 U	1,700	920	900	740 J	650 J	1,100
PCB-189	ng/kg dw	220 U	110 U	110 U	1,400 U	470 U	270 U	250 U	1,100 U	220 U	230 U					250 U	190 U	210 U
PCB-195	ng/kg dw	360 U	180 U	180 U	500 U	770 U	700 J	820 J	370 U	360 U	370 U					400 U	320 U	340 U
PCB-206	ng/kg dw	370 J	94 U	110 U	350 U	410 U	490 U	270 J	190 U	190 U	190 U	190 U	940 U	160 U	160 U	280 J	170 U	260 J
PCB-209	ng/kg dw	760 U	120 U	120 U	340 U	520 U	300 U	890 U	250 U	270 J	250 U					270 U	210 U	230 U
Total PCBs, Congeners	ng/kg dw	17,000 J	3,400 J	4,900 J	12,000 J	2,200 U	9,100 J	14,000 J	2,900 J	4,400 J	5,000 J	4,100 J	13,000 J	11,000 J	10,000 J	12,000 J	9,900 J	29,000 J
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	1.7	0.29	0.37	0.2	150 U	0.1	0.13	0.37	0.065	0.071					1.1	0.92	2.8
Other																		
Total TEQ	ng/kg dw	77.6	5.22	15.1	56.5	179	94.2	105	13	44.2	41	40.4	47.7	35.4	35.1	75.4	77.9	71.4
Aromatic Hydrocarbons																		
Total LPAH	µg/kg dw	450 J	54 J	690 J	720 J	260 J	1,400 J	390 J	110 J	230 J	300 J	500 J	360 J	520 J	2,900 J			
Naphthalene	µg/kg dw	120 J	23 U	23 U	65 U	50 U	240 J	120 J	11 J	49 J	60	45	44 U	37 J	84 J			
Acenaphthylene	µg/kg dw	31 J	12 U	23 J	69 J	26 U	55 J	23 J	7.6 J	16 J	23	36	34 J	44 J	48 J			
Acenaphthene	µg/kg dw	28 J	14 U	22 J	45 J	30 U	58 J	24 J	5.7 U	7.7 J	11 J	20 J	27 U	24 J	23 J			
Fluorene	µg/kg dw	36 J	11 U	34 J	79 J	33 J	120 J	36 J	8.9 J	16 J	24	42	38 J	40 J	280 J			
Phenanthrene	µg/kg dw	170 J	54 J	520 J	390 J	170 J	480 J	130 J	57 J	110 J	120	240	190 J	250 J	970 J			
Anthracene	µg/kg dw	67 J	16 U	87 J	140 J	57 J	420 J	55 J	22 J	35 J	61	120	93 J	120 J	1,500 J			
2-Methylnaphthalene	µg/kg dw	45 J	22 U	22 U	62 U	47 U	140 J	41 J	12 J	16 J	23	18 J	42 U	19 U	65 J			
Total HPAH	µg/kg dw	1,200 J	390 J	6,300	4,100 J	1,200 J	5,200 J	880 J	560 J	920 J	1,200 J	3,000	2,600 J	3,300 J	5,900 J			
Fluoranthene	µg/kg dw	240 J	77 J	1,400 J	980 J	230 J	1,100 J	160 J	110 J	210 J	250	730	520 J	700 J	1,200 J			
Pyrene	µg/kg dw	260 J	83 J	1,000 J	690 J	220 J	1,100 J	160 J	87 J	180 J	190	550	410 J	590 J	900 J			
Benzo(a)anthracene	µg/kg dw	93 J	28 J	520 J	320 J	110 J	440 J	72 J	55 J	70 J	120	190	240 J	250 J	590 J			
Chrysene	µg/kg dw	140 J	69 J	700 J	740 J	220 J	1,300 J	170 J	87 J	160 J	230	530	550 J	590 J	1,300 J			
Total Benzofluoranthenes	µg/kg dw	180 J	44	1,100	720	190 J	680	150	110	170	240	570	540	710	1,100			
Benzo(b)fluoranthene	µg/kg dw	140 J	44 J	840 J	530 J	140 J	510 J	110 J	85 J	130 J	170	450	410 J	530 J	860 J			
Benzo(k)fluoranthene	µg/kg dw	43 J	14 U	270 J	190 J	49 J	170 J	35 J	27 J	40 J	71	120	130 J	180 J	260 J			
Benzo(a)pyrene	µg/kg dw	110 J	30 J	560 J	270 J	90 J	240 J	61 J	43 J	57 J	90	180	180 J	200 J	430 J			
Benzo(g,h,i)perylene	µg/kg dw	61 J	37 J	440 J	170 J	65 J	120 J	44 J	26 J	31 J	42	85	73 J	87 J	150 J			
Indeno(1,2,3-cd)pyrene	µg/kg dw	70 J	26 J	500 J	180 J	57 J	150 J	51 J	30 J	37 J	53	110	97 J	110 J	200 J			
Dibenzo(a,h)anthracene	µg/kg dw	30 U	15 U	110 J	58 J	33 U	61 J	13 J	9.5 J	8.6 J	12 J	27	30 J	31 J	48 J			
Carcinogenic PAH TEQ, 0 DL[6,7]	µg/kg dw	150 J	40 J	790	410 J	130 J	390 J	91 J	65 J	87 J	130 J	280	280 J	320 J	640 J			
Carcinogenic PAH TEQ, 1/2 DL[6,8]	µg/kg dw	150 J	42 J	790	410 J	130 J	390 J	91 J	65 J	87 J	130 J	280	280 J	320 J	640 J			
Total LPAH	mg/kg OC		2.5 J	20 J														
Naphthalene	mg/kg OC		1.1 U	0.67 U														
Acenaphthylene	mg/kg OC		0.56 U	0.67 J														
Acenaphthene	mg/kg OC		0.65 U	0.64 J														
Fluorene	mg/kg OC		0.51 U	0.99 J														

Table C.7
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Station ID		NPI-L1	NPI-L2	NPI-L3	NPI-PA1	NPI-PA2	NPI-PA3	NPI-PA4	NPI-PA5	NPI-PA6		NPI-PA8	NPI-PA9	NPI-PA10		LA01A-01	LA02A-01	LA03A-01
Sample ID		LP-1/ NPI-L1-01	LP-2/ NPI-L2-01	LP-3/ NPI-L3-01	PA-1/ NPI-PA1-01	PA-2/ NPI-PA2-01	PA-3/ NPI-PA3-01	PA-4/ NPI-PA4-01	PA-5/ NPI-PA5-01	PA-6/ NPI-PA6-01	PA-6/ NPI-PA6-02	PA-8/ NPI-PA8-01	PA-9/ NPI-PA9-01	PA-10/ NPI-PA10-01	PA-10/ NPI-PA10-02	LA01A-1	LA02A-1	LA03A-1
Sample Date		2/28/2008	2/27/2008	2/27/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	2/28/2008	3/17/2008	3/17/2008	3/17/2008	3/17/2008	7/23/2008	7/23/2008	7/23/2008
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample
Reoccupied		WPAH002	No	No	WPAH049	No	WPAH009	WPAH010	No	WPAH011	WPAH011	WPAH004	WPAH005	WPAH007	WPAH007	No	WPAH001	No
Analyte	**Units**																	
Aromatic Hydrocarbons (cont.)																		
Phenanthrene	mg/kg OC		2.5 J	15 J														
Anthracene	mg/kg OC		0.74 U	2.5 J														
2-Methylnaphthalene	mg/kg OC		1 U	0.64 U														
Total HPAH	mg/kg OC		18 J	180														
Fluoranthene	mg/kg OC		3.6 J	41 J														
Pyrene	mg/kg OC		3.9 J	29 J														
Benzo(a)anthracene	mg/kg OC		1.3 J	15 J														
Chrysene	mg/kg OC		3.2 J	20 J														
Total Benzofluoranthenes	mg/kg OC		2	32														
Benzo(b)fluoranthene	mg/kg OC		2 J	24 J														
Benzo(k)fluoranthene	mg/kg OC		0.65 U	7.9 J														
Benzo(a)pyrene	mg/kg OC		1.4 J	16 J														
Benzo(g,h,i)perylene	mg/kg OC		1.7 J	13 J														
Indeno(1,2,3-cd)pyrene	mg/kg OC		1.2 J	15 J														
Dibenzo(a,h)anthracene	mg/kg OC		0.7 U	3.2 J														
Carcinogenic PAH TEQ, 0 DL[6,7]	mg/kg OC		1.9 J	23														
Carcinogenic PAH TEQ, 1/2 DL[6,8]	mg/kg OC		2 J	23														
Phthalate Esters																		
Dimethyl Phthalate	µg/kg dw	20 U	10 U	10 U	28 U	22 U	25 U	4.4 U	4.1 U	4 U	2.1 U	2 U	19 U	8.5 U	8.5 U			
Diethyl Phthalate	µg/kg dw	26 U	13 U	13 U	37 U	28 U	32 U	5.8 U	6.2 J	5.2 U	2.7 U	8.8 J	25 U	12 U	13 J			
Di-n-butyl Phthalate	µg/kg dw	160 U	79 U	79 U	230 U	170 U	200 U	35 U	32 U	32 U	24 J	16 U	150 U	68 U	67 U			
Butylbenzyl Phthalate	µg/kg dw	63 U	32 U	32 U	90 U	69 U	79 U	15 U	13 U	13 U	6.5 U	52	60 U	28 U	28 U			
bis(2-ethylhexyl)phthalate	µg/kg dw	140 U	70 U	380 J	210 J	150 U	180 U	31 U	60 J	43 J	36 J	23 J	140 U	220 J	60 U			
Di-n-octyl Phthalate	µg/kg dw	34 U	17 U	17 U	48 U	37 U	42 U	7.5 U	6.9 U	6.8 U	3.5 U	3.4 U	32 U	15 U	15 U			
Dimethyl Phthalate	mg/kg OC		0.47 U	0.29 U														
Diethyl Phthalate	mg/kg OC		0.6 U	0.38 U														
Di-n-butyl Phthalate	mg/kg OC		3.7 U	2.3 U														
Butylbenzyl Phthalate	mg/kg OC		1.5 U	0.93 U														
bis(2-ethylhexyl)phthalate	mg/kg OC		3.3 U	11 J														
Di-n-octyl Phthalate	mg/kg OC		0.79 U	0.5 U														
Miscellaneous Nonionizable Organic Compounds																		
Dibenzofuran	µg/kg dw	42 J	12 U	21 J	53 J	26 U	79 J	31 J	5.6 J	11 J	16 J							
Dibenzofuran	mg/kg OC		0.56 U	0.61 J														

Notes:

Source: Washington State Department of Ecology. 2012. *Sediment Investigation Report, Port Angeles Harbor Sediment Characterization Study, Port Angeles, Washington.* December.

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).

2 Calculated using detected dioxin/furan concentrations.

3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

4 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ and dioxin-like PCB congener TEQ (Van den Berg et al. 2006).

5 Calculated using detected congener concentrations.

6 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

7 Calculated using detected cPAH concentrations.

8 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DL Detection limit
DNR Washington State Department of Natural Resources
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
mg/kg OC Milligrams per kilogram organic carbon normalized
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.8
City of Port Angeles Former Rayonier WWTP Outfall Sediment Baseline Monitoring

Station ID		PASED-01	PASED-02	PASED-03	PASED-04	PASED-05	PASED-06
Sample ID		PASED-1	PASED-2	PASED-3	PASED-4	PASED-5	PASED-6
Sample Date		9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No
Analyte	**Units**						
Conventionals							
Sulfides	mg/kg dw	4.5	1.6 U	16	4.3	2.5	1.4 U
Total Organic Carbon	%	0.541	0.55	0.532	0.5	0.667	0.51
Total Solids	%	67.7	75.9	66.2	67.9	67	70.6
Total Solids, Preserved	%	64	63	65	68	61	69
Nutrients							
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	9.8	11	26	7.7	8.5	13
Particle/Grain Size							
Phi Class 10.00+	%	4.2	2.6	2.4	4.4	4.9	4.1
Phi Class 9.00+ to 10.00	%	1.8	1.2	3.2	2	2.1	1.7
Phi Class 8.00+ to 9.00	%	1.9	1.1	2.1	2	2.2	1.7
Phi Class 7.00+ to 8.00	%	1.9	1.1	2	1.6	2.2	1.4
Phi Class 6.00+ to 7.00	%	2.6	1.5	2.5	2.9	2.9	2.1
Phi Class 5.00+ to 6.00	%	3.6	2.3	3.6	3.7	4.2	3.5
Percent Fines (clay & silt)	%	25	17	25	24	27	22
Phi Class 4.00+ to 5.00	%	8.4	7.2	9.3	7.6	8.8	7.8
Phi Class 3.00+ to 4.00	%	46	26	51	46	49	49
Phi Class 2.00+ to 3.00	%	20	13	21	25	21	23
Phi Class 1.00+ to 2.00	%	5.6	11	1.6	1.3	1.5	1.7
Phi Class 0.00+ to 1.00	%	2.4	8.1	0.7	1.2	0.9	1.5
Phi Class -1.00+ to 0.00	%	1	6.7	0.2	1.1	0.3	1.1
Phi Class < -1.00	%	1	18	0.2	0.5	0.1	1.4
Metals							
Arsenic	mg/kg dw	7 U	7 U	7 U	7 U	7 U	7 U
Cadmium	mg/kg dw	0.4	0.3	0.3	0.4	0.4	0.4
Chromium	mg/kg dw	26	23	28	34	28	26
Copper	mg/kg dw	17	19	17	17	18	16
Lead	mg/kg dw	5	4	5	6	6	5
Mercury	mg/kg dw	0.03 U	0.03 U	0.03 U	0.03 U	0.03	0.03
Silver	mg/kg dw	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Zinc	mg/kg dw	56	48	60	60	61	58
Polychlorinated Biphenyls (PCBs)							
Aroclor 1016	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1221	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1232	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1242	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1248	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1254	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1260	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Total PCBs, Aroclors	µg/kg dw	3.9 U	3.9 U	4 U	3.9 U	3.9 U	3.9 U
Aroclor 1016	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1221	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1232	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1242	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1248	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1254	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aroclor 1260	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Total PCBs, Aroclors	mg/kg OC	0.72 U	0.71 U	0.75 U	0.78 U	0.58 U	0.76 U
Aromatic Hydrocarbons							
Total LPAH	µg/kg dw	10 J	19 U	20 U	19 U	20 U	19 U
Naphthalene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Acenaphthylene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Acenaphthene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Fluorene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Phenanthrene	µg/kg dw	10 J	19 U	20 U	19 U	20 U	19 U
Anthracene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
2-Methylnaphthalene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Total HPAH	µg/kg dw	19 U	19 U	20 U	19 U	20 U	10 J
Fluoranthene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	10 J
Pyrene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Benzo(a)anthracene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U

Table C.8
City of Port Angeles Former Rayonier WWTP Outfall Sediment Baseline Monitoring

Station ID		PASED-01	PASED-02	PASED-03	PASED-04	PASED-05	PASED-06
Sample ID		PASED-1	PASED-2	PASED-3	PASED-4	PASED-5	PASED-6
Sample Date		9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No
Analyte	**Units**						
Aromatic Hydrocarbons (cont.)							
Chrysene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Total Benzofluoranthenes	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Benzo(b)fluoranthene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Benzo(k)fluoranthene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Benzo(a)pyrene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Benzo(g,h,i)perylene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Indeno(1,2,3-cd)pyrene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Dibenzo(a,h)anthracene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Carcinogenic PAH TEQ, 1/2 DL[1,2]	µg/kg dw	14 U	14 U	15 U	14 U	15 U	14 U
Total LPAH	mg/kg OC	1.8 J	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Naphthalene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Acenaphthylene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Acenaphthene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Fluorene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Phenanthrene	mg/kg OC	1.8 J	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Anthracene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
2-Methylnaphthalene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Total HPAH	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	2 J
Fluoranthene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	2 J
Pyrene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Benzo(a)anthracene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Chrysene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Total Benzofluoranthenes	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Benzo(b)fluoranthene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Benzo(k)fluoranthene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Benzo(a)pyrene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Benzo(g,h,i)perylene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Indeno(1,2,3-cd)pyrene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Dibenzo(a,h)anthracene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Carcinogenic PAH TEQ, 1/2 DL[1,2]	mg/kg OC	2.7 U	2.6 U	2.8 U	2.9 U	2.3 U	2.8 U
Chlorinated Benzenes							
1,2-Dichlorobenzene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
1,4-Dichlorobenzene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
1,2,4-Trichlorobenzene	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Hexachlorobenzene	µg/kg dw	0.98 U	0.98 U	0.99 U	0.98 U	0.98 U	0.98 U
1,2-Dichlorobenzene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
1,4-Dichlorobenzene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
1,2,4-Trichlorobenzene	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Hexachlorobenzene	mg/kg OC	0.18 U	0.18 U	0.19 U	0.2 U	0.15 U	0.19 U
Phthalate Esters							
Dimethyl Phthalate	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Diethyl Phthalate	µg/kg dw	19 U	26 U	20 U	19 U	20 U	19 U
Di-n-butyl Phthalate	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Butylbenzyl Phthalate	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
bis(2-ethylhexyl)phthalate	µg/kg dw	19 U	19 U	44 U	2,000 JB	20 U	19 U
Di-n-octyl Phthalate	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Dimethyl Phthalate	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Diethyl Phthalate	mg/kg OC	3.5 U	4.7 U	3.8 U	3.8 U	3 U	3.7 U
Di-n-butyl Phthalate	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Butylbenzyl Phthalate	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
bis(2-ethylhexyl)phthalate	mg/kg OC	3.5 U	3.5 U	8.3 U	400 JB	3 U	3.7 U
Di-n-octyl Phthalate	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Miscellaneous Nonionizable Organic Compounds							
Dibenzofuran	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Hexachlorobutadiene	µg/kg dw	0.98 U	0.98 U	0.99 U	0.98 U	0.98 U	0.98 U
N-nitrosodiphenylamine	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Dibenzofuran	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U
Hexachlorobutadiene	mg/kg OC	0.18 U	0.18 U	0.19 U	0.2 U	0.15 U	0.19 U
N-nitrosodiphenylamine	mg/kg OC	3.5 U	3.5 U	3.8 U	3.8 U	3 U	3.7 U

Table C.8
City of Port Angeles Former Rayonier WWTP Outfall Sediment Baseline Monitoring

Station ID		PASED-01	PASED-02	PASED-03	PASED-04	PASED-05	PASED-06
Sample ID		PASED-1	PASED-2	PASED-3	PASED-4	PASED-5	PASED-6
Sample Date		9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010	9/8/2010
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No
Analyte	**Units**						
Ionizable Organic Compounds							
Phenol	µg/kg dw	200 JB	180 JB	84 JB	99 JB	160 JB	110 JB
2-Methylphenol	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
4-Methylphenol	µg/kg dw	16 J	61	18 J	41	63	12 J
2,4-Dimethylphenol	µg/kg dw	19 U	19 U	20 U	19 U	20 U	19 U
Pentachlorophenol	µg/kg dw	96 U	96 U	98 U	97 U	98 U	97 U
Benzyl Alcohol	µg/kg dw	19 UJ	19 UJ	20 UJ	19 UJ	20 UJ	19 UJ
Benzoic Acid	µg/kg dw	190 U	190 U	200 U	190 U	200 U	190 U

Notes:

1 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.

2 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cPAH	Carcinogenic polycyclic aromatic hydrocarbon
cm	Centimeters
DL	Detection limit
HPAH	High molecular weight polycyclic aromatic hydrocarbon
LPAH	Low molecular weight polycyclic aromatic hydrocarbon
µg/kg dw	Migrograms per kilogram dry weight
mg/kg dw	Milligrams per kilogram dry weight
mg/kg OC	Milligrams per kilogram organic carbon normalized
QC	Quality control
WWTP	Waste water treatment plant

Qualifiers:

J	Analyte was detected, concentration is considered to be an estimate.
JB	Analyte was detected, concentration is considered to be an estimate due to potential blank contamination.
U	Analyte was not detected, concentration given is the reporting limit.
UJ	Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Conventionals				
Moisture Content	%	51.9	53.1	38.4
Sulfide	mg/kg dw	650	940	1,290
Total Organic Carbon	%	4.39	7.64	1.98
Total Solids	%	45.8	46.8	59.1
Total Volatile Solids	%	11.3	16.6	6.73
Nutrients				
Ammonia (NH3) as Nitrogen (N)	mg/kg dw	20	8.9	12
Particle/Grain Size				
Percent fines (clay & silt)	%	65	38	30
<0.98 µm	%	7.4	5.9	4
1.95–3.9 µm	%	3.8	2.8	1.9
3.9–7.8 µm	%	5.5	3.7	2.4
7.8–15.6 µm	%	9.1	4.8	3
15.6–31.3 µm	%	18	8.7	4.9
31.3–62.5 µm	%	17	9.5	12
62.5–125 µm	%	20	23	36
125–250 µm	%	6.7	11	23
250–500 µm	%	2.2	5.5	3.7
500–1,000 µm	%	1.4	4.2	1.2
1,000–2,000 µm	%	1.6	3.9	0.78
Percent Gravel	%	0.59	3.5	0.15
0.98–1.95 µm	%	3.8	2.7	1.8
Metals				
Arsenic	mg/kg dw	9.1	8.5	4.8
Cadmium	mg/kg dw	1.4	0.8	0.33
Chromium	mg/kg dw	33	27	28
Copper	mg/kg dw	40	36	32
Lead	mg/kg dw	13	9.4	7.5
Mercury	mg/kg dw	0.1	0.071	0.041
Silver	mg/kg dw	0.17	0.095	0.07
Zinc	mg/kg dw	88 J	66 J	58 J
Butyltins				
Dibutyltin	µg/kg dw	6.5	5 J	0.59 JQ
n-Butyltin Cation	µg/kg dw	2.9	2.5 J	0.52 JQ
Tri-n-butyltin Cation	µg/kg dw	24	13 J	1.3 JQ
Tetra-n-butyltin	µg/kg dw	2.2 U	2.1 UJ	1.7 U
Dioxins/Furans				
2,3,7,8-TCDD	ng/kg dw	0.67 J	1.15	0.341 J
1,2,3,7,8-PeCDD	ng/kg dw	1.86 J	2.85 J	0.54 J
1,2,3,4,7,8-HxCDD	ng/kg dw	2.27 J	2.2 J	0.475 J
1,2,3,6,7,8-HxCDD	ng/kg dw	11.1	8.21	1.85 J
1,2,3,7,8,9-HxCDD	ng/kg dw	9.53	7.58	1.3 J
1,2,3,4,6,7,8-HpCDD	ng/kg dw	417	253	40.2
Total OCDD	ng/kg dw	3,020	2,110	340
2,3,7,8-TCDF	ng/kg dw	2.36	6.16	0.598 J
1,2,3,7,8-PeCDF	ng/kg dw	1.58 J	3.13 J	0.393 U
2,3,4,7,8-PeCDF	ng/kg dw	2.42 J	5.12	0.591 J
1,2,3,4,7,8-HxCDF	ng/kg dw	2.58 J	2.88 J	0.587 J
1,2,3,6,7,8-HxCDF	ng/kg dw	1.89 J	2.18 J	0.402 J
1,2,3,7,8,9-HxCDF	ng/kg dw	0.223 J	0.234 J	0.094 U
2,3,4,6,7,8-HxCDF	ng/kg dw	1.75 J	2.16 J	0.343 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw	28.3	23.9	7.08
1,2,3,4,7,8,9-HpCDF	ng/kg dw	1.77 J	1.78 J	0.343 J
Total OCDF	ng/kg dw	67.2	153	32.4
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw	11.9 J	12.3 J	2.2 J
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw	11.9 J	12.3 J	2.21 J
Polychlorinated Biphenyls (PCBs)				
PCB-1	ng/kg dw	26	60	4.9 J
PCB-2	ng/kg dw	36	160	14 J
PCB-3	ng/kg dw	40	130	7.4

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Polychlorinated Biphenyls (cont.)				
PCB-4	ng/kg dw	28	61	6.8 J
PCB-5	ng/kg dw	3.3 J	7.3 J	0.94 U
PCB-6	ng/kg dw	29	35	4.3 J
PCB-7	ng/kg dw	8.3 J	9.8 J	0.88 J
PCB-8	ng/kg dw	100	130	20
PCB-9	ng/kg dw	9.9 J	12	1.1 J
PCB-10	ng/kg dw	1.8 J	2.9 J	0.8 U
PCB-11	ng/kg dw	53	63	32
PCB-12, 13	ng/kg dw	30	61	4.6 J
PCB-14	ng/kg dw	2.2 U	6.1 J	0.85 U
PCB-15	ng/kg dw	70	75	16
PCB-16	ng/kg dw	52	140	11
PCB-17	ng/kg dw	69	170	13
PCB-18, 30	ng/kg dw	130	330	30
PCB-19	ng/kg dw	11 J	42	2.8
PCB-20, 28	ng/kg dw	290	550	67
PCB-21, 33	ng/kg dw	130	280	29
PCB-22	ng/kg dw	88	180	21
PCB-23	ng/kg dw	0.5 U	4.7 U	0.1 U
PCB-24	ng/kg dw	2.1 J	7.4 J	0.31 J
PCB-25	ng/kg dw	25	36	4.6
PCB-26, 29	ng/kg dw	56	92	10
PCB-27	ng/kg dw	12 J	31	2.2
PCB-31	ng/kg dw	230	410	49
PCB-32	ng/kg dw	47	120	9.1
PCB-34	ng/kg dw	1.7 J	4.7 U	0.26 J
PCB-35	ng/kg dw	13 J	18	3
PCB-36	ng/kg dw	2.5 U	4.7 U	0.79 J
PCB-37	ng/kg dw	79	120	19
PCB-38	ng/kg dw	1 U	4.8 U	0.55 J
PCB-39	ng/kg dw	2.9 J	4.7 U	0.68 J
PCB-40, 41, 71	ng/kg dw	130	200	25
PCB-42	ng/kg dw	70	95	12
PCB-43	ng/kg dw	14 J	27	2
PCB-44, 47, 65	ng/kg dw	300	350	57
PCB-45, 51	ng/kg dw	39	72	6.9
PCB-46	ng/kg dw	14 J	26	2.5
PCB-48	ng/kg dw	55	88	9.7
PCB-49, 69	ng/kg dw	220	250	37
PCB-50, 53	ng/kg dw	35	55	6.1
PCB-52	ng/kg dw	440	510	84
PCB-54	ng/kg dw	0.68 J	0.99 J	0.13 J
PCB-55	ng/kg dw	12 J	30	1.5 J
PCB-56	ng/kg dw	130	160	29
PCB-57	ng/kg dw	1.5 J	2.5 J	0.37 J
PCB-58	ng/kg dw	1.3 U	1.7 U	0.19 U
PCB-59, 62, 75	ng/kg dw	27	39	4.7
PCB-60	ng/kg dw	77	110	18
PCB-61, 70, 74, 76	ng/kg dw	620	700	140
PCB-63	ng/kg dw	13 J	14	2.6
PCB-64	ng/kg dw	120	160	21
PCB-66	ng/kg dw	300	330	67
PCB-67	ng/kg dw	9.6 J	13	2
PCB-68	ng/kg dw	2.3 J	2 J	0.64 J
PCB-72	ng/kg dw	4.3 J	3.1 J	0.72 J
PCB-73	ng/kg dw	0.19 U	0.34 U	0.046 U
PCB-77	ng/kg dw	35	39	8.7
PCB-78	ng/kg dw	1.4 U	1.8 U	0.21 U
PCB-79	ng/kg dw	8.2 J	8 J	1.9
PCB-80	ng/kg dw	1.2 U	1.6 U	0.18 U

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Polychlorinated Biphenyls (cont.)				
PCB-81	ng/kg dw	1.6 U	2.2 U	0.39 U
PCB-82	ng/kg dw	77	82	20
PCB-83, 99	ng/kg dw	410	350	93
PCB-84	ng/kg dw	150	140	36
PCB-85, 116, 117	ng/kg dw	110	100	28
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	440	410	110
PCB-88, 91	ng/kg dw	77	73	18
PCB-89	ng/kg dw	5.5 J	7 J	1.3 J
PCB-90, 101, 113	ng/kg dw	750	660	180
PCB-92	ng/kg dw	130	120	29
PCB-93, 98, 100, 102	ng/kg dw	540	500	120
PCB-94	ng/kg dw	2.8 J	2.3 J	0.48 J
PCB-96	ng/kg dw	3.6 J	3.5 J	0.63 J
PCB-103	ng/kg dw	7.5 J	4.9 J	1.3 J
PCB-104	ng/kg dw	0.14 U	0.3 U	0.046 U
PCB-105	ng/kg dw	260	240	66
PCB-106	ng/kg dw	0.83 U	1.1 U	0.95 U
PCB-107, 124	ng/kg dw	26	25	6.7
PCB-109	ng/kg dw	46	40	13
PCB-110, 115	ng/kg dw	760	680	190
PCB-111	ng/kg dw	1.1 U	0.55 U	0.15 U
PCB-112	ng/kg dw	1 U	0.41 U	0.14 U
PCB-114	ng/kg dw	11 J	12	3.1
PCB-118	ng/kg dw	670	610	170
PCB-120	ng/kg dw	1.7 J	0.77 J	0.53 J
PCB-121	ng/kg dw	1 U	0.45 J	0.14 U
PCB-122	ng/kg dw	7.5 J	7 J	2.2
PCB-123	ng/kg dw	11 J	11	2.9
PCB-126	ng/kg dw	2.1 J	1.9 J	1.1 U
PCB-127	ng/kg dw	0.97 U	1.2 U	1 U
PCB-128, 166	ng/kg dw	160	210	42
PCB-129, 138, 160, 163	ng/kg dw	1,000	1,100	300
PCB-130	ng/kg dw	62	67	16
PCB-131	ng/kg dw	12 J	15	3
PCB-132	ng/kg dw	320	340	84
PCB-133	ng/kg dw	15 J	15	3.5
PCB-134, 143	ng/kg dw	53	56	12
PCB-135, 151, 154	ng/kg dw	340	340	82
PCB-136	ng/kg dw	110	110	26
PCB-137	ng/kg dw	41	52	11
PCB-139, 140	ng/kg dw	15 J	17	3.7
PCB-141	ng/kg dw	190	250	52
PCB-142	ng/kg dw	1.4 U	2.1 U	1.7 U
PCB-144	ng/kg dw	50	53	12
PCB-145	ng/kg dw	0.58 J	0.091 U	0.097 U
PCB-146	ng/kg dw	150	170	39
PCB-147, 149	ng/kg dw	820	790	210
PCB-148	ng/kg dw	1.3 J	1.1 J	0.24 J
PCB-150	ng/kg dw	1.3 J	1.4 J	0.32 J
PCB-152	ng/kg dw	0.68 J	0.89 U	0.15 U
PCB-153, 168	ng/kg dw	920	1,000	250
PCB-155	ng/kg dw	0.19 J	0.25 J	0.07 J
PCB-156, 157	ng/kg dw	100	130	31
PCB-158	ng/kg dw	110	120	29
PCB-159	ng/kg dw	15 J	16	4
PCB-161	ng/kg dw	0.99 U	1.5 U	1.2 U
PCB-162	ng/kg dw	3.7 J	3 J	1.3 U
PCB-164	ng/kg dw	67	75	20
PCB-165	ng/kg dw	1.1 U	1.8 U	1.4 U
PCB-167	ng/kg dw	37	44	11

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Polychlorinated Biphenyls (cont.)				
PCB-169	ng/kg dw	1.3 U	2 U	1.5 U
PCB-170	ng/kg dw	280	310	84
PCB-171, 173	ng/kg dw	92	110	25
PCB-172	ng/kg dw	50	63	15
PCB-174	ng/kg dw	270	330	77
PCB-175	ng/kg dw	13 J	18	4
PCB-176	ng/kg dw	38	48	10
PCB-177	ng/kg dw	170	190	48
PCB-178	ng/kg dw	60	71	17
PCB-179	ng/kg dw	120	150	32
PCB-180, 193	ng/kg dw	600	760	180
PCB-181	ng/kg dw	1.9 J	3.4 J	0.71 J
PCB-182	ng/kg dw	2.6 J	0.16 U	0.58 J
PCB-183, 185	ng/kg dw	210	270	58
PCB-184	ng/kg dw	0.42 U	0.55 U	0.088 J
PCB-186	ng/kg dw	0.22 U	0.13 U	0.046 U
PCB-187	ng/kg dw	370	530	95
PCB-188	ng/kg dw	0.72 U	0.42 J	0.19 J
PCB-189	ng/kg dw	10 J	12	3.1
PCB-190	ng/kg dw	56	68	16
PCB-191	ng/kg dw	14 J	19	3.7
PCB-192	ng/kg dw	0.27 J	0.16 U	0.048 U
PCB-194	ng/kg dw	170	200	49
PCB-195	ng/kg dw	62	83	20
PCB-196	ng/kg dw	89	120	25
PCB-197, 200	ng/kg dw	27	42	11 J
PCB-198, 199	ng/kg dw	190	250	54
PCB-201	ng/kg dw	24	34	8.2 J
PCB-202	ng/kg dw	37	50	12
PCB-203	ng/kg dw	120	160	35
PCB-204	ng/kg dw	0.15 U	0.23 U	0.046 U
PCB-205	ng/kg dw	7.2 J	12	2.2
PCB-206	ng/kg dw	86 J	93 J	23
PCB-207	ng/kg dw	9.9 J	15 J	3.4
PCB-208	ng/kg dw	27	27	9
PCB-209	ng/kg dw	58	28	18
Total PCBs, Congeners	ng/kg dw	16,000	19,000	4,100
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	0.25 J	0.22 J	0.0094
Other				
Total TEQ	ng/kg dw	12.1	12.5	2.22
Aromatic Hydrocarbons				
Total LPAH	µg/kg dw	1,000	3,200	240
Naphthalene	µg/kg dw	100	1,100	10
Acenaphthylene	µg/kg dw	59	430	6.8
Acenaphthene	µg/kg dw	38	75	8.3
Fluorene	µg/kg dw	72	140	14
Phenanthrene	µg/kg dw	540	1,200	150
Anthracene	µg/kg dw	190	300	51
2-Methylnaphthalene	µg/kg dw	26	68	4.8
Total HPAH	µg/kg dw	7,400	8,000	1,300
Fluoranthene	µg/kg dw	1,900	2,600	310
Pyrene	µg/kg dw	1,600	2,100	300
Benzo(a)anthracene	µg/kg dw	500	440	110
Chrysene	µg/kg dw	1,400	930	160
Total Benzofluoranthenes	µg/kg dw	1,100	1,000	190
Benzo(b)fluoranthene	µg/kg dw	820	740	140
Benzo(k)fluoranthene	µg/kg dw	310	270	53
Benzo(a)pyrene	µg/kg dw	390	400	97
Benzo(g,h,i)perylene	µg/kg dw	210	210	56
Indeno(1,2,3-cd)pyrene	µg/kg dw	260	240	59

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Aromatic Hydrocarbons (cont.)				
Dibenzo(a,h)anthracene	µg/kg dw	49	47	11
Carcinogenic PAH TEQ, 0 DL[6,7]	µg/kg dw	600	580	140
Carcinogenic PAH TEQ, 1/2 DL[6,8]	µg/kg dw	600	580	140
Total LPAH	mg/kg OC			12
Naphthalene	mg/kg OC			0.51
Acenaphthylene	mg/kg OC			0.34
Acenaphthene	mg/kg OC			0.42
Fluorene	mg/kg OC			0.71
Phenanthrene	mg/kg OC			7.6
Anthracene	mg/kg OC			2.6
2-Methylnaphthalene	mg/kg OC			0.24
Total HPAH	mg/kg OC			65
Fluoranthene	mg/kg OC			16
Pyrene	mg/kg OC			15
Benzo(a)anthracene	mg/kg OC			5.6
Chrysene	mg/kg OC			8.1
Total Benzofluoranthenes	mg/kg OC			9.7
Benzo(b)fluoranthene	mg/kg OC			7.1
Benzo(k)fluoranthene	mg/kg OC			2.7
Benzo(a)pyrene	mg/kg OC			4.9
Benzo(g,h,i)perylene	mg/kg OC			2.8
Indeno(1,2,3-cd)pyrene	mg/kg OC			3
Dibenzo(a,h)anthracene	mg/kg OC			0.56
Carcinogenic PAH TEQ, 0 DL[6,7]	mg/kg OC			6.9
Carcinogenic PAH TEQ, 1/2 DL[6,8]	mg/kg OC			6.9
Chlorinated Benzenes				
1,2-Dichlorobenzene	µg/kg dw	11 U	11 U	8.5 U
1,3-Dichlorobenzene	µg/kg dw	11 U	11 U	8.5 U
1,4-Dichlorobenzene	µg/kg dw	11 U	11 U	8.5 U
1,2,4-Trichlorobenzene	µg/kg dw	11 U	11 U	8.5 U
Hexachlorobenzene	µg/kg dw	11 U	11 U	8.5 U
1,2-Dichlorobenzene	mg/kg OC			0.43 U
1,4-Dichlorobenzene	mg/kg OC			0.43 U
1,2,4-Trichlorobenzene	mg/kg OC			0.43 U
Hexachlorobenzene	mg/kg OC			0.43 U
Phthalate Esters				
Dimethyl Phthalate	µg/kg dw	11 U	19	19
Diethyl Phthalate	µg/kg dw	11 U	11 U	8.5 U
Di-n-butyl Phthalate	µg/kg dw	22 U	7.2 JQ	17 U
Butylbenzyl Phthalate	µg/kg dw	11 U	11 U	8.5 U
bis(2-ethylhexyl)phthalate	µg/kg dw	37 JQ	44 JQ	17 JQ
Di-n-octyl Phthalate	µg/kg dw	11 U	11 U	8.5 U
Dimethyl Phthalate	mg/kg OC			0.96
Diethyl Phthalate	mg/kg OC			0.43 U
Di-n-butyl Phthalate	mg/kg OC			0.86 U
Butylbenzyl Phthalate	mg/kg OC			0.43 U
bis(2-ethylhexyl)phthalate	mg/kg OC			0.86 JQ
Di-n-octyl Phthalate	mg/kg OC			0.43 U
Miscellaneous Nonionizable Organic Compounds				
Dibenzofuran	µg/kg dw	50	180	5.1
Hexachlorobutadiene	µg/kg dw	11 U	11 U	8.5 U
N-nitrosodiphenylamine	µg/kg dw	11 U	11 U	8.5 U
Dibenzofuran	mg/kg OC			0.26
Hexachlorobutadiene	mg/kg OC			0.43 U
N-nitrosodiphenylamine	mg/kg OC			0.43 U
Ionizable Organic Compounds				
Phenol	µg/kg dw	28 JQ	340	12 JQ
2-Methylphenol	µg/kg dw	11 U	61	8.5 U
4-Methylphenol	µg/kg dw	30	120	5.1 JQ
2,4-Dimethylphenol	µg/kg dw	55 U	15 JQ	43 U

Table C.9
K Ply Site Remedial Investigation/Feasibility Study

	Station ID	**KSS-1**	**KSS-2**	**KSS-3**
	Sample ID	**SD0001K**	**SD0002K**	**SD0003K**
	Sample Date	**7/9/2013**	**7/9/2013**	**7/9/2013**
	Depth Range (cm)	**0–10**	**0–10**	**0–10**
	Field QC	**Field Sample**	**Field Sample**	**Field Sample**
	Reoccupied	**No**	**No**	**No**
Analyte	**Units**			
Ionizable Organic Compounds (cont.)				
Pentachlorophenol	µg/kg dw	110 U	110 U	85 U
Benzyl alcohol	µg/kg dw	22 U	22 U	17 U
Benzoic acid	µg/kg dw	220 U	150 JQ	200 U
Other Semivolatile Organic Compounds				
2,2'-Oxybis(2-chloropropane)	µg/kg dw	11 U	11 U	8.5 U
2,4,5-Trichlorophenol	µg/kg dw	11 U	11 U	8.5 U
2,4,6-Trichlorophenol	µg/kg dw	11 U	11 U	8.5 U
2,4-Dichlorophenol	µg/kg dw	11 U	11 U	8.5 U
2,4-Dinitrophenol	µg/kg dw	220 U	220 U	200 U
2,4-Dinitrotoluene	µg/kg dw	11 U	11 U	8.5 U
2,6-Dinitrotoluene	µg/kg dw	11 U	11 U	8.5 U
2-Chloronaphthalene	µg/kg dw	11 U	11 U	8.5 U
2-Chlorophenol	µg/kg dw	11 U	5 JQ	8.5 U
2-Methyl-4,6-dinitrophenol	µg/kg dw	110 U	110 U	85 U
2-Nitroaniline	µg/kg dw	22 U	22 U	17 U
2-Nitrophenol	µg/kg dw	11 U	11 U	8.5 U
3,3'-Dichlorobenzidine	µg/kg dw	110 U	110 U	85 U
3-Nitroaniline	µg/kg dw	22 U	22 U	17 U
4-Bromophenyl-phenyl Ether	µg/kg dw	11 U	11 U	8.5 U
4-Chloro-3-methylphenol	µg/kg dw	11 U	11 U	8.5 U
4-Chloroaniline	µg/kg dw	11 U	11 U	10 U
4-Chlorophenyl-phenyl Ether	µg/kg dw	11 U	11 U	8.5 U
4-Nitroaniline	µg/kg dw	22 U	22 U	17 U
4-Nitrophenol	µg/kg dw	110 U	110 U	85 U
bis(2-chloroethoxy)methane	µg/kg dw	11 U	11 U	8.5 U
bis(2-chloroethyl)ether	µg/kg dw	11 U	11 U	8.5 U
Hexachloroethane	µg/kg dw	11 U	11 U	8.5 U
Hexachlorocyclopentadiene	µg/kg dw	55 U	54 U	50 U
Isophorone	µg/kg dw	11 U	11 U	8.5 U
Nitrobenzene	µg/kg dw	11 U	11 U	8.5 U
N-nitroso-di-n-propylamine	µg/kg dw	11 U	11 U	8.5 U
Total Petroleum Hydrocarbons				
Diesel Range Organics	mg/kg dw	47 JQ	94 J	16 JQ
Residual Range Organics	mg/kg dw	210 JQ	330 J	120 JQ

Notes:

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
2 Calculated using detected dioxin/furan concentrations.
3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.
4 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
5 Calculated using detected congener concentrations.
6 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.
7 Calculated using detected cPAH concentrations.
8 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm	Centimeters	mg/kg dw	Milligrams per kilogram dry weight
cPAH	Carcinogenic polycyclic aromatic hydrocarbon	mg/kg OC	Milligrams per kilogram organic carbon normalized
DL	Detection limit	ng/kg dw	Nanograms per kilogram dry weight
HPAH	High molecular weight polycyclic aromatic hydrocarbon	OCDD	Octachlorodibenzodioxin
HpCDD	Heptachlorodibenzodioxin	OCDF	Octachlorodibenzofuran
HpCDF	Heptachlorodibenzofuran	PeCDD	Pentachlorodibenzodioxin
HxCDD	Hexachlorodibenzodioxin	PeCDF	pentachlorodibenzofuran
HxCDF	Hexachlorodibenzofuran	QC	Quality control
LPAH	Low molecular weight polycyclic aromatic hydrocarbon	TCDD	Tetrachlorodibenzodioxin
µm	Micrometer	TCDF	tetrachlorodibenzodioxin
µg/kg dw	Migrograms per kilogram dry weight	TEQ	Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

	Station ID	WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
	Sample ID	SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
	Sample Date	7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Conventionals											
Moisture Content	%	77	71			76	75	72	63	63	55
Soot	%	0.092 J	0.87 J	0.71 J	0.17 J	0.44 J	0.54 J	0.42 J	0.16 J	0.22 J	0.011 J
Total Organic Carbon	%	17 J	13 J	9.8 J	9 J	10 J	9.5 J	7.5 J	5.4 J	5.3 J	4.5 J
Total Solids	%	20	28	27.6	31.6	23.5	25.6	26.6	35.4	35.3	40.8
Total Volatile Solids	%	54.6	44.6	30.1	23.7 J	29.3	23	16.9	14.8	14.8	1.63
Particle/Grain Size											
Percent Gravel	%	32	35	19.6	4.68	6.4	5.6	0.37	0 U	0.15	0.99
Very Coarse Sand	%	12	6	5.74	3.07	5.4	4.4	1.4	1.44	0.82	1.35
Coarse Sand	%	8.6	5.1	4.81	2.96	5	4.3	3.3	2.45	1.67	1.83
Medium Sand	%	6.1	5.8	5.09	4.89	7.5	6.9	6.8	5.8	5.51	4.12
Fine Sand	%	3.7	5	6	7.23	6.1	4.6	4.4	5.68	6.15	4.84
Very Fine Sand	%	3.2	5.5	9.55	14.7	5.2	3.3	5.2	8.27	9.13	15.7
Percent Fines (clay & silt)	%	38	39	55.7	65.9	71	67	81	78	76.1	77.3
62.5 µm	%	2.7	4.3	2.97	11	6.3	5.8	7	7.89	10.5	13.7
31.3 µm	%	13	10	10.6	13.6	20	16	25	18.6	16.9	17.1
15.6 µm	%	5.4	7.8	10.1	10.4	13	12	15	13.4	11.8	12.1
7.8 µm	%	2.5	3.5	8.18	8.01	5.5	7.2	7.2	9.86	10.2	9.4
3.9 µm	%	2.1	2.7	6.15	5.85	4.7	5.8	6.1	7.63	7	7.2
1.95 µm	%	0.99	2.6	4.26	4.43	6.3	6	5.6	7.21	7.51	6.92
0.98 µm	%	11	8.2	13.5	12.6	14	14	16	13.4	12.3	11
Metals											
Arsenic	mg/kg dw	16		13	8.7				13	12	9.5
Cadmium	mg/kg dw	2.8		2.7	2.2				2.2	2.2	1.1
Chromium	mg/kg dw	25		29	24				29	31	29
Copper	mg/kg dw	32		43	38				44	47	35
Lead	mg/kg dw	15 J		18	18 J				22 J	24 J	17 J
Mercury	mg/kg dw	0.32		0.41	0.4				0.81	0.77	0.46
Silver	mg/kg dw	0.15		0.13	0.13				0.17	0.17	0.15
Zinc	mg/kg dw	120		170	130				190	200	110
Dioxins/Furans											
2,3,7,8-TCDD	ng/kg dw		1.75 J			3.29	2.7	1.36	1.41	1.13	0.747 J
1,2,3,7,8-PeCDD	ng/kg dw		4.63 J			6.34	5.9	3.94 J	3.32 J	3.09 J	2.21 J
1,2,3,4,7,8-HxcDD	ng/kg dw		5.16 J			8.72	6.06	3.56 J	2.76 J	2.74 J	2.29 J
1,2,3,6,7,8-HxCDD	ng/kg dw		49.9			103	134	48.5	29.1	30.6	14.4
1,2,3,7,8,9-HxCDD	ng/kg dw		16.5			38.5	24.9	13.1	10.3	10	7.07
1,2,3,4,6,7,8-HpCDD	ng/kg dw		1,340			2,910	4,400	1,120	632	677	252
Total OCDD	ng/kg dw		14,800			22,200	44,200	10,800	5,120	5,930	2,720

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Dioxins/Furans (cont.)											
2,3,7,8-TCDF	ng/kg dw		4.01			6.56	6.36	3.55	5.8	3.56	2.87
1,2,3,7,8-PeCDF	ng/kg dw		2.41 J			5.23	19	2.33 J	2.87 J	1.77 J	1.72 J
2,3,4,7,8-PeCDF	ng/kg dw		3.05 J			5.62	7.98	2.71 J	4.11 J	2.27 J	1.95 J
1,2,3,4,7,8-HxCDF	ng/kg dw		7.51 J			20.2	61.6	8.74	5.72	5.47	4.86
1,2,3,6,7,8-HxCDF	ng/kg dw		4.57 J			11.2	32.4	4.69 J	2.97 J	3.04 J	2.36 J
1,2,3,7,8,9-HxCDF	ng/kg dw		0.377 U			0.911 J	12.2	0.407 J	0.343 U	0.266 J	0.622 J
2,3,4,6,7,8-HxCDF	ng/kg dw		4.58 J			10.3	16.4	3.95 J	2.98 J	2.76 J	1.66 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw		297			659	1,250	318	188	206	77.9
1,2,3,4,7,8,9-HpCDF	ng/kg dw		9.17 J			22.3	137	10.7	6.53	7.03	9.05
Total OCDF	ng/kg dw		994			1,790	4,020	1,010	714	979	267
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw		37.8			74.5	113	32.9	22	21.8	11.5
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw		37.8			74.5	113	32.9	22	21.8	11.5
Polychlorinated Biphenyls (PCBs)											
PCB-1	ng/kg dw	42	130			540	69	70	150	200	190
PCB-2	ng/kg dw	19	89			91	68	59	98	70	86
PCB-3	ng/kg dw	35	120			510	100	75	190	150	180
PCB-4	ng/kg dw	74	77			300	150	71	260	110	170
PCB-5	ng/kg dw	5.4	8.7 J			28	11 J	6.8 J	18	15 J	24
PCB-6	ng/kg dw	50	66			230	110	48	130	75	120
PCB-7	ng/kg dw	10	20 J			80	24	14	34	24	39
PCB-8	ng/kg dw	260	350			910	620	250	920	410	660
PCB-9	ng/kg dw	14	22			75	25	13	35	23	38
PCB-10	ng/kg dw	3.3	3.7 J			19 J	6.9 J	2.4 J	9 J	7.3 J	9.1 J
PCB-11	ng/kg dw	100	130			110	80	120	69	75	73
PCB-12, 13	ng/kg dw	30 J	74 J			150 J	78 J	54 J	130 J	70 J	97 J
PCB-14	ng/kg dw	1.4 J	3.6 J			3.5 J	2.9 J	2.1 J	2.6 J	2.7 J	2.6 J
PCB-15	ng/kg dw	160	260			610	360	190	420	270	290
PCB-16	ng/kg dw	260	180			360	550	150	7,100	250	400
PCB-17	ng/kg dw	270	250			440	580	190	7,200	330	470
PCB-18, 30	ng/kg dw	590	530			770	1,200	380	22,000	750	1,100
PCB-19	ng/kg dw	50	48			89	110	37	2,000	63	85
PCB-20, 28	ng/kg dw	1,400	1,500			1,900	2,700	960	28,000	1,700	2,100
PCB-21, 33	ng/kg dw	670	670			870	1,400	450	15,000	790	1,000
PCB-22	ng/kg dw	540	470			600	920	310	10,000	550	690
PCB-23	ng/kg dw	1 J	5.1 U			1.9 J	2.1 J	2.2 U	4.8 J	2.8 U	1.3 J
PCB-24	ng/kg dw	5.1	4.8 U			14 J	15 J	5 J	57	6.2 J	6.5 U

Table C.10
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Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-25	ng/kg dw	76	82			130	160	55	1,000	77	89
PCB-26, 29	ng/kg dw	190 J	190			270	350	120	2,900	190	230
PCB-27	ng/kg dw	39	39			77	88	35	990	58	70
PCB-31	ng/kg dw	1,300	1,200			1,400	2,300	750	33,000	1,500	2,000
PCB-32	ng/kg dw	200	200			300	430	140	6,500	280	390
PCB-34	ng/kg dw	3.6	5 U			6.4 J	7.1 J	2.9 J	49	6.1 J	5.6 J
PCB-35	ng/kg dw	22	26			41	35	21	47	27	19
PCB-36	ng/kg dw	0.14 U	5.1 U			1.5 U	1.7 U	2.6 J	3 U	2.9 U	0.71 U
PCB-37	ng/kg dw	400	360			530	580	220	5,200	350	320
PCB-38	ng/kg dw	3.6	5.2 U			1.5 U	1.8 U	2.3 U	57	2.9 U	0.76 U
PCB-39	ng/kg dw	19	8.8 J			10 J	19 J	5.5 J	530	12 J	11
PCB-40, 41, 71	ng/kg dw	1,300	600			660	1,300	370	52,000	770	820
PCB-42	ng/kg dw	610	320			350	610	190	22,000	360	410
PCB-43	ng/kg dw	86	89			81	150	41	3,900	76	90
PCB-44, 47, 65	ng/kg dw	2,300	1,400			1,700	2,600	830	86,000	1,600	1,500
PCB-46	ng/kg dw	110	67			70	130	41	6,700	88	94
PCB-48	ng/kg dw	510	280			270	560	160	21,000	310	340
PCB-49, 69	ng/kg dw	1,400 J	1,000			1,200	1,600	570	49,000	990	980
PCB-50, 53	ng/kg dw	260 J	160			170	310	93	14,000	210	230
PCB-45, 51	ng/kg dw	340 J	190			200	380	120	19,000	260	280
PCB-52	ng/kg dw	2,800	2,200			3,000	4,000	1,300	87,000	2,000	1,800
PCB-54	ng/kg dw	3.1	2.3 J			2.9 J	4.7 J	1.4 J	240	2.9 J	3 J
PCB-55	ng/kg dw	33	99			110	150	40	1,600	59	66
PCB-56	ng/kg dw	1,300	640			750	1,200	390	38,000	750	680
PCB-57	ng/kg dw	24	5.5 J			5.9 J	10 J	3.6 J	280	6.2 J	4.7 J
PCB-58	ng/kg dw	18	2.4 U			1.4 U	3.3 U	1.3 J	72	2.7 J	2 J
PCB-59, 62, 75	ng/kg dw	180 J	110			120	200	68	6,500	130	140
PCB-60	ng/kg dw	860	440			440	780	230	24,000	450	430
PCB-61, 70, 74, 76	ng/kg dw	5,100	3,300			4,200	5,500	1,900	130,000	3,100	2,900
PCB-63	ng/kg dw	110	56			65	93	34	2,900	59	55
PCB-64	ng/kg dw	1,000 J	620			690	1,100	350	40,000	690	730
PCB-66	ng/kg dw	2,500	1,400			1,700	2,400	820	70,000	1,500	1,400
PCB-67	ng/kg dw	69	38			45	65	25	1,500	40	34
PCB-68	ng/kg dw	5.3	3.4 J			3.8 J	3.5 J	2 J	69	4.3 J	3.4 J
PCB-72	ng/kg dw	11	7.9 J			11 J	13 J	5.7 J	230	11 J	6.7 J
PCB-73	ng/kg dw	20	0.41 U			0.65 U	0.59 U	0.12 U	0.97 U	0.21 U	0.38 U
PCB-77	ng/kg dw	200	120			150	200	77	4,900	120	100

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Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-78	ng/kg dw	2.2 U	2.4 U			1.6 U	3.6 U	0.95 U	9.3 U	1.7 U	1.5 U
PCB-79	ng/kg dw	37	27			65	58	19	490	26	17
PCB-80	ng/kg dw	2 U	2.1 U			1.4 U	3.2 U	0.83 U	8.3 U	1.5 U	1.4 U
PCB-81	ng/kg dw	8	4.9 U			4.9 U	13 U	3 U	230	5.2 U	4.2 U
PCB-82	ng/kg dw	360	320			650	650	210	8,200	270	220
PCB-83, 99	ng/kg dw	1,500	1,500			3,100	2,900	970	22,000	1,200	950
PCB-84	ng/kg dw	730	550			1,200	1,300	360	15,000	540	400
PCB-85, 116, 117	ng/kg dw	520 J	440			940	870	290	10,000	390	300
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	2,000	1,600			3,600	4,100	1,100	29,000	1,400	1,100
PCB-88, 91	ng/kg dw	380 J	300			600	600	190	9,300	270	220
PCB-89	ng/kg dw	33	22			44	54	15	1,800	26	23
PCB-90, 101, 113	ng/kg dw	2,900	2,500			5,200	10,000	1,700	28,000	2,100	1,700
PCB-92	ng/kg dw	330 J	400			830	1,400	270	4,700	360	260
PCB-93, 95, 98, 100, 102	ng/kg dw	1,400 J	1,800			3,700	6,600	1,200	31,000	1,600	1,300
PCB-94	ng/kg dw	14	8.6 J			16 J	20	5.5 J	490	9 J	7.8 J
PCB-96	ng/kg dw	22	14 J			21	29	8.3 J	970	14 J	12
PCB-103	ng/kg dw	14	16 J			27	38	11	270	17 J	13
PCB-104	ng/kg dw	0.26 J	0.27 U			0.53 U	0.34 U	0.091 U	9.8 J	0.35 U	0.24 J
PCB-105	ng/kg dw	1,300	1,100			2,500	2,300	730	15,000	850	650
PCB-106	ng/kg dw	2.4 U	1.6 U			3.1 U	6.9 U	1.3 U	88	1.9 U	0.82 U
PCB-107, 124	ng/kg dw	130 J	100 J			240 J	270 J	67 J	1,200 J	79 J	55 J
PCB-109	ng/kg dw	190	170			410	390	120	2,300	140	110
PCB-110, 115	ng/kg dw	3,000	2,700			6,200	7,700	1,800	34,000	2,400	1,800
PCB-111	ng/kg dw	0.32 U	1.6 U			4 U	1.7 U	0.32 U	7.6 U	0.77 U	1.1 J
PCB-112	ng/kg dw	0.31 U	1.6 U			3.8 U	1.7 U	0.31 U	7.5 U	0.75 U	1 U
PCB-114	ng/kg dw	74	49			120	130	30	1,300	40	33
PCB-118	ng/kg dw	2,800	2,500			6,000	6,000	1,700	24,000	2,000	1,500
PCB-120	ng/kg dw	2.7	1.5 U			3.9 U	4.9 J	1.2 J	15	2.6 U	1.2 U
PCB-121	ng/kg dw	0.32 U	1.6 U			3.8 U	1.7 U	0.31 U	7.4 U	0.75 U	0.97 U
PCB-122	ng/kg dw	37	26			87	83	22	810	25	24
PCB-123	ng/kg dw	42	42			94	100	28	820	33	30
PCB-126	ng/kg dw	7 U	3.8 J			6.7 J	8.8 U	2.8 J	96	3.3 J	2 J
PCB-127	ng/kg dw	10	1.8 U			3.6 U	7.8 U	1.5 U	2.1 U	2.1 U	0.93 U
PCB-128, 166	ng/kg dw	740 J	510			1,500	2,900	380	1,300	410	420
PCB-129, 138, 160, 163	ng/kg dw	5,200	2,900			7,600	28,000	2,200	8,400	2,400	3,000
PCB-130	ng/kg dw	250	190			460	1,100	140	500	150	150
PCB-131	ng/kg dw	58	41			100	290	28	130	30	31

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Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-132	ng/kg dw	1,600	890			2,400	7,100	670	3,100	790	760
PCB-133	ng/kg dw	55	35			81	350	26	89	30	35
PCB-134, 143	ng/kg dw	210 J	150 J			360 J	1,000 J	100 J	560 J	120 J	130 J
PCB-135, 151, 154	ng/kg dw	2,100 J	690			1,500	9,400	550	2,400	680	890
PCB-136	ng/kg dw	690	250			580	2,700	190	1,000	240	260
PCB-137	ng/kg dw	200	160			450	510	110	410	110	91
PCB-139, 140	ng/kg dw	67 J	57 J			140 J	240 J	35 J	150 J	38 J	36 J
PCB-141	ng/kg dw	1,200	490			1,200	7,600	400	2,000	420	630
PCB-142	ng/kg dw	2.7 U	1.5 U			3.3 U	10 U	1.1 U	11 U	1.9 U	1.8 U
PCB-144	ng/kg dw	290	120			260	2,400	87	450	110	180
PCB-145	ng/kg dw	1.4 J	1.7 J			3.8 J	0.35 U	1.2 J	9.6 U	1.2 J	1.3 U
PCB-146	ng/kg dw	650	380			830	4,100	280	1,000	300	410
PCB-147, 149	ng/kg dw	4,400	1,900			4,400	22,000	1,500	6,100	1,800	2,300
PCB-148	ng/kg dw	2.1	2.5 J			4.2 U	18 J	1.6 J	4.4 U	2.1 J	2.3 J
PCB-150	ng/kg dw	3.1	2.9 J			5.7 J	24	2 J	9 J	2.2 J	2.3 J
PCB-152	ng/kg dw	2.8	2.6 J			5.3 J	7.2 J	1.4 J	17 J	1.9 J	1.4 J
PCB-153, 168	ng/kg dw	4,900	2,400			5,500	30,000	1,900	6,600	2,000	2,800
PCB-155	ng/kg dw	0.14 J	0.26 U			0.31 U	0.27 U	0.17 J	0.59 U	0.3 J	0.11 U
PCB-156, 157	ng/kg dw	500	360			1,100	2,900	270	920	290	290
PCB-158	ng/kg dw	500	330			860	3,900	230	910	250	350
PCB-159	ng/kg dw	1.9 U	24			66	680	24	120	30	61
PCB-161	ng/kg dw	1.8 U	1.1 U			2.5 U	6.9 U	0.76 U	8.5 U	1.4 U	1.2 U
PCB-162	ng/kg dw	1.9 U	10 J			23	46	4.8 J	16 U	6.8 J	7.3 J
PCB-164	ng/kg dw	320	200			470	2,200	160	590	170	200
PCB-165	ng/kg dw	2.1 U	1.2 U			2.9 U	7.9 U	0.87 U	9.6 U	1.5 U	1.4 U
PCB-167	ng/kg dw	160	130			330	1,200	89	270	95	110
PCB-169	ng/kg dw	16	3.6 U			5 U	67 U	2.3 U	10 U	2.6 U	4.6 U
PCB-170	ng/kg dw	1,200	480			1,400	14,000	530	3,000	570	1,200
PCB-171, 173	ng/kg dw	650 J	170			490	6,700	170	810	180	480
PCB-172	ng/kg dw	360	92			250	3,600	100	500	99	240
PCB-174	ng/kg dw	2,700	470			1,400	16,000	500	2,500	540	1,300
PCB-175	ng/kg dw	110	24			70	1,300	28	110	27	98
PCB-176	ng/kg dw	360	69			180	2,700	67	310	75	220
PCB-177	ng/kg dw	1,400	280			780	7,700	300	1,500	330	730
PCB-178	ng/kg dw	540	100			260	3,000	110	450	110	290
PCB-179	ng/kg dw	1,200	200			480	5,600	200	900	220	540
PCB-180, 193	ng/kg dw	4,500	1,100			2,900	38,000	1,200	6,400	1,200	3,200

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Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-181	ng/kg dw	8.3	5.8 J			19 J	200	4.7 J	21 J	5.1 J	14
PCB-182	ng/kg dw	0.25 U	0.72 U			13 J	180	5.6 J	1 U	3.8 J	17
PCB-183, 185	ng/kg dw	1,800 J	390			1,100	17,000	380	1,600	410	1,500
PCB-184	ng/kg dw	0.18 U	0.71 J			1.2 U	15 J	0.3 U	0.85 J	0.39 U	0.75 J
PCB-186	ng/kg dw	0.2 U	0.58 U			0.4 U	3.1 U	0.33 U	0.81 U	0.43 U	0.38 U
PCB-187	ng/kg dw	3,200	670			1,700	19,000	650	2,900	690	1,800
PCB-188	ng/kg dw	0.58 J	0.97 U			1.6 J	19 J	0.69 J	1.1 J	0.67 J	1.4 J
PCB-189	ng/kg dw	55	20			54	850	22	120	22	62
PCB-190	ng/kg dw	410	91			290	4,800	100	600	110	310
PCB-191	ng/kg dw	83	27			68	1,300	26	170	25	89
PCB-192	ng/kg dw	0.23 U	0.72 U			0.49 U	4.2 U	0.41 U	0.97 U	0.98 U	0.43 U
PCB-194	ng/kg dw	960	260			740	11,000	340	2,300	340	1,100
PCB-195	ng/kg dw	360	100			280	5,000	120	700	140	420
PCB-196	ng/kg dw	740	150			400	7,500	170	820	180	780
PCB-197, 200	ng/kg dw	230 J	53 J			130 J	2,400 J	51 J	190 J	14 J	250 J
PCB-198, 199	ng/kg dw	1,600 J	330			820	11,000	360	1,600	360	1,300
PCB-201	ng/kg dw	220	48			110	1,800	46	160	46	200
PCB-202	ng/kg dw	240	65			170	2,300	74	240	70	240
PCB-203	ng/kg dw	930	190			530	9,500	210	840	220	1,000
PCB-204	ng/kg dw	0.26 U	0.95 U			0.33 U	15 J	0.3 J	0.55 U	0.23 U	0.16 U
PCB-205	ng/kg dw	57	13 J			39	860	15	82	17 J	82
PCB-206	ng/kg dw	880	120 J			370 J	4,900 J	170 J	360 J	150 J	730 J
PCB-207	ng/kg dw	26	19 J			56 J	770 J	24 J	46 J	22 J	110 J
PCB-208	ng/kg dw	61	43			110	1,600	54	75	49	200
PCB-209	ng/kg dw	28	65			140	1,400	90	64	91	230
Total PCBs, Congeners	ng/kg dw	95,000	54,000			110,000	410,000	39,000	1,100,000	52,000	66,000
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	0.65	0.52			0.99	0.42	0.38	11	0.44	0.29
Other											
Total TEQ	ng/kg dw		38.2			75.5	114	33.2	33.5	22.2	11.8
Aromatic Hydrocarbons											
Total LPAH	µg/kg dw	790		550	250				240	220	340
Naphthalene	µg/kg dw	100		24	48				91	69	160
Acenaphthylene	µg/kg dw	28		32	12				10	9.5	15
Acenaphthene	µg/kg dw	37		15	9.2				6.1 J	5.3 J	14
Fluorene	µg/kg dw	62		38	17				11	15	17
Phenanthrene	µg/kg dw	290		310	110				90	90	100
Anthracene	µg/kg dw	270		130	50				30	31	36

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Aromatic Hydrocarbons (cont.)											
2-Methylnaphthalene	µg/kg dw	33		12	18				18	18	28
Total HPAH	µg/kg dw	5,000		5,900	1,300				570	620	550
Fluoranthene	µg/kg dw	790		900	290				150	120	140
Pyrene	µg/kg dw	650		780	290				130	110	130
Benzo(a)anthracene	µg/kg dw	500		670	110				39	68	38
Chrysene	µg/kg dw	980		1,200	240				76	100	68
Total Benzofluoranthenes	µg/kg dw	1,100		1,400	230				86	120	79
Benzo(b)fluoranthene	µg/kg dw	800		1,000	160				65	88	58
Benzo(k)fluoranthene	µg/kg dw	330		360	66				21	34	21
Benzo(a)pyrene	µg/kg dw	470		480	84				36	44	38
Benzo(g,h,i)perylene	µg/kg dw	180		200	44				22	22	24
Indeno(1,2,3-cd)pyrene	µg/kg dw	240		240	55				24	26	24
Dibenzo(a,h)anthracene	µg/kg dw	56		70	9.1				4 J	5.4 J	4.2 J
Carcinogenic PAH TEQ, 0 DL[6,7]	µg/kg dw	670		730	130				52	67	53
Carcinogenic PAH TEQ, 1/2 DL[6,8]	µg/kg dw	670		730	130				52	67	53
Chlorinated Benzenes											
1,2-Dichlorobenzene	µg/kg dw	68 U		49 U	43 U				38 U	39 U	33 U
1,4-Dichlorobenzene	µg/kg dw	68 U		49 U	43 U				38 U	39 U	33 U
1,2,4-Trichlorobenzene	µg/kg dw	42 U		30 U	27 U				24 U	24 U	21 U
Hexachlorobenzene	µg/kg dw	57 U		41 U	36 U				32 U	32 U	28 U
Phthalate Esters											
Dimethyl Phthalate	µg/kg dw	60 U		44 U	39 U				34 U	34 U	30 U
Diethyl Phthalate	µg/kg dw	53 U		38 U	34 U				30 U	30 U	26 U
Di-n-butyl Phthalate	µg/kg dw	45 U		33 U	29 U				26 U	26 U	22 U
Butylbenzyl Phthalate	µg/kg dw	60 U		44 U	95 J				34 U	34 U	30 U
bis(2-ethylhexyl)phthalate	µg/kg dw	71 U		52 U	46 U				41 U	41 U	35 U
Di-n-octyl Phthalate	µg/kg dw	90 U		65 U	58 U				51 U	51 U	44 U
Miscellaneous Nonionizable Organic Compounds											
Dibenzofuran	µg/kg dw	45 U		33 U	29 U				26 U	26 U	22 U
Hexachlorobutadiene	µg/kg dw	53 U		38 U	34 U				30 U	30 U	26 U
N-nitrosodiphenylamine	µg/kg dw	68 U		49 U	43 U				38 U	39 U	33 U
Ionizable Organic Compounds											
Phenol	µg/kg dw	130 J		52 U	46 U				41 U	270 J	35 U
2-Methylphenol	µg/kg dw	64 U		46 U	41 U				36 U	36 U	32 U
4-Methylphenol	µg/kg dw	190 J		46 U	57 J				36 U	49 J	32 U
2,4-Dimethylphenol	µg/kg dw	57 U		41 U	36 U				32 U	32 U	28 U

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH003	WPAH004	WPAH006	WPAH008	WPAH009	WPAH010	WPAH011	WPAH013		WPAH015
Sample ID		SD0003	SD0004	SD0006	SD0008	SD0009	SD0010	SD0011	SD0013	SD0016	SD0015
Sample Date		7/1/2013	7/2/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/8/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Ionizable Organic Compounds (cont.)											
Pentachlorophenol	µg/kg dw	490 U		360 U	320 U				280 U	280 U	240 U
Benzyl Alcohol	µg/kg dw	64 U		46 U	41 U				36 U	36 U	32 U
Benzoic Acid	µg/kg dw			380 U	340 U				300 U	300 U	

Notes:

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
2 Calculated using detected dioxin/furan concentrations.
3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.
4 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
5 Calculated using detected congener concentrations.
6 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.
7 Calculated using detected cPAH concentrations.
8 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm	Centimeters
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
DL	Detection limit
HPAH	High molecular weight polycyclic aromatic hydrocarbon
HpCDD	Heptachlorodibenzodioxin
HpCDF	Heptachlorodibenzofuran
HxCDD	Hexachlorodibenzodioxin
HxCDF	Hexachlorodibenzofuran
LPAH	Low molecular weight polycyclic aromatic hydrocarbon
µm	Micrometer
µg/kg dw	Migrograms per kilogram dry weight
mg/kg dw	Milligrams per kilogram dry weight
ng/kg dw	Nanograms per kilogram dry weight
OCDD	Octachlorodibenzodioxin
OCDF	Octachlorodibenzofuran
PeCDD	Pentachlorodibenzodioxin
PeCDF	pentachlorodibenzofuran
QC	Quality control
TCDD	Tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzodioxin
TEQ	Toxic equivalency

Qualifiers:

J	Analyte was detected, concentration is considered to be an estimate.
JQ	Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U	Analyte was not detected, concentration given is the reporting limit.
UJ	Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

	Station ID	WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
	Sample ID	SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
	Sample Date	6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Conventionals											
Moisture Content	%	61	59	48	33	54	78	74	78	72	59
Soot	%	0.044 J	0.01 U	0.2 J	0.11 J	1.5 J	0.25 J	0.46 J	0.81 J	2.3 J	0.1 J
Total Organic Carbon	%	5.1 J	4.1 J	3.1 J	1.1 J	6.9 J	15 J	9.6 J	12 J	13 J	3.1 J
Total Solids	%	35.8	38.8	48.6	62	39.9	21	25.3	23.7	28.4	40.2
Total Volatile Solids	%	13.4	11.7 J	8	3.62	27.2	40.7	29	33	32.2	11.2
Particle/Grain Size											
Percent Gravel	%	0.65	0.47	0.24	0.18	10.8	0.29	2.5	7.6	3.22	1.02
Very Coarse Sand	%	1.65	1.44	1.72	0.2	11.2	3.08	4.8	5.6	4.07	1.97
Coarse Sand	%	1.89	1.32	1.51	0.3	17.8	6.75	7.7	9.5	8.1	3.21
Medium Sand	%	4.25	3.21	2.95	2.21	23.4	10.3	16	14	11.6	3.41
Fine Sand	%	5.27	4.3	19.3	39.2	18.2	8.82	11	7.2	11.9	1.64
Very Fine Sand	%	12.4	13.5	30.4	33	3.69	5.56	7.5	5	8.66	4.17
Percent Fines (clay & silt)	%	77.9	69.9	43.6	23.9	19.6	64.2	52	47	47	85.2
62.5 µm	%	4.96	11.9	7.16	4.11	0.43	3.69	6.4	4.9	4.23	11.7
31.3 µm	%	21.4	15.5	13.4	6.09	2.59	12.2	19	9.5	7.35	18.3
15.6 µm	%	15	11.1	5.42	2.7	3.05	12	7.5	5.6	7.94	14.8
7.8 µm	%	9.93	8.97	4.11	2.5	2.87	9.31	4.2	4.6	6.44	11.8
3.9 µm	%	7.42	7.23	3.4	2.04	2.48	6.73	2.3	3.6	8.26	8.17
1.95 µm	%	6.6	6.11	2.61	1.78	2.48	3.22	1.5	4.6	1.04	6.88
0.98 µm	%	12.7	9.02	7.44	4.66	5.67	17.1	11	14	11.7	13.5
Metals											
Arsenic	mg/kg dw	11									
Cadmium	mg/kg dw	1.8									
Chromium	mg/kg dw	33									
Copper	mg/kg dw	41									
Lead	mg/kg dw	21									
Mercury	mg/kg dw	0.46									
Silver	mg/kg dw	0.16									
Zinc	mg/kg dw	140									
Dioxins/Furans											
2,3,7,8-TCDD	ng/kg dw		0.808 J	0.598 J	0.439 J	0.437 U	3.69	2.51	2.62	6.44	0.385 U
1,2,3,7,8-PeCDD	ng/kg dw		2.33 J	1.82 J	3.06 J	1.37 J	7.5	5.22	4.56 J	10.3	0.698 J
1,2,3,4,7,8-HxcDD	ng/kg dw		2.46 J	2 J	4.56	1.26 J	11.1	7.62	5.21 J	13.3	0.789 U
1,2,3,6,7,8-HxCDD	ng/kg dw		17.1	15.9	19	6.49	48.7	53.7	99.2	84.3	3.85 J
1,2,3,7,8,9-HxCDD	ng/kg dw		8.35	7.34	12.2	3.39 J	26.8	24.5	17.3	32.2	2.74 J
1,2,3,4,6,7,8-HpCDD	ng/kg dw		304	306	340	79.8	887	1,310	2,720	1,010	52.3
Total OCDD	ng/kg dw		2,630	2,980	2,310	530	7,820	10,900	39,000	6,750	505

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

	Station ID	WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
	Sample ID	SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
	Sample Date	6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Dioxins/Furans (cont.)											
2,3,7,8-TCDF	ng/kg dw		3.17	1.91	0.878 J	1.49	4.78	5.41	4.82	7.66	1.06
1,2,3,7,8-PeCDF	ng/kg dw		1.31 J	0.903 J	0.983 J	0.789 J	3.16 J	2.69 J	6 J	4.47 J	0.443 J
2,3,4,7,8-PeCDF	ng/kg dw		2.46 J	0.996 J	1.02 J	1.23 J	3.83 J	3.9 J	4.5 J	5.72	0.586 J
1,2,3,4,7,8-HxCDF	ng/kg dw		3.36 J	2.13 J	2.66 J	1.47 J	9.42	9.4	21.6	12.4	0.841 J
1,2,3,6,7,8-HxCDF	ng/kg dw		1.91 J	1.29 J	2 J	1.22 J	8.53	5.85	9.66	9.88	0.495 J
1,2,3,7,8,9-HxCDF	ng/kg dw		0.204 J	0.209 U	0.171 J	0.1 J	0.375 J	0.57 J	1.53 J	0.823 J	0.06 J
2,3,4,6,7,8-HxCDF	ng/kg dw		1.8 J	1.15 J	1.7 J	1.12 J	8.29	5.44	8.04 J	9.89	0.46 J
1,2,3,4,6,7,8-HpCDF	ng/kg dw		78.1	53.5	45.7	23.1	231	248	761	313	12.2
1,2,3,4,7,8,9-HpCDF	ng/kg dw		3.06 J	2.11 U	1.87 J	1.1 J	7.7	10	17.7	10.2	0.507 J
Total OCDF	ng/kg dw		252	148	85.9	42.6	553	505	2,190	418	49.2
Dioxin/Furan Congener TEQ, 0 DL[1,2]	ng/kg dw		12.5	10.4 J	12.7	4.63	38	39.3	72.8	51.1	2.65
Dioxin/Furan Congener TEQ, 1/2 DL[1,3]	ng/kg dw		12.5	10.5 J	12.7	4.85	38	39.3	72.8	51.1	2.89
Polychlorinated Biphenyls (PCBs)											
PCB-1	ng/kg dw	240 J	250	870	18 J	200	41	77	64	74	37
PCB-2	ng/kg dw	50	68	98	11 J	46	91	130	46	170	33
PCB-3	ng/kg dw	260	270	550	19	130	67	100	82	140	33
PCB-4	ng/kg dw	120	190	340	10 J	92	61	110	120	120	26
PCB-5	ng/kg dw	42	37	37	2.6 UJ	11 J	6.3 J	7.6 J	7.3 J	11 J	1.9 U
PCB-6	ng/kg dw	110	120	230	12 J	53	57	110	83	100	16 J
PCB-7	ng/kg dw	46	49	61	3.2 J	22	12 J	18 J	17 J	23	3.9 J
PCB-8	ng/kg dw	620	810	1,300	64 J	230	260	420	460	470	78
PCB-9	ng/kg dw	37	40	63	3.1 J	22	16 J	24	21	25	4.3 J
PCB-10	ng/kg dw	8.5	10 J	12	2.3 UJ	7.7 J	2.5 J	4.3 J	4.4 J	4.3 J	1.6 U
PCB-11	ng/kg dw	71	86	82	35 J	44	370	330	45	440	68
PCB-12, 13	ng/kg dw	92 J	120 J	150 J	13 J	41 J	70 J	82 J	49 J	130 J	16 J
PCB-14	ng/kg dw	0.61 U	1.2 U	2.6 U	2.4 UJ	2 J	3.5 J	4.3 U	1.8 U	5.9 J	1.7 U
PCB-15	ng/kg dw	370	540	820	60	120	260	400	250	460	60
PCB-16	ng/kg dw	360	4,400	1,900	25	56	140	340	410	410	27
PCB-17	ng/kg dw	470	4,700	2,000	33	73	170	410	460	470	34
PCB-18, 30	ng/kg dw	1,000 J	15,000	3,900	60	130	310	980	1,100	1,100	65
PCB-19	ng/kg dw	78	1,300	530	4.4 J	13 J	33	110	97	96	6.1 J
PCB-20, 28	ng/kg dw	2,800	18,000	8,000	280	270	980	1,800	1,800	2,200	170
PCB-21, 33	ng/kg dw	1,300	9,800	4,400	120	120	430	780	950	1,100	79
PCB-22	ng/kg dw	880	6,900	3,000	78	87	350	590	640	750	53
PCB-23	ng/kg dw	6.3 U	27 U	7.5 J	0.78 U	1.7 U	1.6 U	5.2 U	5.9 U	1.8 J	0.74 U
PCB-24	ng/kg dw	6.9 U	20 U	63	0.97 J	2.1 J	5.8 J	8.1 J	11 J	9.7 J	1 J

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

	Station ID	WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
	Sample ID	SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
	Sample Date	6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-25	ng/kg dw	130	800	480	18 J	17 J	65	110	89	130	12 J
PCB-26, 29	ng/kg dw	300 J	2,000	1,100	35	38	150	270	230	310	23
PCB-27	ng/kg dw	70	560	330	5.7 J	16 J	27	64	69	73	5.5 J
PCB-31	ng/kg dw	2,400	22,000	6,600	200	200	760	1,600	1,600	1,900	130
PCB-32	ng/kg dw	400	4,500	1,500	28	47	120	320	340	340	22
PCB-34	ng/kg dw	10	47	22	1.2 J	1.7 U	3.5 J	5.5 J	5.8 U	6.4 J	0.74 U
PCB-35	ng/kg dw	24	36	87	6.8 J	7.4 J	38	36	21	56	5.3 J
PCB-36	ng/kg dw	5.8 U	28 U	3.2 U	0.76 U	1.6 U	6.9 J	5.4 U	5.8 U	8.3 J	1.7 J
PCB-37	ng/kg dw	550	3,900	2,000	59	63	320	550	400	620	45
PCB-38	ng/kg dw	6.5 U	59	6.8 J	0.78 U	1.7 U	1.7 U	5.4 U	6 U	1.5 U	0.75 U
PCB-39	ng/kg dw	26	460	46	2 J	2.6 U	8.1 J	20	11 J	21	1.2 U
PCB-40, 41, 71	ng/kg dw	2,100	36,000	3,600	130	100	380	1,300	910	1,200	76
PCB-42	ng/kg dw	970	16,000	1,800	73	62	190	590	410	610	40
PCB-43	ng/kg dw	180	3,100	330	15 J	14 J	40	130	100	130	11 J
PCB-44, 47, 65	ng/kg dw	3,900	60,000	5,900	300	270	1,100	2,500	2,100	2,600	250
PCB-46	ng/kg dw	180	5,000	420	9.7 J	13 J	33	170	100	140	6.1 J
PCB-48	ng/kg dw	830	14,000	1,600	50	49	150	540	360	530	31
PCB-49, 69	ng/kg dw	2,600 J	34,000	3,700	260	190	670	1,400	1,200	1,700	150
PCB-50, 53	ng/kg dw	430 J	11,000	810	28	30	95	380	250	330	20
PCB-45, 51	ng/kg dw	540 J	14,000	1,200	28 J	34	95	480	290	390	18 J
PCB-52	ng/kg dw	4,500	59,000	5,800	460	370	2,300	2,900	3,600	4,000	460
PCB-54	ng/kg dw	5.6	180	17	0.42 J	0.47 J	1.1 J	6.9 J	3.1 J	4.9 J	0.38 J
PCB-55	ng/kg dw	160	1,200	350	1.2 U	11 J	28	66	84	170	16 J
PCB-56	ng/kg dw	2,500 J	28,000	3,000	170	120	450	1,200	800	1,300	85
PCB-57	ng/kg dw	18 J	200	36	1.5 J	1.1 J	4.5 J	11 J	5.4 J	11 J	0.67 U
PCB-58	ng/kg dw	14 U	51	7.8 J	1.4 J	0.75 U	0.62 U	2.9 U	1.8 U	3.1 U	0.68 U
PCB-59, 62, 75	ng/kg dw	320 J	4,800	640	25	24	62	200	140	200	14 J
PCB-60	ng/kg dw	1,500 J	18,000	2,200	95	69	250	740	490	820	55
PCB-61, 70, 74, 76	ng/kg dw	9,800 J	96,000	11,000	820	520	2,900	4,600	4,500	6,100	590
PCB-63	ng/kg dw	210 J	2,200	250	15 J	9.9 J	41	100	64	100	7.8 J
PCB-64	ng/kg dw	2,000	27,000	2,700	130	120	420	1,100	900	1,200	100
PCB-66	ng/kg dw	4,500 J	49,000	6,000	420	240	980	2,300	1,700	2,500	220
PCB-67	ng/kg dw	120 J	1,200	230	11 J	9.2 J	37	67	41	73	3.8 J
PCB-68	ng/kg dw	10	59	14	3.1 J	1.4 U	3.2 J	4.8 J	1.9 J	6.2 J	0.73 J
PCB-72	ng/kg dw	23	210	27	6.3 J	3.4 J	9.2 J	12 J	7.3 J	19 J	1.1 J
PCB-73	ng/kg dw	0.2 U	3.1 U	1.7 U	0.22 U	0.095 U	0.26 U	0.25 U	0.37 U	0.6 U	0.11 U
PCB-77	ng/kg dw	370 J	3,900	540	44	27	98	220	110	240	18 J

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	Station ID	WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
	Sample ID	SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
	Sample Date	6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-78	ng/kg dw	15 U	9.4 U	3.1 U	1.3 U	0.81 U	0.66 U	3 U	1.9 U	3.5 U	0.74 U
PCB-79	ng/kg dw	89 J	410	44	11 J	8 J	57	38	37	62	9.1 J
PCB-80	ng/kg dw	13 U	8.2 U	2.8 U	1.1 U	0.71 U	0.57 U	2.6 U	1.6 U	2.9 U	0.64 U
PCB-81	ng/kg dw	23 J	200	26	1.7 U	0.84 U	4.1 U	12 J	4.4 U	10 U	0.73 U
PCB-82	ng/kg dw	1,200 J	6,800	450	100	69	460	480	440	580	110
PCB-83, 99	ng/kg dw	4,400 J	18,000	1,800	590	400	2,200	1,700	1,700	2,400	540
PCB-84	ng/kg dw	1,900 J	12,000	710	200	130	1,000	830	890	970	210
PCB-85, 116, 117	ng/kg dw	1,700 J	8,300	640	150	95	700	630	590	840	180
PCB-86, 87, 97, 108, 119, 125	ng/kg dw	5,200 J	23,000	2,200	540	350	2,900	2,200	2,300	3,000	590
PCB-88, 91	ng/kg dw	1,100 J	6,800	440	100	66	470	430	440	510	110
PCB-89	ng/kg dw	180 J	1,400	55	8.7 J	3.8 J	29	56	33	51	6.9 J
PCB-90, 101, 113	ng/kg dw	6,200 J	22,000	2,900	880	610	4,200	2,700	3,100	4,100	860
PCB-92	ng/kg dw	1,100 J	3,900	480	150	110	720	470	510	660	140
PCB-93, 95, 98, 100, 102	ng/kg dw	4,600 J	24,000	2,100	580	480	3,000	2,200	2,700	2,900	640
PCB-94	ng/kg dw	50 J	370	17	3.2 J	1.9 J	12 J	17 J	13 J	17 J	2.4 J
PCB-96	ng/kg dw	79 J	760	25	3.9 J	2.8 J	16 J	30	18	25	4 J
PCB-103	ng/kg dw	42 J	210	20	8.8 J	7 J	17 J	16 J	13 J	21	5.1 J
PCB-104	ng/kg dw	0.97 J	8 J	1 U	0.18 J	0.16 U	0.26 U	0.32 U	0.26 U	0.4 U	0.16 U
PCB-105	ng/kg dw	3,200 J	13,000	1,300	350	210	1,800	1,400	1,400	2,100	360
PCB-106	ng/kg dw	8.4 U	54	5.1 J	0.66 U	1.1 U	2.6 U	1.4 U	1.9 U	2.6 U	0.86 U
PCB-107, 124	ng/kg dw	270 J	940 J	120 J	32 J	19 J	190 J	120 J	120 J	200 J	31 J
PCB-109	ng/kg dw	510 J	1,700	230	67	39	300	200	200	350	54
PCB-110, 115	ng/kg dw	7,200 J	28,000	3,000	960	640	4,600	3,400	3,700	4,900	1,000
PCB-111	ng/kg dw	1.9 U	7.3 U	1.6 U	0.71 U	0.8 U	0.96 U	1.4 U	1.9 U	3 J	0.66 U
PCB-112	ng/kg dw	1.8 U	7.1 U	1.6 U	0.68 U	0.77 U	0.93 U	1.4 U	1.8 U	1.5 U	0.63 U
PCB-114	ng/kg dw	240 J	1,100	79	14 J	8.1 J	93	82	73	120	23
PCB-118	ng/kg dw	6,100 J	20,000	2,900	940	520	4,300	2,900	3,200	4,700	880
PCB-120	ng/kg dw	4	16 J	1.8 U	2.5 U	2 U	2.6 J	2.5 U	1.8 U	4.5 J	0.63 U
PCB-121	ng/kg dw	1.8 U	7.1 U	1.6 U	0.69 U	0.78 U	0.93 U	1.4 U	1.8 U	1.5 U	0.64 U
PCB-122	ng/kg dw	140 J	640	58	12 J	5 J	55	53	49	80	13 J
PCB-123	ng/kg dw	150 J	680	57	14 J	9.1 J	67	65	49	99	15 J
PCB-126	ng/kg dw	17 J	80	4.3 J	2.5 J	2.1 J	7.5 J	7.6 J	3.2 J	10 J	1.2 U
PCB-127	ng/kg dw	12 J	2.6 U	2.8 U	0.76 U	1.3 U	2.9 U	1.6 U	2.2 U	2.9 U	1 U
PCB-128, 166	ng/kg dw	960 J	1,200	370 J	200	120	950	560	570	970	200
PCB-129, 138, 160, 163	ng/kg dw	6,100 J	7,500	2,200 J	1,000	780	5,200	2,900	3,000	4,800	1,000
PCB-130	ng/kg dw	360 J	480	130 J	68	46	340	190	180	300	61
PCB-131	ng/kg dw	84 J	130	28 J	14 J	8.7 J	72	40	39	67	14 J

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Station ID		WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
Sample ID		SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
Sample Date		6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-132	ng/kg dw	2,000 J	2,900	610 J	330	240	1,700	930	970	1,500	310
PCB-133	ng/kg dw	73 J	86	27 J	15 J	11 J	59	33	31	56	9.9 J
PCB-134, 143	ng/kg dw	290 J	470 J	110 J	55 J	38 J	250 J	140 J	150 J	210 J	51 J
PCB-135, 151, 154	ng/kg dw	1,700 J	2,200	490 J	250	250	1,000	610	690	910	220
PCB-136	ng/kg dw	570 J	930	160 J	92	86	420	230	270	340	92
PCB-137	ng/kg dw	300 J	370	110 J	48	27	340	180	180	310	68
PCB-139, 140	ng/kg dw	100 J	140 J	38 J	18 J	11 J	97 J	54 J	55 J	86 J	22 J
PCB-141	ng/kg dw	1,200 J	1,600	370 J	140	130	790	430	520	780	150
PCB-142	ng/kg dw	14 U	3.8 U	1.7 UJ	1.1 U	1.2 U	2 U	2 U	2.3 U	3.5 U	1.9 U
PCB-144	ng/kg dw	360 J	370	84 J	38	38	180	100	120	170	37
PCB-145	ng/kg dw	4.4 J	11 J	1 UJ	0.58 J	0.37 U	2.3 J	1.3 U	1.7 J	2 J	0.78 J
PCB-146	ng/kg dw	780 J	900	250 J	140	120	560	320	320	580	120
PCB-147, 149	ng/kg dw	4,300 J	5,600	1,400 J	660	620	3,000	1,700	1,900	2,800	630
PCB-148	ng/kg dw	4 J	6.7 J	1.3 J	1.5 J	1.4 U	2.9 J	2 J	1.4 J	2.8 J	1.2 J
PCB-150	ng/kg dw	6.2 J	8.9 J	2.3 UJ	1.3 J	1.2 J	4.4 J	2.3 J	2.6 J	4 J	1.4 J
PCB-152	ng/kg dw	5.7 U	16 J	1.4 J	0.83 J	0.71 J	4.1 J	2.1 J	2 J	3.2 U	0.95 J
PCB-153, 168	ng/kg dw	5,400 J	5,600	1,600 J	800	730	3,500	2,000	2,200	3,500	740
PCB-155	ng/kg dw	0.18 U	0.35 U	0.74 U	0.11 U	0.11 U	0.19 U	0.16 U	0.33 J	0.3 J	0.1 J
PCB-156, 157	ng/kg dw	710 J	880	280	120	72	750	390	410	650	140
PCB-158	ng/kg dw	730 J	770	250 J	120	84	570	320	340	540	110
PCB-159	ng/kg dw	89 J	110	19 J	9.2 J	9.9 J	34	21	34	41	6.2 U
PCB-161	ng/kg dw	10 U	2.8 U	1.3 UJ	0.81 U	0.88 U	1.5 U	1.5 U	1.7 U	2.6 U	1.4 U
PCB-162	ng/kg dw	18 J	17 J	7.6 J	3.8 J	2.5 U	19 J	11 J	8.9 J	20	1.9 U
PCB-164	ng/kg dw	430 J	520	150 J	71	53	330	180	210	290	60
PCB-165	ng/kg dw	12 U	3.1 U	1.4 UJ	0.91 U	0.99 U	1.7 U	1.7 U	1.9 U	3 U	1.6 U
PCB-167	ng/kg dw	240 J	260	91	43	28	230	130	130	210	40
PCB-169	ng/kg dw	9.5 U	8.9 U	2.4 UJ	1.1 U	1.1 U	3.4 U	2.1 U	3.6 U	4.4 U	1.8 U
PCB-170	ng/kg dw	1,900 J	2,600	390	190	190	710	460	600	790	170
PCB-171, 173	ng/kg dw	790 J	610	170	64	67	230	140	190	270	55
PCB-172	ng/kg dw	420 J	380	80	33	35	130	78	110	150	26
PCB-174	ng/kg dw	2,000 J	1,900	460	180	180	640	390	600	750	140
PCB-175	ng/kg dw	140 J	77	23	8.9 J	9.8 J	35	22	31	46	6.8 J
PCB-176	ng/kg dw	340 J	220	56	25	26	87	52	84	100	21
PCB-177	ng/kg dw	1,000 J	1,100	260	110	120	360	240	320	440	91
PCB-178	ng/kg dw	400 J	330	86	40	44	130	84	130	160	32
PCB-179	ng/kg dw	770 J	650	160	73	82	240	150	240	300	60
PCB-180, 193	ng/kg dw	5,000 J	5,200	1,200	380	400	1,600	970	1,500	1,800	300

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Station ID		WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
Sample ID		SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
Sample Date		6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Polychlorinated Biphenyls (cont.)											
PCB-181	ng/kg dw	22 J	10 J	5.8 J	2 J	1.8 J	12 J	5.3 J	5 J	12 J	2 J
PCB-182	ng/kg dw	17 J	8.1 J	0.94 U	0.22 UJ	2.3 J	6.1 J	3.8 J	3.4 J	7.8 J	2 J
PCB-183, 185	ng/kg dw	2,100 J	1,200	360	140	150	520	320	510	650	110
PCB-184	ng/kg dw	1.9 J	0.57 U	0.64 U	0.3 U	0.35 U	0.45 U	0.49 U	0.4 U	1.4 J	0.24 J
PCB-186	ng/kg dw	0.34 U	0.62 U	0.72 U	0.18 U	0.11 J	0.5 U	0.53 U	0.44 U	1.2 U	0.14 U
PCB-187	ng/kg dw	2,600 J	2,100	500	240	270	800	520	820	1,100	190
PCB-188	ng/kg dw	2.6 J	0.96 J	1 J	0.6 J	0.52 J	1.3 J	0.86 J	0.55 J	1.8 J	0.4 J
PCB-189	ng/kg dw	100 J	110	18	7.6 J	7 J	33	21	22	35	7.4 J
PCB-190	ng/kg dw	530 J	430	94	34	36	140	79	130	160	30
PCB-191	ng/kg dw	150 J	99	24	9.6 J	9.9 J	32	19 J	31	36	7.8 J
PCB-192	ng/kg dw	0.42 U	0.75 U	0.86 U	0.22 U	0.097 U	0.6 U	0.64 U	0.55 U	1.5 U	0.18 U
PCB-194	ng/kg dw	1,600 J	1,800	250	97	90	510	310	520	590	82
PCB-195	ng/kg dw	700 J	570	88	38	34	190	110	180	200	33
PCB-196	ng/kg dw	1,000 J	660	120	62	54	270	150	280	300	45
PCB-197, 200	ng/kg dw	330 J	150 J	35 J	0.065 U	16 J	83 J	45 J	93 J	91 J	13 J
PCB-198, 199	ng/kg dw	1,600 J	1,300	250	120	110	550	310	590	640	95
PCB-201	ng/kg dw	250 J	120	36	16 J	14 J	71	41	81	86	12 J
PCB-202	ng/kg dw	350 J	200	55	24	23	120	69	130	140	17 J
PCB-203	ng/kg dw	1,300 J	620	150	76	68	340	190	390	410	54
PCB-204	ng/kg dw	2 U	0.5 U	0.61 U	0.13 U	0.19 J	0.47 U	0.33 U	0.29 U	0.1 U	0.093 U
PCB-205	ng/kg dw	120 J	59	12	4.7 J	4 J	25	14 J	28	29	4 J
PCB-206	ng/kg dw	880 J	360 J	110 J	51 J	51 J	280 J	150 J	460 J	340 J	37 J
PCB-207	ng/kg dw	150 J	43 J	11 J	7.9 J	6.9 J	43 J	24 J	59 J	54 J	5 J
PCB-208	ng/kg dw	290	90	27	22	20 J	75	53	130	90	11 J
PCB-209	ng/kg dw	170	160	46	45	31	52	82	250	77	16 J
Total PCBs, Congeners	ng/kg dw	150,000	830,000	130,000	16,000	14,000	71,000	67,000	70,000	94,000	15,000
PCB Congener TEQ, 0 DL[4,5]	ng/kg dw	2.1 J	9.5	0.63 J	0.3	0.23	0.97	0.94	0.49	1.3	0.046
Other											
Total TEQ	ng/kg dw		21.9	11.1 J	13	5.08	39	40.3	73.3	52.4	2.93
Aromatic Hydrocarbons											
Total LPAH	µg/kg dw	130									
Naphthalene	µg/kg dw	31									
Acenaphthylene	µg/kg dw	8.1									
Acenaphthene	µg/kg dw	4.3 J									
Fluorene	µg/kg dw	9									
Phenanthrene	µg/kg dw	50									
Anthracene	µg/kg dw	29									

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

	Station ID	WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
	Sample ID	SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
	Sample Date	6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
	Depth Range (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
	Field QC	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
	Reoccupied	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Aromatic Hydrocarbons (cont.)											
2-Methylnaphthalene	µg/kg dw	13									
Total HPAH	µg/kg dw	760									
Fluoranthene	µg/kg dw	130									
Pyrene	µg/kg dw	130									
Benzo(a)anthracene	µg/kg dw	53									
Chrysene	µg/kg dw	120									
Total Benzofluoranthenes	µg/kg dw	180									
Benzo(b)fluoranthene	µg/kg dw	130									
Benzo(k)fluoranthene	µg/kg dw	48									
Benzo(a)pyrene	µg/kg dw	70									
Benzo(g,h,i)perylene	µg/kg dw	39									
Indeno(1,2,3-cd)pyrene	µg/kg dw	35									
Dibenzo(a,h)anthracene	µg/kg dw	9.4									
Carcinogenic PAH TEQ, 0 DL[6,7]	µg/kg dw	99									
Carcinogenic PAH TEQ, 1/2 DL[6,8]	µg/kg dw	99									
Chlorinated Benzenes											
1,2-Dichlorobenzene	µg/kg dw	38 U									
1,4-Dichlorobenzene	µg/kg dw	38 U									
1,2,4-Trichlorobenzene	µg/kg dw	23 U									
Hexachlorobenzene	µg/kg dw	32 U									
Phthalate Esters											
Dimethyl Phthalate	µg/kg dw	34 U									
Diethyl Phthalate	µg/kg dw	30 U									
Di-n-butyl Phthalate	µg/kg dw	26 U									
Butylbenzyl Phthalate	µg/kg dw	35 J									
bis(2-ethylhexyl)phthalate	µg/kg dw	48 J									
Di-n-octyl Phthalate	µg/kg dw	51 U									
Miscellaneous Nonionizable Organic Compounds											
Dibenzofuran	µg/kg dw	26 U									
Hexachlorobutadiene	µg/kg dw	30 U									
N-nitrosodiphenylamine	µg/kg dw	38 U									
Ionizable Organic Compounds											
Phenol	µg/kg dw	40 U									
2-Methylphenol	µg/kg dw	36 U									
4-Methylphenol	µg/kg dw	44 J									
2,4-Dimethylphenol	µg/kg dw	32 U									

Table C.10
Western Port Angeles Harbor Remedial Investigation (2013)

Station ID		WPAH016	WPAH017	WPAH024	WPAH025	WPAH027	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
Sample ID		SD0017	SD0018	SD0025	SD0026	SD0028	SD0051	SD0052	SD0053	SD0054	SD0055
Sample Date		6/28/2013	7/9/2013	6/27/2013	6/27/2013	6/27/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No
Analyte	**Units**										
Ionizable Organic Compounds (cont.)											
Pentachlorophenol	µg/kg dw	280 U									
Benzyl Alcohol	µg/kg dw	36 U									
Benzoic Acid	µg/kg dw	300 UJ									

Notes:

Blank cells are intentional.

1 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
2 Calculated using detected dioxin/furan concentrations.
3 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.
4 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
5 Calculated using detected congener concentrations.
6 Calculation of cPAH TEQ concentrations was performed using the California Enviornmental Protection Agency 2005 Toxic Equivalency Factors as presented in Table 708-2 of WAC 173-340-900.
7 Calculated using detected cPAH concentrations.
8 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.

Abbreviations:

cm Centimeters
cPAH Carcinogenic polycyclic aromatic hydrocarbon
DL Detection limit
HPAH High molecular weight polycyclic aromatic hydrocarbon
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
LPAH Low molecular weight polycyclic aromatic hydrocarbon
µm Micrometer
µg/kg dw Migrograms per kilogram dry weight
mg/kg dw Milligrams per kilogram dry weight
ng/kg dw Nanograms per kilogram dry weight
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF pentachlorodibenzofuran
QC Quality control
TCDD Tetrachlorodibenzodioxin
TCDF tetrachlorodibenzodioxin
TEQ Toxic equivalency

Qualifiers:

J Analyte was detected, concentration is considered to be an estimate.
JQ Analyte was detected between the method detection limit and reporting limit, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.
UJ Analyte was not detected, concentration given is the reporting limit which is considered to be an estimate.

Table C.11
Western Port Angeles Harbor Remedial Investigation (2013): Conventionals and Grain Size Analysis Only

Station ID		WPAH001	WPAH002	WPAH003	WPAH004	WPAH005	WPAH006	WPAH007	WPAH008	WPAH009	WPAH010	WPAH011	WPAH012	WPAH013	
Sample ID		SD0001	SD0002	SD0003	SD0004	SD0005	SD0006	SD0007	SD0008	SD0009	SD0010	SD0011	SD0012	SD0013	SD0016
Sample Date		7/3/2013	7/3/2013	7/1/2013	7/2/2013	6/27/2013	6/27/2013	6/27/2013	7/9/2013	7/1/2013	7/1/2013	7/2/2013	7/2/2013	7/8/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Conventionals															
Moisture Content	%			77	71					76	75	72		63	63
Soot	%	0.76 J	0.47 J	0.092 J	0.87 J	0.68 J	0.71 J	0.53 J	0.17 J	0.44 J	0.54 J	0.42 J	0.85 J	0.16 J	0.22 J
Total Organic Carbon	%	12 J	8.2 J	17 J	13 J	7.9 J	9.8 J	6.7 J	9 J	10 J	9.5 J	7.5 J	5.6 J	5.4 J	5.3 J
Total Solids	%	24.7	29.2	20	28	30.9	27.6	33.8	31.6	23.5	25.6	26.6	34.1	35.4	35.3
Total Volatile Solids	%	44.7	29.3	54.6	44.6	19.5	30.1	16.8	23.7 J	29.3	23	16.9	20.6	14.8	14.8
Particle/Grain Size															
Percent Gravel	%	0.1	4.08	32	35	0.64	19.6	1.05	4.68	6.4	5.6	0.37	2.5	0 U	0.15
Very Coarse Sand	%	2.69	3.72	12	6	2.35	5.74	1.16	3.07	5.4	4.4	1.4	5.1	1.44	0.82
Coarse Sand	%	10.1	9.01	8.6	5.1	2.28	4.81	1.46	2.96	5	4.3	3.3	5.5	2.45	1.67
Medium Sand	%	14.3	17.1	6.1	5.8	5.15	5.09	3.46	4.89	7.5	6.9	6.8	5.5	5.8	5.51
Fine Sand	%	8.55	11.6	3.7	5	5.45	6	5.35	7.23	6.1	4.6	4.4	2.4	5.68	6.15
Very Fine Sand	%	5.85	8.23	3.2	5.5	6.79	9.55	8.01	14.7	5.2	3.3	5.2	4.3	8.27	9.13
Percent Fines (clay & silt)	%	52.8	47.7	38	39	78.1	55.7	80.3	65.9	71	67	81	82	78	76.1
62.5 µm	%	4.16	4.34	2.7	4.3	3.02	2.97	2.25	11	6.3	5.8	7	9.3	7.89	10.5
31.3 µm	%	9.34	8.73	13	10	19.7	10.6	23.3	13.6	20	16	25	19	18.6	16.9
15.6 µm	%	9.58	8.67	5.4	7.8	14.8	10.1	14.9	10.4	13	12	15	15	13.4	11.8
7.8 µm	%	7.22	5.76	2.5	3.5	10.7	8.18	10.5	8.01	5.5	7.2	7.2	9.5	9.86	10.2
3.9 µm	%	4.48	4.87	2.1	2.7	8.28	6.15	7.56	5.85	4.7	5.8	6.1	7.3	7.63	7
1.95 µm	%	4	3.68	0.99	2.6	7.51	4.26	6.95	4.43	6.3	6	5.6	6.7	7.21	7.51
0.98 µm	%	14	11.6	11	8.2	14.1	13.5	14.8	12.6	14	14	16	15	13.4	12.3

Abbreviations:
cm Centimeter
µm Micrometer
QC Quality Control

Qualifiers:
J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.11
Western Port Angeles Harbor Remedial Investigation (2013): Conventionals and Grain Size Analysis Only

Station ID		WPAH014	WPAH015	WPAH016	WPAH017	WPAH018	WPAH019	WPAH020	WPAH021	WPAH022	WPAH023	WPAH024	WPAH025	WPAH026
Sample ID		SD0014	SD0015	SD0017	SD0018	SD0019	SD0020	SD0021	SD0022	SD0023	SD0024	SD0025	SD0026	SD0027
Sample Date		6/28/2013	7/8/2013	6/28/2013	7/9/2013	6/28/2013	6/28/2013	7/8/2013	7/3/2013	6/26/2013	6/26/2013	6/27/2013	6/27/2013	6/25/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**													
Conventionals														
Moisture Content	%		55	61	59							48	33	
Soot	%	0.88 J	0.011 J	0.044 J	0.01 U	0.061 J	0.024 J	0.01 U	0.26 J	0.01 U	0.34 J	0.2 J	0.11 J	1.2 J
Total Organic Carbon	%	5.9 J	4.5 J	5.1 J	4.1 J	5.6 J	15 J	13 J	11 J	12 J	16 J	3.1 J	1.1 J	7.9 J
Total Solids	%	32.6	40.8	35.8	38.8	30	25.5	24.8	31.2	27.1	37.3	48.6	62	25.1
Total Volatile Solids	%	15.4	1.63	13.4	11.7 J	19.5	31.1	36.8	23	27.4	38.1	8	3.62	21.4
Particle/Grain Size														
Percent Gravel	%	1.07	0.99	0.65	0.47	8.52	5.35	2.91	4.08	15.6	13.3	0.24	0.18	0.28
Very Coarse Sand	%	2.17	1.35	1.65	1.44	3.9	6.04	4.19	2.19	2.92	7.14	1.72	0.2	2.43
Coarse Sand	%	1.86	1.83	1.89	1.32	3.44	6.04	5.53	4.36	4.2	9.57	1.51	0.3	3.09
Medium Sand	%	5.11	4.12	4.25	3.21	3.42	12.2	9.36	6.84	9.09	12.4	2.95	2.21	6.95
Fine Sand	%	4.09	4.84	5.27	4.3	2.97	14.3	11.1	6.26	6.23	12	19.3	39.2	6.72
Very Fine Sand	%	8.22	15.7	12.4	13.5	4.61	11.9	7.95	7.81	5.68	17.8	30.4	33	6.27
Percent Fines (clay & silt)	%	77	77.3	77.9	69.9	77.6	49.2	56.4	63.6	65.5	31	43.6	23.9	77
62.5 µm	%	3.48	13.7	4.96	11.9	2.52	3.31	5.22	10.4	8.05	10.3	7.16	4.11	8.67
31.3 µm	%	23.4	17.1	21.4	15.5	22.3	8.98	10.4	14.1	21.9	9.14	13.4	6.09	20.4
15.6 µm	%	12.9	12.1	15	11.1	17.2	10.2	10.4	9.77	10.9	2.63	5.42	2.7	14.1
7.8 µm	%	9.57	9.4	9.93	8.97	8.42	6.78	7.59	7.93	5.27	1.56	4.11	2.5	7.06
3.9 µm	%	6.78	7.2	7.42	7.23	6.68	4.65	5.7	5.51	3.91	0.85	3.4	2.04	6.01
1.95 µm	%	6.04	6.92	6.6	6.11	5.95	1.73	4.35	4.09	3.91	0.68	2.61	1.78	4.46
0.98 µm	%	14.9	11	12.7	9.02	14.5	13.6	12.7	11.8	11.5	5.87	7.44	4.66	16.3

Abbreviations:
cm Centimeter
µm Micrometer
QC Quality Control

Qualifiers:
J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.11
Western Port Angeles Harbor Remedial Investigation (2013): Conventionals and Grain Size Analysis Only

Station ID		WPAH027	WPAH028	WPAH029	WPAH030	WPAH031	WPAH032	WPAH033	WPAH034	WPAH035	WPAH036	WPAH037	WPAH038	WPAH039	WPAH040
Sample ID		SD0028	SD0029	SD0030	SD0031	SD0032	SD0033	SD0034	SD0035	SD0036	SD0037	SD0038	SD0039	SD0040	SD0041
Sample Date		6/27/2013	6/27/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/25/2013	6/26/2013	6/26/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Conventionals															
Moisture Content	%	54													
Soot	%	1.5 J	0.89 J	0.41 J	0.17 J	0.33 J	0.62 J	0.27 J	0.18 J	0.33 J	0.2 J	0.17 J	0.051 J	0.8 J	0.037 J
Total Organic Carbon	%	6.9 J	10 J	3.8 J	2.7 J	3.8 J	5.2 J	5.3 J	3.3 J	3.7 J	3.6 J	4 J	0.99 J	4.9 J	2.6 J
Total Solids	%	39.9	26.8	44.9	47.9	40	33.9	45.3	43.2	61.9	44.3	45.1	66.4	37.3	42.9
Total Volatile Solids	%	27.2	32.6	10	7.96	10.6	14	13.6	11.7	7.05	10.9	11.4	3.55	16.6	8.62
Particle/Grain Size															
Percent Gravel	%	10.8	12.1	0.02	0.32	0.29	4.43	1.19	2.22	33	0.48	1.03	0.27	8.26	2.81
Very Coarse Sand	%	11.2	8.03	0.81	0.45	0.9	1.9	2.02	1.85	9.57	1.08	1.54	0.55	3.23	0.59
Coarse Sand	%	17.8	7.93	2.58	0.82	1.37	1.53	2.42	1.69	14	1.25	1.94	0.43	3.51	1.17
Medium Sand	%	23.4	8.99	7.08	1.91	3.79	2.8	3.36	4.68	8.55	2.72	3.27	0.78	5.24	3.4
Fine Sand	%	18.2	9.4	3.04	5.56	3.83	2.88	11.7	4.72	2.85	4.94	12.1	5.67	4.03	1.37
Very Fine Sand	%	3.69	5.97	15.2	18.8	11.2	5.6	22.8	14.4	3.14	14.7	22.8	49.9	7.24	6.7
Percent Fines (clay & silt)	%	19.6	45.5	73.2	72.7	84.2	81.5	58.8	71	28.4	76.4	60.4	43.6	70.5	84.5
62.5 µm	%	0.43	2.82	24.1	18.9	18.2	21.4	17.1	21	4.76	28.5	19.1	24.3	4.79	14.3
31.3 µm	%	2.59	7.99	12.6	14.3	19.1	33	22.6	28.5	6.75	32.1	23.6	9.17	20.6	23.3
15.6 µm	%	3.05	8.2	10.2	11.6	14.2	7.43	6.13	7.52	5.25	1.72	5.4	3.05	13.8	16.4
7.8 µm	%	2.87	6.13	7.08	7.54	7.94	3.4	2.56	2.47	2.82	2.66	2.6	1.38	8.88	6.57
3.9 µm	%	2.48	4.68	5.17	7.24	7.33	2.74	1.91	2.05	2.16	2.36	1.93	1.2	5.54	5.03
1.95 µm	%	2.48	3.1	4.16	4.26	6.35	2.18	1.88	1.96	1.95	1.72	1.58	1.05	4.69	4.95
0.98 µm	%	5.67	12.5	9.93	8.83	11.1	11.3	6.62	7.46	4.71	7.35	6.24	3.41	12.3	13.9

Abbreviations:
cm Centimeter
µm Micrometer
QC Quality Control

Qualifiers:
J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.11
Western Port Angeles Harbor Remedial Investigation (2013): Conventionals and Grain Size Analysis Only

Station ID		WPAH040	WPAH041	WPAH042	WPAH043	WPAH044	WPAH045	WPAH046		WPAH047	WPAH048	WPAH049	WPAH050	WPAH051	WPAH052
Sample ID		SD0042	SD0043	SD0044	SD0045	SD0046	SD0047	SD0048	SD0050	SD0049	SD0051	SD0052	SD0053	SD0054	SD0055
Sample Date		6/26/2013	6/26/2013	6/25/2013	6/26/2013	6/26/2013	6/26/2013	6/26/2013	6/26/2013	6/26/2013	7/3/2013	7/1/2013	7/1/2013	7/3/2013	7/8/2013
Depth Range (cm)		0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Field QC		Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Duplicate	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Reoccupied		No	No	No	No	No	No	No	No	No	No	No	No	No	No
Analyte	**Units**														
Conventionals															
Moisture Content	%										78	74	78	72	59
Soot	%	0.01 U	0.01 U	0.23 J	0.01 U	0.01 U	0.24 J	0.096 J	0.01 J	0.041 J	0.25 J	0.46 J	0.81 J	2.3 J	0.1 J
Total Organic Carbon	%	2.4 J	2 J	2.8 J	6.4 J	1.9 J	1.5 J	0.49 J	0.43 J	0.31 J	15 J	9.6 J	12 J	13 J	3.1 J
Total Solids	%	42.4	53.3	49.2	35.9	48.8	55.3	71.1	70.3	74.5	21	25.3	23.7	28.4	40.2
Total Volatile Solids	%	8.57	6.73	8.28	17.2	7.35	5.74	3.19 J	3.49	2.48	40.7	29	33	32.2	11.2
Particle/Grain Size															
Percent Gravel	%	0.11	0.01	0.74	3.19	0.02	0.42	0.74	1.69	0.06	0.29	2.5	7.6	3.22	1.02
Very Coarse Sand	%	0.59	0.51	0.81	2.38	0.19	0.33	0.51	0.46	0.41	3.08	4.8	5.6	4.07	1.97
Coarse Sand	%	0.9	0.7	2.67	2.28	0.22	0.86	0.78	0.71	1.16	6.75	7.7	9.5	8.1	3.21
Medium Sand	%	3.96	1.75	6.99	5.11	0.77	2.36	2.76	2.69	12	10.3	16	14	11.6	3.41
Fine Sand	%	2.01	9.75	7.11	5.22	1.38	12	61.1	60.8	60.2	8.82	11	7.2	11.9	1.64
Very Fine Sand	%	7.44	22.1	10.8	8.65	10.9	23.4	22.7	21.4	10.1	5.56	7.5	5	8.66	4.17
Percent Fines (clay & silt)	%	85.2	65.7	74.8	76.7	90.8	60.9	11.3	13.5	13.6	64.2	52	47	47	85.2
62.5 µm	%	14.6	18.2	13.7	12.7	18.1	17.2	1.37	1.63	1.9	3.69	6.4	4.9	4.23	11.7
31.3 µm	%	29.1	13.4	19.4	22	21	12.1	2.93	3.32	3.8	12.2	19	9.5	7.35	18.3
15.6 µm	%	14.4	9.78	13.4	12.9	14.3	8.72	1.43	1.77	2.02	12	7.5	5.6	7.94	14.8
7.8 µm	%	5.3	6.2	7.3	6.17	9.32	5.79	1.1	1.35	1.38	9.31	4.2	4.6	6.44	11.8
3.9 µm	%	4.67	5.7	6.02	6.61	6.95	4.27	1.54	1.39	1.05	6.73	2.3	3.6	8.26	8.17
1.95 µm	%	3.98	4.32	5.67	4.5	5.08	3.49	0.4	1.05	0.86	3.22	1.5	4.6	1.04	6.88
0.98 µm	%	13.2	8.1	9.39	11.8	16	9.31	2.53	2.95	2.56	17.1	11	14	11.7	13.5

Abbreviations:
cm Centimeter
µm Micrometer
QC Quality Control

Qualifiers:
J Analyte was detected, concentration is considered to be an estimate.
U Analyte was not detected, concentration given is the reporting limit.

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	B.R. Origin (physical/ biological)	RPD Area	RPD Mean (cm)	RPD Minimum (cm)	RPD Maximum (cm)	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	Methane	Low DO	Void #	Void Minimum Depth (cm)
02	A	11/5/98	9:34	48 08.260N	123 25.900W	NA	NA	15.57	15.27	15.87	0.60	PHYSICAL	76.37	5.59	3.73	6.37	4-3	2	>4	0	NO	NA	NA
02AR						14.00	229.73	16.41	15.78	16.65	0.88	BIOGENIC	77.48	5.54	4.52	5.83	>4	1	>4	0	NO	1	8.22
03	B	11/5/98	9:45	48 08.310N	123 26.019W	NA	NA	11.54	10.15	12.94	2.79	Ind	50.19	3.77	1.54	5.77	>4	2	>4	0	NO	NA	NA
03BR						14.00	163.44	11.68	10.38	13.31	2.93	PHYSICAL	46.58	3.33	1.31	3.34	>4	2	>4	0	NO	0	-
03CR						14.00	122.80	8.77	8.00	10.38	2.38	PHYISICAL	Ind	Ind	Ind	Ind	>4	2	>4	0	NO	0	-
04	B	11/5/98	9:58	48 08.310N	123 26.189W	NA	NA	13.96	13.68	14.23	0.55	BIOGENIC	8.91	2.40	0.10	4.88	>4	2	>4	0	NO	NA	NA
04BR						14.00	201.66	14.41	14.02	14.65	0.63	BIOGENIC	39.99	2.86	0.74	6.44	>4	2	>4	0	NO	4	7.75
05	A	11/5/98	10:09	48 08.380N	123 26.014W	NA	NA	12.06	11.09	13.03	1.94	PHYISICAL	20.52	2.03	0.35	3.63	4-3	2	>4	0	NO	NA	NA
05AR						14.00	176.48	12.61	11.83	13.61	1.78	PHYSICAL	27.21	1.94	0.58	3.83	>4	2	>4	0	NO	0	-
06	A	11/5/98	10:19	48 08.159N	123 26.424W	NA	NA	8.76	8.46	9.05	0.59	Ind	14.00	2.46	0.20	3.63	4-3	2	>4	0	NO	NA	NA
06AR						14.00	125.82	8.99	8.68	9.39	0.71	BIOGENIC	44.12	3.15	1.92	3.62	>4	2	>4	0	NO	3	5.01
06	B	11/5/98	10:22	48 08.169N	123 26.419W	NA	NA	12.46	11.84	13.08	1.24	BIOGENIC	44.82	4.14	0.55	6.27	4-3	2	>4	0	NO	NA	NA
06BR						14.00	181.98	13.00	12.68	13.58	0.90	BIOGENIC	51.90	3.71	1.84	6.22	>4	2	>4	0	NO	4	4.93
07	A	11/5/98	10:34	48 08.262N	123 26.721W	NA	NA	12.11	11.74	12.00	0.26	BIOGENIC	18.00	2.04	0.15	3.63	>4	2	>4	0	NO	NA	NA
07AR						14.00	174.62	12.48	12.24	12.68	0.44	BIOGENIC	25.57	1.83	0.30	3.37	>4	2	>4	0	NO	0	-
08	A	11/4/98	15:07	48 08.320N	123 26.980W	NA	NA	4.83	3.98	5.67	1.69	PHYISICAL	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	NA	NA
08AR						14.00	70.53	5.04	4.16	5.97	1.81	PHYSICAL	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
08	C	11/4/98	15:08	48 08.320N	123 26.980W	NA	NA	17.51	17.11	17.91	0.80	PHYISICAL	6.17	0.57	0.10	0.95	>4	3	>4	0	NO	NA	NA
08CR						14.00	250.37	17.89	17.53	18.32	0.79	BIOGENIC	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
09	C	11/4/98	14:57	48:08.130N	123 26.920W	NA	NA	15.70	14.63	16.77	2.14	PHYISICAL	Ind	Ind	Ind	Ind	>4	>4	>4	0	YES	NA	NA
09CR						14.00	221.67	15.84	15.31	17.42	2.11	PHYISICAL	Ind	Ind	Ind	Ind	>4	3	>4	0	YES	0	-
10	E	11/4/98	14:44	48 08.170N	123 27.160W	NA	NA	9.30	9.20	9.40	0.20	Ind	7.00	0.54	0.05	0.99	>4	3	>4	0	NO	NA	NA
10ER						14.00	133.88	9.57	9.34	9.89	0.55	PHYISICAL	0.00	0.00	0.00	0.00	>4	4	>4	0	YES	1R	5.34
11	A	11/4/98	14:12	48 08.081N	123 27.360W	NA	NA	15.62	15.17	16.07	0.90	Ind	36.70	3.23	1.49	4.98	>4	2	>4	0	NO	NA	NA
11AR						14.00	223.07	15.94	15.26	16.60	1.34	BIOGENIC	31.47	2.25	0.93	3.15	>4	2	>4	0	NO	2	10.71
12	A	11/4/98	14:24	48 08.201N	123 27.545W	NA	NA	19.15	18.31	20.00	1.69	PHYISICAL	0.00	0.00	0.00	0.00	>4	3	>4	YES	YES	NA	NA
12AR						14.00	283.59	20.26	18.90	21.01	2.11	BIOGENIC	0.00	0.00	0.00	0.00	>4	3	>4	2	YES	1R	14.57
12	C	11/4/98	14:26	48 08.200N	123 27.540W	NA	NA	20.12	19.80	20.45	0.65	BIOGENIC	0.00	0.00	0.00	0.00	>4	3	>4	0.00	YES	NA	NA
12CR						14.00	289.61	20.69	20.30	21.01	0.71	BIOGENIC	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
13	A	11/4/98	12:41	48 08.081N	123 27.720W	NA	NA	4.00	2.64	5.37	2.73	PHYISICAL	Ind	Ind	Ind	Ind	4-3	4	>4	0	NO	NA	NA
13AR						14.00	74.80	5.34	4.66	5.61	0.96	PHYISICAL	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	0	-
14	B	11/4/98	12:30	48 07.970N	123 27.490W	NA	NA	20.20	19.95	20.45	0.50	Ind	8.19	1.23	0.21	2.12	>4	3	>4	0	NO	NA	NA
14BR						14.00	294.69	21.05	21.01	21.01	0.00	Ind	Ind	Ind	Ind	Ind	>4	3	>4	0	YES	2	9.37
15	A	11/4/98	12:17	48 07.790N	123 27.310W	NA	NA	18.01	17.56	18.46	0.90	BIOGENIC	30.55	2.62	0.65	6.37	4-3	3	>4	0	NO	NA	NA
15AR						14.00	258.78	18.49	17.97	19.14	1.18	BIOGENIC	19.36	1.38	0.88	2.30	>4	2	>4	0	NO	1	5.48
16	A	11/4/98	12:04	48 07.670N	123 26.970W	NA	NA	14.40	14.13	14.68	0.55	BIOGENIC	18.22	2.70	0.05	4.18	>4	3	>4	0	NO	NA	NA
16AR						14.00	205.86	14.71	12.96	15.15	2.19	BIOGENIC	27.60	1.97	1.04	2.63	>4	2	>4	0	NO	0	-
17	C	11/4/98	11:17	48 07.580N	123 26.670W	NA	NA	12.09	11.79	12.39	0.60	BIOGENIC	12.99	1.97	0.30	3.18	>4	3	>4	0	NO	NA	NA
17CR						14.00	173.65	12.41	12.11	12.85	0.74	PHYISICAL	19.18	1.37	0.38	2.14	>4	2	>4	0	NO	2	5.23
18	A	11/4/98	11:03	48 07.500N	123 26.259W	NA	NA	14.35	13.58	15.12	1.54	Ind	5.95	0.57	0.16	0.93	>4	3	>4	0	NO	NA	NA
18 AR						14.00	209.14	14.94	13.97	15.56	1.59	BIOGENIC	5.83	0.42	0.00	0.85	>4	2	>4	0	YES	0	-
19	A	11/4/98	10:29	48 07.398N	123 26.031W	NA	NA	12.71	12.44	12.99	0.55	BIOGENIC	10.05	1.65	0.10	2.75	>4	2	>4	0	NO	NA	NA
19AR						14.00	183.18	13.09	12.71	13.37	0.66	BIOGENIC	27.57	1.97	0.71	3.01	>4	2	>4	0	NO	3	5.67
19	D	11/4/98	10:37	48 07.410N	123 26.030W	NA	NA	11.12	10.60	11.64	1.04	Ind	29.30	2.37	0.16	3.78	4-3	2	>4	0	NO	NA	NA
19DR						14.00	158.37	11.32	10.60	12.08	1.48	PHYISICAL	32.66	2.33	0.41	3.37	>4	2	>4	0	NO	1	4.74
20	F	11/4/98	10:01	48 07.190N	123 25.500W	NA	NA	2.31	1.14	3.48	2.34	PHYISICAL	29.14	2.04	1.19	3.83	4-3	2	>4	0	NO	NA	NA
20FR						14.00	29.47	2.11	1.45	3.40	1.94	PHYISICAL	29.47	2.11	1.45	3.40	4-3	2	>4	0	NO	0	-
21	B	11/4/98	9:00	48 07.220N	123 25.110W	NA	NA	7.46	7.26	7.66	0.40	Ind	Ind	Ind	Ind	Ind	4-3	3	>4	0	NO	NA	NA

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	B.R. Origin (physical/ biological)	RPD Area	RPD Mean (cm)	RPD Minimum (cm)	RPD Maximum (cm)	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	Methane	Low DO	Void #	Void Minimum Depth (cm)
21BR						14.00	52.37	3.74	1.56	7.50	5.94	PHYISICAL	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	0	-
22	C	11/4/98	9:17	48 07.080N	123 24.900W	NA	NA	0.22	0.15	0.30	0.15	PHYISICAL	Ind	Ind	Ind	Ind	>-1	-1	-1.00	0	NO	NA	NA
22CR						14.00	38.95	2.78	1.59	4.05	2.47	PHYISICAL	Ind	Ind	Ind	Ind	-4.00	-6	>4	0	NO	0	-
23	C	11/4/98	9:30	48 07.170N	123 24.600W	NA	NA	7.16	6.77	7.56	0.79	PHYISICAL	Ind	Ind	Ind	Ind	4-3	2	>4	0	NO	NA	NA
23CR						14.00	105.92	7.57	6.87	8.33	1.45	PHYISICAL	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	0	-
24	C	11/4/98	9:43	48 07.300N	123 24.780W	NA	NA	2.29	1.79	2.79	1.00	PHYISICAL	7.59	1.24	0.20	2.04	4-3	2	>4	0	NO	NA	NA
24CR						14.00	17.21	1.23	0.33	2.38	2.05	PHYISICAL	Ind	Ind	Ind	Ind	4-3	-4	>4	0	NO	0	-
25	A	11/4/98	8:36	48 07.570N	123 25.080W	NA	NA	7.99	6.92	9.05	2.13	PHYISICAL	37.70	2.82	0.10	4.13	4-3	2	>4	0	NO	NA	NA
25AR						14.00	112.92	8.07	6.96	9.15	2.19	BIOGENIC	38.98	2.79	1.34	3.53	4-3	2	>4	0	NO	2	5.01
25	B	11/4/98	8:37	48 07.570N	123 25.068W	NA	NA	9.50	9.35	9.65	0.30	BIOGENIC	40.86	3.00	1.39	4.83	4-3	2	>4	0	NO	NA	NA
25BR						14.00	135.65	9.69	9.42	9.97	0.55	BIOGENIC	28.50	2.04	1.45	3.51	4-3	2	>4	0	NO	4	3.53
26	A	11/4/98	10:17	48 07.430N	123 25.639W	NA	NA	9.85	9.55	10.15	0.60	BIOGENIC	43.79	3.25	1.34	4.73	4-3	2	>4	0	NO	NA	NA
26AR						14.00	140.55	10.04	9.70	10.16	0.47	BIOGENIC	27.45	1.96	1.37	2.88	>4	3	>4	0	NO	7	4.44
27	A	11/4/98	10:50	48 07.560N	123 26.019W	NA	NA	10.35	10.20	10.50	0.30	BIOGENIC	30.30	2.26	0.73	3.52	4-3	2	>4	0	NO	NA	NA
27AR						14.00	148.54	10.61	10.33	10.90	0.58	BIOGENIC	28.23	2.02	0.71	3.40	>4	3	>4	0	NO	4	4.88
28	A	11/4/98	17:04	48 07.850N	123 26.200W	NA	NA	12.76	11.79	13.73	1.94	BIOGENIC	43.36	3.22	1.24	4.93	4-3	2	>4	0	NO	NA	NA
28AR						14.00	175.25	12.52	12.08	13.97	1.89	BIOGENIC	45.75	3.27	1.64	6.00	>4	3	>4	0	NO	4	1.56
29	A	11/4/98	15:34	48 07.740N	123 26.718W	NA	NA	13.38	13.03	13.73	0.70	BIOGENIC	9.33	1.52	0.16	2.54	4-3	2	>4	0	NO	NA	NA
29AR						14.00	191.37	13.67	13.37	13.86	0.49	BIOGENIC	16.96	1.21	0.16	1.86	>4	3	>4	0	NO	2	5.97
30	A	11/4/98	15:22	48 07.921N	123 27.148W	NA	NA	18.91	18.36	19.45	1.09	BIOGENIC	93.18	6.99	2.04	10.25	4-3	2	>4	0	NO	NA	NA
30AR						14.00	268.98	19.22	18.73	19.99	1.26	BIOGENIC	44.09	3.15	1.95	5.04	>4	1	>4	0	NO	0	-
30	B	11/4/98	15:23	48 07.920N	123 27.150W	NA	NA	15.85	15.32	16.37	1.05	Ind	40.73	3.16	0.50	4.68	4-3	2	>4	0	NO	NA	NA
30BR						14.00	226.29	16.17	15.64	17.06	1.42	BIOGENIC	40.06	2.86	0.60	3.51	>4	1	>4	0	NO	2	4.85
31	A	11/5/98	10:46	48 08.040N	123 26.654W	NA	NA	17.06	16.17	17.96	1.79	PHYISICAL	12.35	0.05	6.12	3.06	4-3	2	>4	0	NO	NA	NA
31AR						14.00	251.44	17.96	16.63	18.60	1.97	BIOGENIC	33.83	2.42	1.92	3.53	>4	1	>4	0	NO	1	14.87
32	C	11/5/98	10:57	48 08.120N	123 26.162W	NA	NA	10.72	8.26	13.18	4.92	Ind	44.13	3.45	1.19	5.12	4-3	2	>4	0	NO	NA	NA
32CR						14.00	140.50	10.04	8.46	13.50	5.04	SAMPLING	Ind	Ind	3.37	3.92	>4	2	>4	0	NO	0	-
33	A	11/4/98	16:13	48 08.220N	123 25.340W	NA	NA	10.92	10.50	11.34	0.84	Ind	49.95	3.67	2.84	4.53	4-3	3	>4	0	NO	NA	NA
33AR						14.00	155.88	11.14	10.68	11.70	1.01	PHYISICAL	50.25	3.59	3.01	4.49	>4	2	>4	0	NO	0	-
33	C	11/4/98	16:14	48 08.220N	123 25.330W	NA	NA	7.89	7.66	8.11	0.45	BIOGENIC	23.63	1.97	0.25	3.38	4-3	3	>4	0	NO	NA	NA
33CR						14.00	109.45	7.82	7.48	8.11	0.63	BIOGENIC	37.29	2.66	2.11	3.40	>4	2	>4	0	NO	1	5.51
34	A	11/5/98	9:05	48 07.831N	123 25.573W	NA	NA	4.85	4.51	5.18	0.67	PHYISICAL	14.91	1.11	0.05	2.15	4-3	3	>4	0	NO	NA	NA
34AR						14.00	67.79	4.84	4.49	5.12	0.63	BIOGENIC	16.07	1.15	0.71	1.56	4-3	2	>4	0	NO	1	3.12
34	C	11/5/98	9:06	48 07.830N	123 25.570W	NA	NA	7.59	7.23	7.95	0.72	BIOGENIC	12.45	2.00	0.05	3.49	4-3	3	>4	0	NO	NA	NA
34CR						14.00	105.40	7.53	6.90	8.05	1.15	BIOGENIC	25.25	1.80	1.04	2.85	4-3	2	>4	0	NO	4	2.36
35	A	11/4/98	16:26	48 08.040N	123 24.949W	NA	NA	9.21	7.90	10.51	2.61	PHYISICAL	38.26	2.80	0.62	4.21	4-3	3	>4	0	NO	NA	NA
35AR						14.00	129.62	9.26	7.97	10.65	2.68	BIOGENIC	46.85	3.35	2.14	3.83	4-3	2	>4	0	NO	1	6.55
36	C	11/4/98	16:40	48 08.180N	123 24.440W	NA	NA	7.59	7.13	80.50	73.37	PHYISICAL	50.45	3.67	2.51	4.97	4-3	3	>4	0	NO	NA	NA
36CR						14.00	112.01	8.00	7.29	8.60	1.31	BIOGENIC	46.88	3.35	1.67	4.55	4-3	2	>4	0	NO	2	3.75
37	B	11/5/98	8:21	48 07.750N	123 24.550W	NA	NA	3.13	2.67	3.59	0.92	PHYISICAL	Ind	Ind	Ind	Ind	4-3	3	>4	0	NO	NA	NA
37BR						14.00	47.87	3.42	2.60	3.81	1.21	PHYISICAL	Ind	Ind	Ind	Ind	4-3	2	>4	0	NO	0	-
38	A	11/6/98	13:05	48 08.050N	123 27.560W	NA	NA	20.77	20.77	20.77	0.00	Ind	Ind	Ind	Ind	Ind	4-3	3	>4	0	YES	NA	NA
38BR						14.00	294.30	21.03	21.01	21.01	0.00	Ind	Ind	Ind	Ind	Ind	>4	2	>4	0	YES	0	-
39	B	11/6/98	12:41	48 08.130N	123 27.540W	NA	NA	2.27	0.12	4.41	4.29	Ind	Ind	Ind	Ind	Ind	4-3	3	>4	0	YES	NA	NA
39BR						14.00	57.04	4.08	1.62	5.48	3.86	BIOGENIC	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
39	C	11/6/98	12:41	48 08.120N	123 27.520W	NA	NA	12.18	11.23	13.13	1.90	PHYISICAL	19.67	2.95	0.15	4.82	>4	3	>4	0	NO	NA	NA
39CR						14.00	178.08	12.72	11.91	13.94	2.03	BIOGENIC	38.92	2.78	0.90	4.85	>4	3	>4	0	NO	0	-
40	A	11/5/98	14:18	48 08.250N	123 27.283W	NA	NA	17.05	16.15	17.95	1.80	Ind	0.00	0.00	0.00	0.00	4-3	3	>4	0	YES	NA	NA

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STATION	REP	Date	Time	Latitude	Longitude	CAL	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	B.R. Origin (physical/ biological)	RPD Area	RPD Mean (cm)	RPD Minimum (cm)	RPD Maximum (cm)	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	Methane	Low DO	Void #	Void Minimum Depth (cm)
40AR						14.00	254.32	18.17	16.90	18.95	2.05	Ind	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	0	-
41	A	11/5/98	14:29	48 08.118N	123 27.261W	NA	NA	6.51	6.26	6.77	0.51	PHYISICAL	27.12	2.00	0.82	2.92	>4	3	>4	0	NO	NA	NA
41AR						14.00	99.27	7.09	6.82	7.40	0.58	PHYISICAL	33.41	2.39	1.29	3.48	>4	2	>4	0	NO	0	-
42	A	11/5/98	14:10	48 08.260N	123 27.122W	NA	NA	16.44	15.90	16.97	1.07	PHYISICAL	0.00	0.00	0.00	0.00	>4	3	>4	0	NO	NA	NA
42AR						14.00	241.84	17.28	16.57	18.05	1.48	PHYISICAL	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
43	C	11/5/98	12:13	48 07.850N	123 27.010W	NA	NA	8.64	8.36	8.92	0.56	PHYISICAL	0.00	0.00	0.00	0.00	4-3	3	>4	0	YES	NA	NA
43CR						14.00	123.80	8.85	8.65	9.39	0.74	SAMPLING	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	0	-
44	C	11/5/98	12:21	48 07.928N	123 27.330W	NA	NA	13.51	9.44	17.59	8.15	Ind	55.20	4.85	0.26	8.00	4-3	3	>4	0	NO	NA	NA
44CR						14.00	217.87	15.57	9.81	18.32	8.52	SAMPLING	Ind	Ind	1.52	5.92	>4	2	>4	0	NO	0	-
45	A	11/5/98	12:28	48 08.029N	123 27.239W	NA	NA	16.00	15.44	16.56	1.12	Ind	20.31	1.57	0.46	3.44	>4	3	>4	0	NO	NA	NA
45AR						14.00	226.63	16.19	15.64	17.04	1.40	BIOGENIC	22.31	1.59	0.55	2.74	>4	3	>4	0	NO	2	8.08
45	B	11/5/98	12:29	48 08.030N	123 27.241W	NA	NA	18.95	17.33	20.56	3.23	Ind	11.05	1.00	0.41	1.85	>4	3	>4	0	NO	NA	NA
45BR						14.00	277.00	19.79	18.41	21.01	2.60	SAMPLING	19.48	1.39	0.99	1.76	>4	3	>4	0	NO	0	-
46	B	11/5/98	12:37	48 08.100N	123 27.110W	NA	NA	15.36	14.97	15.74	0.77	BIOGENIC	49.56	3.65	1.74	5.08	4-3	3	>4	0	NO	NA	NA
46BR						14.00	218.14	15.59	15.17	16.10	0.93	BIOGENIC	41.41	2.96	1.56	3.83	>4	2	>4	0	NO	1	9.39
47	A	11/5/98	12:54	48 08.200N	123 27.000W	NA	NA	11.31	10.62	12.00	1.38	PHYISICAL	27.53	2.49	0.67	4.26	4-3	3	>4	0	NO	NA	NA
47AR						14.00	163.93	11.71	11.15	12.43	1.29	PHYISICAL	33.73	2.41	0.96	4.03	>4	2	>4	0	NO	0	-
47	B	11/5/98	12:55	48 08.200N	123 27.000W	NA	NA	6.31	4.67	7.95	3.28	PHYISICAL	16.41	1.67	0.46	2.87	>4	3	>4	0	NO	NA	NA
47BR						14.00	100.04	7.15	4.90	7.97	3.07	PHYISICAL	28.35	2.03	0.61	3.10	>4	3	>4	0	YES	0	-
48	B	11/5/98	13:10	48 08.260N	123 26.860W	NA	NA	7.13	4.92	9.33	4.41	Ind	40.33	3.58	0.10	5.13	4-3	3	>4	0	NO	NA	NA
48BR						14.00	109.01	7.79	5.04	9.83	4.79	SAMPLING	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	0	-
50	A	11/5/98	13:27	48 08.360N	123 26.641W	NA	NA	15.15	14.46	15.85	1.39	PHYISICAL	27.41	3.49	0.15	5.49	>4	3	>4	0	NO	NA	NA
50AR						14.00	225.63	16.12	15.28	16.87	1.59	SAMPLING	32.82	2.34	0.90	5.23	>4	3	>4	0	YES	0	-
51	A	11/5/98	14:49	48 07.852N	123 27.240W	NA	NA	18.95	18.31	19.59	1.28	BIOGENIC	28.24	2.25	0.26	3.94	>4	3	>4	0	NO	NA	NA
51AR						14.00	276.75	19.77	19.04	20.62	1.59	BIOGENIC	22.33	1.60	0.47	2.71	>4	2	>4	0	YES	0	-
52	A	11/5/98	14:39	48 08.019N	123 27.039W	NA	NA	11.92	11.44	12.41	0.97	PHYISICAL	46.12	3.37	1.90	5.03	4-3	3	>4	0	NO	NA	NA
52AR						14.00	178.53	12.76	12.08	13.17	1.10	BIOGENIC	40.84	2.92	1.56	3.78	>4	2	>4	0	NO	0	-
52	B	11/5/98	14:40	48 08.020N	123 27.043W	NA	NA	15.56	15.23	15.90	0.67	Ind	45.26	3.34	2.10	4.97	4-3	3	>4	0	NO	NA	NA
52BR						14.00	225.16	16.09	15.64	16.49	0.85	BIOGENIC	21.40	1.53	0.19	3.29	>4	2	>4	0	NO	1	5.62
54	C	11/5/98	13:37	48 08.320N	123 26.560W	NA	NA	14.44	14.05	14.82	0.77	PHYISICAL	7.92	1.69	0.31	4.05	4-3	3	>4	0.00	NO	NA	NA
54CR						14.00	208.84	14.92	14.54	15.31	0.77	BIOGENIC	23.90	1.71	0.74	3.10	>4	3	>4	0	NO	0	-
55	B	11/5/98	14:59	48 07.700N	123 27.190W	NA	NA	17.79	16.97	18.62	1.65	Ind	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
55BR						14.00	256.94	18.36	17.53	19.20	1.67	Ind	0.00	0.00	0.00	0.00	>4	3	>4	0	YES	0	-
55	C	11/5/98	15:00	48 07.712N	123 27.190W	NA	NA	18.95	18.51	19.38	0.87	Ind	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
55CR						14.00	273.29	19.53	19.06	19.89	0.82	BIOGENIC	1.56	0.11	0.00	0.44	>4	3	>4	0	YES	0	-
56	A	11/5/98	15:05	48 07.782N	123 27.101W	NA	NA	15.44	14.97	15.91	0.94	BIOGENIC	8.89	1.50	0.05	2.33	4-3	3	>4	0	NO	NA	NA
56AR						14.00	222.89	15.93	15.28	16.43	1.15	BIOGENIC	24.23	1.73	0.69	2.49	>4	3	>4	0	NO	2	7.34
57	A	11/5/98	15:14	48 07.860N	123 27.041W	NA	NA	15.23	14.77	15.70	0.93	Ind	46.59	4.13	0.10	6.68	4-3	3	>4	0	NO	NA	NA
57AR						14.00	217.82	15.56	15.06	15.97	0.90	BIOGENIC	37.02	2.65	0.90	4.03	>4	3	>4	0	NO	4	4.22
57	B	11/5/98	15:15	48 07.860N	123 27.040W	NA	NA	14.92	11.30	18.55	7.25	PHYISICAL	18.59	3.66	0.21	5.34	4-3	3	>4	0	NO	NA	NA
57BR						14.00	184.39	13.18	11.78	14.71	2.93	SAMPLING	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	2	4.66
58	A	11/5/98	15:22	48 07.940N	123 26.971W	NA	NA	15.13	14.40	15.86	1.46	BIOGENIC	38.75	2.92	0.05	4.82	4-3	3	>4	0	NO	NA	NA
58AR						14.00	219.77	15.70	14.95	16.24	1.29	BIOGENIC	37.62	2.69	2.05	3.37	>4	3	>4	0	NO	2	6.35
59	A	11/5/98	15:30	48 08.030N	123 26.839W	NA	NA	14.97	14.30	15.65	1.35	BIOGENIC	25.70	3.15	0.16	5.70	4-3	3	>4	0	NO	NA	NA
59AR						14.00	212.52	15.18	14.08	16.38	2.30	BIOGENIC	33.94	2.42	0.67	3.26	>4	3	>4	0	NO	1	8.11
60	A	11/5/98	15:39	48 08.120N	123 26.710W	NA	NA	9.09	7.67	10.52	2.85	PHYISICAL	12.92	2.10	0.41	4.25	>4	3	>4	0	NO	NA	NA
60AR						14.00	136.43	9.75	8.05	10.74	2.68	BIOGENIC	29.49	2.11	0.99	3.24	>4	3	>4	0	YES	0	-
60	B	11/5/98	15:40	48 08.120N	123 26.710W	NA	NA	15.31	14.56	16.06	1.50	PHYISICAL	10.30	0.83	0.10	2.18	>4	3	>4	0	NO	NA	NA

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	B.R. Origin (physical/ biological)	RPD Area	RPD Mean (cm)	RPD Minimum (cm)	RPD Maximum (cm)	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	Methane	Low DO	Void #	Void Minimum Depth (cm)
60BR						14.00	224.84	16.06	15.17	16.52	1.34	SAMPLING	0.00	0.00	0.00	0.00	>4	3	>4	1	YES	0	-
61	B	11/5/98	15:52	48 08.210N	123 26.600W	NA	NA	0.41	0.05	0.78	0.73	PHYISICAL	Ind	Ind	Ind	Ind	4-3	3	>4	0	NO	NA	NA
61BR						14.00	14.92	1.07	0.08	1.48	1.40	PHYISICAL	Ind	Ind	Ind	Ind	>4	3	>4	Ind	NO	0	-
62	A	11/6/98	12:24	48 08.258N	123 26.409W	NA	NA	13.37	11.76	14.97	3.21	PHYISICAL	72.30	5.50	2.07	7.88	4-3	3	>4	0.00	NO	NA	NA
62AR						14.00	196.26	14.02	11.94	15.45	3.51	PHYISICAL	43.74	3.13	1.12	5.15	>4	3	>4	0	NO	0	-
63	B	11/6/98	13:27	48 07.760N	123 27.380W	NA	NA	16.84	16.22	17.46	1.24	PHYISICAL	46.80	3.56	1.40	7.31	>4	3	>4	0	NO	NA	NA
63BR						14.00	236.30	16.88	16.30	17.64	1.34	BIOGENIC	27.17	1.94	1.06	2.63	>4	1	>4	0	NO	1R	15.48
64	A	11/6/98	13:35	48 07.790N	123 26.859W	NA	NA	14.82	14.51	15.13	0.62	BIOGENIC	33.38	2.59	0.78	4.25	>4	3	>4	0	NO	NA	NA
64AR						14.00	212.50	15.18	14.79	15.50	0.71	BIOGENIC	35.31	2.52	1.10	3.70	>4	2	>4	0	NO	1	9.67
65	A	11/6/98	11:42	48 07.901N	123 26.600W	NA	NA	18.45	17.31	19.59	2.28	PHYISICAL	30.97	4.72	0.62	7.62	>4	3	>4	0	NO	NA	NA
65AR						14.00	262.04	18.72	17.64	19.80	2.16	BIOGENIC	36.73	2.62	1.86	3.53	>4	3	>4	0	NO	4	6.74
66	A	11/6/98	11:34	48 08.100N	123 26.518W	NA	NA	12.77	12.33	13.21	0.88	Ind	33.77	2.57	0.10	3.99	4-3	3	>4	0	NO	NA	NA
66AR						14.00	179.70	12.84	12.43	13.26	0.82	BIOGENIC	33.50	2.39	1.26	2.79	>4	2	>4	0	NO	3	6.14
67	A	11/6/98	14:24	48 07.608N	123 26.819W	NA	NA	16.06	14.77	17.36	2.59	PHYISICAL	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
67AR						14.00	231.91	16.57	15.12	17.97	2.85	Ind	6.96	0.50	0.05	1.55	>4	3	>4	0	YES	0	-
67	B	11/6/98	14:25	48 07.610N	123 26.820W	NA	NA	13.73	13.26	14.20	0.94	PHYISICAL	36.58	2.80	0.21	6.06	4-3	3	>4	0	NO	NA	NA
67BR						14.00	195.08	13.94	13.26	14.35	1.10	SAMPLING	Ind	Ind	Ind	Ind	>4	3	>4	0	NO	0	-
68	A	11/6/98	9:42	48 07.262N	123 24.438W	NA	NA	0.67	0.52	0.83	0.31	PHYISICAL	Ind	Ind	Ind	Ind	3-2	3	>4	0	NO	NA	NA
68AR						14.00	13.61	0.97	0.44	1.53	1.09	PHYISICAL	13.61	0.97	0.44	1.53	3-2	-2	>4	0	NO	0	-
69	A	11/6/98	9:56	48 07.201N	123 24.500W	NA	NA	13.96	13.37	14.56	1.19	PHYISICAL	13.04	0.88	0.67	1.14	4-3	3	>4	YES	NO	NA	NA
69AR						14.00	195.21	13.95	13.56	14.68	1.12	PHYISICAL	0.00	0.00	0.00	0.00	>4	2	>4	2	YES	0	-
70	A	11/6/98	11:26	48 08.070N	123 26.390W	NA	NA	9.97	7.46	12.49	5.03	BIOGENIC	27.06	2.11	0.10	4.25	4-3	3	>4	0	NO	NA	NA
70AR						14.00	130.99	9.36	7.59	12.52	4.93	SAMPLING	Ind	Ind	Ind	Ind	>4	2	>4	0	NO	0	-
70	C	11/6/98	11:27	48 08.070N	123 26.390W	NA	NA	12.62	11.92	13.32	1.40	BIOGENIC	6.18	1.39	0.05	3.26	>4	4	>4	0	NO	NA	NA
70CR						14.00	181.11	12.94	12.19	13.45	1.26	BIOGENIC	18.00	1.29	1.10	2.41	>4	2	>4	0	NO	2	6.87
71	A	11/6/98	12:16	48 08.200N	123 26.220W	NA	NA	17.98	17.51	18.45	0.94	BIOGENIC	24.84	3.60	0.21	6.58	>4	4	>4	0	NO	NA	NA
71AR						14.00	258.88	18.50	18.02	18.90	0.88	BIOGENIC	41.05	2.93	1.56	5.10	>4	2	>4	0	NO	3	5.18
72	A	11/6/98	13:44	48 07.698N	123 26.418W	NA	NA	12.62	12.07	13.16	1.09	BIOGENIC	36.01	2.60	1.45	4.20	>4	4	>4	0	NO	NA	NA
72AR						14.00	178.43	12.75	12.16	13.37	1.20	BIOGENIC	36.81	2.63	1.53	3.94	>4	2	>4	0	NO	1	4.46
73	A	11/6/98	11:17	48 08.001N	123 26.160W	NA	NA	10.39	10.10	10.67	0.57	PHYISICAL	35.95	2.68	0.26	4.77	>4	4	>4	0	NO	NA	NA
73AR						14.00	148.22	10.59	10.16	10.93	0.77	BIOGENIC	36.41	2.60	1.73	2.93	>4	3	>4	0	NO	1	3.75
74	A	11/6/98	11:07	48 08.160N	123 26.160W	NA	NA	12.07	11.55	12.59	1.04	PHYISICAL	44.08	3.31	1.45	4.72	>4	4	>4	0	NO	NA	NA
74AR						14.00	173.23	12.38	11.61	12.71	1.10	BIOGENIC	49.68	3.55	2.55	4.79	>4	3	>4	0	NO	2	8.03
75	B	11/6/98	9:18	48 08.170N	123 25.640W	NA	NA	13.11	12.54	13.68	1.14	PHYISICAL	54.39	4.00	0.88	6.53	>4	4	>4	0	NO	NA	NA
75BR						14.00	187.19	13.37	12.87	13.89	1.01	BIOGENIC	41.55	2.97	1.34	4.79	>4	1	>4	0	NO	0	-
76	A	11/6/98	9:08	48 08.279N	123 25.660W	NA	NA	12.10	11.66	12.54	0.88	PHYISICAL	32.73	2.67	1.04	3.83	>4	4	>4	0	NO	NA	NA
76AR						14.00	175.12	12.51	11.78	12.96	1.18	SAMPLING	44.26	3.16	1.18	6.16	>4	2	>4	0	NO	0	-
77	A	11/6/98	8:57	48 08.300N	123 25.520W	NA	NA	13.32	12.59	14.04	1.45	PHYISICAL	19.26	2.21	0.47	3.37	>4	4	>4	0	NO	NA	NA
77AR						14.00	192.37	13.74	12.96	14.21	1.26	SAMPLING	45.39	3.24	1.97	4.93	>4	2	>4	1	NO	0	-
78	A	11/6/98	8:48	48 08.380N	123 25.390W	NA	NA	9.84	8.96	10.73	1.77	PHYISICAL	39.52	2.94	0.41	4.46	>4	4	>4	0	NO	NA	NA
78AR						14.00	145.09	10.37	9.23	10.90	1.67	BIOGENIC	37.87	2.71	0.69	3.15	>4	2	>4	0	NO	0	-
79	B	11/6/98	8:37	48 08.290N	123 25.240W	NA	NA	8.55	8.24	8.86	0.62	Ind	23.30	1.70	0.10	2.85	4-3	4	>4	0	NO	NA	NA
79BR						14.00	121.13	8.65	8.38	8.93	0.55	PHYISICAL	28.27	2.02	1.42	3.07	4-3	2	>4	0	NO	1	6.55
80	A	11/6/98	8:25	48 08.260N	123 24.985W	NA	NA	11.93	11.68	12.17	0.49	PHYISICAL	57.47	4.17	2.45	5.65	4-3	3	>4	0	NO	NA	NA
80AR						14.00	168.70	12.05	11.80	12.16	0.36	PHYISICAL	65.93	4.71	3.65	6.05	4-3	2	>4	0	NO	1	4.08
81	A	11/6/98	10:57	48 08.032N	123 25.878W	NA	NA	5.71	5.43	5.98	0.55	PHYISICAL	27.75	2.06	0.98	2.88	4-3	3	>4	0	NO	NA	NA
81AR						14.00	79.42	5.67	5.45	6.14	0.68	PHYISICAL	27.21	1.94	0.88	3.10	4-3	2	>4	0	NO	0	-
82	A	11/6/98	14:14	48 07.570N	123 26.398W	NA	NA	10.11	9.62	10.60	0.98	BIOGENIC	27.09	2.00	1.03	3.26	>4	4	>4	0	NO	NA	NA

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Penetration Area (sq cm)	Penetration Mean (cm)	Penetration Minimum (cm)	Penetration Maximum (cm)	Boundary Roughness (cm)	B.R. Origin (physical/ biological)	RPD Area	RPD Mean (cm)	RPD Minimum (cm)	RPD Maximum (cm)	Grain Size Major Mode (phi)	Grain Size Maximum (phi)	Grain Size Minimum (phi)	Methane	Low DO	Void #	Void Minimum Depth (cm)
82AR						14.00	146.08	10.44	9.83	10.79	0.96	BIOGENIC	29.32	2.10	0.88	3.70	>4	2	>4	0	NO	1	6.27
83	A	11/6/98	13:51	48 07.601N	123 26.169W	NA	NA	12.80	12.28	13.32	1.04	PHYISICAL	14.87	2.05	0.54	4.67	4-3	4	>4	0	NO	NA	NA
83AR						14.00	180.34	12.88	12.35	13.61	1.26	BIOGENIC	22.43	1.60	0.38	3.29	>4	2	>4	0	NO	2	4.38
84	A	11/6/98	14:06	48 07.482N	123 26.359W	NA	NA	17.36	17.23	17.50	0.27	BIOGENIC	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
84AR						14.00	248.45	17.75	17.69	18.08	0.38	BIOGENIC	0.00	0.00	0.00	0.00	>4	1	>4	0	YES	1R	11.23
85	A	11/6/98	13:58	48 07.429N	123 26.180W	NA	NA	17.17	16.85	17.50	0.65	BIOGENIC	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
85AR						14.00	241.98	17.29	17.06	17.80	0.74	Ind	0.59	0.04	0.03	0.22	>4	2	>4	0	YES	0	-
85	B	11/6/98	13:59	48 07.430N	123 26.176W	NA	NA	16.52	15.82	17.23	1.41	PHYISICAL	9.11	1.29	0.16	2.23	>4	4	>4	0	NO	NA	NA
85BR						14.00	239.69	17.13	15.91	17.72	1.81	Ind	7.43	0.53	0.00	1.21	>4	2	>4	0	YES	0	-
86	A	11/6/98	10:42	48 07.418N	123 25.330W	NA	NA	9.27	8.70	9.84	1.14	PHYISICAL	31.81	2.38	0.92	3.91	>4	4	>4	0	NO	NA	NA
86AR						14.00	131.50	9.40	9.01	9.92	0.90	BIOGENIC	24.58	1.76	0.96	2.57	4-3	2	>4	0	NO	5	2.99
87	C	11/6/98	10:08	48 07.160N	123 24.760W	NA	NA	10.92	10.82	11.03	0.21	PHYISICAL	0.00	0.00	0.00	0.00	3-2	3	>4	0	NO	NA	NA
87CR						14.00	155.90	11.14	10.79	11.59	0.79	Ind	0.00	0.00	0.00	0.00	4-3	2	>4	0	YES	0	-
89	A	11/6/98	8:34	48 07.360N	123 24.418W	NA	NA	1.96	0.87	3.04	2.17	PHYISICAL	Ind	Ind	Ind	Ind	4-3	3	>4	0	NO	NA	NA
89AR						14.00	37.22	2.66	1.64	3.37	1.73	PHYISICAL	Ind	Ind	Ind	Ind	-2- -3	-3.00	>4	0	NO	0	-
90	A	11/6/98	8:05	48 07.240N	123 24.310W	NA	NA	9.27	8.10	10.43	2.33	PHYISICAL	33.78	2.47	1.30	3.59	4-3	3	>4	0	NO	NA	NA
90AR						14.00	128.68	9.19	8.30	10.41	2.11	PHYISICAL	39.63	2.83	1.67	4.41	4-3	2	>4	0	NO	0	-
91	C	11/6/98	12:48	48 08.150N	123 27.650W	NA	NA	20.98	20.98	20.98	0.00	Ind	Ind	Ind	Ind	Ind	4-3	3	>4	0	NO	NA	NA
91CR						14.00	294.21	21.02	20.98	20.98	0.00	Ind	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	0	-
92	A	11/6/98	13:11	48 07.990N	123 27.602W	NA	NA	20.16	19.46	20.87	1.41	PHYISICAL	0.00	0.00	0.00	0.00	4-3	3	>4	0	NO	NA	NA
92CR						14.00	284.76	20.35	19.91	21.01	1.10	Ind	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	2	9.37
94	C	11/6/98	10:27	48 07.100N	123 24.670W	NA	NA	0.05	0.05	0.05	0.00	Ind	Ind	Ind	Ind	Ind	>-1	-1	-1.00	0	NO	NA	NA
94CR						14.00	71.37	5.10	4.49	5.31	0.82	PHYISICAL	Ind	Ind	Ind	Ind	Ind	Ind	Ind	Ind	Ind	Ind	Ind
95	A	11/6/98	14:31	48 07.642N	123 27.016W	NA	NA	10.54	10.16	10.92	0.76	PHYISICAL	0.00	0.00	0.00	0.00	>4	4	>4	0	YES	NA	NA
95AR						14.00	151.49	10.82	10.38	11.15	0.77	Ind	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	0	-
95	B	11/6/98	14:32	48 07.640N	123 27.018W	NA	NA	18.59	17.28	19.89	2.61	PHYISICAL	0.00	0.00	0.00	0.00	>4	4	>4	0	NO	NA	NA
95BR						14.00	262.89	18.78	17.47	20.76	3.29	Ind	0.00	0.00	0.00	0.00	>4	2	>4	0	YES	0	-

Notes:

Blank cells are intentional.

BLACK Reported value.

RED Revised values used in the Western Port Angeles Harbor RI/FS for comparison to the 2013 SPI data. An image analyst from Germano & Associates conducted the image re-analysis under subcontract to Integral in 2013.

1 An image analyst from Germano & Associates conducted the image re-analysis under subcontract to Integral.

Abbreviations:

cm Centimeter
DO Dissolved oxygen
NA Not applicable
phi Krumbein phi grain size scale
RPD Relative percent different
SPI Sediment profile imaging
sq cm Square centimeter

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Void Maximum Depth (cm)	Infaunal Successional Stage	Mudclast #	Mudclast State	SOD	Beggiatoa	RPD Code	Successional Stage Code	Low DO Code	Methane Code	OSI	Comments
02	A	11/5/98	9:34	48 08.260N	123 25.900W	NA	NA	Ind	0	-	-	-	6	Ind	0	0	Ind	S/M, WOOD CHUNK, PELLETAL SURFACE
02AR						14.00	8.71	1 ON 3	0	-	LOW	NO	6	5	0	0	11	
03	B	11/5/98	9:45	48 08.310N	123 26.019W	NA	NA	1	0	-	-	-	6	1	0	0	7	S/M, FINE WOOD FRAGS MIXD IN SURF LAYER
03BR						14.00	-	1	0	-	HIGH	NO	5	1	0	0	6	
03CR						14.00	-	1	0	-	HIGH	NO	Ind	1	0	0	Ind	
04	B	11/5/98	9:58	48 08.310N	123 26.189W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, RELIC VOIDS, WORM @ DEPTH, PELLETAL S
04BR						14.00	13.50	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
05	A	11/5/98	10:09	48 08.380N	123 26.014W	NA	NA	1	0	-			3	1	0	0	4	S/M, WORM @ DEPTH, WOOD CHUNKS, SHELL FRAGS, RIPPLED
05AR						14.00	-	1	0	-	LOW	NO	3	1	0	0	4	
06	A	11/5/98	10:19	48 08.159N	123 26.424W	NA	NA	1 ON 3	0	-			4	5	0	0	9	MUD>P, VOIDS, SHELL FRAG, WIPER
06AR						14.00	8.27	1 ON 3	0	-	MOD	NO	5	5	0	0	10	
06	B	11/5/98	10:22	48 08.169N	123 26.419W	NA	NA	1 ON 3	0	-			6	5	0	0	11	S/M, VOIDS, ANENOME BURROW
06BR						14.00	9.53	1 ON 3	0	-	MOD	NO	5	5	0	0	10	
07	A	11/5/98	10:34	48 08.262N	123 26.721W	NA	NA	1	0	-			3	1	0	0	4	S/M, BURROW?, BIOFOULING OF MASS IN FARFIELD
07AR						14.00	-	1	0	-	HIGH	NO	3	1	0	0	4	
08	A	11/4/98	15:07	48 08.320N	123 26.980W	NA	NA	AZOIC	0	-			0	-4	-4	0	-8	MUD>P, WOOD CHUNK IN FARFIELD, SEAGRASS, SULFIDIC
08AR						14.00	-	AZOIC	0	-	V.HIGH	NO	0	-4	-4	0	-8	
08	C	11/4/98	15:08	48 08.320N	123 26.980W	NA	NA	1 ON 3	0	-			1	5	0	0	6	BLK FLOC/MUD>P, VOIDS, SHELL FRAGS @ DEPTH, THIN RPD
08CR						14.00	-	3	0	-	HIGH	YES	0	5	-4	0	1	
09	C	11/4/98	14:57	48:08.130N	123 26.920W	NA	NA	Ind	0	-			Ind	Ind	-4	0	Ind	PULP/MUD, POSSIBLE SULFER REDUCING BACTERIAL MAT?, WIPER CLASTS
09CR						14.00	-	1	0	-	HIGH	YES	Ind	1	-4	0	Ind	
10	E	11/4/98	14:44	48 08.170N	123 27.160W	NA	NA	1 ON 3	0	-			1	5	0	0	6	MUD>P, LIGHT FLOC ON SURF, RELIC VOID, THIN RPD
10ER						14.00	5.95	AZOIC	0	-	V.HIGH	YES	0	-4	-4	0	-8	
11	A	11/4/98	14:12	48 08.081N	123 27.360W	NA	NA	1	0	-			5	1	0	0	6	PULP/MUD?, FINE WOOD FRAGS IN SURF LAYER, BURROW
11AR						14.00	14.41	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
12	A	11/4/98	14:24	48 08.201N	123 27.545W	NA	NA	AZOIC	0	-			0	-4	-4	-2	-10	PULP FLOC/MUD, POSS BACTERIAL MAT?, VOID, METHANE BUBBLE
12AR						14.00	16.30	1 ON 3	0	-	HIGH	YES	0	5	-4	-2	-1	
12	C	11/4/98	14:26	48 08.200N	123 27.540W	NA	NA	1	0	-			0	1	-4	0	-3	PULP FLOC/MUD, BACTERIAL MAT?
12CR						14.00	-	1	0	-	HIGH	YES	0	1	-4	0	-3	
13	A	11/4/98	12:41	48 08.081N	123 27.720W	NA	NA	AZOIC	0	-			Ind	-4	0	0	Ind	PULP FLOC/MUD, WOOD CHIPS, SUSPENDED PULP FLOC, ULVA/ENTEROMORPHA
13AR						14.00	-	Ind	0	-	HIGH	NO	Ind	Ind	0	0	Ind	
14	B	11/4/98	12:30	48 07.970N	123 27.490W	NA	NA	1 ON 3	0	-			2	5	0	0	7	PULP FLOC/MUD, BURROW
14BR						14.00	19.88	3	0	-	HIGH	YES	Ind	5	-4	0	Ind	
15	A	11/4/98	12:17	48 07.790N	123 27.310W	NA	NA	1 ON 3	0	-			4	5	0	0	9	PULP FLOC/MUD, FILAMENTOUS BRN ALGAE @ SURF
15AR						14.00	6.74	1 ON 3	0	-	MOD	NO	2	5	0	0	7	
16	A	11/4/98	12:04	48 07.670N	123 26.970W	NA	NA	1	0	-			4	1	0	0	5	MUD>P, FILAMENTOUS BRN ALGAE @ SURF, SURF BURROW
16AR						14.00	-	1	0	-	MOD	NO	3	1	0	0	4	
17	C	11/4/98	11:17	48 07.580N	123 26.670W	NA	NA	1 ON 3	0	-			3	5	0	0	8	MUD>P, VOIDS, WORMS @ DEPTH, FILAMENTOUS BRN ALGAE @ SURF
17CR						14.00	9.75	1 ON 3	0	-	LOW	NO	2	5	0	0	7	
18	A	11/4/98	11:03	48 07.500N	123 26.259W	NA	NA	1 ON 3	0	-			1	5	0	0	6	COMMENT: MUD>P, RELIC? VOID, WIPER CLASTS
18 AR						14.00	-	1	0	-	HIGH	YES	1	1	-4	0	-2	
19	A	11/4/98	10:29	48 07.398N	123 26.031W	NA	NA	1 ON 3	0	-			3	5	0	0	8	S/M, VOID, BURROW, POSS CREOSOTE? OR OIL
19AR						14.00	9.83	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
19	D	11/4/98	10:37	48 07.410N	123 26.030W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, CREOSOTE? OR OIL, VOID?, WORMS @ DEPTH, WIPER SMEAR
19DR						14.00	6.52	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
20	F	11/4/98	10:01	48 07.190N	123 25.500W	NA	NA	Ind	0	-			3	Ind	0	0	Ind	MUD>P, RPD>P, SEA LETTUCE DRAGGED DOWN, SHELL FRAG, SMOTHERED BOTT
20FR						14.00	-	1	0	-	Ind	NO	3	1	0	0	4	
21	B	11/4/98	9:00	48 07.220N	123 25.110W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	SEA LETTUCE @ SURF DRAGGED DOWN, SMOTHERED BOT

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STATION	REP	Date	Time	Latitude	Longitude	CAL	Void Maximum Depth (cm)	Infaunal Successional Stage	Mudclast #	Mudclast State	SOD	Beggiatoa	RPD Code	Successional Stage Code	Low DO Code	Methane Code	OSI	Comments
21BR						14.00	-	Ind	0	-	Ind	NO	Ind	Ind	0	0	Ind	
22	C	11/4/98	9:17	48 07.080N	123 24.900W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	NO P, ROCKS, SHELLS, SEA LETTUCE, SCOURED BOT, SHELL LAG
22CR						14.00	-	Ind	0	-	Ind	NO	Ind	Ind	0	0	Ind	
23	C	11/4/98	9:30	48 07.170N	123 24.600W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	MUD>P, WOOD CHIPS/FIBER BLANKET, PULL AWAY/NO RPD MEAS, SEA LETT DRAGD DOWN
23CR						14.00	-	Ind	0	-	MOD	NO	Ind	Ind	0	0	Ind	
24	C	11/4/98	9:43	48 07.300N	123 24.780W	NA	NA	Ind	0	-			2	Ind	0	0	Ind	MUD>P, RPD>P, ROCKS, SEA LETTUCE, RED/BRN ALGAE, SMOTHERED BOT
24CR						14.00	-	Ind	0	-	LOW	NO	Ind	Ind	0	0	Ind	
25	A	11/4/98	8:36	48 07.570N	123 25.080W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOIDS, RIPPLED?, SHELL LAG
25AR						14.00	6.25	1 ON 3	0	-	LOW	NO	4	5	0	0	9	
25	B	11/4/98	8:37	48 07.570N	123 25.068W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, VOIDS
25BR						14.00	7.04	1 ON 3	0	-	LOW	NO	3	5	0	0	8	
26	A	11/4/98	10:17	48 07.430N	123 25.639W	NA	NA	1 ON 3	0	-			5	5	0	0	10	S/M, FILAMENTOUS BRN ALGAE @ SURF?, WORM @ DEPTH, VOIDS, BURROWS
26AR						14.00	9.48	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
27	A	11/4/98	10:50	48 07.560N	123 26.019W	NA	NA	1 ON 3	0	-			4	5	0	0	9	MUD>P, VOIDS, BURROWS
27AR						14.00	8.41	1 ON 3	0	-	LOW	NO	3	5	0	0	8	
28	A	11/4/98	17:04	48 07.850N	123 26.200W	NA	NA	1 ON 3	0	-			5	5	0	0	10	S/M, VOIDS, BURROWS, WORM @ DEPTH
28AR						14.00	9.45	1 ON 3	0	-	LOW	NO	5	5	0	0	10	
29	A	11/4/98	15:34	48 07.740N	123 26.718W	NA	NA	1 ON 3	0	-			3	5	0	0	8	S/M, VOID, BURRROW, WORMS @ DEPTH
29AR						14.00	10.98	1 ON 3	0	-	LOW	NO	2	5	0	0	7	
30	A	11/4/98	15:22	48 07.921N	123 27.148W	NA	NA	1 ON 3	0	-			6	5	0	0	11	MUD/PULP, VOID
30AR						14.00	-	1 ON 3	0	-	LOW	NO	5	5	0	0	10	
30	B	11/4/98	15:23	48 07.920N	123 27.150W	NA	NA	1 ON 3	0	-			5	5	0	0	10	S/M, VOID, FINE WOOD FRAGS MIXD IN RPD LAYER
30BR						14.00	7.48	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
31	A	11/5/98	10:46	48 08.040N	123 26.654W	NA	NA	1 ON 3	0	-			1	5	0	0	6	S/M, RELIC VOID, SHELL @ SURF, WIPER SMEARS
31AR						14.00	16.00	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
32	C	11/5/98	10:57	48 08.120N	123 26.162W	NA	NA	1 ON 3	0	-			5	5	0	0	10	S/M, VOID
32CR						14.00	-	Ind	0	-	MOD	NO	Ind	Ind	0	0	Ind	
33	A	11/4/98	16:13	48 08.220N	123 25.340W	NA	NA	1	0	-			5	1	0	0	6	S/M, SHELL @ SURF
33AR						14.00	-	1	0	-	LOW	NO	5	1	0	0	6	
33	C	11/4/98	16:14	48 08.220N	123 25.330W	NA	NA	1 ON 3	0	-			3	5	0	0	8	MUD>P, VOID, WIPER SMEAR
33CR						14.00	6.22	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
34	A	11/5/98	9:05	48 07.831N	123 25.573W	NA	NA	1 ON 3	0	-			2	5	0	0	7	S/M, VOID, EROSIONAL, STRANDED TUBES
34AR						14.00	3.75	1 ON 3	0	-	MOD	NO	2	5	0	0	7	
34	C	11/5/98	9:06	48 07.830N	123 25.570W	NA	NA	1 ON 3	0	-			3	5	0	0	8	S/M, VOID, BURROWS, EROSIONAL
34CR						14.00	5.45	1 ON 3	1	OX	MOD	NO	3	5	0	0	8	
35	A	11/4/98	16:26	48 08.040N	123 24.949W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOID, RIPPLED
35AR						14.00	7.04	1 ON 3	0	-	LOW	NO	5	5	0	0	10	
36	C	11/4/98	16:40	48 08.180N	123 24.440W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, VOID, RIPPLED, BIOFOULING ON SEAGRASS
36CR						14.00	7.51	1 ON 3	0	-	LOW	NO	5	5	0	0	10	
37	B	11/5/98	8:21	48 07.750N	123 24.550W	NA	NA	1	0	-			Ind	1	0	0	Ind	MUD>P, BIG TUBES
37BR						14.00	-	1	0	-	LOW	NO	Ind	1	0	0	Ind	
38	A	11/6/98	13:05	48 08.050N	123 27.560W	NA	NA	Ind	0	-			Ind	Ind	-4	0	Ind	OVER PEN, MUD>P
38BR						14.00	-	Ind	Ind	-	HIGH	YES	Ind	Ind	-4	0	Ind	
39	B	11/6/98	12:41	48 08.130N	123 27.540W	NA	NA	Ind	0	-			Ind	Ind	-4	0	Ind	LOW P, MUD>P, BRN ALGAE, SULFER REDUCING BACT MAT, ANOXIC MUD
39BR						14.00	-	Ind	0	-	HIGH	YES	0	Ind	-4	0	Ind	
39	C	11/6/98	12:41	48 08.120N	123 27.520W	NA	NA	1	0	-			4	1	0	0	5	MUD>P, BRN ALGAE, BURROWS, TUBE MAT
39CR						14.00	-	1	0	-	HIGH	YES	4	1	0	0	5	
40	A	11/5/98	14:18	48 08.250N	123 27.283W	NA	NA	1	0	-			0	1	-4	0	-3	MUD>P, WORM @ DEPTH, SULFIDIC

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40AR						14.00	-	1	0	-	HIGH	YES	0	1	-4	0	-3	
41	A	11/5/98	14:29	48 08.118N	123 27.261W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, WOOD CHIPS, VOID, BURROW, EROSIONAL
41AR						14.00	-	1	0	-	MOD	NO	4	1	0	0	5	
42	A	11/5/98	14:10	48 08.260N	123 27.122W	NA	NA	1	0	-			0	1	0	0	1	S/M, WIPER CLAST, PATCHY SULFER REDUCING BACT?
42AR						14.00	-	1	1	RED	HIGH	YES	0	1	-4	0	-3	
43	C	11/5/98	12:13	48 07.850N	123 27.010W	NA	NA	AZOIC	0	-			0	-4	-4	0	-8	S/M, RELIC BURROWS, SULFIDIC
43CR						14.00	-	AZOIC	Ind	-	V.HIGH	YES	0	-4	-4	0	-8	
44	C	11/5/98	12:21	48 07.928N	123 27.330W	NA	NA	1	0	-			6	1	0	0	7	PULL AWAY, MUD>P, PULP FLOC
44CR						14.00	-	1	Ind	-	MOD	NO	Ind	1	0	0	Ind	
45	A	11/5/98	12:28	48 08.029N	123 27.239W	NA	NA	1	0	-			3	1	0	0	4	MUD/PULP, VOID?, PULP @ DEPTH
45AR						14.00	9.86	1 ON 3	0	-	HIGH	NO	3	5	0	0	8	
45	B	11/5/98	12:29	48 08.030N	123 27.241W	NA	NA	1	0	-			2	1	0	0	3	MUD/PULP, PULP @ DEPTH
45BR						14.00	-	1	1	RED	HIGH	NO	2	1	0	0	3	
46	B	11/5/98	12:37	48 08.100N	123 27.110W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, RELIC VOID
46BR						14.00	10.46	1 ON 3	1	OX	HIGH	NO	4	5	0	0	9	
47	A	11/5/98	12:54	48 08.200N	123 27.000W	NA	NA	1	0	-			4	1	0	0	5	MUD>P, SHRIMP, WOOD STICKS
47AR						14.00	-	1	0	-	HIGH	NO	4	1	0	0	5	
47	B	11/5/98	12:55	48 08.200N	123 27.000W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, SILFIDIC
47BR						14.00	-	1	0	-	V.HIGH	YES	3	1	-4	0	0	
48	B	11/5/98	13:10	48 08.260N	123 26.860W	NA	NA	1	0	-			5	1	0	0	6	S/M, PELLETAL S/M, BIOFOULING OF WOOD IN FAR FIELD
48BR						14.00	-	1	0	-	HIGH	NO	Ind	1	0	0	Ind	
50	A	11/5/98	13:27	48 08.360N	123 26.641W	NA	NA	1	0	-			5	1	0	0	6	MUD>P, BURROWS, WOOD CHIP
50AR						14.00	-	1	2	1 OX 1 RED	HIGH	YES	4	1	-4	0	1	
51	A	11/5/98	14:49	48 07.852N	123 27.240W	NA	NA	1	0	-			4	1	0	0	5	MUD/CLAY/PULP(OR SAND), BLUE=CLAY LAYER ABOVE PULP/SAND
51AR						14.00	-	1 ON 3	0	-	MOD	NO	3	5	-4	0	4	
52	A	11/5/98	14:39	48 08.019N	123 27.039W	NA	NA	1	0	-			5	1	0	0	6	S/MUD/PULP, RIPPLED?
52AR						14.00	-	1	0	-	MOD	NO	4	1	0	0	5	
52	B	11/5/98	14:40	48 08.020N	123 27.043W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD/PULP/MUD, VOID
52BR						14.00	6.24	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
54	C	11/5/98	13:37	48 08.320N	123 26.560W	NA	NA	1.00	0	-			3	1	0	0	4	MUD>P, RIPPLED?
54CR						14.00	-	1	0	-	MOD	NO	3	1	0	0	4	
55	B	11/5/98	14:59	48 07.700N	123 27.190W	NA	NA	1	0	-			0	1	0	0	1	MUD>P, SULFIDIC
55BR						14.00	-	AZOIC	0	-	HIGH	YES	0	-4	-4	0	-8	
55	C	11/5/98	15:00	48 07.712N	123 27.190W	NA	NA	1	0	-			0	1	0	0	1	MUD>P, SURFICIAL OXIDATION, SULFIDIC
55CR						14.00	-	1	0	-	HIGH	YES	1	1	-4	0	-2	
56	A	11/5/98	15:05	48 07.782N	123 27.101W	NA	NA	1 ON 3	0	-			3	5	0	0	8	MUD>P, VOID, BURROW
56AR						14.00	13.20	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
57	A	11/5/98	15:14	48 07.860N	123 27.041W	NA	NA	1 ON 3	0	-			6	5	0	0	11	MUD/PULP, BURROWS, VOID, PULP @ DEPTH
57AR						14.00	11.15	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
57	B	11/5/98	15:15	48 07.860N	123 27.040W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD/PULP/MUD, VOIDS, WORMS @ DEPTH, EROSIONAL, WOOD FRAG
57BR						14.00	11.94	1 ON 3	0	-	LOW	NO	Ind	5	0	0	Ind	
58	A	11/5/98	15:22	48 07.940N	123 26.971W	NA	NA	1 ON 3	0	-			4	5	0	0	9	MUD>P, VOIDS, WORM @ DEPTH
58AR						14.00	14.41	1 ON 3	1	RED	LOW	NO	4	5	0	0	9	
59	A	11/5/98	15:30	48 08.030N	123 26.839W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, VOID, SHELL FRAG NEAR SURF
59AR						14.00	8.96	1 ON 3	1	OX	LOW	NO	4	5	0	0	9	
60	A	11/5/98	15:39	48 08.120N	123 26.710W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, BURROWS, SULFIDIC
60AR						14.00	-	1	0	-	HIGH	YES	3	1	-4	0	0	
60	B	11/5/98	15:40	48 08.120N	123 26.710W	NA	NA	Ind	0	-			2	Ind	0	0	Ind	MUD>P, SULFIDIC, WORM @ DEPTH?

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60BR						14.00	-	AZOIC	0	-	V.HIGH	YES	0	-4	-4	-2	-10	
61	B	11/5/98	15:52	48 08.210N	123 26.600W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	LOW P, WOOD CHIPS, RIPPLED
61BR						14.00	-	Ind	0	-	Ind	NO	Ind	Ind	0	-2	Ind	
62	A	11/6/98	12:24	48 08.258N	123 26.409W	NA	NA	1.00	0	-			6	1	0	0	7	S/M, VOIDS?, ORG DETRITUS
62AR						14.00	-	1	0	-	LOW	NO	5	1	0	0	6	
63	B	11/6/98	13:27	48 07.760N	123 27.380W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, CREOSOTE OR RED-BRN ALGAE?, WOOD FRAGS IN MUD?, VOID
63BR						14.00	16.74	1 ON 3	0	-	LOW	NO	3	5	0	0	8	
64	A	11/6/98	13:35	48 07.790N	123 26.859W	NA	NA	1 ON 3	0	-			4	5	0	0	9	MUD>P, VOIDS
64AR						14.00	10.11	1 ON 3	0	-	LOW	NO	4	5	0	0	9	
65	A	11/6/98	11:42	48 07.901N	123 26.600W	NA	NA	1 ON 3	0	-			6	5	0	0	11	MUD>P, VOIDS, BURROWS, WIPER SMEAR
65AR						14.00	15.69	1 ON 3	1	RED	LOW	NO	4	5	0	0	9	
66	A	11/6/98	11:34	48 08.100N	123 26.518W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOIDS, BURROWS
66AR						14.00	10.03	1 ON 3	0	-	MOD	NO	4	5	0	0	9	
67	A	11/6/98	14:24	48 07.608N	123 26.819W	NA	NA	1	0	-			0	1	0	0	1	MUD>P, OIL OR CREOSOTE?, RED-BRN ALGAE?, SULFIDIC
67AR						14.00	-	1	0	-	HIGH	YES	1	1	-4	0	-2	
67	B	11/6/98	14:25	48 07.610N	123 26.820W	NA	NA	1	0	-			4	1	0	0	5	S/M, RPD=FLOC LAYER, WOOD PULP & FRAG
67BR						14.00	-	1	Ind	-	MOD	NO	Ind	1	0	0	Ind	
68	A	11/6/98	9:42	48 07.262N	123 24.438W	NA	NA	1	0	-			Ind	1	0	0	Ind	LOW P, MUD>P, SM ROCKS, EROSIONAL
68AR						14.00	-	1	0	-	LOW	NO	2	1	0	0	3	
69	A	11/6/98	9:56	48 07.201N	123 24.500W	NA	NA	1	0	-			2	1	0	-2	1	MUD>P, WOOD PULP MIXED IN MUD?, MANY METHANE BUBBLES IN RELIC VOIDS
69AR						14.00	-	1	0	-	HIGH	YES	0	1	-4	-2	-5	
70	A	11/6/98	11:26	48 08.070N	123 26.390W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, WOOD, BURROW
70AR						14.00	-	1	1	OX	LOW	NO	Ind	1	0	0	Ind	
70	C	11/6/98	11:27	48 08.070N	123 26.390W	NA	NA	3	0	-			2	5	0	0	7	MUD>P, VOID, BURROW, WORM @ DEPTH ABOVE VOID
70CR						14.00	11.50	1 ON 3	1	RED	LOW	NO	2	5	0	0	7	
71	A	11/6/98	12:16	48 08.200N	123 26.220W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, VOID, WIPER SMEAR
71AR						14.00	15.42	1 ON 3	1	RED	LOW	NO	4	5	0	0	9	
72	A	11/6/98	13:44	48 07.698N	123 26.418W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOID, WORM @ DEPTH
72AR						14.00	4.85	1 ON 3	0	-	LOW	NO	4	5	0	0	9	
73	A	11/6/98	11:17	48 08.001N	123 26.160W	NA	NA	1 ON 3	0	-			4	5	0	0	9	MUD>P, VOID
73AR						14.00	4.63	1 ON 3	3	OX	LOW	NO	4	5	0	0	9	
74	A	11/6/98	11:07	48 08.160N	123 26.160W	NA	NA	1 ON 3	0	-			5	5	0	0	10	MUD>P, VOIDS, BURROW, WORM @ DEPTH
74AR						14.00	9.12	1 ON 3	2	OX	LOW	NO	5	5	0	0	10	
75	B	11/6/98	9:18	48 08.170N	123 25.640W	NA	NA	1	0	-			6	1	0	0	7	MUD>P, RIPPLED, EROSIONAL?
75BR						14.00	-	1	1	OX	LOW	NO	4	1	0	0	5	
76	A	11/6/98	9:08	48 08.279N	123 25.660W	NA	NA	1	0	-			4	1	0	0	5	MUD>P, ERODED?, SULFIDIC @ DEPTH
76AR						14.00	-	1	0	-	MOD	NO	5	1	0	0	6	
77	A	11/6/98	8:57	48 08.300N	123 25.520W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, BIOFOULING OF WOOD? OR ROCK?
77AR						14.00	-	1	0	-	MOD	NO	5	1	0	-2	4	
78	A	11/6/98	8:48	48 08.380N	123 25.390W	NA	NA	1	0	-			4	1	0	0	5	MUD>P, RIPPLED, ERODED?
78AR						14.00	-	1	0	-	LOW	NO	4	1	0	0	5	
79	B	11/6/98	8:37	48 08.290N	123 25.240W	NA	NA	3	0	-			3	5	0	0	8	S/M, BURROW
79BR						14.00	7.97	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
80	A	11/6/98	8:25	48 08.260N	123 24.985W	NA	NA	1 ON 3	0	-			6	5	0	0	11	MUD>P, BURROWS, BIVALVE @ SURF, WORM @ DEPTH, SURFICIAL EROSION?
80AR						14.00	7.70	1 ON 3	0	-	LOW	NO	6	5	0	0	11	
81	A	11/6/98	10:57	48 08.032N	123 25.878W	NA	NA	1	0	-			3	1	0	0	4	MUD>P, SHELL LAG
81AR						14.00	-	1	2	OX	LOW	NO	3	1	0	0	4	
82	A	11/6/98	14:14	48 07.570N	123 26.398W	NA	NA	1 ON 3	0	-			3	5	0	0	8	MUD>P, VOID, FINE BRN ALGAE OR CREOSOTE?

Table C.12
Sediment-Profile Image Analysis Results from the 1998 SPI Survey of Port Angeles Harbor

STATION	REP	Date	Time	Latitude	Longitude	CAL	Void Maximum Depth (cm)	Infaunal Successional Stage	Mudclast #	Mudclast State	SOD	Beggiatoa	RPD Code	Successional Stage Code	Low DO Code	Methane Code	OSI	Comments
82AR						14.00	7.95	1 ON 3	0	-	MOD	NO	3	5	0	0	8	
83	A	11/6/98	13:51	48 07.601N	123 26.169W	NA	NA	1 ON 3	0	-			3	5	0	0	8	MUD>P, VOIDS
83AR						14.00	6.22	1 ON 3	0	-	LOW	NO	3	5	0	0	8	
84	A	11/6/98	14:06	48 07.482N	123 26.359W	NA	NA	1	0	-			0	1	0	0	1	S/M, RELIC VOID?, AMPHIPOD TUBES?
84AR						14.00	11.48	1	0	-	HIGH	YES	0	1	-4	0	-3	
85	A	11/6/98	13:58	48 07.429N	123 26.180W	NA	NA	1 ON 3	0	-			0	5	0	0	5	MUD>P, BURROW, VOID, WORM @ DEPTH, SULFIDIC
85AR						14.00	-	1	0	-	HIGH	YES	1	1	-4	0	-2	
85	B	11/6/98	13:59	48 07.430N	123 26.176W	NA	NA	1	0	-			2	1	0	0	3	MUD>P, WIPER SMEAR
85BR						14.00	-	1	0	-	HIGH	YES	1	1	-4	0	-2	
86	A	11/6/98	10:42	48 07.418N	123 25.330W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOIDS, WORMS @ DEPTH, SCOURED SURFACE
86AR						14.00	7.84	1 ON 3	0	-	LOW	NO	3	5	0	0	8	
87	C	11/6/98	10:08	48 07.160N	123 24.760W	NA	NA	Ind	0	-			0	Ind	0	0	Ind	S>P, WOOD FRAGS MIXED IN MUD, SEA LETTUCE, BURROW, SUSPENDED WOOD FRAGS
87CR						14.00	-	AZOIC	0	-	MOD	YES	0	-4	-4	0	-8	
89	A	11/6/98	8:34	48 07.360N	123 24.418W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	LOW PEN, ROCKS, SHELLS, VARIOUS ALGAE, POOR SORTING
89AR						14.00	-	Ind	0	-	LOW	NO	Ind	Ind	0	0	Ind	
90	A	11/6/98	8:05	48 07.240N	123 24.310W	NA	NA	1 ON 3	0	-			4	5	0	0	9	S/M, VOID, RED ALGAE, WOOD STICK
90AR						14.00	-	1	0	-	LOW	NO	4	1	0	0	5	
91	C	11/6/98	12:48	48 08.150N	123 27.650W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	OVER PEN, MUD/PULP, POOR SORTING, WOOD FABRIC
91CR						14.00	-	Ind	Ind	-	HIGH	YES	0	Ind	-4	0	Ind	
92	A	11/6/98	13:11	48 07.990N	123 27.602W	NA	NA	1 ON 3	0	-			0	5	0	0	5	MUD>P, PULP FLOC, VOIDS
92CR						14.00	11.89	3	2	RED	HIGH	YES	0	5	-4	0	1	
94	C	11/6/98	10:27	48 07.100N	123 24.670W	NA	NA	Ind	0	-			Ind	Ind	0	0	Ind	NO P, WOOD CHUNKS/CHIPS/FRAGS
94CR						14.00	Ind	Ind	0	-	Ind	NO	Ind	Ind	Ind	-2	Ind	
95	A	11/6/98	14:31	48 07.642N	123 27.016W	NA	NA	Ind	0	-			0	Ind	-4	0	Ind	BLK MUD>P, SULFIDIC, RIPPLED, WORM @ DEPTH
95AR						14.00	-	1	0	-	V.HIGH	NO	0	1	-4	0	-3	
95	B	11/6/98	14:32	48 07.640N	123 27.018W	NA	NA	AZOIC	0	-			0	-4	0	0	-4	BLK MUD>P, SULFIDIC
95BR						14.00	-	1	0	-	V.HIGH	YES	0	1	-4	0	-3	

Notes:

Blank cells are intentional.

BLACK Reported value.

RED Revised values used in the Western Port Angeles Harbor RI/FS for comparison to the 2013 SPI data. An image analyst from Germano & Associates conducted the image re-analysis under subcontract to Integral in 2013.

1 An image analyst from Germano & Associates conducted the image re-analysis under subcontract to Integral.

Abbreviations:

cm Centimeter
DO Dissolved oxygen
NA Not applicable
phi Krumbein phi grain size scale
RPD Relative percent different
SPI Sediment profile imaging
sq cm Square centimeter

Appendix D
Terminal Coring Data Report

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
bml	Below mudline
COPC	Chemical of potential concern
Ecology	Washington State Department of Ecology
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
MLLW	Mean lower low water
ng/kg	Nanograms per kilogram
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SVOC	Semivolatile organic compounds
TEQ	Toxic equivalent

1.0 Introduction

This report presents the results of sediment core sampling conducted at the Port of Port Angeles' Terminal 5 and Terminal 7. This work was a supplemental data collection task to inform the Remedial Investigation and Feasibility Study (RI/FS) for the Western Port Angeles Harbor Sediment Cleanup Unit (SCU). These supplemental data were collected to assist in development and evaluation of dredge and capping alternatives and associated cost evaluations, presented in the RI/FS.

This core sampling was conducted according to the Washington State Department of Ecology (Ecology)-approved Sampling and Analysis Plan (SAP) Addendum (Floyd|Snider 2014) to the RI/FS SAP (Integral Consulting et al. 2013), developed in coordination with Ecology.

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2.0 Background

Port Angeles Harbor in Washington State has been identified as a priority environmental cleanup and restoration embayment by Ecology as part of the Puget Sound Initiative. Under Agreed Order No. DE9781 (Agreed Order), the Western Port Angeles Harbor Group (WPAH Group) has agreed to perform a RI/FS of Western Port Angeles Harbor. A more detailed description of this is provided in the RI/FS Report.

Several investigations have been performed within Port Angeles Harbor, including a limited number of subsurface sediment cores. Previous sampling event locations in the vicinity of Terminal 5 and Terminal 7 include Station IH02 in the northwestern portion of the berthing area at Terminal 5, and Station IH06, shoreward of the berthing area at Terminal 7 (E&E 2012). The cores at Station IH02 and Station IH06 were advanced to a depth of approximately 10 feet below mudline (bml). Both cores encountered abundant wood debris, with IH02 encountering fragments through a depth of 5 feet and 9 inches bml.

Surface and subsurface samples for chemical analysis were collected from Stations IH02 and IH06. Elevated concentrations of wood debris, dioxins/furans, metals, and other chemicals of potential concern (COPCs) were detected in these samples.

Due to limited existing data regarding the depth of the native material present in or near the berthing areas of Terminals 5 and 7 and the presence of COPCs in native material, four sediment cores were advanced in the berthing area at each terminal. These cores were collected in order to delineate the depth to native material, and the presence of potential contamination at the native material contact. The work conducted, including sediment core sampling methodology, was proposed in the Ecology-approved SAP Addendum (Floyd|Snider 2014) to the RI/FS SAP (Integral Consulting et al. 2013), which specified general sediment sampling and analysis methodology.

2.1 SCOPE OF WORK

Sediment cores were collected from a vessel operated by Marine Sampling Services using vibracore methodology. Four borings were advanced in the berthing area of each terminal, as shown on Figure D.1. The drive depth for each core was between 8 and 14 feet bml, which was below the anticipated contact between sediments with abundant wood debris and native sediments; however, native sediments were not encountered at every location. Only one core location (WPAH 0059) was relocated in the field due to refusal.

Samples of the native material, where encountered, were collected for chemical analysis. The presence of wood debris was noted where encountered, but samples of wood debris were not collected because this material is presumed to be contaminated based on previous data.

2.2 VIBRACORE METHODOLOGY

Station positioning was conducted in accordance with the vessel-based global positioning system (GPS) station location procedures described in Section 4.2 of the RI/FS SAP. Mudline depth was measured by a leadline as described in the SAP Addendum (Floyd|Snider 2014).

Sediment cores were collected using a vibracore deployed from the vessel. The vibracore used aluminum core tubes inside a rigid external tube approximately 4 inches in outer diameter. The vibracore was lowered to the mudline, where the unit was energized and allowed to penetrate the sediment. All eight of the cores had a recovery of at least 50 percent of the penetration depth with no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube. Sediment samples were collected over a 1-foot interval below the depth where native material was first encountered.

Sediment core collection forms and field notes for all core samples were maintained as part of the field documentation. Sediment core logs are presented as Attachment D.1. The field technician on the vessel documented the core location, time, and depth to mudline below water surface in the field logbook. After core collection, the cores were delivered to shore to be processed at the uplands processing area. Longer cores were sectioned to allow for transport to the processing area; if a core was sectioned, its ends were capped and the top and bottom depths of each segment were labeled prior to moving the core off the vessel. Once delivered to the processing area, the cores were cut longitudinally using a circular saw.

After cutting the core tube longitudinally, total core tube length and length of recovered sample were measured to calculate sample recovery and determine whether an acceptable core had been obtained (i.e., sufficient material was present for characterization). Upon determining that the core was acceptable, the core tube was marked with equivalent 1-foot depth intervals based on the calculated recovery percentage. A digital photograph of the sediment sample prior to removal from the sampler was then taken.

The following were noted for each core that was processed:

- Texture
- Color
- Biological organisms or structures (e.g., shells)
- Presence of debris (natural or anthropogenic objects)
- Presence of oily sheen or visible contamination
- Odor (e.g., hydrogen sulfide)
- Depth of contact with native material (i.e., no apparent wood debris or other anthropogenic debris present)

Once native material was observed, the top foot of native material was separated from the overlying sediments using a clean stainless steel spoon. The sample material was removed from the core tube, avoiding the material in contact with the sides of the core tube, and placed in a decontaminated stainless steel bowl. Samples were homogenized by mixing with a stainless steel spoon until a consistent color and texture was achieved and then placed in the appropriate sample jars. Jars were stored in a cooler packed with ice and maintained at approximately 4 °C. Equipment decontamination, field quality control samples, sample identification, sample handling, investigation-derived waste management, field documentation, and field data management were consistent with procedures described in Sections 4.6 through 4.13 of the RI/FS SAP.

2.3 ARCHEOLOGICAL MONITORING

Archaeological monitoring was performed by Wessen & Associates Inc. during all sediment core processing activities. An archaeological monitoring report is provided as Attachment D.2.

2.4 FIELD OBSERVATIONS

At Terminal 5, the coring stations were situated at mudline elevations between approximately -38.5 feet and -40.5 feet mean lower low water (MLLW). Shallow sediments in this area consisted of loose sandy silt with abundant wood debris. At the three southernmost coring stations (WPAH 0054 through WPAH 0056), these silts were overlain by 1 to 2 feet of organic mud with fine wood debris. A strong sulfide-like odor was also observed in the shallow sandy silts at WPAH 0054 and WPAH 0055, which were located closest to the center of the berthing area. Native material at Terminal 5 was encountered at depths ranging from 3.2 to 6 feet bml and consisted of a dense, fine silty sand with occasional shell fragments and no wood debris. Samples were collected from the top foot of native material at all locations and a field duplicate, or field split, sample was collected at WPAH 0055.

At Terminal 7, the coring stations were situated at mudline elevations between approximately -35 feet and -38.5 feet MLLW. Surface sediments at all coring stations were soft sandy silts with abundant wood debris. Similarly to Terminal 5, a strong sulfide-like odor was observed in silts encountered at the three southernmost coring stations (WPAH 0058 through WPAH 0060). At station WPAH 0057, located at the north end of the berthing area, a silty sand unit similar to the native material at Terminal 5 was encountered. However, a lens of abundant wood debris was encountered at 7 feet bml, indicating that anthropogenic debris was still present in this unit. A unit of dense fine sand with shell fragments and no wood debris was encountered below the sandy silts or silty sands at all coring stations at Terminal 7, at depths ranging from 4.5 to 9 feet bml; however, this unit was not identified as native material because it was underlain by units with presumed anthropogenic debris (i.e., wood debris or gravel). At stations WPAH 0059 and WPAH 0060, located in the southern portion of the berthing area, the coring apparatus encountered refusal due to the presence of a well-graded gravel at depths of 6 to 7.5 feet bml. WPAH 0059 was moved approximately 15 feet waterward of its original location because the gravel damaged the catcher at the bottom of the core tube, resulting in loss of all sample material

during the first coring attempt. Samples were collected from the top and bottom of the silty sand unit overlying the fine sand at WPAH 0057, from the top of the fine sand unit at WPAH 0058, from the bottom of the sandy silt unit and the top of the fine sand unit overlying the gravel at WPAH 0059, and from the top of the fine sand unit overlying the gravel at WPAH 0060. Presumed native material was not encountered at Terminal 7.

Sediment core logs are presented in Attachment D.3 and note the units encountered and sample collection depth intervals at each coring location.

2.5 SAMPLE ANALYSIS

Sediment samples were analyzed following the procedures outlined in Section 5.1 and Table 5.1 of the RI/FS SAP, for the following chemicals of potential concern:

- Conventionals including grain size and total organic carbon
- Metals by USEPA Method 6020A
- Semivolatile organic compounds (SVOCs) by USEPA Method 8270D
- Polycyclic aromatic hydrocarbons (PAHs; low-level) by USEPA Method 8270D-SIM
- Polychlorinated biphenyl (PCB) congeners by USEPA Method 1668A
- Dioxins/furans by USEPA Method 1613B

Conventionals, metals, SVOC, and PAH analyses were performed by ALS Environmental in Kelso, Washington. PCB congener and dioxins/furans analyses were performed by AXYS Analytical Services in Sidney, British Columbia.

A total of three samples were selected for analysis. These included samples of the presumed native silty sand material encountered at WPAH 0054 and WPAH 0055 in Terminal 5, and the field duplicate sample collected at WPAH 0055. Samples from Terminal 7 were not analyzed because presumed native material was not encountered. Sample results are presented in Table D.1.

An independent USEPA Level IV data validation was performed by EcoChem, Inc., of Seattle, Washington, on all data. The benzoic acid results for all samples were rejected for potential low bias because the analyte was not detected in the laboratory control samples. The remaining results, as qualified, were determined to be acceptable for use. The data validation report is included as Attachment D.3.

2.6 RESULTS

Grain size analysis of the sediment samples showed that the material was primarily composed of silt and sand, consistent with field observations. Total organic carbon concentrations were approximately 1 percent in all samples, indicating that organic carbon normalization was appropriate for comparison to applicable carbon-normalized sediment quality criteria.

Metals, including arsenic, cadmium, copper, mercury, and zinc, were detected at low levels consistent with naturally occurring metals concentrations in all samples. The range of detected metals concentrations were:

- Arsenic: 5.94 to 6.44 milligrams per kilogram (mg/kg)
- Cadmium: 0.462 to 0.509 mg/kg
- Copper: 15.9 to 19.2 mg/kg
- Mercury: 0.033 to 0.041 mg/kg
- Zinc: 50.5 to 56.7 mg/kg

SVOCs and PAHs were generally not detected, or detected at low levels, in all samples. Carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalent (TEQ) concentrations calculated with non-detect results set to one-half the reporting limit ranged from 2.1 micrograms per kilogram (µg/kg) to 6.6 µg/kg.

Total PCB congener concentrations were 0.477 µg/kg in the sample collected from WPAH 0054 and 1.50 µg/kg in both the parent sample and field duplicate collected from WPAH 0055. PCB congener TEQs calculated with non-detect results set to one-half the reporting limit ranged from 0.0042 nanograms per kilogram (ng/kg) to 0.023 ng/kg.

Dioxin/furan TEQ concentrations calculated with non-detect results set to one-half the reporting limit ranged from 0.290 ng/kg to 0.649 ng/kg.

2.7 DISCUSSION

At Port of Port Angeles' Terminal 5, wood debris was present to depths of 5.5 to 6 feet bml in the central portion of the berthing area, and was present at depths of 3.2 to 4 feet bml at the north and south ends of the berthing area. Native material at this terminal is composed of sand and silt. Two samples of native material collected from the central portion of the berthing area contained low-level concentrations of metals, SVOCs, PAHs, PCBs, and dioxins/furans.

At Terminal 7, native material was not encountered in cores that penetrated to depths ranging from 8.6 to 11.2 feet bml.

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3.0 References

Ecology & Environment, Inc. (E&E). 2012. *Port Angeles Harbor Sediment Characterization Study, Port Angeles, WA: Sediment Investigation Report*. Prepared for the Washington State Department of Ecology Toxics Cleanup Program, Lacey, Washington. December.

Integral Consulting, Inc., Anchor QEA, LLC, Exponent, and Floyd|Snider. 2013. *Sampling and Analysis Plan, Western Port Angeles Harbor RI/FS*. 13 June.

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Appendix D
Terminal Coring Data Report

Table

Table D.1
Subsurface Sediment Sample Analytical Data

	Location	**WPAH0054**	**WPAH0055**	**WPAH0055**
	Sample ID	**SD0059**	**SD0057**	**SD0058** [1]
	Sample Date	**09/04/2014**	**09/03/2014**	**09/03/2014**
	Sample Depth (ft bml)	**6–7**	**5.5–7**	**5.5–7**
Analytes	**Units**			
Conventionals				
Moisture	%	30.1	30	30.4
Total Solids	%	69.1	70.4	71
Total Organic Carbon	%	0.92	1.02	0.963
Dioxins/Furans by USEPA 1613B				
2,3,7,8-TCDD	ng/kg	0.088 U	0.1 U	0.108 JQ
1,2,3,7,8-PeCDD	ng/kg	0.084 JQ	0.13 JQ	0.115 JQ
1,2,3,4,7,8-HxCDD	ng/kg	0.0772 U	0.169 JQ	0.145 U
1,2,3,6,7,8-HxCDD	ng/kg	0.304 JQ	0.886 JQ	1.01 JQ
1,2,3,7,8,9-HxCDD	ng/kg	0.271 JQ	0.666 JQ	0.525 JQ
1,2,3,4,6,7,8-HpCDD	ng/kg	4.49 JQ	16.3	15.5
Total OCDD	ng/kg	32.8	104	122
2,3,7,8-TCDF	ng/kg	0.089 JQ	0.089 JQ	0.058 JQ
1,2,3,7,8-PeCDF	ng/kg	0.0483 U	0.0479 U	0.0484 U
2,3,4,7,8-PeCDF	ng/kg	0.072 U	0.078 JQ	0.078 U
1,2,3,4,7,8-HxCDF	ng/kg	0.066 U	0.158 U	0.161 U
1,2,3,6,7,8-HxCDF	ng/kg	0.0527 U	0.128 U	0.141 U
2,3,4,6,7,8-HxCDF	ng/kg	0.0527 U	0.095 U	0.099 U
1,2,3,7,8,9-HxCDF	ng/kg	0.0527 U	0.0479 U	0.071 U
1,2,3,4,6,7,8-HpCDF	ng/kg	1.33 JQ	4.45 JQ	4.2 JQ
1,2,3,4,7,8,9-HpCDF	ng/kg	0.13 U	0.206 JQ	0.243 U
Total OCDF	ng/kg	2.2 JQ	6.4 JQ	7.95 JQ
Dioxin/Furan TEQ ND Zero	ng/kg	0.219 J	0.577 J	0.618 J
Dioxin/Furan TEQ ND 1/2 RL	ng/kg	0.29 J	0.649 J	0.663 J
Polychlorinated Biphenyl (PCB) Congeners by USEPA 1668A				
PCB-077	ng/kg	0.594 JQ	2.15	2.33
PCB-081	ng/kg	0.0483 U	0.103 U	0.087 U
PCB-105	ng/kg	6.07	26.7	27.8
PCB-114	ng/kg	0.375 JQ	1.45 JQ	1.42 JQ
PCB-118	ng/kg	16.2	67.1	68.7
PCB-123	ng/kg	0.19 JQ	0.946 JQ	0.98 JQ
PCB-126	ng/kg	0.0495 U	0.171 JQ	0.111 U
PCB-156/157	ng/kg	2.15 JQ	9.56	8.84
PCB-167	ng/kg	0.696 JQ	3.04	2.7
PCB-169	ng/kg	0.059 U	0.0908 UJ	0.078 U
PCB-189	ng/kg	0.148 JQ	0.532 JQ	0.536 JQ
PCBs (Total, Congeners)	ng/kg	477	1500	1500
PCB Congener TEQ ND Zero	ng/kg	0.000834 J	0.0233 J	0.017 J
PCB Congener TEQ ND 1/2 RL	ng/kg	0.0042 J	0.0233 J	0.017 J
Metals by USEPA 6020A				
Arsenic	mg/kg	5.94	6.44	5.97
Cadmium	mg/kg	0.462	0.505	0.509
Chromium	mg/kg	25.9	27.6	27.2
Copper	mg/kg	15.9	16.8	19.2
Lead	mg/kg	3.76	3.98	3.96
Mercury	mg/kg	0.041	0.036	0.033
Silver	mg/kg	0.053	0.059	0.06
Zinc	mg/kg	50.5	56.2	56.7
Semivolatile Organic Compounds (SVOCs) by USEPA 8270D				
Chlorinated Benzenes				
1,2-Dichlorobenzene	µg/kg	7.3 U	7.1 U	7 U
1,3-Dichlorobenzene	µg/kg	7.3 U	7.1 U	7 U
1,4-Dichlorobenzene	µg/kg	7.3 U	7.1 U	7 U
1,4-Dichlorobenzene	mg/kg-oc	0.79 U	0.70 U	0.73 U
1,2,4-Trichlorobenzene	µg/kg	7.3 U	7.1 U	7 U
Hexachlorobenzene	µg/kg	7.3 U	7.1 U	7 U
Phthalate Esters				
Dimethyl phthalate	µg/kg	7.3 U	7.1 U	7 U
Diethylphthalate	µg/kg	7.3 U	7.1 U	7 U
Di-n-butyl phthalate	µg/kg	15 U	15 U	4.9 JQ
Di-n-butyl phthalate	mg/kg-oc	1.6 U	1.5 U	0.51 JQ

Table D.1
Subsurface Sediment Sample Analytical Data

	Location	**WPAH0054**	**WPAH0055**	**WPAH0055**
	Sample ID	**SD0059**	**SD0057**	**SD0058** [1]
	Sample Date	**09/04/2014**	**09/03/2014**	**09/03/2014**
	Sample Depth (ft bml)	**6–7**	**5.5–7**	**5.5–7**
Analytes	**Units**			
Semivolatile Organic Compounds (SVOCs) by USEPA 8270D (cont.)				
Phthalate Esters (cont.)				
Butyl benzyl phthalate	µg/kg	7.3 U	7.1 U	7 U
Butyl benzyl phthalate	mg/kg-oc	0.79 U	0.70 U	0.73 U
bis(2-ethylhexyl)phthalate	µg/kg	73 U	71 U	70 U
bis(2-ethylhexyl)phthalate	mg/kg-oc	7.9 U	7.0 U	7.3 U
Di-n-octyl phthalate	µg/kg	7.3 U	7.1 U	7 U
Miscellaneous				
Dibenzofuran	µg/kg	7.3 U	3.7 JQ	7 U
Hexachlorobutadiene	µg/kg	7.3 U	7.1 U	7 U
N-Nitroso-di-n-propylamine	µg/kg	7.5 U	7.5 U	7.5 U
Ionizable Organic Compounds				
Phenol	µg/kg	22 U	22 U	21 U
2-Methylphenol	µg/kg	7.5 U	7.5 U	7.5 U
4-Methylphenol	µg/kg	7.5 U	7.5 U	7.5 U
2,4-Dimethylphenol	µg/kg	37 U	36 U	35 U
Pentachlorophenol	µg/kg	73 UJ	71 UJ	70 UJ
Benzyl alcohol	µg/kg	15 U	15 U	14 U
Benzoic Acid	µg/kg	R	R	R
Other				
2,4,5-Trichlorophenol	µg/kg	7.3 U	7.1 U	7 U
2,4,6-Trichlorophenol	µg/kg	7.3 U	7.1 U	7 U
2,4-Dichlorophenol	µg/kg	7.3 U	7.1 U	7 U
2,4-Dinitrophenol	µg/kg	200 U	200 U	200 U
2,4-Dinitrotoluene	µg/kg	7.3 U	7.1 U	7 U
2,6-Dinitrotoluene	µg/kg	7.3 U	7.1 U	7 U
2-Chloronaphthalene	µg/kg	7.3 U	7.1 U	7 U
2-Chlorophenol	µg/kg	7.3 U	7.1 U	7 U
2-Nitroaniline	µg/kg	15 U	15 U	14 U
2-Nitrophenol	µg/kg	7.5 U	7.5 U	7.5 U
3,3'-Dichlorobenzidine	µg/kg	73 U	71 U	70 U
3-Nitroaniline	µg/kg	20 U	20 U	20 U
4,6-Dinitro-o-cresol	µg/kg	73 U	71 U	70 U
4-Bromophenyl phenyl ether	µg/kg	7.3 U	7.1 U	7 U
4-Chloro-3-methylphenol	µg/kg	7.3 U	7.1 U	7 U
4-Chloroaniline	µg/kg	10 U	10 U	10 U
4-Chlorophenyl phenyl ether	µg/kg	7.3 U	7.1 U	7 U
4-Nitroaniline	µg/kg	20 U	20 U	20 U
4-Nitrophenol	µg/kg	73 U	71 U	70 U
bis(2-chloroethoxy)methane	µg/kg	7.5 U	7.5 U	7.5 U
bis(2-chloroethyl)ether	µg/kg	7.5 U	7.5 U	7.5 U
bis(2-chloroisopropyl)ether	µg/kg	7.5 U	7.5 U	7.5 U
Hexachlorocyclopentadiene	µg/kg	50 U	50 U	50 U
Hexachloroethane	µg/kg	7.3 U	7.1 U	7 U
Isophorone	µg/kg	7.3 U	7.1 U	7 U
Nitrobenzene	µg/kg	7.3 U	7.1 U	7 U
N-Nitrosodiphenylamine	µg/kg	7.3 U	7.1 U	7 U
Polycyclic Aromatic Hydrocarbons				
Naphthalene	µg/kg	2.2 JQ	2.4 JQ	3.6
Acenaphthylene	µg/kg	3.6 U	3.6 U	0.63 JQ
Acenaphthene	µg/kg	1.3 JQ	2.6 JQ	15
Fluorene	µg/kg	2 JQ	2.7 JQ	19
Phenanthrene	µg/kg	10	12	37
Phenanthrene	mg/kg-oc	1.1	1.2	3.8
Anthracene	µg/kg	3.6 U	1.4 JQ	9.3
2-Methylnaphthalene	µg/kg	5.7	5.9	6.1
Total LPAH	µg/kg	16 J	22 J	88 J
Fluoranthene	µg/kg	3.7	10	23
Fluoranthene	mg/kg-oc	0.40	1.0	2.4
Pyrene	µg/kg	3.5 JQ	8	16
Benzo(a)anthracene	µg/kg	1.4 JQ	2.6 JQ	11

Table D.1
Subsurface Sediment Sample Analytical Data

	Location	**WPAH0054**	**WPAH0055**	**WPAH0055**
	Sample ID	**SD0059**	**SD0057**	**SD0058** [1]
	Sample Date	**09/04/2014**	**09/03/2014**	**09/03/2014**
	Sample Depth (ft bml)	**6–7**	**5.5–7**	**5.5–7**
Analytes	**Units**			
Semivolatile Organic Compounds (SVOCs) by USEPA 8270D (cont.)				
Polycyclic Aromatic Hydrocarbons (cont.)				
Chrysene	µg/kg	1.9 JQ	4.7 J	21
Benzo(b)fluoranthene	µg/kg	1.8 JQ	2.8 JQ	7.6
Benzo(k)fluoranthene	µg/kg	3.6 U	3.6 U	3.4 JQ
Total Benzofluoranthenes	µg/kg	1.8 J	2.8 J	11 J
Benzo(a)pyrene	µg/kg	3.6 U	0.93 JQ	3.8
Indeno(1,2,3-cd)pyrene	µg/kg	3.6 U	3.6 U	1.8 JQ
Dibenzo(a,h)anthracene	µg/kg	3.6 U	3.6 U	3.5 U
Benzo(g,h,i)perylene	µg/kg	3.6 U	1.1 JQ	2.2 JQ
Benzo(g,h,i)perylene	mg/kg-oc	0.39 U	0.11 JQ	0.23 JQ
Total HPAH	µg/kg	12 J	30 J	90 J
cPAH TEQ ND Zero	µg/kg	0.34 J	1.5 J	6.4 J
cPAH TEQ ND 1/2 RL	µg/kg	2.7 J	2.1 J	6.6 J
Miscellaneous				
Dibenzofuran	µg/kg	1.6 JQ	2.1 JQ	11
Grain Size				
Gravel	%	0	0.55	0.2
GS 1,000–2,000 µm	%	0.15	0.44	0.56
GS 500–1,000 µm	%	0.41	0.46	0.75
GS 250–500 µm	%	0.77	1.03	1.21
GS 125–250 µm	%	2.34	3.41	3.07
GS 62.5–125 µm	%	28.28	29.01	30.71
GS 31.3–62.5 µm	%	25.86	27.46	28.08
GS 15.6–31.3 µm	%	13.06	13.84	13.76
GS 7.8–15.6 µm	%	5.5	5.87	5.67
GS 3.9–7.8 µm	%	1.92	1.84	1.87
GS 1.95–3.9 µm	%	4.12	3.85	4.02
GS 0.98–1.95 µm	%	0.92	1.2	1.58
GS <0.98 µm	%	8.14	7.91	7.18

Notes:

Indicates an organic-carbon normalized concentration.

1 Duplicate sample.

Abbreviations:

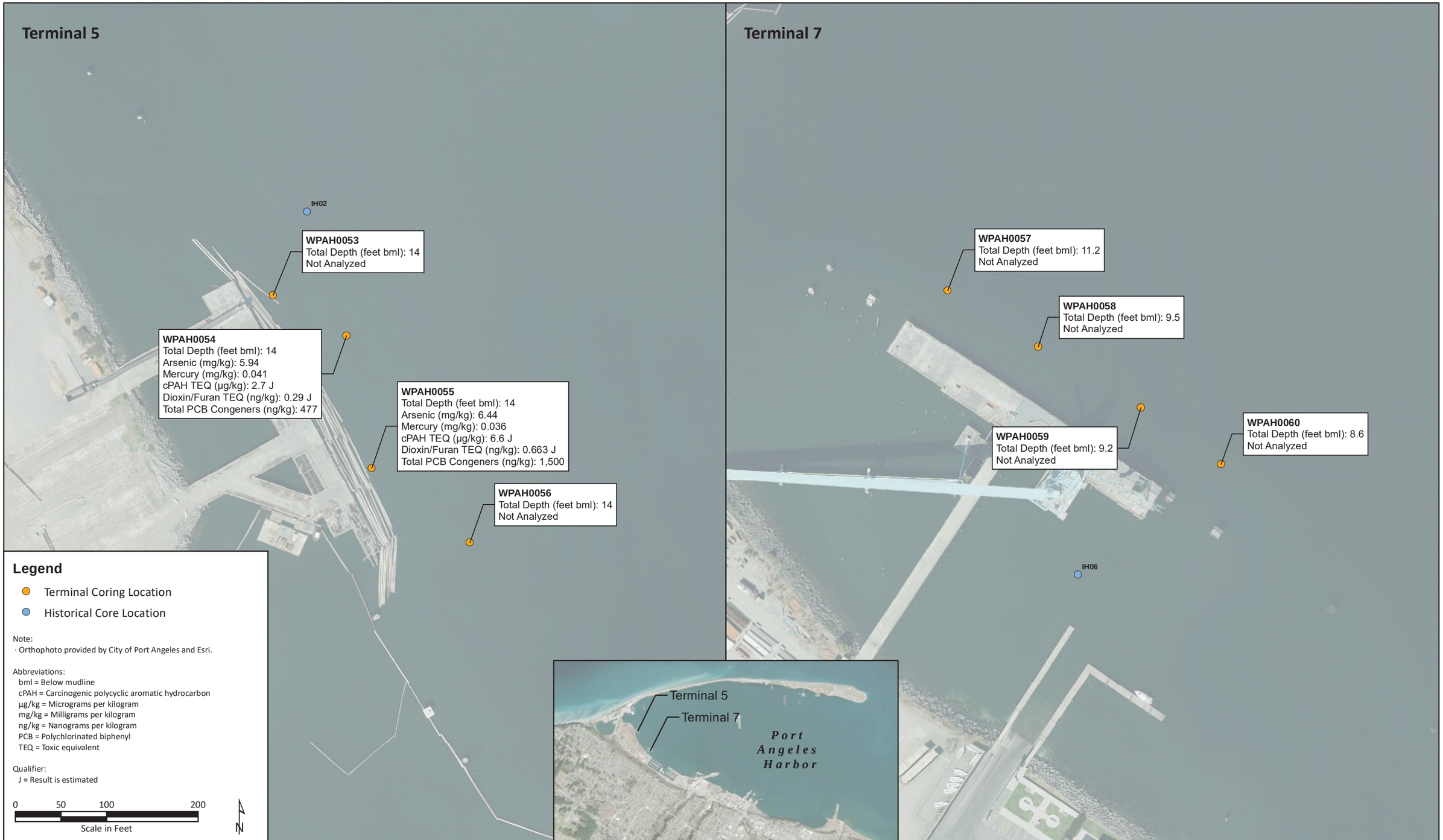
cPAH Carcinogenic polycyclic aromatic hydrocarbon
ft bml Feet below mudline
HPAH High-molecular-weight polycyclic aromatic hydrocarbon
GS Grain size
HpCDD Heptachlorodibenzo-p-dioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzo-p-dioxin
HxCDF Hexachlorodibenzofuran
LPAH Low-molecular-weight polycyclic aromatic hydrocarbon
µg/kg Micrograms per kilogram
µm Micrometers
mg/kg Milligrams per kilogram
mg/kg-oc Milligrams per kilogram organic carbon
ng/kg Nanograms per kilogram
ND Non-detect
OCDD Octochlorodibenzo-p-dioxin
OCDF Octochlorodibenzofuran
PeCDD Pentachlorodibenzo-p-dioxin
PeCDF Pentachlorodibenzofuran
RL Reporting limit
TEQ Toxic equivalent
TCDD Tetrachlorodibenzo-p-dioxin
TCDF Tetrachlorodibenzofuran

Qualifiers:

J Result is estimated.
JQ Result is estimated and reported between the method detection limit and reporting limit.
R Result was rejected during data validation.
U Result was not detected at the given reporting limit.

Appendix D
Terminal Coring Data Report

Figure



WPAHG

Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure D.1
Terminal Coring Locations and Summary of Results

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11/2/2020

Appendix D
Terminal Coring Data Report

Attachment D.1: Sediment Core Logs

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Boring ID: WPAH 0053

Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 14
Boring Depth (ft MLLW): -52.5

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -38.5
Latitude/Northing: 4807.96559 N
Longitude/Easting: 12327.62524 W
Boring Location: Terminal 5

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 43.4 ft, Tide +4.94 ft, Recovered Length = 8.1 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
				ML	Loose, wet, dark brown sandy SILT with abundant coarse wood fragments.
					Wood becomes more fine and silt becomes slightly more firm.
SD0056 @ 1550	4 - 5 ft (-42.5 to -43.5 ft)			SM	Dense silty fine SAND with few shell fragments. Coarse wood and weathered wood fragments no longer present. Presumed native.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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Boring ID: WPAH 0054

Drill Date: 9/4/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 14
Boring Depth (ft MLLW): -53.8

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -39.8
Latitude/Northing: 4807.95875 N
Longitude/Easting: 12327.60515 W
Boring Location: Terminal 5

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 41.9 ft, Tide +2.1 ft, Recovered Length = 7.4 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
SD0059 @ 0930	6 - 7 ft (-45.8 to -46.8 ft)		0–14	OL-OH	Loose, wet, black-brown organic MUD & SILT with trace fine wood fragments.
				ML	Becomes slightly more firm sandy SILT with abundant fine wood fragments. Strong sulfide odor.
					Larger wood fragments present.
				SM	Firm dark grey/brown silty SAND with few shell fragments. Wood fragments no longer present. Presumed native.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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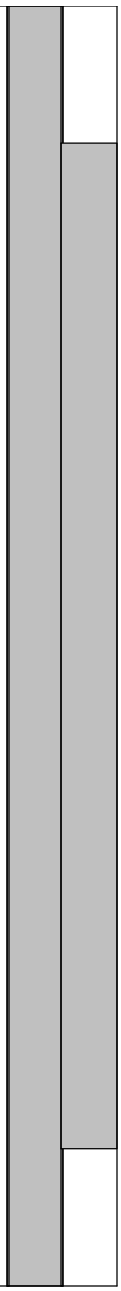
Boring ID: WPAH 0055

Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 14
Boring Depth (ft MLLW): -54.2

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -40.2
Latitude/Northing: 4807.93507 N
Longitude/Easting: 12327.59713 W
Boring Location: Terminal 5

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 45.1 ft, Tide +4.9 ft, Recovered Length = 11 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
SD0057 @ 1640 SD0058 (dup) @ 1645	5.5 - 7 ft (-45.7 to -47.2 ft)			OL-OH	Loose, wet, black-brown organic MUD & SILT.
				ML	Soft sandy SILT with abundant fine wood fragments. Strong sulfide odor.
					Coarse wood fragments (bark) present.
				SM	Dense dark grey/brown silty fine SAND with few shell fragments. Presumed native.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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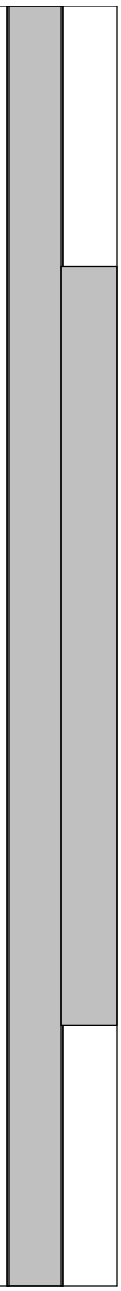
Boring ID: WPAH 0056

Drill Date: 9/4/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 14
Boring Depth (ft MLLW): -54.6

Coordinate System: NAD 1983 WASP N
Mudline Elevation (ft MLLW): -40.6
Latitude/Northing: 4807.92230 N
Longitude/Easting: 12327.57013 W
Boring Location: Terminal 5

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 43.5 ft, Tide +2.9 ft, Recovered Length = 8.3 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
SD0060 @ 1020	3.2 - 4.2 ft (-43.8 to -44.8 ft)			OL-OH	Soft, loose, wet, black-brown organic MUD & SILT with few fine wood fragments.
				ML	Becomes slightly more firm, sandy SILT with abundant fine wood fragments.
				SM	Dense dark grey/brown silty fine SAND with few shell fragments, intact shells, and trace weathered wood fragments. Presumed native.
					Coarse wood fragments present.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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Boring ID: WPAH 0057

Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 11.2
Boring Depth (ft MLLW): -46.2

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -35.0
Latitude/Northing: 4807.76815 N
Longitude/Easting: 12327.43646 W
Boring Location: Terminal 7

Remarks: DTW = 39.2 ft, Tide +4.2 ft, Recovered Length = 7.2 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
			0	ML	Soft, dark grey sandy SILT with wood fragments (~30%) and few shell fragments.
			1		
			2	SM	From 1-2 feet, becomes more dense and silt content decreases. Increased shell fragments and one rounded cobble present at 3 feet. No wood fragments present.
SD0061A @ 1110	3 - 4 ft (-38.0 to -39.0 ft)		3		
			4		
			5		
			6		
			7		At 7 feet, 1-foot lense of silty sand with abundant wood fragments, then same as above.
SD0061 @ 1105	8 - 9 ft (-43.0 to -44.0 ft)		8		
			9	SP	Very dense, poorly graded fine SAND.
			10		
			11		

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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Boring ID: WPAH 0058

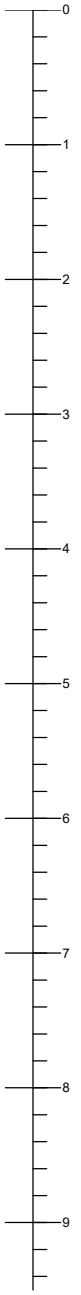
Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 9.5
Boring Depth (ft MLLW): -44.2

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -34.7
Latitude/Northing: 4807.75861 N
Longitude/Easting: 12327.41162 W
Boring Location: Terminal 7

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 39.4 ft, Tide +4.7 ft, Recovered Length = 5.7 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
				ML	Soft, loose, dark grey sandy SILT with abundant wood (~50%). Large wood chunk cored through. Strong sulfide odor.
					Becomes more dense. Abundant fine wood fragments present.
					Abundant large wood and shell fragments present.
SD0062 @ 1155	8 - 9 ft (-42.7 to -43.7 ft)			SP	Dense dark gray, poorly graded SAND with few shell fragments. Wood fragments not present.



Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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Boring ID: WPAH 0059

Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 9.2
Boring Depth (ft MLLW): -47.7

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -38.5
Latitude/Northing: 4807.74826 N
Longitude/Easting: 12327.38349 W
Boring Location: Terminal 7

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 43.5 ft, Tide +5.0 ft, Recovered Length = 6 ft
Vibracore method assumes recovered length is compressed. Location moved approximately 15 ft waterward due to refusal.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
				ML	Soft, dark gray/brown sandy SILT with abundant fine wood fragments. Strong sulfide odor.
SD0063A @ 1515	4 - 4.5 ft (-42.5 to -43.0 ft)				At 3.5 feet, 6-inch lense of dense very fine SAND with silt and few shell fragments, then same as above.
SD0063 @ 1455	4.7 - 5.7 ft (-43.2 to -44.2 ft)			SP	Dense, very fine, poorly graded SAND with shell fragments and wood fragments. Silt no longer present.
				GW	Well graded, rounded and sub-angular GRAVEL with coarse sand.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

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Boring ID: WPAH 0060

Drill Date: 9/3/2014
Logged By: K. Anderson
Drilled By: MSS, Bill Jaworski
Drill Type: Vibracore
Sample Method: Aluminum Core
Boring Diameter: 4 inches
Boring Depth (ft bml): 8.6
Boring Depth (ft MLLW): -46.4

Coordinate System: NAD 1983 WA SP N
Mudline Elevation (ft MLLW): -37.8
Latitude/Northing: 4807.73858 N
Longitude/Easting: 12327.36145 W
Boring Location: Terminal 7

Client: WPAHG
Project: WPAHG-RI/FS
Task: 7
Address:

Remarks: DTW = 42.8 ft, Tide +5.0 ft, Recovered Length = 5 ft
Vibracore method assumes recovered length is compressed.

SAMPLE ID	DEPTH FEET BML (MLLW)	DRIVEN / RECOVERED	DEPTH FT BML	USCS SYMBOL	SEDIMENT DESCRIPTION AND OBSERVATIONS
				ML	Soft, dark gray/brown sandy SILT with sand and abundant fine wood fragments. Strong sulfide odor.
					At 5.5 feet, 6-inch lense of very fine, dense, silty SAND with few shell fragments and fine wood, then same as above.
SD0064 @ 1500	6.7 - 7.7 ft (-44.5 to -45.5 ft)			SP	Dense, fine, poorly graded SAND with few fine shell fragments and no wood or silt.
				GW	Well graded, rounded and sub-angular GRAVEL with coarse sand.

Notes:
ft bml = feet below mudline
MLLW = Mean Lower Low Water
--- Dashed contact line in sediment description indicates a gradational contact
USCS = Unified Soil Classification System

Appendix D
Terminal Coring Data Report

Attachment D.2: Wessen & Associates Archaeological Monitoring Report

CULTURAL RESOURCES REPORT COVER SHEET

Author: Gary C. Wessen

Title of Report: A Report of Archaeological Monitoring of the Investigation of Subtidal Sediment Cores from the Terminal 5 and 7 Berthing Areas, Port Angeles Harbor, Clallam County, Washington

Date of Report: September 2014

County: Clallam Section: 4 Township: 30 N Range: 6 W
Section: 33 Township: 31 N Range: 6 W
Quad: Port Angeles Acres: ~1.6

CD Submitted?: No PDF of Report?: Yes Historic Property Export Files?: No

Archaeological Site(s)/Isolate(s) Found or Amended?: No

TCP(s) found?: No

Replace a draft?: No

Satisfy a DAHP Archaeological Excavation Permit requirement?: No

DAHP Archaeological Site #:

- Please submit paper copies of reports ***unbound.***
- Submission of PDFs is encouraged.
- Please be sure that any PDF submitted to DAHP has its cover sheet, figures, graphics, appendices, attachments, correspondence, etc., compiled into one single PDF file.
- Please check that the PDF displays correctly when opened.

A REPORT OF ARCHAEOLOGICAL MONITORING OF THE INVESTIGATION OF SUBTIDAL SEDIMENT CORES FROM THE TERMINAL 5 AND 7 BERTHING AREAS, PORT ANGELES HARBOR, CLALLAM COUNTY, WASHINGTON

Gary C. Wessen, Ph.D.
Wessen & Associates, Inc.
September 2014

Introduction and Overview

As part of the Remedial Investigation for the Western Port Angeles Harbor Site, the Western Port Angeles Harbor Group undertook sediment core sampling in the berthing areas of Port of Port Angeles Harbor Terminals 5 and 7. These additional investigations of subtidal sediments in the berthing areas were conducted by Floyd | Snider. While there are no recorded archaeological sites in the immediate vicinity of either berthing area, a large complex of prehistoric occupation deposits and graves (45CA523) is known to be present within approximately 600 feet of the Terminal 5 berthing area. As such, an archaeological monitoring plan was developed to oversee the activities and ensure that any archaeological materials exposed during the work would be properly identified and recorded.

The monitoring was conducted by this author on the 3rd and 4th of September 2014. No human remains, potentially intact archaeological deposits, or re-deposited archaeological materials were observed in the core samples.

Background

Terminals 5 and 7 are along the marine shoreline in the southwestern portion of Port Angeles Harbor (see Figure 1). Terminal 5 is in Section 33, Township 31 North, Range 6 West; Terminal 7 is in Section 4, Township 30 North, Range 6 West. Terminal 5 is located close to the base of Ediz Hook. Terminal 7 is located approximately 1,500 feet to the southeast of the latter, near the west side of the Port Angeles Boat Haven Marina. Each terminal includes a large wharf structure approximately 100 feet offshore and oriented with its long axis parallel to the shoreline. Each terminal's berthing area is on the offshore side of this wharf where vessels tie up to the terminal. As a practical matter, each berthing area is approximately 350 feet long and 100 feet wide. Water depths in the Terminal 5 berthing area range between -38 and -41 feet (MLLW). Water depths in the Terminal 7 berthing area range between -35 and -39 feet (MLLW).

The harbor shoreline in this area is the product of a series of 20th century filling episodes and, as such that it is now several hundred feet seaward of its early historic location (Wengler 2009). It did not exist prior to the mid 1960s. Both terminals have use histories handling wood materials. Documentation of dredging in the berthing areas is limited, but at least one episode of dredging is known to have occurred at Terminal 7.

Previous subtidal coring in the southwestern part of Port Angeles Harbor has been limited to sediments within approximately 10 feet of the mud line (E & E 2008 and 2012). Single cores taken near Terminals 5 and 7 encountered accumulations of a very loose silt with abundant woody debris at depths up to 5.75 feet below mudline (bml). A much more compact fine sand was encountered

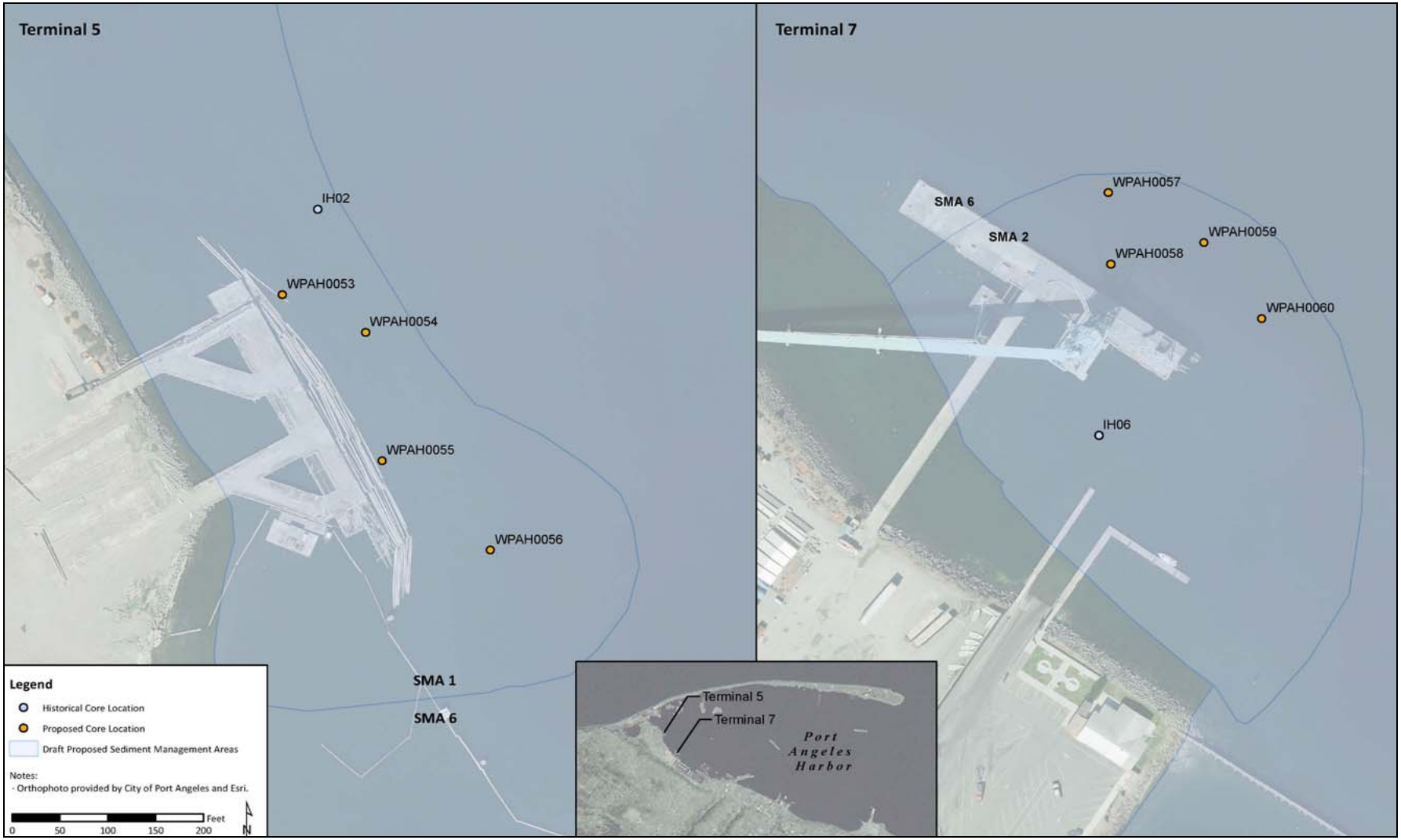

Figure 1 The locations of subtidal sediment cores from the Terminal 5 and 7 berthing areas, Port Angeles Harbor Clallam County, Washington.

beneath the loose silt. The compact fine sand has been interpreted as a native marine deposit. The overlying loose silt with abundant woody debris has been interpreted as an historic accumulation associated with use of the terminals. The sampling addressed by this monitoring report was designed to collect additional information about the depth to native marine deposits in each berthing area. The specific sampling plan called for obtaining four additional sediment cores from each berthing area (see Figure 1). Four inch diameter cores would be recovered using a vibracore technique. The drive goal for each core was to reach between 8 and 15 feet bml.

While the proximity to 45CA523 is of some concern, what is known of the environmental context of the Terminals 5 and 7 berthing areas suggests that they may have low archaeological potentials. First, recall that each berthing area is located approximately 400 to 500 feet seaward of the early historic shoreline. Thus, these were subtidal settings during the Late Holocene. If the observed water depths approximate the natural condition, then reconstructions of local Late Pleistocene and Holocene sea level history suggest the berthing areas could have been subtidal settings for at least the last 16,000 (Mosher and Hewitt 2004, James et al. 2009). While a brief emergent period may have occurred ca. 10,000 to 12,000 year ago, the latter appears to have been the only interval when the formation of terrestrial deposits could have occurred. If the observed water depths have been significantly altered by dredging (i.e., were formerly shallower), then an emergent period is somewhat more likely and/or of longer duration. Nevertheless, we are still speaking of a Late Pleistocene to Early Holocene event; at most it would have been over by ca. 8,000 years ago. Thus, if potential intact archaeological deposits survive in the Terminals 5 and 7 berthing areas, they are most likely to be ancient deposits deeply buried beneath 1,000s of years of more recent marine sediments. The presence of cultural materials in the more recent marine sediments is possible, but such materials represent re-deposited objects from unknown terrestrial sources.

Finally, it should be noted that there have been a few previous investigations of the archaeological potential of subtidal sediments in Port Angeles Harbor. Of particular note, one such study investigated the subtidal surfaces of the immediate vicinities of Terminals 5 and 7 (Wessen 2009). No sediment cores were taken, but an archaeologically-trained diver inspected the seabed around the terminals. His coverage included the shoreward margins of the berthing areas, but did not address the larger areas considered here. No archaeological materials were encountered.

Field Activities and Findings

Archaeological activities and observations described in this report were conducted on the 3rd and 4th of September 2014. It should be noted however, that the work was not 'monitoring' as this term is normally employed. The ground-disturbing action in this effort was the driving of the vibracore's sample tube into the seabed from a boat in water depths of 40 to 45 feet. Thus, it was not possible to directly observe the disturbance. The sample tubes were then brought to the surface and sealed for later examination at an onshore location. As such, there was no reason for me to be present on the boat while the sampling was conducted. Rather, I was present at a temporary field station established in the parking lot at the western end of Port Angeles Boat Haven Marina. Sealed tubes from each sampled location were brought to this field station, where they were opened, examined, sampled, and documented. This work was conducted by Kristin Anderson of Floyd | Snider, who supported my efforts to examine the exposed sediments and provided helpful background information.

Sampling went relatively smoothly, although the very soft character of the seabed's upper deposits resulted in cores in which the deposits are compressed. For the most part, the depositional profiles recovered at all eight investigated locations are quite similar. While some localized variation was observed, the conditions are consistent enough to describe the basic structure in terms of two basic widespread units. The upper of these two is a loose dark grayish brown [10YR4/2] silt with varying - - and frequently high - - densities of wood chips, shredded bark, and other woody debris (Stratum I). The lower unit a compact dark gray [2.5Y4/0] fine sand with a low density of marine shell fragments (Stratum II). By far, most of the marine shell fragments represent bivalves and most of these represent the bent-nosed clam (*Macoma nasuta*). Of some note, occasional examples of still articulated bent-nosed clam shells are present in this deposit. Examples of the butter clam (*Saxidomus giganteus*) and a horse clam (*Tresus* sp.) were also noted, but these were rare. Examples of bone, charcoal, fire-cracked rock, or any type of prehistoric artifact were never encountered. The boundary between Stratum I and Stratum II was usually encountered between approximately -42 and -46 feet (MLLW).

Slight variations on this basic structure were observed in each area. At Terminal 5, a relatively thin layer of very loose black [2.5Y2/0] organic mud with woody debris (Stratum III) was found above Stratum I at three of the four investigated locations. This material was not encountered at Terminal 7. Similarly, two of the four investigated locations at Terminal 7 produced evidence of a compact black [2.5Y2/0] subrounded to angular gravel (Stratum IV) beneath approximately 2 to 2.5 feet of Stratum II. This material was not encountered at Terminal 5.

I had good opportunities to examine all of these deposits and believe that the significance of most of them is clear. In broad terms, I am confident that Stratum I and II are equivalent to the upper very loose silt with abundant woody debris and lower compact fine sand reported earlier (E & E 2012). The earlier interpretations that the compact fine sand represents an *in situ* native marine deposit and the overlying loose silt with woody debris is an historic accumulation associated with use of the terminals continue to appear correct. The very loose black [2.5Y2/0] organic mud with woody debris identified as Stratum III in the Terminal 5 berthing area is clearly a very recent deposit which is unlikely to represent a natural sediment transport mechanism. The significance of the compact black [2.5Y2/0] subrounded to angular gravel identified as Stratum IV in the Terminal 7 berthing area is also uncertain. It is not well sorted, nor is it widespread enough to suggest it is a colluvium. As such, there does not appear to be a natural sediment transport process which could account for its presence.

Discussion and Conclusions

Recent vibracore sampling of eight subtidal locations in the Terminal 5 and 7 berthing areas has produced no evidence of the presence of potentially intact archaeological deposits or re-deposited archaeological materials. Sampling was limited to the uppermost 15 feet bml and the results suggest that these are very recent sediments. Much, if not all, of the deposits may date to the historic period. Only Stratum II appears to have the potential to contain prehistoric deposits and, while undated, I suspect that the marine sediments we examined are unlikely to be as much as 1,500 years old. Potentially intact archaeological deposits - - if present in the berthing areas - - are likely to be buried well below the depths reached by this study.

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Appendix D
Terminal Coring Data Report

Attachment D.3: EcoChem, Inc., Data Validation Report

DATA VALIDATION REPORT

WESTERN PORT ANGELES HARBOR RI/FS

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December 3, 2014

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Basis for Data Validation

This report summarizes the results of validation (Stage 4) performed on sediment and quality control (QC) sample data for the Western Port Angeles Harbor RI/FS. Field sample ID, laboratory sample ID, and requested analyses are provided in the **Sample Indices**. Laboratory batch ID numbers and associated level of validation are provided at the beginning of each technical section.

Samples were analyzed by ALS Environmental, Kelso, Washington and Axys Analytical Ltd., Sidney, British Columbia, Canada. The analytical methods and EcoChem project chemists are listed below.

Analysis	Method of Analysis	Primary Review	Secondary Review
Dioxin/Furans	EPA 1613B	M. Swanson	C. Frans
PCB Congeners	EPA 1668A		
Semivolatile Organic Compounds	SW8270D	Alison Bodkin	M. Swanson
Polycyclic Aromatic Hydrocarbons	SW8270D-SIM		
Metals	SW6020A, 7471A		
Grain Size	PSEP		
TOC	SW9060		
Totals Solids	EPA160.3		

The data were reviewed using guidance and quality control criteria documented in the analytical methods and the following project and guidance documents:

- Sampling and Analysis Plan - *Western Port Angeles Harbor RI/FS* (Integral/Anchor QEA/Exponent/Floyd|Snider, June 2013)
- *USEPA National Functional Guidelines for Organic Data Review* (USEPA 2008)
- *USEPA National Functional Guidelines for Inorganic Data Review* (USEPA October 2004)

EcoChem's goal in assigning data assessment qualifiers is to assist in proper data interpretation. If values are estimated (J or UJ), data may be used for site evaluation and risk assessment purposes but reasons for data qualification should be taken into consideration when interpreting sample concentrations. If values are assigned an R, the data are to be rejected and should not be used for any site evaluation purposes. If values have no data qualifier assigned, then the data meet the data quality objectives as stated in the documents and methods referenced above.

Data qualifier definitions, reason codes, and validation criteria are included as **Appendix A**. The qualified data summary table is included as **Appendix B.** Data Validation Worksheets and the associated communication records will be kept on file at EcoChem, Inc. A qualified laboratory electronic data deliverable (EDD) was also submitted with this report.

Sample Index
Western Port Angeles Harbor RI/FS - Axys Analytical

SDG	Sample ID	Lab ID	PCB	Dioxin
WG48611	SD0057	L21992-1	✓	✓
WG48611	SD0058	L21992-2	✓	✓
WG48611	SD0059	L21992-10	✓	✓

Sample Index
Western Port Angeles Harbor RI/FS - ALS Environmental

SDG	Sample ID	Lab ID	SVOC	PAH	Metals	Grain Size	Total Organic Carbon	Total Solids
K1409547	SD0057	K1409547-007	✓	✓	✓	✓	✓	✓
K1409547	SD0058	K1409547-008	✓	✓	✓	✓	✓	✓
K1409547	SD0059	K1409547-009	✓	✓	✓	✓	✓	✓

DATA VALIDATION REPORT
Western Port Angeles Harbor RI/FS
Polynuclear Aromatic Hydrocarbons by Method SW8270D-SIM

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by ALS Environmental, Kelso, Washington. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
K1409547	3 Sediment	Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. VERIFICATION OF EDD TO LABORATORY REPORT

Sample results and related quality control data were received as an electronic data deliverable (EDD) and laboratory report. The EDD was verified against the laboratory report; no errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

✓	Sample Receipt, Preservation, and Holding Times	✓	Laboratory Control Samples (LCS/LCSD)
✓	GC/MS Instrument Performance Check	1	Field Duplicates
✓	Initial Calibration (ICAL)	✓	Internal Standards
✓	Continuing Calibration (CCAL)	✓	Target Analyte List
✓	Laboratory Blanks	✓	Reporting Limits (MDL and MRL)
1	Field Blanks	✓	Compound Identification
✓	Surrogate Compounds	2	Reported Results
✓	Matrix Spikes/Matrix Spike Duplicates (MS/MSD)	1	Calculation Verification

✓Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Field Blanks

No field blanks were submitted with this data set.

Field Duplicates

The following acceptance criteria were used to evaluate precision: the relative percent difference (RPD) control limit is 50% for results greater than 5x the reporting limit (RL). For results less than 5x the RL, the difference between the sample and duplicate must be less than 2x the RL. No

data were qualified based on field replicate precision outliers. Data users should consider the impact of field precision outliers on the reported results.

One set of field replicates, SD0057 & SD0058, were submitted. For acenaphthene, dibenzofuran, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, and chrysene, the difference criterion was used to evaluate precision and the differences were greater than the control limit.

Reported Results

For Sample SD0057, the chrysene result was flagged by the lab to indicate a possible matrix interference. This result was estimated (J-23H) to indicate a potential high bias.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable as demonstrated by the surrogate and laboratory control sample/laboratory control sample duplicate (LCS/LCSD) and matrix spike/matrix spike duplicate (MS/MSD) recovery values. With the exceptions noted above, precision was acceptable as demonstrated by the LCS/LCSD, MS/MSD, and field replicate RPD values.

One data point was estimated based on possible matrix interference.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Western Port Angeles Harbor RI/FS
Semivolatile Organic Compounds by Method SW8270D

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by ALS Environmental, Kelso, Washington. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
K1409547	3 Sediment	Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. VERIFICATION OF EDD TO LABORATORY REPORT

Sample results and related quality control data were received as an electronic data deliverable (EDD) and laboratory report. The EDD was verified against the laboratory report; no errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

✓	Sample Receipt, Preservation, and Holding Times	2	Laboratory Control Samples (LCS/LCSD)
✓	GC/MS Instrument Performance Check	1	Field Duplicates
✓	Initial Calibration (ICAL)	✓	Internal Standards
2	Continuing Calibration (CCAL)	✓	Target Analyte List
1	Laboratory Blanks	✓	Reporting Limits (MDL and MRL)
1	Field Blanks	✓	Compound Identification
✓	Surrogate Compounds	✓	Reported Results
✓	Matrix Spikes/Matrix Spike Duplicates (MS/MSD)	1	Calculation Verification (Full validation only)

✓Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Continuing Calibration

In the continuing calibration (CCAL) from 10/15/14 the percent difference (%D) value for 4-nitrophenol was greater than the control limit of 25%. This analyte was not detected in the associated sample; no action was necessary as the %D value indicated a potential high bias. The %D for pentachlorophenol was greater than the control limit and indicated a potential low bias. This analyte was not detected in the associated samples, reporting limits were estimated (UJ-5BL).

Laboratory Blanks

Laboratory (method) blanks were analyzed at the appropriate frequency. Bis(2-ethylhexyl)phthalate and di-n-octyl phthalate were detected in the method blank. These analytes were not detected in the associated samples; no qualification of data was necessary.

Field Blanks

No field blanks were submitted with this data set.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed at the proper frequency. Benzoic acid was not recovered in the LCS/LCSD. This analyte was not detected in the associated samples; reporting limits were rejected (R-10L) to indicate potential low bias. The LCS %R value for benzyl alcohol was less than the lower control limit while the LCSD %R value was acceptable. No data were qualified based on this single outlier.

Field Duplicates

The field duplicate relative percent difference (RPD) control limit is 50% for results greater than five times (5x) the RL. For results less than 5x the RL, the difference between the sample and duplicate must be less than 2x the RL.

One set of field replicates, SD0057 & SD0058, were submitted. Field precision was acceptable.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the surrogate, LCS/LCSD, and matrix spike/matrix spike duplicate (MS/MSD) recovery values. Precision was acceptable as demonstrated by the LCS/LCSD, MS/MSD, and field duplicate RPD values.

Data were estimated based on CCAL %D outliers.

Data were based on LCS/LCSD %R values that were less than 10%.

Data that were rejected should not be used for any purpose. All other data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
City of Port Angeles WPAHG
Dioxin & Furan Compounds by Axys Method MLA-017 (EPA 1613B)

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by Axys Analytical Services, Ltd. of Sidney, British Columbia, Canada. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
WG48611	3 Sediment	EPA Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO LABORATORY REPORT PACKAGE VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the laboratory data package. No errors were noted.

III. TECHNICAL DATA VALIDATION

The QC requirements reviewed are summarized in the following table:

1	Sample Receipt, Preservation, and Holding Time	✓	Ongoing Precision and Recovery (OPR)
✓	System Performance and Resolution Checks	1	Field Duplicates
✓	Initial Calibration (ICAL)	1	Laboratory Duplicates
✓	Calibration Verification (CVER)	✓	Target Analyte List
1	Method Blanks	2	Reported Results
1	Field Blanks	2	Compound Identification
✓	Labeled Compound Recovery	1	Calculation Verification

✓ Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that sample shipping coolers should arrive at the laboratory within the advisory temperature range of 2° to 6°C. The laboratory received the sample cooler with a temperature greater than the upper control limit, at 6.5 °C. This outlier did not impact data quality; no data were qualified.

Method Blanks

Method blanks were analyzed at the appropriate frequency. The analytes OCDD and OCDF were detected in the method blank, but were assigned "K" flags by the laboratory to indicate a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are “estimated maximum possible concentrations”. No action levels were established for these analytes and no data were qualified.

Field Blanks

No field blanks were submitted with these data.

Field Duplicates

The following acceptance criteria were used to evaluate precision: the relative percent difference (RPD) control limit is 50% for results greater than 5x the reporting limit (RL). For results less than 5x the RL, the absolute difference between the sample and replicate must be less than 2x the RL.

One set of field replicates, SD0057 & SD0058, were submitted. Field precision was acceptable.

Laboratory Duplicates

No laboratory duplicates were submitted with these data. Accuracy was evaluated using the labeled compound and ongoing precision and recovery (OPR) standard results. Precision was evaluated from the field duplicate results.

Reported Results

All results for 2,3,7,8-TCDF were confirmed on a DB-225 column as required by the method. The 2,3,7,8-TCDF results from both columns were reported. The 2,3,7,8-TCDF results from the DB-5 column were qualified do-not-report (DNR-11).

Compound Identification

The laboratory assigned a" K" flag to one or more analytes in all samples to indicate the ion ratio criterion were not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy, an outlier indicates that the reported result may be a false positive. All “K” flagged results were qualified as not detected (U-25) at the reported concentration.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable as demonstrated by the labeled compound and on-going precision and recovery standard recoveries and precision was acceptable as demonstrated by the field duplicate RPD values.

Detection limits were elevated based on ion ratio outliers.

Results for 2,3,7,8-TCDF on the DB-5 column were qualified do-not-report (DNR). Since a usable result remains for this compound in all samples; completeness was unaffected.

Data that have been flagged DNR should not be used. All other data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Western Port Angeles Harbor RI/FS
PCB Congeners by Axys Method MLA-010 (EPA 1668)

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by Axys Analytical Services Ltd. of Sydney, British Columbia, Canada. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
WG48611	3 Sediment	EPA Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. EDD TO LABORATORY REPORT PACKAGE VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the laboratory data package. No errors were noted.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

1	Sample Receipt, Preservation, and Holding Times	✓	Ongoing Precision and Recovery (OPR)
✓	System Performance and Resolution Checks	1	Field Duplicates
✓	Initial Calibration (ICAL)	1	Laboratory Duplicates
✓	Continuing Calibration (CCAL)	2	Reported Results
1	Method Blanks	1	Reporting Limits
1	Field Blanks	2	Compound Identification
✓	Labeled Compound Recovery	1	Calculation Verification

✓Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that sample shipping coolers should arrive at the laboratory within the advisory temperature range of 2° to 6°C. The laboratory received the sample cooler with a temperature of 6.5 °C, which is greater than the upper control limit. This outlier did not impact data quality; no data were qualified.

Method Blanks

Method blanks were analyzed at the appropriate frequency. To assess the impact of each blank contaminant on the reported sample results, an action level was established at five times the concentration detected in the blank and the sample results were compared to these action levels. The laboratory assigned "K" flag to values when a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are "estimated maximum possible concentrations". When these occurred in the method blank the results were considered as false positives. No action levels were established for these analytes.

Seventeen congeners were detected in the method blank. All results for these congeners in the associated samples were greater than the action levels; no data were qualified.

Field Blanks

No field blanks were submitted.

Field Duplicates

The following acceptance criteria were used to evaluate precision: the relative percent difference (RPD) control limit is 50% for results greater than 5x the reporting limit (RL). For results less than 5x the RL, the difference between the sample and duplicate must be less than 2x the RL. No data were qualified based on field replicate precision outliers. Data users should consider the impact of field precision outliers on the reported results.

One set of field replicates, SD0057 & SD0058, were submitted. The RPD value for total octachlorobiphenyls was greater than the control limit and the difference between the replicate results for PCB 80 was greater than 2x the RL.

Laboratory Duplicates

Laboratory duplicates were not analyzed. Accuracy was evaluated using the labeled compound and ongoing precision and recovery (OPR) standard results. Precision was evaluated from the field duplicate results.

Reported Results

Lock-mass interferences were present that affected the quantitation and/or resolution of one or more results in several samples. These samples were diluted and re-analyzed, the laboratory reported only the most appropriate result for each congener. The laboratory assigned a "G" flag to the result for PCB 169 in Sample SD0057 due to lock-mass disturbances. This "G" flagged result was estimated (UJ-24).

Reporting Limits

All samples in this SDG were reanalyzed at dilution (10x or 20x) due to lock-mass interferences. Reporting limits were elevated accordingly.

Compound Identification

The laboratory assigned a" K" flag to one or more analytes in all samples to indicate the ion ratio criterion were not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy, an outlier indicates that the reported result may be a false positive. All “K” flagged results were qualified as not detected (U-25) at the reported concentration.

Calculation Verification

Several results were verified by recalculation from the raw data. No transcription or calculation errors were found.

IV. OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable as demonstrated by the labeled compound and OPR recoveries. With the exceptions noted above, precision was acceptable as demonstrated by the RPD values for the field duplicates.

One result was estimated due to a lock-mass interference. Detection limits were elevated due to ion ratio outliers.

All data, as qualified, are acceptable for use.

DATA VALIDATION REPORT
Western Port Angeles Harbor RI/FS
Metals by Methods SW6020A and SW7471B

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. ALS Environmental, Kelso, Washington, analyzed the samples. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
K1409547	3 Sediment	Stage 4

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. VERIFICATION OF EDD TO LABORATORY REPORT

Sample results and related quality control data were received as an electronic data deliverable (EDD) and laboratory report. The EDD was verified against the laboratory report; no errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

✓	Sample Receipt, Preservation, and Holding Times	✓	Matrix Spike Samples
✓	Initial Calibration	✓	Laboratory Duplicates
✓	Continuing Calibration Verification	1	Field Duplicates
✓	ICP-MS Tune	✓	Interference Check Samples
✓	CRDL Standards	✓	Serial Dilutions
1	Laboratory Blanks	✓	ICP-MS Internal Standards
1	Field Blanks	✓	Reporting Limits (MDL and MRL)
✓	Laboratory Control Samples (LCS)	✓	Reported Results
✓	Reference Materials	1	Calculation Verification

✓ ***Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.***
[1] ***Quality control results are discussed below, but no data were qualified.***
[2] ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Laboratory Blanks

Laboratory blanks were analyzed at the appropriate frequency. Lead was detected in the method blank, however all positive result for lead in the associated samples were greater than the action level of five times (5x) the concentration. No qualifiers were assigned.

Field Blanks

No field blanks were submitted with this data set.

Field Duplicates

The field duplicate relative percent difference (RPD) control limit is 50% for results greater than five times (5x) the RL. For results less than 5x the RL, the difference between the sample and duplicate must be less than 2x the RL.

One set of field duplicates, SD0057 & SD0058, were submitted. Field precision was acceptable.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable as demonstrated by the laboratory control sample and matrix spike percent recovery values. Precision was also acceptable as demonstrated by the laboratory and field duplicate RPD values.

No data were qualified for any reason.

All data, as reported, are acceptable for use.

DATA VALIDATION REPORT
Western Port Angeles Harbor RI/FS
Conventional Parameters

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by ALS Environmental, Kelso, Washington. Refer to the **Sample Index** for a complete list of samples.

SDG	Number of Samples	Validation Level
K1409547	3 Sediment	Stage 3

The analytical tests that were performed are summarized below.

Parameter	Method
Grain Size	PSEP
Total Solids	160.3
Total Organic Carbon	SW9060

I. DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

II. VERIFICATION OF EDD TO LABORATORY REPORT

Sample results and related quality control data were received as an electronic data deliverable (EDD) and laboratory report. The EDD was verified against the laboratory report; with the exceptions noted below no errors were found.

III. TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed in the following table.

✓	Sample Receipt, Preservation, and Holding Times	1	Field Duplicates
✓	Laboratory Blanks	✓	Matrix Spikes
✓	Laboratory Control Samples (LCS)	✓	Reported Results
✓	Laboratory Replicates	✓	Reporting Limits
1	Field Blanks	1	Calculation Verification

✓ Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
[1] Quality control results are discussed below, but no data were qualified.
[2] Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Field Blanks

No field blanks were submitted with this data set.

Field Duplicates

The field duplicate relative percent difference (RPD) control limit is 50% for results greater than five times (5x) the RL. For results less than 5x the RL, the difference between the sample and duplicate must be less than 2x the RL.

One set of field duplicates, SD0057 & SD0058, were submitted. Field precision was acceptable.

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were noted.

IV. OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical methods. Accuracy was acceptable as demonstrated by the laboratory control sample, reference material, and matrix spike recoveries. Precision was acceptable as demonstrated by the laboratory duplicate RPD, laboratory triplicate %RSD, and field duplicate RPD values.

No data were qualified for any reason.

All data, as reported, are acceptable for use.

ECOCHEM
Data Quality

APPENDIX A

DATA QUALIFIER DEFINITIONS
REASON CODES
AND CRITERIA TABLES

DATA VALIDATION QUALIFIER CODES
National Functional Guidelines

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents the approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following is an EcoChem qualifier that may also be assigned during the data review process:

DNR	Do not report; a more appropriate result is reported from another analysis or dilution.

DATA QUALIFIER REASON CODES

Group	Code	Reason for Qualification
Sample Handling	1	Improper Sample Handling or Sample Preservation (i.e., headspace, cooler temperature, pH, summa canister pressure); Exceeded Holding Times
Instrument Performance	24	Instrument Performance (i.e., tune, resolution, retention time window, endrin breakdown)
	5A	Initial Calibration (RF, %RSD, r^2)
	5B	Calibration Verification (ICV, CCV, CCAL; RF, %D, %R) Use bias flags (H,L)[1] where appropriate
Blank Contamination	6	Field Blank Contamination (Equipment Rinsate, Trip Blank, etc.)
	7	Lab Blank Contamination (i.e., method blank, instrument blank, etc.) Use low bias flag (L)[1] for negative instrument blanks
Precision and Accuracy	8	Matrix Spike (MS &/or MSD) Recoveries Use bias flags (H,L)[1] where appropriate
	9	Precision (all replicates: LCS/LCSD, MS/MSD, Lab Replicate, Field Replicate)
	10	Laboratory Control Sample Recoveries (a.k.a. Blank Spikes) Use bias flags (H,L)[1] where appropriate
	12	Reference Material Use bias flags (H,L)[1] where appropriate
	13	Surrogate Spike Recoveries (a.k.a. labeled compounds, recovery standards) Use bias flags (H,L)[1] where appropriate
Interferences	16	ICP/ICP-MS Serial Dilution Percent Difference
	17	ICP/ICP-MS Interference Check Standard Recovery Use bias flags (H,L)[1] where appropriate
	19	Internal Standard Performance (i.e., area, retention time, recovery)
	22	Elevated Detection Limit due to Interference (i.e., chemical and/or matrix)
	23	Bias from Matrix Interference (i.e. diphenyl ether, PCB/pesticides)
Identification and Quantitation	2	Chromatographic pattern in sample does not match pattern of calibration standard
	3	2nd column confirmation (RPD or %D)
	4	Tentatively Identified Compound (TIC) (associated with NJ only)
	20	Calibration Range or Linear Range Exceeded
	25	Compound Identification (i.e., ion ratio, retention time, relative abundance, etc.)
Miscellaneous	11	A more appropriate result is reported (multiple reported analyses i.e., dilutions, re-extractions, etc. Associated with "R" and "DNR" only)
	14	Other (See DV report for details)
	26	Method QC information not provided

[1] H = high bias indicated
L = low bias indicated

EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS (Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature	4°C ±2°	J(+)/UJ(-) if greater than 6 deg. C (EcoChem PJ)	1
Holding Time	Water: 7 days from collection Soil: 14 days from collection Analysis: 40 days from extraction	Water: J(+)/UJ(-) if ext. > 7 and < 21 days J(+)/R(-) if ext > 21 days (EcoChem PJ) Solids/Wastes: J(+)/UJ(-) if ext. > 14 and < 42 days J(+)/R(-) if ext. > 42 days (EcoChem PJ) J(+)/UJ(-) if analysis >40 days	1
Tuning	DFTPP Beginning of each 12 hour period Method acceptance criteria	R(+/-) all analytes in all samples associated with the tune	5A
Initial Calibration (Minimum 5 stds.)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5A
	%RSD < 30%	(EcoChem PJ, see TM-06) J(+) if %RSD > 30%	5A
Continuing Calibration (Prior to each 12 hr. shift)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5B
	%D <25%	(EcoChem PJ, see TM-06) If > +/-90%: J+/R- If -90% to -26%: J+ (high bias) If 26% to 90%: J+/UJ- (low bias)	5B
Method Blank	One per matrix per batch No results > CRQL	U(+) if sample (+) result is less than CRQL and less than appropriate 5X or 10X rule (raise sample value to CRQL)	7
		U(+) if sample (+) result is greater than or equal to CRQL and less than appropriate 5X and 10X rule (at reported sample value)	7
	No TICs present	R(+) TICs using 10X rule	7
Field Blanks (Not Required)	No results > CRQL	Apply 5X/10X rule; U(+) < action level	6

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EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS (Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
MS/MSD (recovery)	One per matrix per batch Use method acceptance criteria	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	One per matrix per batch Use method acceptance criteria	J(+) in parent sample if RPD > CL	9
LCS low conc. H2O SVOA	One per lab batch Within method control limits	J(+) assoc. cmpd if > UCL J(+)/R(-) assoc. cmpd if < LCL J(+)/R(-) all cmpds if half are < LCL	10
LCS regular SVOA (H2O & solid)	One per lab batch Lab or method control limits	J(+) if %R > UCL J(+)/UJ(-) if %R <LCL J(+)/R(-) if %R < 10% (EcoChem PJ)	10
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J(+)/UJ(-) assoc. cmpd. in all samples	9
Surrogates	Minimum of 3 acid and 3 base/neutral compounds Use method acceptance criteria	Do not qualify if only 1 acid and/or 1 B/N surrogate is out unless <10% J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) if %R < 10%	13
Internal Standards	Added to all samples Acceptable Range: IS area 50% to 200% of CCAL area RT within 30 seconds of CC RT	J(+) if > 200% J(+)/UJ(-) if < 50% J(+)/R(-) if < 25% RT>30 seconds, narrate and Notify PM	19
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
TICs	Major ions (>10%) in reference must be present in sample; intensities agree within 20%; check identification	NJ the TIC unless: R(+) common laboratory contaminants See Technical Director for ID issues	4
Quantitation/ Identification	RRT within 0.06 of standard RRT Ion relative intensity within 20% of standard All ions in std. at > 10% intensity must be present in sample	See Technical Director if outliers	14 21 (false +)

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EcoChem Validation Guidelines for PCB Congener Analysis by HRMS (Based on EPA Reg. 10 SOP, Rev. 1, 12/1995 & EPA SW-846, Method 1668)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler/Storage Temperature	Waters/Solids <4°C Tissues <-10°C	EcoChem PJ, see TM-05	1
Holding Time	Samples: Up to one year if stored in the dark & temp as above. Extracts: Up to 1 year if stored at <-10°C and in the dark	J(+)/UJ(-) if HT > 1 year EcoChem PJ, see TM-05	1
Mass Resolution	>=10,000 resolving power at m/z 330.9792 <5 ppm deviation from each m/z listed in Table 7 of method. Analyzed prior to ICAL and at the beginning and end of each 12 hr. shift	R(+/-) if not met	14
Column Resolution 209 Congener Solution	Mix of all 209 PCBs run prior to each ICAL and each 12 hour shift RT of PCB209 must be > 55 min PCB 156 & 157 must coelute w/in 2 sec PCB34 & 23 and PCB187 & 182 must be resolved where ((x/y)*100%) < 40% x = ht. of valley and y = ht of shortest peak	J(+) if valley >40%	5A (ICAL) 5B (CCAL)
Initial Calibration	Minimum of five standards %RSD < 20% for native compounds %RSD < 35% for labeled compounds	J(+) natives if %RSD > 20%	5A
	Ion Abundance ratios within QC limits (Method 1668, Table 8) in CS1 std.	EcoChem PJ, see TM-05	
	S/N ratio > 10 for all native and labeled compounds in CS1 std.	If <10, elevate Det. Limit or R(-)	
Continuing Calibration	Every 12 hours: Concentrations must meet criteria specified in Method 1668, Table 6	J(+)/(UJ(-) natives if %D = 30% - 50% J(+)/R(-) natives if %D > 75%	5B
	Absolute RT of all Labelled Compounds and Window Defining Congeners must be +/- 15 sec of RT in ICAL RRT of all compounds must meet Table 2 of method.	EcoChem PJ, see ICAL section of TM-05	
	S/N ratio > 10	If <10, elevate Det. Limit or R(-)	
	Ion Abundance ratios must meet criteria specified in Method 1668, Table 8	EcoChem PJ, see TM-05	
Method Blank	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	7

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EcoChem Validation Guidelines for PCB Congener Analysis by HRMS (Based on EPA Reg. 10 SOP, Rev. 1, 12/1995 & EPA SW-846, Method 1668)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Rinse/Field Blank (if required)	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	6
LCS / OPR	One per matrix per batch %R Values w/in limits specified in Method 1668, Table 6	J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) using PJ if %R <<LCL (< 10%)	10
MS/MSD (if required)	Accuracy: %R values within laboratory limits	Qualify parent sample only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
	Precision: RPD < 20%	J(+) in parent sample if RPD > 20%	9
Duplicate (if required)	RPD <25%	J(+)/UJ(-) if outside limts	9
Labeled Compounds / Internal Standards	%R must meet limits specified in Method 1668, Table 6.	J(+)/UJ(-) if %R = 10% to LCL J(+) if %R > UCL J(+)/R(-) if %R < 10%	13
Quantitation/ Identification	Ions for analyte, IS, and rec. std. must max w/in 2 sec. S/N >2.5 Ion abundance (IA ratios) must meet limits stated in Table 8 of Method 1668 Relative retention times (RRT) must be w/in limits stated in Table 2 of Method 1668	If RT criteria not met, use PJ (see TM-05) J(+) if S/N criteria not met if unlabelled ion abundance not met, change to EMPC J(+) if labelled ion abundance not met.	21
Interferences	Lock masses must not deviate +/- 20%	Change result to EMPC	14
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
Two analyses for one sample	Report only one result per analyte	"DNR" results that should not be used to avoid reporting two results for one sample	11

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EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler/Storage Temperature	Waters/Solids < 4°C Tissues <-10°C	EcoChem PJ, see TM-05	1
Holding Time	Extraction - Water: 30 days from collection *Note:* Under CWA, SDWA, and RCRA the HT for H2O is 7 days* Extraction - Soil: 30 days from collection Analysis: 40 days from extraction	J(+)/UJ(-) if ext > 30 days J(+)/UJ(-) if analysis > 40 Days EcoChem PJ, see TM-05	1
Mass Resolution	>=10,000 resolving power at m/z 304.9824 Exact mass of m/z 380.9760 w/in 5 ppm of theoretical value (380.97410 to 380.97790) . Analyzed prior to ICAL and at the start and end of each 12 hr. shift	R(+/-) if not met	14
Window Defining Mix and Column Performance Mix	Window defining mixture/Isomer specificity std run before ICAL and CCAL Valley < 25% (valley = (x/y)*100%) x = ht. of TCDD y = baseline to bottom of valley For all isomers eluting near 2378-TCDD/TCDF isomers (TCDD only for 8290)	J(+) if valley > 25%	5A (ICAL) 5B (CCAL
Initial Calibration	Minimum of five standards %RSD < 20% for native compounds %RSD <30% for labeled compounds (%RSD <35% for labeled compounds under 1613b)	J(+) natives if %RSD > 20%	5A
	Abs. RT of $^{13}C_{12}$-1234-TCDD >25 min on DB5 >15 min on DB-225	EcoChem PJ, see TM-05	
	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	EcoChem PJ, see TM-05	
	S/N ratio > 10 for all native and labeled compounds in CS1 std.	If <10, elevate Det. Limit or R(-)	

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EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Continuing Calibration	Analyzed at the start and end of each 12 hour shift. %D+/-20% for native compounds %D +/-30% for labeled compounds (Must meet limits in Table 6, Method 1613B) (If %Ds in the closing CCAL are w/in 25%/35% the avg RF from the two CCAL may be used to calculate samples per Method 8290, Section 8.3.2.4)	Do not qualify labeled compounds. Narrate in report for labeled compound %D outliers. For native compound %D outliers: 8290: J(+)/UJ(-) if %D = 20% - 75% J(+)/R(-) if %D > 75% 1613: J(+)/UJ(-) if %D is outside Table 6 limits J(+)/R(-) if %D is +/- 75% of Table 6 limit	5B
	Abs. RT of $^{13}C_{12}$-1234-TCDD and $^{13}C12$-123789-HxCDD +/- 15 sec of ICAL.	EcoChem PJ, see ICAL section of TM-05	
	RRT of all other compounds must meet Table 2 of 1613B.	EcoChem PJ, see TM-05	
	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	EcoChem PJ, see TM-05	
	S/N ratio > 10	If <10, elevate Det. Limit or R(-)	
Method Blank	One per matrix per batch No positive results	If sample result <5X action level, qualify U at reported value.	7
Field Blanks (Not Required)	No positive results	If sample result <5X action level, qualify U at reported value.	6
LCS / OPR	Concentrations must meet limits in Table 6, Method 1613B or lab limits.	J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) using PJ if %R <<LCL (< 10%)	10
MS/MSD (recovery)	May not analyze MS/MSD %R should meet lab limits.	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	May not analyze MS/MSD RPD < 20%	J(+) in parent sample if RPD > CL	9

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EcoChem Validation Guidelines for Dioxin/Furan Analysis by HRMS
(Based on EPA Reg. 10 SOP, Rev. 2, 1996 & EPA SW-846, Methods 1613b and 8290)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Lab Duplicate	RPD <25% if present.	J(+)/UJ(-) if outside limts	9
Labeled Compounds / Internal Standards	*Method 8290:* %R = 40% - 135% in all samples *Method 1613B:* %R must meet limits specified in Table 7, Method 1613	J(+)/UJ(-) if %R = 10% to LCL J(+) if %R > UCL J(+)/R(-) if %R < 10%	13
Quantitation/ Identification	Ions for analyte, IS, and rec. std. must max w/in 2 sec. S/N >2.5 IA ratios meet limits in Table 9 of 1613B or Table 8 of 8290 RRTs w/in limits in Table 2 of 1613B	If RT criteria not met, use PJ (see TM-05) If S/N criteria not met, J(+). if unlabelled ion abundance not met, change to EMPC If labelled ion abundance not met, J(+).	21
EMPC (estimated maximum possible concentration)	If quantitation idenfication criteria are not met, laboratory should report an EMPC value.	If laboratory correctly reported an EMPC value, qualify with U to indicate that the value is a detection limit.	14
Interferences	PCDF interferences from PCDPE	If both detected, change PCDF result to EMPC	14
Second Column Confirmation	All 2378-TCDF hits must be confirmed on a DB-225 (or equiv) column. All QC specs in this table must be met for the confirmation analysis.	Report lower of the two values. If not performed use PJ (see TM-05).	3
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
Two analyses for one sample	Report only one result per analyte	"DNR" results that should not be used	11

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EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS (Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature	4°C ±2°	J(+)/UJ(-) if greater than 6 deg. C (EcoChem PJ)	1
Holding Time	Water: 7 days from collection Soil: 14 days from collection Analysis: 40 days from extraction	Water: J(+)/UJ(-) if ext. > 7 and < 21 days J(+)/R(-) if ext > 21 days (EcoChem PJ) Solids/Wastes: J(+)/UJ(-) if ext. > 14 and < 42 days J(+)/R(-) if ext. > 42 days (EcoChem PJ) J(+)/UJ(-) if analysis >40 days	1
Tuning	DFTPP Beginning of each 12 hour period Method acceptance criteria	R(+/-) all analytes in all samples associated with the tune	5A
Initial Calibration (Minimum 5 stds.)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5A
	%RSD < 30%	(EcoChem PJ, see TM-06) J(+) if %RSD > 30%	5A
Continuing Calibration (Prior to each 12 hr. shift)	RRF > 0.05	(EcoChem PJ, see TM-06) If MDL= reporting limit: J(+)/R(-) if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05	5B
	%D <25%	(EcoChem PJ, see TM-06) If > +/-90%: J+/R- If -90% to -26%: J+ (high bias) If 26% to 90%: J+/UJ- (low bias)	5B
Method Blank	One per matrix per batch No results > CRQL	U(+) if sample (+) result is less than CRQL and less than appropriate 5X or 10X rule (raise sample value to CRQL)	7
		U(+) if sample (+) result is greater than or equal to CRQL and less than appropriate 5X and 10X rule (at reported sample value)	7
	No TICs present	R(+) TICs using 10X rule	7
Field Blanks (Not Required)	No results > CRQL	Apply 5X/10X rule; U(+) < action level	6

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EcoChem Validation Guidelines for Semivolatile Analysis by GC/MS (Based on Organic NFG 1999)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
MS/MSD (recovery)	One per matrix per batch Use method acceptance criteria	Qualify parent only unless other QC indicates systematic problems: J(+) if both %R > UCL J(+)/UJ(-) if both %R < LCL J(+)/R(-) if both %R < 10% PJ if only one %R outlier	8
MS/MSD (RPD)	One per matrix per batch Use method acceptance criteria	J(+) in parent sample if RPD > CL	9
LCS low conc. H2O SVOA	One per lab batch Within method control limits	J(+) assoc. cmpd if > UCL J(+)/R(-) assoc. cmpd if < LCL J(+)/R(-) all cmpds if half are < LCL	10
LCS regular SVOA (H2O & solid)	One per lab batch Lab or method control limits	J(+) if %R > UCL J(+)/UJ(-) if %R <LCL J(+)/R(-) if %R < 10% (EcoChem PJ)	10
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J(+)/UJ(-) assoc. cmpd. in all samples	9
Surrogates	Minimum of 3 acid and 3 base/neutral compounds Use method acceptance criteria	Do not qualify if only 1 acid and/or 1 B/N surrogate is out unless <10% J(+) if %R > UCL J(+)/UJ(-) if %R < LCL J(+)/R(-) if %R < 10%	13
Internal Standards	Added to all samples Acceptable Range: IS area 50% to 200% of CCAL area RT within 30 seconds of CC RT	J(+) if > 200% J(+)/UJ(-) if < 50% J(+)/R(-) if < 25% RT>30 seconds, narrate and Notify PM	19
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (EcoChem PJ)	9
TICs	Major ions (>10%) in reference must be present in sample; intensities agree within 20%; check identification	NJ the TIC unless: R(+) common laboratory contaminants See Technical Director for ID issues	4
Quantitation/ Identification	RRT within 0.06 of standard RRT Ion relative intensity within 20% of standard All ions in std. at > 10% intensity must be present in sample	See Technical Director if outliers	14 21 (false +)

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EcoChem Validation Guidelines for Metals Analysis by ICP-MS (Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler temperature: 4°C ±2° Waters: Nitric Acid to pH < 2 For Dissolved Metals: 0.45um filter & preserve after filtration	EcoChem Professional Judgment - no qualification based on cooler temperature outliers J(+)/UJ(-) if pH preservation requirements are not met	1
Holding Time	180 days from date sampled Frozen tissues - HT extended to 2 years	J(+)/UJ(-) if holding time exceeded	1
Tune	Prior to ICAL monitoring compounds analyzed 5 times wih Std Dev. ≤ 5% mass calibration <0.1 amu from True Value Resolution < 0.9 AMU @ 10% peak height or <0.75 amu @ 5% peak height	Use Professional Judgment to evaluate tune J(+)/UJ(-) if tune criteria not met	5A
Initial Calibration	Blank + minimum 1 standard If more than 1 standard, r>0.995	J(+)/UJ(-) if r<0.995 (for multi point cal)	5A
Initial Calibration Verification (ICV)	Independent source analyzed immediately after calibration %R within ±10% of true value	J(+)/UJ(-) if %R 75-89% J(+) if %R = 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5A
Continuing Calibration Verification (CCV)	Every ten samples, immediately following ICV/ICB and at end of run ±10% of true value	J(+)/UJ(-) if %R = 75-89% J(+) if %R 111-125% R(+) if %R > 125% R(+/-) if %R < 75%	5B

Initial and Continuing Calibration Blanks (ICB/CCB)	After each ICV and CCV
	every ten samples and end of run
	| blank | < IDL (MDL)
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Reporting Limit Standard (CRI)	2x RL analyzed beginning of run Not required for Al, Ba, Ca, Fe, Mg, Na, K %R = 70%-130% (50%-150% Co,Mn, Zn)	R(-),(+) < 2x RL if %R < 50% (< 30% Co,Mn, Zn) J(+) < 2x RL, UJ(-) if %R 50-69% (30%-49% Co,Mn, Zn) J(+) < 2x RL if %R 130%-180% (150%-200% Co,Mn, Zn) R(+) < 2x RL if %R > 180% (200% Co, Mn, Zn)	14
Interference Check Samples (ICSA/ICSAB)	Required by SW 6020, but not 200.8 ICSAB %R 80% - 120% for all spiked elements | ICSA | < IDL (MDL) for all unspiked elements	For samples with Al, Ca, Fe, or Mg > ICS levels R(+/-) if %R < 50% J(+) if %R >120% J(+)/UJ(-) if %R = 50% to 79% Use Professional Judgment for ICSA to determine if bias is present see TM-09 for additional details	17
Method Blank	One per matrix per batch (batch not to exceed 20 samples) blank < MDL	Action level is 5x blank concentration U(+) results < action level	7

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EcoChem Validation Guidelines for Metals Analysis by ICP-MS
(Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Laboratory Control Sample (LCS)	One per matrix per batch Blank Spike: %R within 80%-120%	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	10
	CRM: Result within manufacturer's certified acceptance range or project guidelines	J(+)/UJ(-) if < LCL, J(+) if > UCL	
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	One per matrix per batch 75-125% for samples where results do not exceed 4x spike level	J(+) if %R>125% J(+)/UJ(-) if %R <75% J(+)/R(-) if %R<30% or J(+)/UJ(-) if Post Spike %R 75%-125% Qualify all samples in batch	8
Post-digestion Spike	If Matrix Spike is outside 75-125%, Spike parent sample at 2x the sample conc.	No qualifiers assigned based on this element	
Laboratory Duplicate (or MS/MSD)	One per matrix per batch RPD < 20% for samples > 5x RL Diff < RL for samples > RL and < 5 x RL (Diff < 2x RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9
Serial Dilution	5x dilution one per matrix %D < 10% for original sample values > 50x MDL	J(+)/UJ(-) if %D >10% All samples in batch	16
Internal Standards	Every sample SW6020: 60%-125% of cal blank IS 200.8: 30%-120% of cal blank IS	J (+)/UJ (-) all analytes associated with IS outlier	19
Field Blank	Blank < MDL	Action level is 5x blank conc. U(+) sample values < AL in associated field samples only	6
Field Duplicate	For results > 5x RL: Water: RPD < 35% Solid: RPD < 50% For results < 5 x RL: Water: Diff < RL Solid: Diff < 2x RL	J(+)/UJ(-) in parent samples only	9
Linear Range	Sample concentrations must fall within range	J values over range	20

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EcoChem Validation Guidelines for Mercury Analysis by CVAA (Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler temperature: 4°C ±2° Waters: Nitric Acid to pH < 2 For Dissolved Metals: 0.45um filter & preserve after filtration	EcoChem Professional Judgment - no qualification based on cooler temperature outliers J(+)/UJ(-) if pH preservation requirements are not met	1
Holding Time	28 days from date sampled Frozen tissues: HT extended to 6 months	J(+)/UJ(-) if holding time exceeded	1
Initial Calibration	Blank + 4 standards, one at RL r > 0.995	J(+)/UJ(-) if r<0.995	5A
Initial Calibration Verification (ICV)	Independent source analyzed immediately after calibration %R within ±20% of true value	J(+)/UJ(-) if %R = 65%-79% J(+) if %R = 121-135% R(+/-) if %R < 65% R(+) if %R > 135%	5A
Continuing Calibration Verification (CCV)	Every ten samples, immediately following ICV/ICB and at end of run %R within ±20% of true value	J(+)/UJ(-) if %R = 65%-79% J(+) if %R = 121-135% R(+/-) if %R < 65% R(+) if %R > 135%	5B

Initial and Continuing Calibration Blanks (ICB/CCB)	after each ICV and CCV
	every ten samples and end of run
	| blank | < IDL (MDL)
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Reporting Limit Standard (CRA)	conc at RL - analyzed beginning of run %R = 70-130%	R(-),(+)<2xRL if %R <50% J(+)<2x RL, UJ(-) if %R 50-69% J(+) <2x RL if %R 130-180% R(+)<2x RL if %R>180%	14
Method Blank	One per matrix per batch (batch not to exceed 20 samples) blank < MDL	Action level is 5x blank concentration U(+) results < action level	7
Laboratory Control Sample (LCS)	One per matrix per batch		10
	Blank Spike: %R within 80-120%	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	
	CRM: Result within manufacturer's certified acceptance range or project guidelines	J(+)/UJ(-) if < LCL, J(+) if > UCL	
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One per matrix per batch 5% frequency 75-125% for samples less than 4x spike level	J(+) if %R>125% J(+)/UJ(-) if %R <75% J(+)/R(-) if %R<30% all samples in batch	8
Laboratory Duplicate (or MS/MSD)	One per matrix per batch RPD < 20% for samples > 5x RL Diff < RL for samples > RL and < 5x RL (Diff < 2x RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9

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EcoChem Validation Guidelines for Mercury Analysis by CVAA (Based on Inorganic NFG 1994 & 2004)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Field Blank	Blank < MDL	Action level is 5x blank conc. U(+) sample values < action level in associated field samples only	6
Field Duplicate	For results > 5x RL: Water: RPD < 35% Solid: RPD < 50% For results < 5x RL: Water: Diff<RL Solid: Diff < 2x RL	J(+)/UJ(-) in parent samples only	9
Linear Range	Sample concentrations must be less than 110% of high standard	J values over range	20

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EcoChem Validation Guidelines for Conventional Chemistry Analysis (Based on EPA Standard Methods)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Cooler Temperature and Preservation	Cooler Temperature 4°C ±2°C Preservation: Method Specific	Use Professional Judgment to qualify based to qualify for coole temp outliers J(+)/UJ(-) if preservation requirements not met	1
Holding Time	Method Specific	Professional Judgment J(+)/UJ(-) if holding time exceeded J(+)/R(-) if HT exceeded by > 3X	1
Initial Calibration	Method specific r>0.995	Use professional judgment J(+)/UJ(-) for r < 0.995	5A
Initial Calibration Verification (ICV)	Where applicable to method Independent source analyzed immediately after calibration %R method specific, usually 90% - 110%	R(+/-) if %R significantly < LCL J(+)/UJ(-) if %R < LCL J(+) if %R > UCL R(+) if %R significantly > UCL	5A
Continuing Cal Verification (CCV)	Where applicable to method Every ten samples, immed. following ICV/ICB and end of run %R method specific, usually 90% - 110%	R(+/-) if %R significantly < LCL J(+)/UJ(-) if %R < LCL J(+) if %R > UCL R(+) if %R significantly > UCL	5B

Initial and Continuing Cal Blanks (ICB/CCB)	Where applicable to method
	After each ICV and CCV every ten samples and end of run
	| blank| < MDL
		Action level is 5x absolute value of blank conc.
		For (+) blanks, U(+) results < action level
		For (-) blanks, J(+)/UJ(-) results < action level
		refer to TM-02 for additional details
			7

Method Blank	One per matrix per batch
	(not to exceed 20 samples)
	blank < MDL
		Action level is 5x absolute value of blank conc.
		For (+) blk value, U(+) results < action level
		For (-) blk value, J(+)/UJ(-) results < action level
			7

Laboratory Control Sample	Waters: One per matrix per batch %R (80-120%)	R(+/-) if %R < 50% J(+)/UJ(-) if %R = 50-79% J(+) if %R >120%	10
	Soils: One per matrix per batch Result within manufacturer's certified acceptance range	J(+)/UJ(-) if < LCL, J(+) if > UCL	10
Matrix Spike	One per matrix per batch; 5% frequency 75-125% for samples less than 4 x spike level	J(+) if %R > 125% or < 75% UJ(-) if %R = 30-74% R(+/-) results < IDL if %R < 30%	8
Laboratory Duplicate	One per matrix per batch RPD <20% for samples > 5x RL Diff <RL for samples >RL and <5 x RL (may use RPD < 35%, Diff < 2X RL for solids)	J(+)/UJ(-) if RPD > 20% or diff > RL all samples in batch	9

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EcoChem Validation Guidelines for Conventional Chemistry Analysis (Based on EPA Standard Methods)

VALIDATION QC ELEMENT	ACCEPTANCE CRITERIA	ACTION	REASON CODE
Field Blank	blank < MDL	Action level is 5x blank conc. U(+) sample values < action level in associated field samples only	6
Field Duplicate	For results > 5X RL: Water: RPD < 35% Solid: RPD < 50% For results < 5 x RL: Water: Diff<RL Solid: Diff < 2X RL	J(+)/UJ(-) in parent samples only	9

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ECOCHEM
Data Quality

APPENDIX B

QUALIFIED DATA SUMMARY TABLE

Qualified Data Summary Table
Western Port Angeles Harbor RI/FS

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Flag	Validation Qualifier	Validation Reason
K1409547	SD0057	K1409547-007	8270D SIM	Chrysene	4.7	ug/Kg	=, X	J	23H
K1409547	SD0057	K1409547-007	8270D	Pentachlorophenol	ND	ug/Kg	ND	UJ	5BL
K1409547	SD0057	K1409547-007	8270D	Benzoic Acid	ND	ug/Kg	ND	R	10L
K1409547	SD0058	K1409547-008	8270D	Pentachlorophenol	ND	ug/Kg	ND	UJ	5BL
K1409547	SD0058	K1409547-008	8270D	Benzoic Acid	ND	ug/Kg	ND	R	10L
K1409547	SD0059	K1409547-009	8270D	Pentachlorophenol	ND	ug/Kg	ND	UJ	5BL
K1409547	SD0059	K1409547-009	8270D	Benzoic Acid	ND	ug/Kg	ND	R	10L
WG48611	SD0057	L21992-1	EPA 1668A	3,4-DiCB	1.96	pg/g	C K	U	25
WG48611	SD0057	L21992-1	EPA 1668A	3,3',4,4',5,5'-HxCB	0.0908	pg/g	U G	UJ	24
WG48611	SD0057	L21992-1	EPA 1668A	2,2',3,5,6,6'-HxCB	0.079	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,3',4,5,5'-PeCB	0.13	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,3,3',5,5'-PeCB	0.048	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,2',3,6,6'-PeCB	0.342	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,2',3,4,6'-PeCB	0.585	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,2',3,4',5,6,6'-HpCB	0.048	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	3,3',5-TriCB	0.066	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,3,3',4',5,5'-HxCB	0.233	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,3-DiCB	0.164	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1613B	2,3,4,6,7,8-HXCDF	0.095	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1613B	1,2,3,6,7,8-HXCDF	0.128	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1613B	1,2,3,4,7,8-HXCDF	0.158	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1613B	2,3,7,8-TCDF	0.181	pg/g	J	DNR	11
WG48611	SD0057	L21992-1	EPA 1613B	2,3,7,8-TCDD	0.1	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	3,4,4',5-TeCB	0.103	pg/g	K J	U	25
WG48611	SD0057	L21992-1	EPA 1668A	2,2',3,4',5,6'-HxCB	0.139	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	3,4',5-TriCB	0.169	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	2,3,7,8-TCDF	0.196	pg/g	J	DNR	11
WG48611	SD0058	L21992-2	EPA 1613B	1,2,3,4,7,8-HXCDD	0.145	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	1,2,3,4,7,8-HXCDF	0.161	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,2',3,3',4,5,5',6-OcCB	8.75	pg/g	C K D J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	1,2,3,6,7,8-HXCDF	0.141	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	2,3,4,7,8-PECDF	0.078	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	1,2,3,4,7,8,9-HPCDF	0.243	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,5-DiCB	0.365	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,2',6,6'-TeCB	0.049	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,3',4,5'-TeCB	0.182	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	3,4,4',5-TeCB	0.087	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,3',4,5,5'-PeCB	0.12	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,2',3,4',6,6'-HxCB	0.311	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,3,3',4,4',5',6-HpCB	0.61	pg/g	K J	U	25
WG48611	SD0058	L21992-2	EPA 1668A	2,2',3,3',4,4',6,6'-OcCB	1.51	pg/g	C K D J	U	25
WG48611	SD0058	L21992-2	EPA 1613B	2,3,4,6,7,8-HXCDF	0.099	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',3,4',5,6'-HxCB	0.135	pg/g	K J	U	25

Qualified Data Summary Table
Western Port Angeles Harbor RI/FS

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Flag	Validation Qualifier	Validation Reason
WG48611	SD0059	L21992-10	EPA 1613B	2,3,7,8-TCDD	0.088	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3,3',4,5,5'-HxCB	0.229	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',3,3',5,5'-HxCB	0.317	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3,3',4',5,5'-HxCB	0.054	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3,3',4,4',5',6-HpCB	0.235	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',4,4',6,6'-HxCB	0.069	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1613B	2,3,7,8-TCDF	0.118	pg/g	J	DNR	11
WG48611	SD0059	L21992-10	EPA 1613B	2,3,4,7,8-PECDF	0.072	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1613B	1,2,3,4,7,8-HXCDF	0.066	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',3,4,4',5-HxCB	0.787	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3',4,5,5'-PeCB	0.257	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3,3',5,5'-PeCB	0.057	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',3,5,6'-PeCB	0.082	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	3,3',4,5'-TeCB	0.182	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,3,3',5-TeCB	0.29	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	3,4,5-TriCB	0.285	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	3,3',5-TriCB	0.049	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	2,2',3,3',4,4',6,6'-OcCB	0.795	pg/g	C K D J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	4,4'-DiCB	0.698	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1668A	3,5-DiCB	0.288	pg/g	K J	U	25
WG48611	SD0059	L21992-10	EPA 1613B	1,2,3,4,7,8,9-HPCDF	0.13	pg/g	K J	U	25

Appendix E
Source Control Evaluation

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
Agreed Order	Agreed Order No. DE9781
BMP	Best management practice
City	City of Port Angeles
COC	Contaminant of concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSO	Combined sewer overflow
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
Harbor	Port Angeles Harbor
IHS	Indicator Hazardous Substance
µg/kg	Micrograms per kilogram
MS4	Municipal separate storm sewer system
MTA	Marine Trades Area
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
Port	Port of Port Angeles
RAL	Remedial action level
RI/FS	Remedial Investigation/Feasibility Study
SCU	Sediment Cleanup Unit
TEQ	Toxic equivalent
USCG	U.S. Coast Guard
WPAH Group	Western Port Angeles Harbor Group
Work Plan	RI/FS Work Plan

1.0 Introduction

Port Angeles Harbor (Harbor) in Port Angeles, Washington, has been identified as a priority environmental cleanup and restoration project by the Washington State Department of Ecology (Ecology) as part of the Puget Sound Initiative. Under Agreed Order No. DE9781 (Agreed Order) effective May 28, 2013, the Western Port Angeles Harbor Group (WPAH Group) agreed to perform a remedial investigation/feasibility study (RI/FS) of Western Port Angeles Harbor. The Western Port Angeles Harbor RI/FS Work Plan (WPAH Group 2013) is Exhibit B to the Agreed Order, and describes data gaps and data collection required to complete the RI/FS.

As described in the RI/FS Work Plan (WPAH Group 2013), an objective of the RI/FS is to identify ongoing sources that have the potential to result in sediment recontamination at levels greater than remedial action levels (RALs) developed in the RI/FS. Adequate source controls to prevent or reduce potential recontamination should be in place prior to implementation of a final sediment remedial action for the Sediment Cleanup Unit (SCU).

Historically, the SCU has received hazardous substance releases from a variety of sources since commercial/industrial operations began, including: upland, in-water, and overwater operations; spills; leaks; discharges of stormwater, sewage, and wastewater; nearshore burning; and direct discharges. Historical releases were of greater magnitude than ongoing sources, as evidenced by the greater chemical concentrations in deeper subsurface sediments in areas of the SCU (refer to Figure 7.37 of the RI/FS). With increased regulation and changes to industrial uses in the Port Angeles community, many of these types of historical releases no longer occur.

As described in the RI/FS Work Plan (WPAH Group 2013), if surface sediments exceed cleanup levels or RALs developed in the RI/FS process, pathways to that area will be considered. As discussed in more detail in the RI/FS (Sections 8.6 and 11.2), areas exceeding RALs for bioaccumulative indicator hazardous substances (IHSs) identified within the SCU (i.e., dioxin/furan toxic equivalent [TEQ], carcinogenic polycyclic aromatic hydrocarbon [cPAH] TEQ, and mercury) are depicted in Figure E.1. Potential contaminant transport pathways to these areas that were considered in the RI/FS include migration from upland activities, nearshore bank soil erosion, discharges from overwater operations, spills, stormwater, creek drainage of surface soils, atmospheric deposition, and other discharges, including from National Pollutant Discharge Elimination System (NPDES) permitted outfalls. Per the Work Plan, and based on the relatively broad spatial extent of surface sediments exceeding the cPAH TEQ RAL developed in the RI/FS, creosote-treated pilings placed historically in the SCU are included as a potential source control issue, as discussed further in Section 2.5.

As per the RI/FS Work Plan (WPAH Group 2013), categories of historical and ongoing sources were identified, and the data quality objective process described in Section 4.0 of the RI/FS was used to focus the source evaluation for the RI/FS. This appendix summarizes the evaluation of ongoing sources of hazardous substances to sediments, consistent with the RI/FS Work Plan (refer to Section 4.3.4 of the RI/FS).

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2.0 Potential Ongoing WPAH Sediment Cleanup Unit Inputs

2.1 DIRECT STORMWATER DISCHARGE AND SURFACE RUNOFF

2.1.1 NPDES Permitted Discharges

There are currently four parties (City of Port Angeles [City], Port of Port Angeles [Port], Westport Shipyard Inc., and Platypus Marine Inc.) that discharge stormwater to the Harbor through NPDES-permitted conveyance systems. These four parties hold six permits in total for discharges to the SCU. Table E.1 presents the facilities, permit numbers and types, and stormwater analyses required for each of these permits.

2.1.1.1 Port, Westport Shipyard Inc., and Platypus Marine Inc. Permitted Discharges

The Port holds two permits, one that covers their industrial areas and one for their boatyard area. Westport Shipyard Inc. and Platypus Marine Inc. each hold a permit for their facilities.

Table E.2 provides the stormwater data for Platypus Marine Inc., Port, and Westport Shipyard Inc. collected from 2015 to October 2017, available on Ecology's Permit and Reporting Information System (PARIS). Data are limited to metals (copper, lead, zinc), chemical oxygen demand, turbidity, total suspended solids, and pH, with the data required to be collected varying between permits. There are no data available for the human health IHSs. For Platypus Marine Inc., exceedances of copper and zinc benchmarks were measured in 14 and 11 of 17 sampling events, respectively. For the Port, stormwater samples collected from the industrial areas regularly exceed benchmarks for chemical oxygen demand and copper (5 of 7 sampling events), suspended solids (2 of 7 sampling events), and turbidity (all 7 events). For the Port's boatyard area, two samples were collected in 2015; and one exceedance of the zinc benchmark was measured. Finally, for Westport Shipyard, Inc., benchmark exceedances of turbidity and copper have been measured in 2 and 3 of 11 sampling events, respectively.

Additionally, the Port collected one catch basin solids grab sample in September 2016 from their Terminal 7 log yard outfall. Chemical data collected included polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), metals, and total petroleum hydrocarbons and are presented in Table E.3. The cPAH TEQ concentration reported in the storm solids sample was 33 micrograms per kilogram (µg/kg) and the reported mercury concentration (0.13 milligrams per kilogram [mg/kg]) were less than the RALs used for cPAH TEQ and mercury in the RI/FS, and the cPAH TEQ is also less than the regional background level of 64 µg/kg. The mercury value in the storm solids sample is equal to the total mercury sediment regional background level.

2.1.1.2 City of Port Angeles Permitted Discharges

The City holds two permits relevant to the source control evaluation (Table E.1). The City is covered under the Western Washington Phase II Municipal Stormwater Permit (No. WAR045028) governing discharges from its small municipal separate storm sewer system (MS4) Phase II

Permit. This permit has been administratively extended until August 1, 2019. A separate permit (No. WA0023973) governs discharges associated with the City's wastewater treatment plant outfall, which is located outside of the SCU. This permit also covers potential discharges from four combined sewer overflow (CSO) outfalls.

As described in Section 3.3.2.1 of the RI/FS, to address overflow events, the City has implemented a $46 million CSO reduction program approved by Ecology. Four CSOs remain in the combined system (CSOs-6, -7, -8, and -10). However, only three CSOs are located inside the SCU; CSO-10 is outside of the SCU. CSO-6 and CSO-8 are considered active but controlled, where CSO-6 is mechanically plugged and may be permanently plugged in the near future if it is determined that it is not needed. CSO-7 is still active, yet overflow discharge events are not to exceed more than one event per year

CSO-6 and CSO-7 are in the vicinity of a cPAH TEQ sediment footprint near Terminal 2 (the Black Ball Ferry Terminal) and City Pier. CSO-8 discharges into Peabody Creek. The City's CSO discharges are not to exceed more than one discharge event per year per outfall. Based on the City's modeling of the sewer infrastructure at the completion of the CSO reduction project, overflows are unlikely to occur during events smaller than a 100-year storm. Since September 2016, when Pump Station No. 4 came into operation, the City has had no CSO discharges (Bender 2018).

The City's population is approximately 19,000, which is substantially smaller than the statutory population requirement of 50,000 for a municipality to have an MS4 permit. However, Ecology required that, as the largest municipality on the Olympic Peninsula, the City operate under an MS4 Phase II Permit. Under the MS4 Phase II Permit, the City follows a Stormwater Management Program that is revised annually (City of Port Angeles 2017). This plan addresses public education and involvement, illicit discharge detection and elimination, control of runoff from development or redevelopment, and pollution prevention/good housekeeping. The City is not required to sample individual stormwater outfalls or perform chemical testing under its MS4 Phase II permit.

2.1.2 Other Non-MS4 and Unpermitted Discharges

Diffuse, non-point sources of contaminants in stormwater continuously enter the environment, and in many cases cannot be controlled or eliminated in any practicable or timely manner. Ecology has identified surface runoff, broadly defined to include stormwater and non-point source overland flow to surface waters, as the most significant ongoing upland contributor of contaminants to Puget Sound (Herrera 2011).

Since 2007, Ecology has conducted phased studies to quantify surface runoff loading rates to Puget Sound. The most recent study, the Phase 3 study (Herrera 2011), refined estimates of contaminant loading contributions to Puget Sound via surface runoff by monitoring contaminant concentrations and discharge from four land use categories, including commercial/industrial, residential, agricultural, and forest/field/other (Herrera 2011). This study found that diffuse watershed sources contain a number of chemicals that have the potential to cause recontamination, which includes some SCU benthic and bioaccumulative IHSs (mercury, zinc, and

PAHs). In Ecology's Puget Sound-wide study, surface runoff from commercial/industrial areas, similar to the commercial and industrial areas directly surrounding the Harbor, contained greater concentrations of contaminants than other land uses.

2.1.3 Atmospheric Deposition

Atmospheric deposition from industrial and urban areas is a recognized pathway of contamination for ubiquitous chemicals such as metals, PCBs, dioxins/furans, and PAHs (Larson et al. 1997, ESA 2000, Landis and Keeler 2002, Rolfhus et al. 2003, Kuang et al. 2003, USGS 2005, Urbaniak 2007, Brandenberger et al. 2010, Zhang et al. 2013, Amodio et al. 2014, Brzuzy and Hites 1996). The impact of atmospheric deposition can be challenging to ascertain. Types and volumes of pollutants deposited from the atmosphere will vary depending on atmospheric conditions (e.g., wind speed, temperature, and rainfall) and particle characteristics (size and shape). If atmospheric deposition occurs on land, it contributes to the quality of surface water runoff as per the discussion above, but it can also occur directly on the water surface and functions as a direct discharge to the waterbody.

Though impacts of atmospheric deposition directly to surface water may be small relative to other recontamination sources, they are not insignificant. Air deposition to impervious surfaces can contribute contaminants to stormwater discharges. Studies of atmospheric deposition in Washington State have generally concluded that atmospheric deposition may account for up to 5 percent of any particular chemical in sediment that is well outside of the influence of urbanized areas (Brandenberger et al. 2010). While increasing requirements on emission controls will slowly decrease the impacts of atmospheric deposition, this pathway will continue and represents a lower-level, but constant, input to the SCU.

2.1.4 Creeks

Three creeks, Tumwater, Valley, and Peabody Creeks, drain from the mountains to the south, through the City, and into the SCU. Tumwater and Valley Creeks generally drain into areas with limited exceedances of the RALs. Peabody Creek drains into an area near surface sediment cPAH TEQ exceedances. Many of the City's stormwater outfalls discharge into the creeks, as opposed to directly into the Harbor. The creeks drain forested, undeveloped land upstream of the City limits, and City stormwater mixes with creek drainage prior to creek discharge to the Harbor. The City's Stormwater Management Program identifies Peabody Creek, Tumwater Creek, and Valley Creek as impacted waterbodies based on 303(d) listings. Peabody Creek is Category 5-listed for bioassessment (benthic toxicity), bacteria, temperature, and turbidity, and Tumwater Creek and Valley Creek are both Category 5-listed for bacteria only.

As part of MS4 monitoring, the City has performed visual inspections of the creeks and has taken measurements of physical parameters (temperature and turbidity) and fecal coliform counts. Monitoring data collection is routinely performed by Stream Keepers of Clallam County through an Inter Local Agreement with the City. Monitoring includes several points along Peabody, Valley, and Tumwater Creeks, and within Port Angeles Harbor at the mouth of Peabody Creek and

Hollywood Beach. The most recent data available are from 2017. While these data are relevant to the 303(d) listing for Peabody and Tumwater Creeks, they are not relevant to surface sediment conditions within the SCU and, therefore, are not presented here.

2.2 CONTAMINATED SITES

As discussed in Section 3.4.5.5 of the RI/FS, there are currently two Model Toxics Control Act (MTCA) cleanup sites located along the shoreline in the SCU that are under Agreed Orders with Ecology: the Marine Trades Area (MTA) and the K Ply Site. For the MTA, the final RI/FS was approved in August 2013, and the Cleanup Action Plan is currently being developed. In 2016, the Port completed extensive soil removal as part of the remediation of the K Ply Site under Agreed Order No. DE 11302. Bioremediation polishing and confirmation groundwater monitoring are currently being conducted. Because the remediation at the K Ply Site is generally complete, it is not considered to pose a potential recontamination risk to the SCU.

In addition to MTA and the K Ply Site, a number of shoreline sites located within the SCU are listed on Ecology's confirmed and suspected contaminated sites list (Ecology 2017b). These sites are awaiting cleanup, reported as being cleaned up, or do not require further action. Contaminants of concern (COCs) at these sites are primarily petroleum hydrocarbons and metals, with more limited occurrences of PAHs and phenolic compounds. Table E.4 presents the shoreline sites located on the SCU shoreline, their current status with Ecology, and the associated COCs.

2.3 OVERWATER OPERATIONS, UPLAND ACTIVITIES, AND DIRECT DISCHARGES

The majority of overwater structures in the SCU have ongoing activities. This includes Port Marine Terminals 1, 2, 3, 4, and 7, the City Pier, and the McKinley-owned pier leased to Tesoro (Figure 3.9 of the RI/FS). The most prevalent overwater- or in-water-operation is wood handling by the Port. These wood handling areas include an area east of the Port's Boat Haven marina, an area off of Terminal 7 where transloading of logs occurs (i.e., placement into or retrieval of logs from the water), and an area east/northeast of the Tesoro-leased pier. All of these areas are addressed by the Port's Port Management Area (PMA) or Washington State Department of Natural Resources (DNR) lease agreements (Figure 3.8 of the RI/FS), which include specific best management practices (BMPs) for log storage, including loading logs into the water via log loader and ramp without tumbling or free rolling of the logs, transporting logs via barge when feasible, cleanup and upland disposal of any debris that accumulates, and protection of upland catch basins with ecology blocks and geotextile fabric. Nevertheless, sediments in these areas are anticipated to receive ongoing, relatively low-level (compared to historical practices) wood debris releases.

2.4 NEARSHORE BANK SOILS EROSION

Subsequent to development of the Work Plan, the WPAH Group discussed with Ecology the need for a shoreline survey to evaluate areas of potential nearshore bank soil erosion. The survey's

objective was to document conditions of the shoreline and identify areas potentially subject to soil erosion.

A shoreline photographic survey was performed on February 5 and 6, 2014. During the survey, all banks accessible by foot were observed during low water conditions to determine the presence/absence of riprap, bulkheads, exposed soils, and outfalls. Due to high winds, the shoreline could not be observed from a boat. Figure E.2 presents the shoreline survey extent and the locations of all photographs that were taken. These photographs are presented and described in Attachment E.1. Since the time of the survey, the Lower Elwha Klallam Tribe is known to have conducted additional restoration work on the upper shore and shoreline along Ediz Hook, and the City of Port Angeles constructed pocket beaches at the mouth of Valley Creek. Photographs collected during this shoreline survey are not representative of current conditions in these areas; however, these areas were not identified as areas of potential contamination sources or pathways to sediment.

During the survey, a variety of shoreline conditions were identified. Shoreline conditions ranged from natural shoreline along Ediz Hook and in the lagoon to hardened surfaces, such as riprap and bulkheads, throughout industrial areas. Shoreline conditions observed during the survey are identified in Figure E.3.

During the shoreline survey, areas of the SCU with the potential for bank erosion were noted, including relatively steep slopes and banks where erosion was observed. These areas are generally exposed, non-vegetated soil that are not constrained or restricted by rocks, riprap, or other structures. These are identified with letters in Figure E.4 with corresponding descriptions and photographs of these areas in Table E.5. Many of these areas may not be significantly impacted by contaminants and may not be a potential recontamination source to sediments. Certain areas that are located adjacent to possible historical upland waste handling areas may be a concern that should be evaluated further if located adjacent to nearshore sediments exceeding RALs (Figure E.1) or if they consist of fill material from potentially contaminated sources. For example, portions of potentially erodible shorelines near the lagoon and potentially erodible shorelines at Terminal 6 are located near possible historical waste handling areas; sediments offshore of these shorelines also contain dioxin/furan TEQ, cPAH TEQ, and/or mercury concentrations that exceed RALs. It may be appropriate to evaluate bank stabilization in these areas in conjunction with sediment remediation alternatives. Other potentially erodible shoreline areas with possible contaminant impacts will be further considered by Ecology, as appropriate, outside of the Agreed Order. Remaining shoreline areas of potential concern for erodible soil are generally small and not immediately adjacent to a sediment area targeted in the RI/FS for remediation.

2.5 CREOSOTE PILING

The presence of creosote pilings throughout the SCU is of concern relative to PAH recontamination, and is intended to be addressed at a future time by various entities, including

private entities, the Port, the City, and DNR. Figure E.3 identifies the locations of overwater structures and pilings in the SCU. Historically, timber structures were treated with creosote. However, some timber features identified on Figure E.3 are treated with other preservative materials, such as ammoniacal copper zinc arsenate (ACZA).

The Port anticipates continued pile removal and replacement as part of in-water structure rehabilitation and maintenance activities, which are described in the Port's Final Mitigation Plan submitted to the U.S. Army Corps of Engineers in 2015 (BergerABAM 2015). This programmatic pile replacement is conducted in the confines of the Port capital budget and per local, state, and federal in-water permit BMPs. Figure E.3 identifies Port structures, such as Terminal 3, where wood pilings are not currently used.

The City of Port Angeles Master Program (City of Port Angeles 2014) prohibits the use of creosote on new shoreline structures. Over the past few decades, the City has been removing hundreds of creosote-treated timbers and piles from the former railroad trestle and dock structures (e.g., at City Pier in 1994 and 2005 [Johnson Coastline Associates 1994; WDFW 2005]) throughout a three block area of downtown Port Angeles from North Laurel Street to the Valley Creek Estuary. The City also removed a historical overwater structure at the end of North Oak Street (just east of Terminal 4) and several piles under and near this structure. These removal efforts, which removed at least several hundred tons of creosote-treated timber and piles, have all been accomplished in conjunction with other development, maintenance, or repair projects undertaken by the City in the Harbor. The City anticipates continued pile removal and replacement as part of future in-water and nearshore projects, repair, and maintenance activities. Removal of creosote-treated pilings is limited by the funds available in the City's capital budget and by local, state, and federal in-water permitting practices.

DNR leads a program to remove derelict, creosote-treated piles throughout Puget Sound (DNR 2017). The program was created in 2004 to "help fund public and private community restoration projects that remove creosote-treated debris and pilings on or adjacent to state-owned aquatic lands" (DNR 2014). Under this program, DNR has already completed two creosote-treated wood removal projects in the Harbor. In 2007, 8.85 tons of creosote-treated wood were removed from the U.S. Coast Guard (USCG) facility on Ediz Hook in coordination with USCG volunteers, and, in 2008, DNR removed the overwater portion of a former log dump on Ediz Hook, including an A-frame structure and creosote-treated pilings comprising 508 tons of material (USCG ND, NW Treaty Tribes 2012). Through this program, remaining derelict piles in the Harbor are expected to be targeted for removal at a future time as part of overall Puget Sound source control efforts.

3.0 Next Steps for Ecology

As described in the RI/FS Work Plan (WPAH Group 2013), appropriate follow-up source control actions will be determined by Ecology. Generally, stormwater inputs will continue. Selected municipal and industrial stormwater discharges are subject to NPDES permitting oversight. Low-level inputs will undoubtedly continue, such as from atmospheric deposition and surface water runoff. Ongoing industrial and maritime operations will also continue, including wood handling. Creosote-treated piling removal is addressed by other regulatory programs, and the Port and City have specific planning documents relevant to these removals. New creosote-treated piling placement is prohibited by the City. Areas of potential shoreline soil erosion have been identified; however, there are no data available documenting chemical concentrations of these shoreline soils.

Potential sources of most concern, due to their proximity to surface sediments that exceed RALs, include potentially erodible shoreline areas identified within the lagoon and the Terminal 6 bulkhead. As described in the RI/FS Work Plan (WPAH Group 2013), follow-up actions in these areas will be developed as appropriate, either during forthcoming remedial design of the cleanup remedy or as part of complementary redevelopment and/or habitat restoration efforts. Regardless of the approach, planning around lagoon and Terminal 6 shoreline actions will be coordinated with Ecology.

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Appendix E
Source Control Evaluation

Tables

Table E.1
Current NPDES Permit Holders within the Western Port Angeles Harbor Sediment Cleanup Unit

Facility	Permit Number	Permit Type	Analytes Required
City of Port Angeles	WAR045028	Western Washington Phase II Municipal Stormwater Permit	The City of Port Angeles is currently not required to conduct water sampling or other testing
City of Port Angeles Wastewater Treatment Plant[1]	WA0023973	Individual Waste Discharge Permit	Biological Oxygen Demand, Total Suspended Solids, Fecal Coliform, Total Residual Chlorine
Platypus Marine Inc.	WAG031047	Boatyard General Permit	Copper, Lead, Zinc
Port of Port Angeles Combined Permit (Marine Terminal, Marine Terminal Cargo Surge Area, Terminal 7 Log Yard, Terminal 5 Log Yard)	WAR000314	Industrial Stormwater General Permit	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc, Chemical Oxygen Demand, Total Suspended Solids
Port of Port Angeles Boatyard	WAG031027	Boatyard General Permit	Total Copper, Total Lead, Total Zinc
Westport Shipyard Inc.	WAR006713	Industrial Stormwater General Permit	Turbidity, pH, Oil Sheen, Total Copper, Total Zinc

Note:

1 The City of Port Angeles Wastewater Treatment Plan discharges outside of the SCU, however this permit also covers CSO discharges inside the SCU.

Abbreviations:

CSO Combined sewer overflow
SCU Sediment Cleanup Unit

Table E.2
NPDES Stormwater Data from 2015 to 2017

		Conventionals				Total Metals		
Analyte		Oxygen Demand	pH[1]	Suspended Solids	Turbidity	Copper	Lead	Zinc
Units		mg/L	pH	mg/L	NTU	µg/L	µg/L	µg/L
Permit Benchmark (ISGP/BGP)[2]		120/NA	5 to 9/5 to 11	100/NA	25/NA	14/147	81.6/NA	117/90
Outfall	Date							
Platypus Marine Inc.: BGP WAG031047								
1	1/1/2015–1/31/2015	--	--	--	--	725	66.6	453
	4/1/2015–4/30/2015	--	--	--	--	281	31.0	313
	5/1/2015–5/31/2015	--	--	--	--	104	6.94	87.8
	11/1/2015–11/30/2015	--	--	--	--	104	15.3	140
	10/14/2016	--	--	--	--	444	--	349
	11/22/2016	--	--	--	--	3,850	--	2,730
	01/31/2017	--	--	--	--	3,380	--	2,020
	5/30/2017	--	--	--	--	4,070	--	2,630
2	6/1/2015–6/30/2015	--	8.82	--	--	246	10.0 U	370
	8/1/2015–8/31/2015	--	8.97	--	--	1,400	10.0 U	354
	6/1/2016–6/30/2016	--	8.99	--	--	1,420	10.0 U	60.7
	07/08/2016	--	8.64	--	--	1,700	11.0	2.10
	09/15/2016	--	9.10	--	--	2,040	10.0	13.2
	06/01/2017	--	9.13	--	--	278	10.0	160
	06/08/2017	--	8.98	--	--	14.0	10.0	86.9
	07/13/2017	--	8.76	--	--	238	10.0	8.90
	08/01/2017		8.50			93.0	10.0	362
Port Angeles Combined Permit: ISGP WAR000314								
OF7	3/15/2015	140	7.00	16.0	55.6	7.00	--	75.0
	10/7/2015	100	7.00	30.0	93.9	16.0	--	94.0
	2/12/2016	440	7.00	170	328	29.0	--	47.0
	9/2/2016	110	7.00	60.0	160	30.0	--	78.0
	10/14/2016	150	7.00	120	326	13.0	--	29.0
	3/28/2017	290	7.00	44.0	110	52.0	--	96.0
	5/15/2017	230	7.00	100	245	20.0	--	44.0
Port of Port Angeles Boatyard: BGP WAG031027								
1	1/1/2015–1/31/2015	--	--	--	--	79.0	1.30	120
	4/1/2015–4/30/2015	--	--	--	--	54.0	--	21.0
Westport Shipyard Inc.: ISGP WAR006713								
DP1	1/22/2015	--	7.40	--	0.900	1.00	--	45.7
	4/14/2015	--	7.50	--	2.10	9.90	--	41.6
	9/1/2015	--	7.04	--	9.40	9.40	--	29.2
	10/7/2015	--	7.30	--	3.40	8.90	--	17.2
	1/27/2016	--	7.50	--	10.0	14.8	--	22.0
	11/9/2016	--	7.37	--	113	67.7	--	85.5
	12/6/2016	--	7.40	--	1.00	4.80	--	14.5
	12/12/2016	--	7.80	--	50.0	26.3	--	42.6
	12/29/2016	--	7.32	--	1.10	0.300	--	21.3
	Average: 10/1/16 to 12/31/16				41.3	24.8		41.0
	2/7/2017	--	7.30	--	3.00	2.20	--	20.6

Notes:

Blank cells are intentional.

-- Not analyzed.

Gray shaded cells exceed permit benchmark(s).

1 pH is not a required analyte for any of the boatyard permits listed.

2 Analytes are compared against their applicable benchmarks for either the ISGP or BGP permit. The applicable benchmarks are presented as ISGP/BGP.

Abbreviations:

BGP Boatyard General Permit
ISGP Industrial Stormwater General Permit
µg/L Micrograms per liter
mg/L Milligrams per liter
NTU Nephelometric turbidity unit

Table E.3
Port of Port Angeles Stormwater Solids Data from 2016

	Facility Name	**Terminal 7**
	Outfall	**OF7**
	Sample Date	**9/21/2016**
Analytes	**Units**	
Conventionals		
Solids (Residue)	%	38
Total Organic Carbon	%	17
Grain Size		
Gravel	%	0.34
Sand, Very Coarse	%	0.49
Sand, Course	%	0.60
Sand, Medium	%	1.2
Sand, Fine	%	5.3
Sand, Very Fine	%	3.1
Total Sand	%	0.16
Silt, Coarse	%	44
Silt, Very Fine	%	11
Total Silt	%	44
Total Clay	%	44
Fines (Silt + Clay)	%	89
Polycyclic Aromatic Hydrocarbons		
LPAHs		
Naphthalene	µg/kg	20 U
Acenaphthylene	µg/kg	20 U
Acenaphthene	µg/kg	20 U
Fluorene	µg/kg	22
Phenanthrene	µg/kg	140
Anthracene	µg/kg	67
2-Methylnaphthalene	µg/kg	20 U
HPAHs		
Fluoranthene	µg/kg	170
Pyrene	µg/kg	120
Benzo(a)anthracene	µg/kg	45
Chrysene	µg/kg	47
Benzo(b)fluoranthene	µg/kg	130
Benzo(k)fluoranthene	µg/kg	20 U
Benzo(a)pyrene	µg/kg	20 U
Benzo(ghi)perylene	µg/kg	20 U
Indeno(1-2-3-cd)pyrene	µg/kg	30
Polycyclic Aromatic Hydrocarbons (cont.)		
HPAHs (cont.)		
Dibenzo(a-h)anthracene	µg/kg	20 U
cPAH TEQ	µg/kg	33
Other SVOCs		
1-Methylnaphthalene	µg/kg	20 U
Polychlorinated Biphenyls		
PCBs (Total Aroclors)	µg/kg	100 U
Total Metals		
Antimony	mg/kg	0.62 U
Arsenic	mg/kg	4.7
Beryllium	mg/kg	0.90 U
Cadmium	mg/kg	0.59 U
Chromium	mg/kg	56
Copper	mg/kg	140
Lead	mg/kg	20
Mercury	mg/kg	0.13
Nickel	mg/kg	69
Selenium	mg/kg	8.4 U
Silver	mg/kg	0.60 U
Thallium	mg/kg	11 U
Zinc	mg/kg	160
Total Petroleum Hydrocarbons		
Diesel by NWTPH-Dx	mg/kg	210 U

Abbreviations:
SVOC Semivolatile organic compound
PCB Polychlorinated biphenyl
LPAH Low molecular weight polycyclic aromatic hydrocarbon
HPAH High molecular weight polycyclic aromatic hydrocarbon
mg/kg Milligrams per kilogram
µg/kg Micrograms per kilogram
cPAH Carcinogenic polycyclic aromatic hydrocarbon
TEQ Toxicity equivalent

Table E.4
MTCA Confirmed and Suspected Contaminated Sites along the WPAH Study Area Shoreline

Ecology Cleanup Site ID	Cleanup Site Name	Address	Site Status	Contaminants of Concern	Groundwater[1]	Soil[1]
10819	436 Marine Drive	436 Marine Drive	Cleanup Started	Benzene, Lead, Other Non-Halogenated Organics, Petroleum Hydrocarbons (Gasoline)	--	RA
13147	Former Shell Oil Bulk Plant	220 Tumwater Truck Route	Awaiting Cleanup	Benzene, Other Non-Halogenated Organics, Petroleum Hydrocarbons (Diesel, Gasoline, Others)	B	B
13146	Pettit Oil Company Tumwater Truck Route	220 Tumwater Truck Route	Awaiting Cleanup	Benzene, Other Non-Halogenated Organics, Petroleum Hydrocarbons (Diesel, Gasoline, Others)	B	B
4750	Fuds Port Angeles AAF	338 W 1st Street	Awaiting Cleanup	Base/Neutral/Acid Organics, Metals Priority Pollutants, Petroleum Hydrocarbons	--	S
7710	ITT-Ediz Hook Maintenance Facility	219 S Tumwater Truck Route	Cleanup Started	Petroleum Hydrocarbons (Diesel, Gasoline, Others)	C	--
28	K Ply	439 Marine Drive	Cleanup Complete	Benzene, Non-Halogenated Organics, Petroleum Hydrocarbons (Diesel, Gasoline, Others), Phenolic Compounds, Dioxin/Dibenzofuran Compounds	--	--
11150	Marine Drive Exxon	402 Marine Drive	Cleanup Started	Benzene, Lead, Other Non-Halogenated Organics, Petroleum Hydrocarbons (Diesel, Gasoline, Others)	--	C
2496	Nippon Paper Industries USA Co.	1815 Marine Drive	Awaiting Cleanup	Petroleum Hydrocarbons, Phenolic Compounds	C	C
3447	Pettit Oil Company Port Angeles WHS	638 Marine View Drive	Cleanup Started	Petroleum Hydrocarbons	C	C
8192	Port of Port Angeles	Marine Drive & B Street	Cleanup Started	Petroleum Hydrocarbons	C	C
1301	Port of Port Angeles Marine Trades Area	617 & 637 Marine Drive	Cleanup Started	Benzene, Non-Halogenated Organics, Petroleum Hydrocarbons (Diesel, Gasoline, Others), Metals Priority Pollutants	C (S for metals)	C (S for metals)
12297	Port Angeles Red Lion	221 N Lincoln Street	Cleanup Started	Arsenic, Benzene, Petroleum Hydrocarbons (Gasoline, Others), Polycyclic Aromatic Hydrocarbons	C	--
4976	Unocal Bulk Plant 0601	738 W Marine Drive	Cleanup Started	Petroleum Hydrocarbons	--	--

Note:

1 B: Contaminants less than MTCA Cleanup Levels After Assessment Completed
C: Contaminants Confirmed Greater than MTCA Cleanup Levels
S: Contamination Suspected
RA: Remediated, Contaminants Remain On-Site Above MTCA Cleanup Levels

Table E.5

Shoreline Areas of Interest Descriptions and Photographs[1]

Area of Interest	Photo Number	Field Observations	Photographs
A	10	4–5' of erosion from the ground surface to the beach.	
B	15a	Rusty sheetpile bulkhead next to the lagoon channel, potential for soil erosion through degraded bulkhead.	
C	17	Undercutting at the top of the bank along the entire length of the southern side of the lagoon channel.	
D	19a	Erosion behind sheetpile, and along lagoon channel where sheetpile transitions to riprap.	
E	21a (See also Attachment E.1 photos 20, 21b, 22, 28, 32)	Erosion on natural bank. 2–3' cut at the parking lot elevation. Observation applies to the majority of the lagoon.	

Table E.5

Shoreline Areas of Interest Descriptions and Photographs[1]

Area of Interest	Photo Number	Field Observations	Photographs
F	24a	Anthropogenic debris observed on slope above the water line.	
G	35a (See also Attachment E.1 photo 35b)	Timber piling/plank bulkhead with small cobbles and riprap in poor condition.	
H	37a	Some soil eroding/undercutting the corner of the pier.	
I	38c (See also Attachment E.1 photos 38b, 38d)	Sparse coverage of slope, with potential for erosion.	
J	39b	Soil on top of riprap slope with potential for erosion.	

Table E.5

Shoreline Areas of Interest Descriptions and Photographs[1]

Area of Interest	Photo Number	Field Observations	Photographs
K	46a	Sparse riprap on a steep slope with potential for erosion.	
L	48c (See also Attachment E.1 photo 48a)	Exposed soil and visible sloughing.	
M	49b	Sparse riprap and visible erosion.	
N	57e (See also Attachment E.1 photos 57a, 57d, 58a, 58b)	Steep riprap slope along Tumwater Creek.	
O	60b (See also Attachment E.1 photo 60a)	Steep riprap slope with visible soil erosion.	

Table E.5

Shoreline Areas of Interest Descriptions and Photographs[1]

Area of Interest	Photo Number	Field Observations	Photographs
P	63b (See also Attachment E.1 photo 63a)	Overwater and bank structure in poor condition, exposed soil with potential for erosion.	
Q	64c	Soil berm above riprap with potential for erosion.	
R	69b	Visible exposed soil and bank erosion.	

Note:

1 Areas of Interest locations are shown on Figure E.4

Appendix E
Source Control Evaluation

Figures

Legend
Remedial Action Levels for a Restoration Timeframe of 10 Years Post-Construction

- Carcinogenic PAH TEQ > 434 µg/kg dw
- Mercury > 0.84 mg/kg
- Total TEQ > 17.1 ng/kg dw
- Area of Potential Sources and Pathways to Sediment
- Creek

Note:
· Orthophoto provided by USDA, 2011.

Abbreviations:
dw = Dry weight
µg/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
ng/kg = Nanograms per kilogram
PAH = Polycyclic aromatic hydrocarbon
TEQ = Toxic equivalent

0 625 1,250 2,500
Scale in Feet

N

WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure E.1
Areas Exceeding Remedial Action Levels
for a 10-Year Restoration Timeframe

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10/29/2020

WPAHG

Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure E.2
Shoreline Survey Extent and Photograph Locations

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10/29/2020

Extent of shoreline photographic survey

Ediz Hook

Extent of shoreline photographic survey

Tumwater Creek

Valley Creek

Ennis Creek

Legend

- Industrial Outfall
- Combined Sewer Outfall
- Discharge Point
- Bulkhead
- Undeveloped[1]
- Riprap
- Outfall Pipe
- Stormwater Main
- Creek
- Individual Wood Piling
- Multiple Wood Piling
- Multiple Wood and Other Piling
- Multiple Non-Wood Piling

Notes:
1. Undeveloped shoreline includes man-made, restored, and naturally occurring beaches.
· The shoreline photographic survey was performed on February 5 and 6, 2014.
· Orthophoto provided by USDA, 2011.

0 625 1,250 2,500
Scale in Feet

N

WPAHG
Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure E.3
Shoreline Features

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10/29/2020

WPAHG

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Port Angeles, Washington

Figure E.4
Potentially Erodible Soils

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10/29/2020

Appendix E
Source Control Evaluation

Attachment E.1: Shoreline Survey Photographs

Photograph 1a. Looking NE at undeveloped shoreline from a dock at the public boat launch on Ediz Hook.

NOTE: Undeveloped shoreline references throughout this document include man-made, restored, and naturally occurring beaches.

Photograph 1b. Looking NW at wood piling and plank bulkhead from a dock at the public boat launch on Ediz Hook.

Note: Photograph locations are shown on Figure E.2.

Photograph 2a. Looking NE at undeveloped shoreline transitioning to wood piling, plank, and concrete bulkhead on Ediz Hook.

Photograph 2b. Looking E from undeveloped shoreline at wood piling, plank, and concrete bulkhead and overwater structure on Ediz Hook.

Photograph 2c. Looking NE at undeveloped shoreline (restored by the Lower Elwha Klallam Tribe [LEKT]) on Ediz Hook.

Photograph 2d. Looking W at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 3. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 4a. Looking W at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 4b. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 5a. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 5b. Looking W at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 6a. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 6b. Looking W at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 7. Looking N at undeveloped shoreline (restored by LEKT) on Ediz Hook, looking away from the Harbor toward the roadway.

Photograph 8a. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 8b. Looking W at undeveloped shoreline (restored by LEKT) and the Olympic Peninsula Rowing Association boat house on Ediz Hook.

Photograph 9a. Looking E at undeveloped shoreline (restored by LEKT) on Ediz Hook.

Photograph 9b. Looking W at undeveloped shoreline (restored by LEKT) on Ediz Hook. McKinley facility visible in background.

Photograph 10. Looking N at the primarily undeveloped shoreline with sparse armoring. Top of bank erosion visible, approximately 4 feet from the ground surface to the beach.

Photograph 11a. Looking W at undeveloped shoreline with sparse armoring and top of bank erosion from an overwater structure at the McKinley facility.

Photograph 11b. Looking NW at undeveloped shoreline with top of bank erosion.

Photograph 12. Looking W at riprap slope with concrete debris.

Photograph 13. Looking W at riprap slope with concrete debris, within the McKinley facility.

Photograph 14a. Looking SE at riprap slope with concrete debris, within the McKinley facility.

Photograph 14b. Looking S at riprap slope with concrete debris and logs along the McKinley facility.

Photograph 14c. Looking S at riprap slope with concrete debris and logs along the McKinley facility.

Photograph 14d. Looking SE at dolphins offshore of the McKinley facility.

Photograph 15a. Looking E at deteriorating sheet pile bulkhead adjacent to the lagoon channel near the McKinley facility.

Photograph 15b. Looking NE at the sheet pile bulkhead of the lagoon channel (eastern portion of the channel).

Photograph 15c. Looking SW at the sheet pile bulkhead of the lagoon channel (eastern portion of the channel).

Photograph 15d. Looking SE along undeveloped shoreline of the inner harbor, east of the lagoon channel.

Photograph 16a. Looking WSW at the riprap armored western portion of the lagoon channel.

Photograph 16b. Looking WSW at the riprap armored western portion of the lagoon channel.

Photograph 17. Looking SW at the undeveloped shoreline along the western portion of the lagoon channel, with top of bank erosion.

Photograph 18a. Looking NW at undeveloped shoreline along the western portion of the lagoon channel.

Photograph 18b. Looking NE at the undeveloped shoreline along the western portion of the lagoon channel; top of bank erosion visible along southern bank.

Photograph 19a. Looking NW at undeveloped and/or sparsely armored shoreline within the lagoon channel. Erosion visible behind sheet pile on south side of channel.

Photograph 19b. Looking W at the undeveloped shoreline on the northern side of the lagoon.

Photograph 20. Looking S at the undeveloped shoreline on the southeastern side of the lagoon. Top of bank erosion visible on distant shoreline.

Photograph 21a. Looking NE at the undeveloped shoreline on the southeastern side of the lagoon.

Photograph 21b. Looking W at the undeveloped shoreline on the southern side of the lagoon.

Photograph 22. Looking S at undeveloped shoreline on the southern side of the lagoon. Visible top of bank erosion.

Photograph 23. Looking S at undeveloped shoreline in the southern portion of the lagoon, seeps in the beach visible.

Photograph 24a. Looking NW at undeveloped shoreline and the McKinley facility waste water treatment plant in the background.

Photograph 24b. Looking SE at undeveloped lagoon shoreline; anthropogenic debris visible.

Photograph 25. Looking SE at the undeveloped shoreline along the southeastern corner of the lagoon, near the creek entrance to the lagoon.

Photograph 26a. Looking SW at undeveloped shoreline, near a drainage culvert discharging into the lagoon.

Photograph 26b. Looking NW at mud flats and undeveloped shoreline on the southwest edge of the lagoon.

Photograph 27. Looking SW at a 12-inch polyvinylchloride (PVC) drainage culvert discharging into the lagoon.

Photograph 28. Looking NW at the undeveloped shoreline along the southwest side of the lagoon.

Photograph 29. Looking NW at the undeveloped shoreline along the western portion of the lagoon.

Photograph 30. Looking NE at the undeveloped shoreline along the northwestern shore of the lagoon.

Photograph 31. Looking S at the undeveloped shoreline along the southern shore of the lagoon.

Photograph 32. Looking E at the undeveloped shoreline along the northern shore of the lagoon towards the McKinley facility.

Photograph 33. Looking E at the undeveloped shoreline of the western portion of the lagoon channel.

Photograph 34a. Looking SE at undeveloped shoreline in the inner harbor and immediately south of the lagoon channel.

Photograph 34b. Looking N at undeveloped shoreline in the inner harbor, immediately south of the lagoon channel.

Photograph 35a. Looking SE at riprap slope and wood bulkhead in the vicinity of Terminal 6.

Photograph 35b. Looking NW at a wood piling and plank bulkhead with small cobbles and riprap in front of and behind the bulkhead.

Photograph 36. Looking SE at wood piling and plank bulkhead, with riprap in front of and behind the bulkhead.

Photograph 37a. Looking SE at riprap slope, looking toward the chip loader and log storage at Terminal 5.

Photograph 37b. Looking NW at riprap slope with some wood piling and plank bulkhead features in the vicinity of Terminal 5.

Photograph 38a. Looking SE at concrete and sheet pile bulkhead in the vicinity of the Terminal 5/Terminal 7 log ramp area.

Photograph 38b. Looking NW at the riprap slope comprised of sparse concrete debris, logs, and riprap in the vicinity of the Terminal 5/Terminal 7 log ramp area.

Photograph 38c. Looking NW at the riprap slope comprised of sparse concrete debris, logs, and riprap in the vicinity of the Terminal 5/Terminal 7 log ramp area.

Photograph 38d. Looking NW at the riprap slope comprised of sparse concrete debris, logs, and riprap in the vicinity of the Terminal 5/Terminal 7 log ramp area.

Photograph 39a. Looking SE at the riprap slope comprised of concrete debris, logs, and riprap in the vicinity of the Terminal 5/Terminal 7 log ramp area.

Photograph 39b. Looking NW at the Terminal 7 log ramp composed of sand and small cobbles.

Photograph 40a. Looking SE at riprap slope, toward the public boat ramp west of the Boat Haven Marina.

Photograph 40b. Looking NW at riprap slope, toward chip loader at Terminal 7.

Photograph 40c. Looking NE at riprap slope beneath Terminal 7.

Photograph 41. Looking NW at riprap slope, toward Terminal 7.

Photograph 42. Looking SE at riprap slope, just west of the Boat Haven Marina.

Photograph 43. Looking NW at riprap slope, at northern corner of the Boat Haven Marina.

Photograph 44a. Looking NW at riprap slope along northwestern edge of the Boat Haven Marina.

Photograph 44b. Looking N at riprap slope along the northwestern edge of the Boat Haven Marina, and the piling breakwater between the marina and the harbor.

Photograph 45. Looking NW at the riprap slope along the northwestern edge of the Boat Haven Marina.

Photograph 46a. Looking SW at the smaller diameter riprap slope in the northwestern corner of the Boat Haven Marina.

Photograph 46b. Looking NE at the riprap slope along northwestern edge of the Boat Haven Marina.

Photograph 46c. Looking SE at the riprap slope (in front of wood bulkhead—not visible) along the southwestern shore of the Boat Haven Marina and the adjacent, elevated concrete pipe to the City's wastewater treatment plant (WWTP).

Photograph 46d. Looking SW at riprap slope (in front of wood bulkhead—not visible) along the southwestern shore of the Boat Haven Marina, in the vicinity of a stormwater discharge pipe, and the elevated concrete pipe to the City's WWTP .

Photograph 47a. Looking SE at riprap slope in front of wood plank bulkhead along the southwestern edge of the Boat Haven Marina and the adjacent, elevated concrete pipe to the City's WWTP.

Photograph 47b. Looking SE at sand and cobble slope in front of a wood plank bulkhead along the southwestern edge of the Boat Haven Marina and the adjacent, elevated concrete pipe to the City's WWTP.

Photograph 47c. Looking NW at sand and cobble slope in front of a wood plank bulkhead, southwestern edge of the Boat Haven Marina and the elevated concrete pipe to the City's WWTP.

Photograph 48a. Looking NE at riprap slope along the southeastern edge of the Boat Haven Marina; visible top of bank erosion.

Photograph 48b. Looking S at a sheet pile bulkhead (transitions to riprap slopes on either side) in the southern corner of the Boat Haven Marina.

Photograph 48c. Looking SE at sand and cobble shoreline slope with sparse riprap in the southern corner of the Boat Haven Marina.

Photograph 49a. Looking NW at riprap slope along the northeastern edge of the Boat Haven Marina.

Photograph 49b. Looking SE at sand/cobble slope with sparse riprap in the northeastern corner of the Boat Haven Marina.

Photograph 49c. Looking S at riprap slope along the southeastern edge of the Boat Haven Marina.

Photograph 50a. Looking N at riprap slope along the northeastern edge of the Boat Haven Marina.

Photograph 50b. Looking SE at riprap slope along the northeastern edge of the Boat Haven Marina.

Photograph 51. Looking SE at riprap slope in the Boat Haven Marina, on the internal side of the eastern breakwater.

Photograph 52a. Looking SE at riprap slope below the Boat Haven Marina office on the eastern breakwater.

Photograph 52b. Looking NE at the riprap slope transition to the wood piling section of the eastern breakwater in the Boat Haven Marina.

Photograph 53. Looking SE at riprap slope on the harbor side of the eastern marina breakwater, toward a historical log slide.

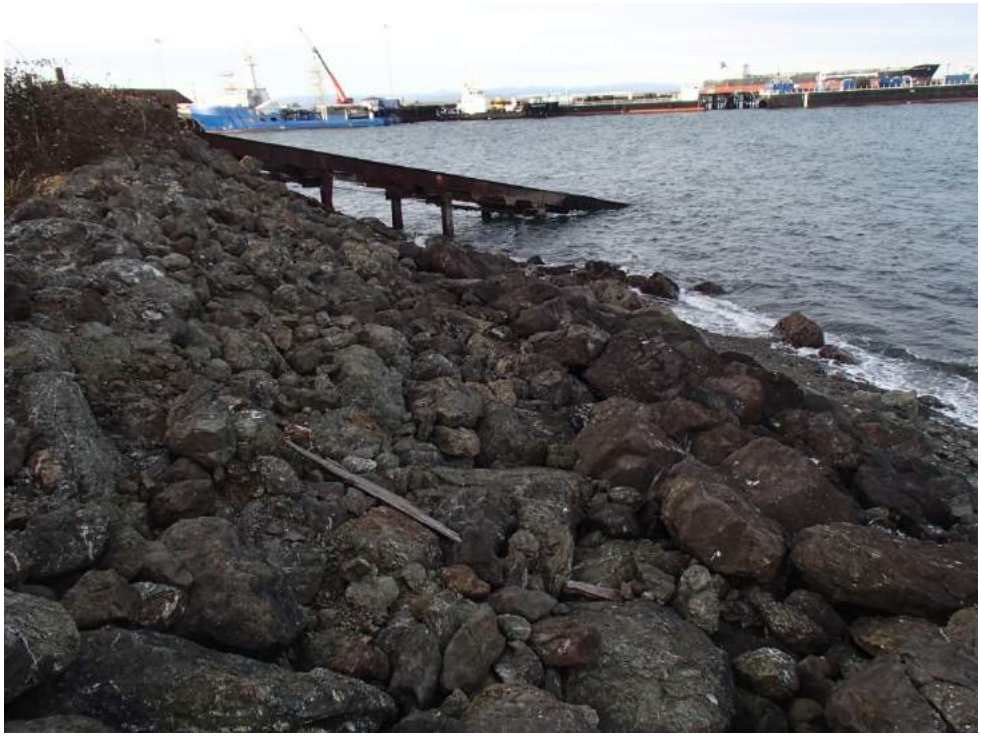
Photograph 54a. Looking NE from riprap slope on the eastern marina breakwater into the harbor.

Photograph 54b. Looking N from riprap slope on the eastern marina breakwater into the harbor, with a historical log slide visible on the left of the photo.

Photograph 54c. Looking NW at riprap slope on the eastern marina breakwater, toward the historical log slide.

Photograph 55a. Looking SE at riprap slope on the eastern marina breakwater, toward Terminal 3 in the distance.

Photograph 55b. Looking NW at riprap slope from the start of the eastern marina breakwater.



Photograph 56. Looking NW at the riprap slope west of Terminal 3, toward a historical log slide.

Photograph 57a. Looking N at the riprap slopes at the mouth of Tumwater Creek.

Photograph 57b. Looking SW at the riprap slopes and sheet pile bulkheads at the mouth of Tumwater Creek, looking upstream.

Photograph 57c. Looking W at riprap slope, west of Tumwater Creek and Terminal 3.

Photograph 57d. Looking N at riprap slopes and sheet pile bulkheads upstream of the mouth of Tumwater Creek at the bridge crossing.

Photograph 57e. Looking SW at riprap slope and concrete bulkhead wall, upstream of the bridge crossing on Tumwater Creek.

Photograph 58a. Looking SW at riprap slope downstream of the bridge crossing on Tumwater Creek.

Photograph 58b. Looking W at riprap slope at the mouth of Tumwater Creek.

Photograph 59. Looking SW at riprap slope on the western side of Terminal 3.

Photograph 60a. Looking W at riprap slope in front of Terminal 3; top of bank erosion visible.

Photograph 60b. Looking SW at riprap slope in front of Terminal 3, with top of bank erosion visible.

Photograph 61a. Looking W at riprap slope in front of Terminal 1.

Photograph 61b. Looking SW at riprap slope in front of Terminal 1.

Photograph 61c. Looking E at riprap slope in front of Terminal 1.

Photograph 62a. Looking NW at riprap slope in front of Terminal 1.

Photograph 62b. Looking SE at riprap slope in front of Terminal 1.

Photograph 63a. Looking NE at mixed shoreline of sheet pile and riprap adjacent to a small overwater structure.

Photograph 63b. Looking SE at the mixed shoreline of riprap, sheet pile, railroad tie, and concrete debris behind the overwater structure in Photograph 63a.

Photograph 64a. Looking NW at riprap slope west of Valley Creek, with exposed soil berm at the top of bank.

Photograph 64b. Looking NE at riprap slope in front of a wood piling and plank bulkhead wall, west of Valley Creek.

Photograph 64c. Looking SE at the riprap slope and top of bank exposed soil berm in Photograph 64a.

Photograph 65a. Looking SE at undeveloped shoreline at the mouth of Valley Creek.
NOTE: Photo taken prior to Valley Creek Estuary pocket beach construction in 2013–2014.

Photograph 65b. Looking S at riprap slope and undeveloped shoreline at mouth of Valley Creek.
NOTE: Photo taken prior to Valley Creek Estuary pocket beach construction in 2013–2014.

Photograph 65c. Looking S at riprap slope and undeveloped shoreline along the eastern side of the mouth of Valley Creek. Erosion visible at the top of bank.
NOTE: Photo taken prior to Valley Creek Estuary pocket beach construction in 2013–2014.

Photograph 65d. Looking NW at riprap slope, and exposed soil at the top of bank, west of Valley Creek.

Photograph 66a. Google Earth image of restored pocket beaches east of Valley Creek.

Photograph 66b. Looking SE at undeveloped shoreline and riprap slopes of the Valley Creek estuary pocket beaches constructed after the 2014 Shoreline Investigation (Photo taken February 2018).

Photograph 66c. Looking SE at undeveloped shoreline and riprap slopes of the Valley Creek estuary pocket beaches constructed after the Shoreline Investigation in 2014 (Photo taken in February 2018).

Photograph 66d. Looking SW at the undeveloped shoreline and riprap slopes along the east side of Valley Creek; visible top of bank erosion.
NOTE: Photo taken prior to Valley Creek Estuary pocket beach construction in 2013–2014.

Photograph 67. Looking NW at riprap slope, just west of Terminal 2.

Photograph 68. Looking NE at Terminal 2.

Photograph 69a. Looking NE at riprap slopes and undeveloped shoreline at the mouth of Peabody Creek.

Photograph 69b. Looking SE at riprap slope and eroded bank at the mouth of Peabody Creek.

Photograph 69c. Looking NW at riprap slope along the west shore at the mouth of Peabody Creek.

Photograph 70a. Looking SE at undeveloped shoreline in the foreground, and riprap slope in the background below the Red Lion Hotel.

Photograph 70b. Looking SE at riprap slope SE of the Red Lion Hotel.

Photograph 71a. Looking NW at undeveloped shoreline below a riprap slope, in the vicinity of the former City Combined Sewer Outfall.

Photograph 71b. Looking SE at riprap slope, with the Rayonier Site in the background.

Photograph 71c. Looking NW at riprap slope, toward downtown Port Angeles from the Western Port Angeles Harbor Study Area boundary.

Appendix F
Settlement Agreement and LEKT Monitoring and Discovery Plan

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

5.790

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DOCUMENT TITLE: SETTLEMENT AGREEMENT

State of Washington
Lower Elwha Klallam Tribe
City of Port Angeles
Port of Port Angeles

August 14, 2006
Settlement agreement
With (3) Exhibits

SETTLEMENT AGREEMENT AMONG THE STATE OF WASHINGTON, LOWER ELWHA KLALLAM TRIBE, CITY OF PORT ANGELES, AND PORT OF PORT ANGELES

THIS **SETTLEMENT AGREEMENT** ("Agreement") is entered into effective as of August 14, 2006, by and among the State of Washington ("State"); the Lower Elwha Klallam Tribe, a federally-recognized sovereign Indian tribe ("Tribe"); the City of Port Angeles ("City"); and the Port of Port Angeles, a special purpose district of the State of Washington organized and existing pursuant to RCW Title 53 ("Port") – hereinafter singularly referred to as a "Party" or collectively referred to as the "Parties."

In consideration of the real property transactions described herein and the mutual benefit to the Parties arising from the agreements and undertakings hereinafter set forth, the Parties hereby recite, covenant, and agree as follows:

Section 1. Recital of Principles.

1.1. This Agreement is not intended to create new or supersede existing law; provide any new causes of action under existing law; or imply that the Tribe's interests are not protected under or derived from federal, state, local, tribal and/or common law.

1.2. The Parties acknowledge, reference and intend to abide by existing and future applicable law. *See* § 7 below.

1.3. That portion of Tse whit zen that sits astride the former Graving Dock site and is delineated in Section 2 below should be protected and promoted in perpetuity as a cemetery and place for cultural and historic preservation.

1.4. The circumstances and the consequences of the discovery of Tse whit zen are unique and the events at the former Graving Dock site do not represent the normal process, and do not set precedent for any other situation. The decisions and actions of the State with regard to the Graving Dock and Tse whit zen are not precedent, and do not represent desirable, required or appropriate procedure or outcome.

1.5. The Parties agree that the property delineated at Section 3 below will be buffered from uses on adjoining property. Buffering will be the responsibility of the Tribe and will be inside the boundaries of that property.

1.6. The Parties intend that appropriate commercial and industrial use and development will continue on property adjacent to the property delineated at Sections 2 and 3 below, and all other property within the City limits, including designated Urban Growth Areas.

1.7. Development, commercial activities or industrial operations on property within the City limits that may possibly contain archaeological resources shall be allowed so long as those archaeological resources are not displaced or disturbed as a result of such activities or operations.

1.8. The Parties intend that if any phenomena of possible archaeological interest are uncovered during any excavation subject to the City's Shoreline Master Program, work shall immediately stop and the developer shall immediately notify the City and Tribe, and the City shall notify the State Department of Archaeology and Historic Preservation (DAHP). *See* § 10.7 below.

1.9. The Parties pledge to institute and maintain active communication with each other for the purposes of assuring cooperation, coordination and collaboration with regard to issues of archaeological, cultural and historic significance.

1.10 For all purposes of this Agreement, "archaeologist" means a trained, professional archaeologist meeting federal qualifications.

1.11. These recitals are a substantive manifestation of the Parties' collective intent.

Section 2. Transfer to Port.

The State will assign its lease of or relinquish its interest in 2.5 acres connecting the harborfront with the former Graving Dock site (the so-called "DNR leased land"), to the Port, which will make contiguous Port-owned property to the "north" and "east" of the site. The State will also convey to the Port fee title to all acreage north of the sheet pile wall known as the "5 Line" to the former Graving Dock. The Tribe will dedicate about 50 feet of the property identified in Section 3 below as a buffer between the Port's property and the historic shoreline. The State, Port and Tribe will cooperate with regard to the preservation and use of the stormwater treatment ponds along the west boundary of the property identified in Section 3 below, which could include the buffers contemplated by Section 4.1 below. *See* the area depicted in **Exhibit A** hereto. An easement allowing ingress and egress to and from the harbor shall be granted by the State and/or the Port to the Tribe for ceremonial use (*see* § 5 below). Said easement shall be on and across the area depicted in **Exhibit B** hereto. The Tribe shall be entitled to use the easement four times per year for up to a total of 12 days per year. The Tribe shall give at least two weeks notice, whenever practicable, and no less than 48 hours notice, to the Port Executive Director of intended use to facilitate rescheduling of Port uses in the easement area depicted in **Exhibit B**. In special circumstances, the Tribe may request, on at least two weeks written notice, use of the easement in excess of these limits, and the Port shall consider such requests in good faith but may decline additional use if such use shall significantly disrupt Port Terminal activities in the easement area.

Section 3. Transfer to Tribe.

The State will convey to the Tribe fee title, subject to reversion, to property "south" of the "5 Line," to a line 200 feet "north" of the "north" right of way line of Marine Drive, with an easement allowing ingress and egress to and from Marine Drive and restrictions that such property be used exclusively for cultural and historic preservation purposes. *See* the area depicted in **Exhibit A** hereto. That State conveyance will be premised upon findings from the Federal Highway Administration (FHWA) under 23 CFR part 710.403 and Section 106 of the National Historic Preservation Act that Tribal ownership and such restricted Tribal use is reasonable mitigation for that portion of Tse whit zen that sits astride the former Graving Dock site, and a reasonable expenditure of public funds for that purpose. The Tribe, with written support from the State, City and Port, will seek to accomplish the following, in decreasing order of priority: (1) conversion of all or part of that property described in this Section from fee to trust under federal law, subject to the same land use restrictions; (2) designation as a National Historic Site under the Historic Sites Act of 1935 and other applicable federal laws; and (3) inclusion on the National Register of Historic Places.

Section 4. Land Retained by State & Leased to Tribe.

The State will retain fee title to the property south of that line 200 feet "north" of the "north" right of way line of Marine Drive, and lease that acreage to the Tribe subject to cultural and historic preservation use restrictions that are effectuated through a consultative process with the Tribe, City and Port. *See* the area depicted in **Exhibit A** hereto. That State lease would also be premised on FHWA mitigation and permissible public expenditure findings, as set forth in Section 3 to this Agreement.

Section 5. Land Use Restrictions.

The State and Tribe will expressly restrict use of the land to be owned or leased by the Tribe as described in Sections 3 and 4 for cultural and historic preservation, which for purposes of this Agreement means: site restoration; reburial of Klallam ancestors; maintaining ancestral burial grounds; ceremonial uses; and developing a facility to promote cultural heritage and create significant local economic benefit related to the uses (so long as archaeology supports development); to be effectuated through a collaborative process with the Tribe, City and Port. The Parties agree that the Tribe's use of the land described in Sections 3 and 4 shall specifically preclude gaming activities, whether such activities are subject to compacting requirements or not. The State, City and Port do not foresee any public purpose reason for exercising public condemnation authority on the property described in Section 3 (to the extent not acquired by the federal government in trust for the Tribe) and Section 4. The State, City or Port will cooperate with the Tribe's reasonable efforts to minimize any taxation of that property, including but not limited to seeking tax exemptions and structuring of an entity or entities that will own and/or lease the land. The City will provide utility services to and on that land, and the Tribe will pay all necessary utility fees and assessments.

5.1 The Tribe shall determine and install appropriate buffers for its cultural and historic preservation uses, and those buffers shall be within the property described in Section 3 to insulate the Tribe's uses from surrounding uses; provided that the Tribe will not be required to remove any archaeological resources to create such buffers.

5.2 The Tribe acknowledges that the property surrounding the property that will be conveyed or leased to the Tribe under Sections 3 and 4 to this Agreement, will be utilized for heavy industrial and maritime use creating noise, dust, vibration and other similar impacts typical of such uses. The Tribe accepts the property delineated in those Sections 3 and 4 with knowledge of that surrounding land use activity and agrees to not take any action opposing such use as long as such use complies with existing and future applicable law and this Agreement.

5.3 Within sixty (60) days of execution of this Agreement, the State, at its own expense, shall prepare legal descriptions of the property and easement described above in Sections 2, 3 and 4, and depicted in **Exhibits A and B.** The State shall deliver the legal descriptions to the Port and Tribe for review. Any review costs shall be borne by the Port and Tribe. Thereafter, under the terms of separate but related agreements between the State, City and Port, and the State and Tribe, respectively (*see* § 15 below), the State shall convey title or lease that property to the Port and Tribe, respectively, as contemplated by Sections 2, 3 and 4.

Section 6. Land Use Regulations.

The State, City and Port will initiate the process to modify, as needed, their respective current land use designations, policies and regulations that presently apply to the acreage that will be conveyed and leased to the Tribe for cultural and historic preservation to remove any conflicts with the intended uses of these properties, as envisioned in Section 12 below; and agree to support proposed changes that effectuate this Section and Section 12.

Section 7. Applicable Law.

The Parties shall abide by and do not intend to alter existing and future applicable law relating to discovery and treatment of historic properties, including artifacts, features and human remains, as applied by the terms of this Agreement to property within the jurisdiction of the City. *See* § 1.2 above. The Parties acknowledge the existence of tribal law, and that certain property and other rights derived from tribal law are recognized and enforced by state and federal courts. This Agreement does not intend to alter existing law. The State, City and Port reserve the right to assert that tribal law does not apply.

Section 8. Archaeological Analysis.

8.1 The City shall hire as its employee an archaeologist for a five year period. The State shall bear all the costs for employing the City Archaeologist, as well as appropriate consultants, and the cost of the archaeological analysis

contemplated by this Section, subject to the provisions of subsection 8.1.1 below.

8.1.1 The Parties acknowledge that the State, through this Agreement, cannot budget at one time five years of funding for the City Archaeologist, consultants, and analysis contemplated in this Section. Therefore, the Parties agree that the City will develop budgets for the City Archaeologist, consultants, and analysis, in coordination with the State's biennial budget cycle. The City will develop each budget and submit it to the State in adequate time for the State to include the funding in the regular or supplemental budget cycle, as appropriate. The State covenants that it will initiate and take all reasonable means to support and include in the State's budget authorization to pay to the City sufficient funds for the archaeologist, consultants, and analysis contemplated in this Section.

8.1.2 The Tribe, State, and Port shall be consulted during the City's interview process for the City Archaeologist position and their representatives shall be allowed to participate in candidate interviews, but the final decision about whom should fill that position shall rest solely with the City.

8.2 On land identified in Section 8.9 below, the City Archaeologist, in consultation with the Tribe, State, Port and other interested parties, will conduct, administer and manage an archaeological analysis designed to determine the potential locations of archaeological resources. Subject to available state funding, the predictive analysis will include one or more of the following methods: ethnographic studies, statistically-based archaeological predictive modeling, geomorphological studies, remote sensing methods, forensic canines, and/or other scientifically appropriate methods. Based on these methods, the City Archaeologist, in consultation with the Parties, will establish the appropriate archaeological fielding testing methods, which will include pedestrian surveys, subsurface test units, backhoe trenching, augering, coring, geoslicing, and/or other scientifically appropriate methods appropriate to the environmental conditions of the field inventory area and probability designation.

8.3 The analysis shall be conducted expeditiously and in good faith and completed as soon as possible, but not later than two years after State funding or City hiring of the City Archaeologist, whichever is later. Permitting processes will proceed in the normal course of business and under existing and future applicable law while the analysis is conducted. Mitigation plans will be subject to the protocols set forth in Sections 9 and 10. Completion of the analysis is not a prerequisite to permit processing.

8.4 As part of the analysis, the Tribe agrees to cooperate with the State, City and Port for purposes of allowing them access to the Tribal repository of history and information, which would aid in the thoroughness and accuracy of

the analysis. The State, City and Port agree to consult with the Tribe regarding the design, implementation and results of the analysis, including data quality and data analysis.

8.5 The analysis is intended to help reduce uncertainty, which will promote predictable development by informing governmental permitting personnel how to devise appropriate mitigation in accordance with this Agreement.

8.6 The end product of the archaeological analysis will be detailed maps designating areas as having high, medium or low probability for the presence of archaeological resources. Buffers and other protections for identified archaeological resources will be determined by the City Archaeologist, in consultation with all the Parties, based on the nature and size of the resource, the environmental conditions, nature and extent of the proposed development project, confidence in the delineation of the site boundaries, and any other factors the City Archaeologist deems necessary to provide reasonable protection to the archaeological resources. Section 11 below discusses the confidential treatment of these reports, maps and other documents.

8.7 These maps will also depict recorded archaeological sites, districts, traditional cultural properties and isolated features, as well as sacred areas, to aid in predictability and appropriate mitigation as development occurs. This information will be considered confidential and exempt from public disclosure by state and local government under RCW 27.53.070 and RCW 42.56, except as necessary to carry out government activities to manage, mitigate, or protect these archaeological resources, and consistent with Section 11 below.

8.8 The City and Tribe will continually update these maps as new information is discovered, and will provide this information to the Tribe and DAHP.

8.9 The archaeological analysis contemplated herein shall encompass the following areas and the uplands contiguous to those areas: all of Ediz Hook, and along the shoreline from the base of Ediz Hook to the Rayonier mill site from the toe of the bluff line as it currently exists to the existing shoreline.

8.10 The Parties recognize that the site of the former Rayonier pulp mill is subject to a Superfund deferral agreement and a clean-up process under authority of the State's Model Toxics Control Act. For that reason, operations and activities on that property are already subject to strict review and regulation and are subject to different laws and considerations than other properties on the Port Angeles waterfront. For these reasons, the Parties agree that no term or condition of this Agreement shall apply to the Rayonier property. If the federal Environmental Protection Agency ever (1) removes that site from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), or (2) revokes deferral of the National Priorities List (NPL) listing process or otherwise reasserts authority over the investigation and/or cleanup of the Rayonier site, then Rayonier (or

its successor), the Tribe and any other party with a legally recognizable interest in that site may elect by written agreement to apply the terms and conditions of this Agreement to the site. Additionally, those parties may elect by written agreement to apply the terms and conditions of this Agreement to that site at any time of their choosing. However, nothing in this Agreement shall be read to compel those parties to effect such an agreement. The exclusion of Rayonier property, provided above, is not intended to restrict or abridge the jurisdiction of the City as permitting authority over that property.

Section 9. Project Permitting

9.1 The Port and City will prepare and implement permitting and planning procedures consistent with this Agreement.

9.2 The Port and City will provide training on these procedures to all City and Port personnel who are involved with approving or conducting ground-disturbing work, and the State, City, Port and Tribe will collaborate to produce educational materials for the public, landowners, and developers about the sensitive nature and protection of archaeological resources.

9.3 The City, Port and State permitting staff will promptly consult the analysis maps described in Section 8 when they are contacted by landowners or developers with potential ground-disturbing projects, whether within or outside of Shoreline Management Act jurisdiction, and will use the maps to devise appropriate mitigation.

9.3.1. For purposes of this Agreement, "ground-disturbing" means operations, such as digging, trenching, boring, excavating, and drilling, that cause physical penetration of the surface of the ground by tools or equipment.

9.4 The State, City, Port and Tribe will identify or establish inter-governmental liaison positions for purposes of providing the verbal and written notice envisioned in this Agreement.

9.5 The Tribe will designate a person to serve as the agent for the Tribe in all matters relating to discoveries of archaeological resources. The City, Port and State permitting staff will provide oral and written notification to Tribal and DAHP contact persons as early in the process as possible, to inform the Tribe and DAHP when ground-disturbing projects are proposed within or near culturally sensitive areas. The names and phone numbers of the Tribal, City, Port and DAHP contact persons contemplated by this Section and Section 10.6 below are set forth in **Exhibit C** hereto, which shall be annually updated by the Parties' inter-governmental liaisons upon the anniversary of the effective date of this Agreement.

9.6 Mitigation.

9.6.1 As allowed by law and as provided herein, the Parties will mitigate development-related impacts to archaeological resources consistent with this Agreement and the order of preference for mitigation measures set forth in the State Environmental Policy Act (SEPA) and Shoreline Management Act (SMA), including those statutes' respective regulations, and other applicable law.

9.6.2 Under appropriate circumstances, the local government may deny a permit or other approval.

9.6.3 If ground-disturbing work is to occur in a culturally sensitive area of interest to the Tribe, to be determined through the archaeological analysis contemplated by Section 8 (*see* § 8.4), the Tribe shall be consulted with regard to a proposed mitigation plan before work commences, with the goal being development of a mitigation plan acceptable to all parties. By way of example, the agreed-upon mitigation plan could dictate that an on-site archaeologist and/or Tribal members or staff persons may monitor the work, and that the City, Port or State will take all reasonable means to ensure the Tribal representatives access to the site.

Section 10. Disposition of Discovered Artifacts and Human Remains

10.1 Under RCW 27.53 and subject to Section 10.3 below, archaeological resources may not be disturbed without a permit from DAHP. The City and Port will work with the Tribe and DAHP to ensure that cultural artifacts removed from government-owned lands are provided to the Tribe for appropriate curation or use. In addition, the City and Port will work with the Tribe, DAHP and landowners to encourage the transfer of cultural artifacts removed from private lands to the Tribe.

10.2 Based upon the Tribe's interests in human remains and funerary objects that are affiliated with the Tribe, if testing reveals human remains of five or less associated individuals (defined in Section 10.4 below) and if a different arrangement is not agreed to by the landowner, the human remains and associated funerary objects will be reinterred on the property described in Section 3 under the Tribe's supervision. Development may proceed within the area from which the remains and funerary objects were discovered.

10.3 Based upon the Tribe's interests in human remains and funerary objects that are affiliated with the Tribe, if testing reveals human remains of six or more associated individuals (defined in Section 10.4 below), the Parties will follow existing and future applicable law to determine, on a case-by-case basis and subject to such law, the disposition of the remains and associated funerary

objects. This Section is not intended to create any new or additional right of action for any party. *See* § 7 above.

10.4 For purposes of Sections 10.2 and 10.3, "associated individuals" shall be determined collectively by the Parties' archaeologists or designees, applying generally accepted archaeological methods, with the goal being a determination that is acceptable to all parties. In the event the archaeologists or designees collectively cannot agree within fourteen (14) days of their and the Parties' inspection of the site under Section 10.6 below, the City Archaeologist shall make the determination and the Parties shall defer to that determination unless inconsistent with generally accepted archaeological methods.

10.5 To the extent allowed by law, the applicable terms of this Agreement will be incorporated into federal, State and local permits and other approvals.

10.6 As a local permit condition, the permittee will immediately notify the Tribal Chair and specified Tribal staff by both letter and telephone (work and cellular), as well as the City, when new artifacts, features or human remains are discovered. In turn, the City will immediately notify DAHP, as required in RCW 27.44 and 27.53.

10.7 If archaeological resources are discovered, no further ground-disturbing activity will occur and no materials will be removed in an area around the discovery to be determined collectively by the Parties' archaeologists or designees, applying generally accepted archaeological methods with the goal being a determination that is acceptable to all parties, until such time as the requirements of subsections (1) through (5) below are satisfied; provided that in the event those archaeologists or designees cannot collectively agree on that initial "stop work" area within fourteen (14) days of the discovery, the City Archaeologist shall make the determination, and the Parties shall defer to that determination unless inconsistent with generally accepted archaeological methods.

(1) The notices contemplated by Section 10.6 are given;

(2) They and the Parties inspect the site along with the affected landowner;

(3) They determine the full extent of the culturally sensitive area affected by the project;

(4) An acceptable mitigation plan is developed and implemented in accordance with Section 10 and consistent with Sections 10.1 above regarding disposition of artifacts, and 10.2 and 10.3 regarding treatment of human remains, and applicable law; and

(5) A permit is obtained from DAHP, as required in RCW 27.44 and RCW 27.53, which may impose additional or different conditions on ground-disturbing activities.

If the Parties' archaeologists or designees collectively cannot agree on the matters in subsections (3) and/or (4), within fourteen (14) days of their and Parties' inspection of the site under subsection (2), determinations on such matters shall be made by the City Archaeologist applying generally accepted archaeological methods. The Parties shall defer to such determinations unless inconsistent with generally accepted archaeological methods.

With regard to subsection (5), any disturbance, excavation, or removal of archaeological resources or sites must comply with the conditions imposed in such permit. Alternatively, if ground-disturbing activities occur as part of a federal undertaking, as that term is defined in Section 301(7) of the National Historic Preservation Act (NHPA), 16 U.S.C. § 470w(7), any disturbance, excavation, or removal of archaeological resources or sites must comply with the requirements of Section 106 of the NHPA, 16 U.S.C. § 470f.

The provisions of Section 9 and 10 of this Agreement shall be applied in those areas which are subject to archaeological analysis pursuant to Section 8.9 hereof, and shall also be utilized as guidelines for permitting and construction activity in other areas of the City of Port Angeles and its Urban Growth Areas as now established or hereafter defined.

Section 11. Confidentiality

11.1 To the extent authorized by law, those portions of all reports, maps, or other information identifying the location of archaeological sites, objects, or human remains will be treated as confidential and exempt from public disclosure, to discourage looting and depradation.

11.2 To the extent authorized by law, those portions of the reports, maps, or other information identifying the location of archaeological sites or objects or human remains will be shared with state and local governmental permitting personnel. These portions of the reports, maps, or other information will be shared with landowners and their consultants only as absolutely necessary and with confidentiality procedures firmly in place, including, but not limited to: (1) maintaining a registry of names, addresses, and telephone numbers of those who view the information; (2) restricting copying; (3) notifying the Tribe if copies are requested or released; and (4) requiring that all copies are eventually returned or destroyed. These restrictions will be incorporated into all federal, State, and local permits and other approvals. Information identifying the location of archaeological sites or objects or human remains located on a particular parcel may be shared with the owner of that parcel during permitting activities or as otherwise required under law.

11.3 The State, City and Port may share with the public the non-confidential and non-exempt portions of the reports, maps, or other information for purposes of: (1) educating the public as to the sensitive nature of the cultural resources and the Tribe's cultural affiliation with the cultural resources; (2) encouraging repatriation (as described in Section 10); and (3) avoiding similar damage to cultural resources in the future; so long as the sharing of such information does not reveal the specific location of artifacts, human remains, features and sites, consistent with RCW 42.56.

Section 12. Future Planning

As necessary, the City will initiate and take all reasonable means to support the process to amend the Shoreline Master Program, and the City, Port and State will amend any plans or authorities, to reflect and implement this Agreement, and to provide notification to the public, landowners, and developers.

Section 13. State and Federal Designations

Under Sections 10.1 and 10.3 but not 10.2, the Tribe may seek the listing of historic properties under federal and state law for all qualifying properties, and take other action necessary to protect such properties.

Section 14. Dispute Resolution

14.1 The Parties agree that they shall attempt to resolve any dispute arising under this Agreement according to the following sequence of dispute resolution measures, until the dispute is finally resolved: (1) government-to-government consultation between the State, City, Port and Tribe through their inter-governmental liaisons designated pursuant to Section 9.4 above; (2) government-to-government consultation between the City Mayor, President of the Port Commission, Tribal Council Chair and designated representative of the State; and (3) mediation between the State, City, Port and Tribe facilitated by John Bickerman or some other mediator to be mutually agreed upon by the Parties.

14.2 If the measures in Section 14.1 do not result in final resolution of the dispute, any party may take such legal action as they deem appropriate. The Thurston County Superior Court will retain jurisdiction to enforce the terms of this Agreement. In the event any Party is required by the Thurston County Superior Court to file a new cause of action to enforce the terms of this Agreement, the Parties hereby waive sovereign immunity and consent to be sued to the extent necessary for such an action to proceed in the Thurston County Superior Court.

Section 15. Other Agreements

The agreement reached between the State and Tribe, and agreement reached between the State, City and Port, are each incorporated by reference as if fully set forth herein.

STATE OF WASHINGTON

By: _____
Christine O. Gregoire
Its Governor

LOWER ELWHA KLALLAM TRIBE

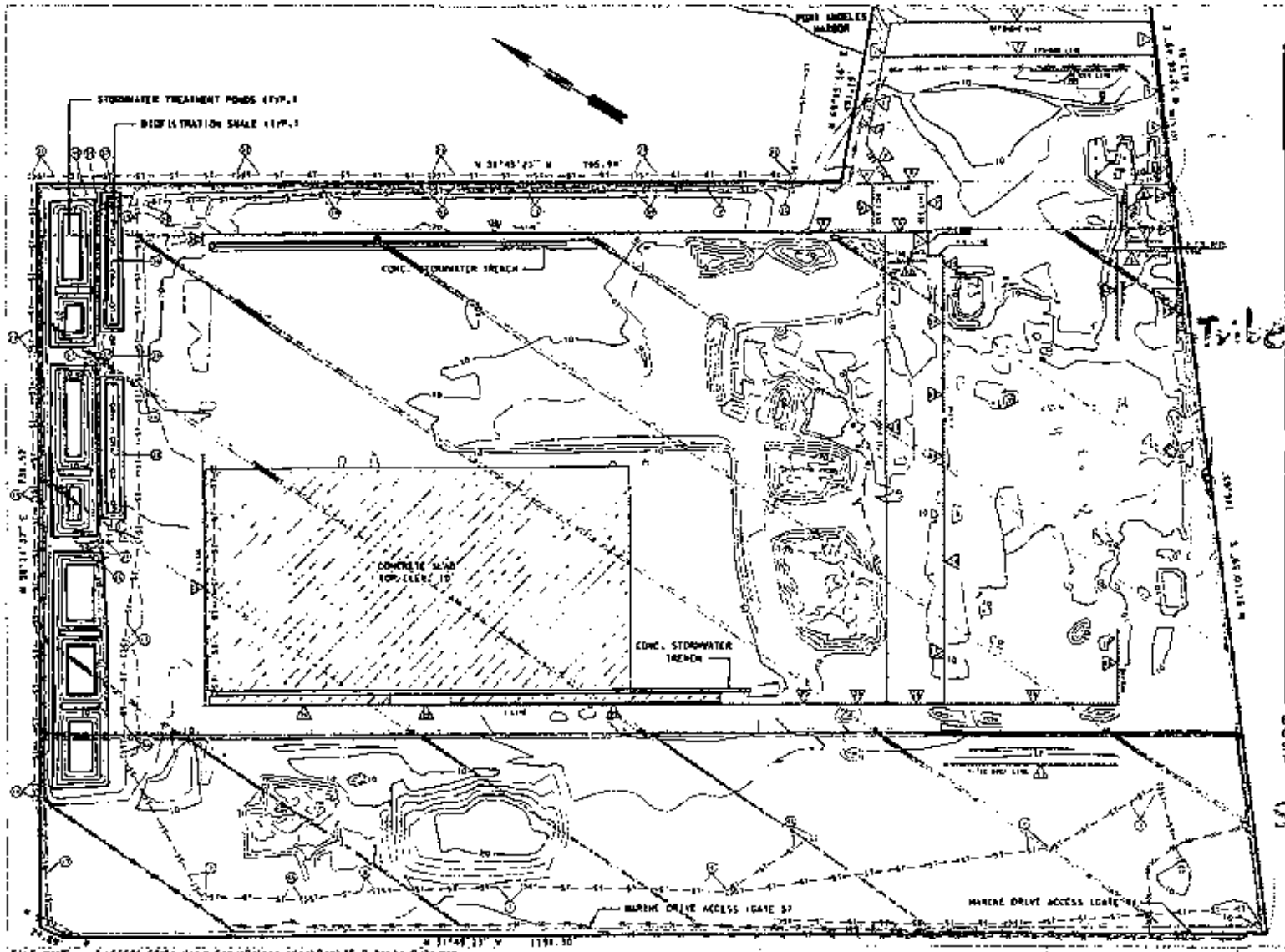
By: _____
Frances G. Charles
Its Tribal Chairperson

CITY OF PORT ANGELES

By: _____
Karen A. Rogers
Its Mayor

PORT OF PORT ANGELES

By: _____
W.M. "Bill" Hannan
President, Port of Port Angeles Commission



SHEET PILE CODES

△	PILE TYPE	TOP ELEVATION	PILE WIDTH
1	AZ 48	-70	45.63'
2	AZ 48	-55	45.63'
3	AZ 48	-54	45.63
4	AZ 48	-53.5	45.63'
5	AZ 48	-50	45.63'
6	AZ 48	-50	45.63'
7	AZ 36	-70	49.55'
8	AZ 36	-68	49.55
9	AZ 36	-64	49.55'
10	AZ 36	-62	49.55'
11	AZ 36	-50	49.55'
12	AZ 36	-43 TO -58	49.55
13	AZ 36	-51.5	49.55
14	AZ 36	-48	49.55'
15	AZ 36	-36 TO -44	49.55'
16	AZ 36	-42.5	49.55'
17	AZ 36	-41	49.55'
18	AZ 36	-27	49.55'
19	AZ 36	-6 TO -48	49.55'
20	PZ 40	-70	39.25
21	PZ 40	-47	39.25'
22	PZ 27	-30	36.00'
23	PZ 27	-35	36.00
24	PZ 27	-3 TO -15	36.00
25	PZ 22	-35	44.00'
26	PZ 22	-31	44.00'
27	PZ 22	-16 TO -17	44.00'
	PIPE	-82	2' DIAM.

LEGEND

- INLET
- CATCH BASIN
- MANHOLE
- DRAINAGE STRUCTURE CODE
- 2' DIAM. PIPE PILE
- SHEET PILE CODE
- SHEET PILE
- PROPERTY LINE
- STORM SEWER
- UNDERDRAIN LINE
- FENCE
- CONCRETE SLAB

BEARINGS AND DISTANCES ARE INFORMATIONAL ONLY. SEE THE PORT ANGELES GRAVING DOCK SITE SUNDRY SITE PLAN FOR MORE INFORMATION AND ACCURACY.

PROJECT DATUM NAVD 88

0 50 100
SCALE IN FEET

FILE NAME CJC6525 S104, Pasa Cons\Bridge Mach\Dgn\AS Built\As Built.dgn
FINE 07:56:55 AM
DATE 10/19/2005
PLOTTED BY
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.

REVISION DATE BY

FED. AID PROJ. NO.
10 WASH

Washington State Department of Transportation

PORT ANGELES GRAVING DOCK
TSE-WHIT-ZEN VILLAGE SITE
CITY OF PORT ANGELES
CLALLAM COUNTY, WA

AS BUILT EXHIBIT

PLOT 1

LEKT v State

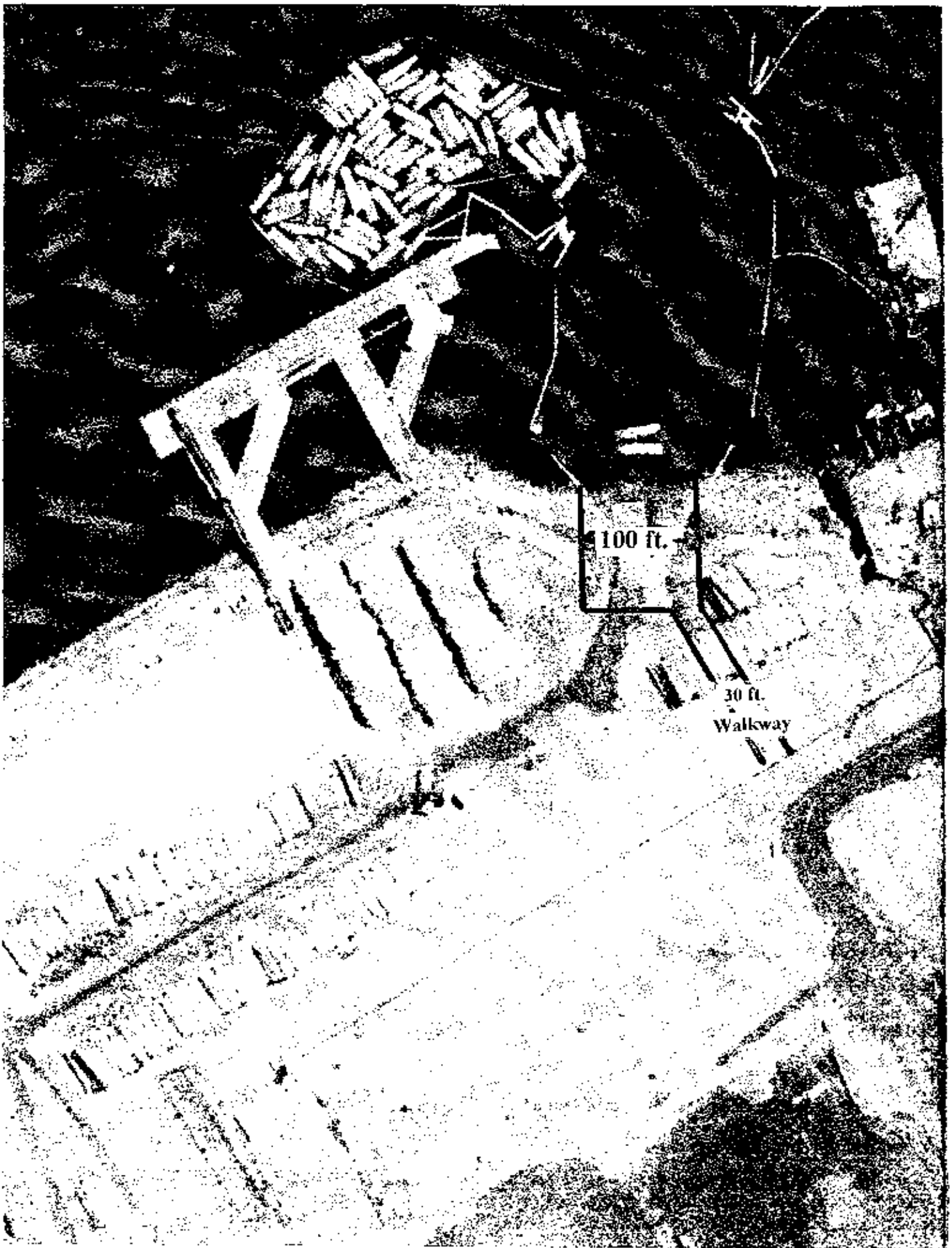


EXHIBIT B

EXHIBIT C

CONTACT PERSONS

LOWER ELWHA KLALLAM TRIBE

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CITY OF PORT ANGELES

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City Archaeologist
(Position yet to be filled)
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Phone: (360) 417-4500

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Randy Hain
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Washington State Department of Transportation
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MONITORING AND DISCOVERY PLAN

This monitoring plan establishes policies, describes the pre-project briefing, states responsibilities and chain of command, and provides procedures to ensure that any cultural resources or human remains encountered during construction are properly identified and appropriately treated. The Appendix (A) to this plan provides contact information for the personnel referenced in the following sections.

Policies

As a general policy, and as far as practically feasible, all cultural resources, prehistoric and historic, and buried human remains, will be avoided and actively protected in place. Collection of artifacts by employees, construction personnel, or others with access to the construction zone is prohibited. Typical markers of prehistoric activity include discarded shell, fire-modified rock, animal bone, lithic debitage, flaked or ground stone and bone tools, cordage, fibers, burned earth, charcoal, ash, and exotic rocks and minerals. Historic artifacts prior to the 1950s may include milled lumber, masonry features, concrete, glass, ceramic, brick, metal fragments or other evidence of early historic occupation and industry. In those instances where modification of the project to accommodate avoidance of an archaeological resource is not possible, the resource in question will be treated in the manner described below.

Briefing

Prior to construction, the Monitoring Coordinator will brief the Construction Supervisor and construction crew members on cultural resource issues. The briefing will include information on the legal context of cultural resources protection and on the prehistoric, ethnographic and historic cultural resources likely to be present in the construction area. The primary goals of this briefing are to familiarize construction personnel with the procedures to be followed in the event there is discovery of cultural material (see

below), and to provide contact protocols and information to construction supervisors.

Chain of Communication

The project supervisor will insure that the provisions of this document are carried out, and the Supervising Professional Archaeologist will report to the project supervisor. The Supervising Professional Archaeologist's designated Monitoring Coordinator will schedule the monitoring activities. (A minimum of 48 hours notification of the need for a monitor is required if monitoring becomes intermittent as construction progresses.) The archaeological monitor will be present whenever ground-disturbing construction activities occur within the areas determined to be archaeologically sensitive as identified The Monitor will have the authority to temporarily halt construction while examining possible discoveries, and will also be responsible for notifying the project supervisor and Construction Superintendent immediately of any discoveries. The project supervisor is then responsible for notifying the appropriate officials including the Department of Archaeology and Historic Preservation (DAHP), the Lower Elwha Klallam Tribe (LEKT), the Clallam County Coroner, and the Port Angeles Police (see Appendix A). The Monitor will be responsible for maintaining daily work records and documentation of any discoveries.

MONITORING PROCEDURES

The Monitor will examine cleared and graded surfaces exposed by grading and trenching to identify any previously undocumented prehistoric or historic archaeological materials. The Monitor will be observing construction equipment work and sediment removal from multiple perspectives around and in front of working equipment, requiring close communications with construction supervisors and equipment operators; be safely stationed on the edge of a trench, or near a track hoe bucket, to observe trench sidewalls as they are excavated; will coordinate with construction personnel to enter an excavation trench or similar type of shored, enclosed space; may examine excavation spoils, if the material is placed on the ground prior to removal.

1) The LEKT Cultural Resources Program (CRP) Monitor will examine cleared and graded surfaces exposed by excavation and the excavation spoils to identify any previously undocumented cultural remains within the project area. These may include the remains of both prehistoric and historic activities and occupations. Typical markers of prehistoric activity include such things as: discarded shell, fire-modified rock, animal bone, lithic debitage, flaked or ground stone tools, burned earth, cordage or fiber, charcoal, ash, and exotic rocks and minerals. Typical markers of historic activity include such things as: old bottles, ceramic shards, nails, wire, and wood.

2) The contractor's construction supervisors will report any cultural, historic or archeological resources, including isolated artifacts, encountered by construction personnel to the CRP Monitor, who will communicate the nature of the find to the CRP Monitoring Supervisor. The CRP Monitors will ensure proper documentation and assessment of the finds.

3) The CRP Monitor will record all prehistoric and historic cultural material discovered by the Monitors or construction personnel on CRP standard forms. Initial effort will focus on establishing the nature, provenience and integrity of any discovery. Documentation methods include photographs, sketches, scaled drawings, and written descriptions. The CRP Monitor may take samples and artifacts for identification or analysis.

4) The primary goal of archaeological monitoring will be discovery and documentation of previously unknown cultural material in the project. Where complex or extensive cultural remains are encountered, the CRP Monitoring Supervisor may assign a team of archaeologists and CRP cultural resources technicians (CRTs) to provide timely documentation and assessment of the resource.

5) Newly discovered sites or components that appear to be significant will include resources with intact, stratified deposits or diagnostic artifacts or features that could provide chronological data as well as information about prehistoric or historic activities. If in the opinion of the CRP Monitor, significant cultural material has been encountered, the CRP Monitor will immediately contact the equipment operator, the CRP Monitoring Supervisor, and the Construction Superintendent and arrange for the re-direction or the halting of construction as needed until preliminary investigation and documentation can be completed. Where such sites or components are encountered during construction, but in the opinion of the CRP Monitor additional project effects to the resource are not anticipated, project construction may continue while cultural resource documentation and assessment proceed. If, in the opinion of the CRP Monitor, continued construction could cause additional impacts to such resources, project activities may be stopped in the vicinity of the discovery until the find has been documented, evaluated for significance, and potential project effects assessed.

6) Newly discovered cultural material will be reported by the CRP Monitor to the Construction Supervisor and CRP Monitoring Supervisor upon discovery. The CRP Monitoring Supervisor will ensure that the Tribal Archaeologist is fully briefed on the discovery. The CRP Monitoring Supervisor will assemble the documentation produced by the CRP Monitors and the preliminary assessment of significance that will accompany

draft site records. If warranted, site registration forms will be filed with the Washington State Department of Archaeology and Historic Preservation (DAHP). Criteria and integrity requirements for listing on the National Register (36 CFR 60.4) will provide the standards for identification and evaluation of significance for cultural material. If a discovery is made during construction, the agency official, in consultation with the SHPO, may assume eligibility for purposes of Section 106 and resolution of adverse effects [36 CFR 800.13 (c)].

7) Should the project require excavation or removal of archaeological or historic archaeological resources or sites, or Indian cairn or grave, or glyphic or painted record, an Archaeological Excavation and Removal permit will be obtained from the DAHP prior to excavation (WAC 25-48).

8) If project effects to an historic property cannot be avoided, a treatment plan will be developed and implemented by the agency and the CRP, in consultation with the DAHP. The Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation will apply including provisions for a Research Design, Documentation, Reporting, and Curation.

9) The particular data recovery measures applied to any given property will depend on development of research questions and design of excavation strategies to acquire the data needed to answer those questions. Field notes, maps, plans, profiles, and photographs should document the process. The final report should follow style guidelines of the professional archaeological journal, American Antiquity, synthesize the data collected, and address the research questions posed.

10) The CRP Monitoring Supervisor will co-ordinate the dissemination of any information beyond required reports that is deemed appropriate by the CRP, concerning cultural resources and this project.

11) Any samples or artifacts collected during monitoring will be held in secure storage by the CRP until such a time as they can be analyzed, conveyed to a repository that meets federal standards (36 CFR part 79), or returned to their original location. The CRP may provide this service.

12) The agency or private party agrees to donate to the Lower Elwha Klallam Tribe any artifact discovered that the CRP determines is of significance to the Tribe. If the artifact is exhibited in the Lower Elwha Klallam Tribe's Museum, Library and Research Center (MLRC), the display information will state that the agency or private party donated the artifact.

13) If items of cultural patrimony are identified on federal property, the agency will comply with the Native American Graves Protection and Repatriation Act (NAGPRA).

Communication

The Monitor will communicate with the onsite Construction Supervisor to make general requests about equipment movement, placement of spoils for examination, or to access trench excavations. The Monitor may also need to communicate with excavation equipment operators to determine appropriate timing and procedures to access construction excavation areas such as trenches or open excavations. The Monitor may direct the equipment operator to stop excavation or modify excavation, but will notify the Construction Supervisor prior to communicating excavation procedures directly to the equipment operator.

Work Stoppage

If the Monitor determines that archaeological resources considered significant may be exposed by construction excavation in a particular area, the Monitor may ask the Construction Supervisor to request equipment operators to modify construction excavation procedures to provide exposures of subsurface stratigraphy in order to confirm the presence of any such resources in that area. Work may be stopped in an area sufficient to assess resources that may be significant and time will be provided for additional evaluation by field archaeologists.

1) If significant, or potentially significant, archaeological resources are identified during construction; the Monitor will inform the Construction Supervisor. The Construction Supervisor will halt activity in the area of discovery large enough to ensure the integrity of the find is not compromised (though construction activities may continue elsewhere in the project area). The Construction Supervisor will contact the Project Engineer.

2) The project supervisor will contact the DAHP and the affected tribes within one working day.

3) The project supervisor shall arrange for the parties, including the Supervising Professional Archaeologist, to conduct a joint viewing of the discovery within forty-eight (48) hours of the notification, or, if that is not feasible, at the earliest time thereafter.

4) The project supervisor shall consult with the DAHP and affected tribes, if remains are Native American, on a data recovery plan. Resumption of work in the area of the discovery will be consistent with the results of the consultation.

DISCOVERY OF HUMAN REMAINS

If any construction activity exposes anything that appears to be human remains, either burials or isolated teeth or bones, or other mortuary items, construction in the vicinity of the find will halt immediately in an area sufficient to maintain integrity of the deposit and the following protocol shall be used:

1) All persons shall immediately halt ground-disturbing activities around the discovery and it shall be secured with a perimeter of not less than thirty (30) feet (Area of Discovery).

2) The Supervising Professional Archaeologist will immediately notify the Project Supervisor.

3) Upon receiving notice, the project supervisor shall immediately notify the Port Angeles City Police and the Clallam County Coroner and request that the Coroner determine if the remains are Native American and if the site is a crime scene.

4) Contemporaneous with notifying law enforcement and the Coroner, the Project Supervisor shall also notify the DAHP and the Lower Elwha Klallam Tribe (LEKT) of the discovery.

5) The project supervisor and the Supervising Professional Archaeologist will work with the responsible law enforcement designee and the Coroner and request they handle the remains and disturb the site only to the extent needed to determine if the remains are Native American and if the setting is a crime scene.

6) If the human remains are determined by the Coroner to be Native American, then the Project Supervisor shall consult with the Lower Elwha Klallam Tribe (LEKT) and DAHP to determine treatment and disposition.

7) If the human remains are determined by the Coroner not to be Native American, and the Lower Elwha Klallam Tribe (LEKT) does not reasonably object to that determination, then neither the Project Supervisor nor the LEKT shall have any further obligation to one another for the handling of such remains under this agreement.

8) If human remains, funerary objects, ceremonial objects, or artifacts are inadvertently collected during any archaeological investigation on behalf of the Project Proponent and identified as Native American in the field or in the laboratory, the Project Proponent in

consultation with DAHP and LEKT, will notify and return the remains, objects or artifacts to the LEKT within twenty-four (24) hours of the identification, or if that is not practical, then at a time acceptable to the LEKT. Such human remains, funerary objects or artifacts shall remain unwashed and without further analysis, and shall remain onsite with 24-hour security.

CONFIDENTIALITY

All parties recognize that archaeological properties are of a sensitive nature, and sites where cultural resources are discovered can become targets of vandalism and illegal removal activities. All parties shall keep and maintain as confidential all information regarding any discovered cultural resources, particularly the location of known or suspected archaeological property, and exempt all such information from public disclosure consistent with RCW 42.56.300.

All information indicating the location of known suspected archaeological properties from this Project shall be turned over to DAHP. While any party is in possession of this confidential information, such party shall limit access to these records to authorized persons with a need to know the information and shall keep a log identifying all persons who access the record, that person's governmental agency or private affiliation, the date the access was permitted, any materials copied, and the purpose and for whom such records were copied. DAHP will keep all information received permanently secured and confidential.

All parties shall ensure that its personnel, contractors, and permittees keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential, including but not limited to, refraining such persons from contacting the media or any third party or otherwise sharing information regarding the discovery with any member of the public. All parties shall require its personnel, contractors and permittees to immediately notify the Project Proponent of any inquiry from the media or public. The Project Proponent shall immediately notify DAHP of any inquiries it receives. Prior to any public information release, the Project Proponent, DAHP, and LEKT shall

concur on the amount of information, if any, to be released to the public, any third party, and the media, and the procedures for such a release.

REPORTING

The LEKT will prepare a report documenting the results of the archaeological monitoring within 60 days of the conclusion of monitoring activities and no later than 13 months after the issuance of the construction contract. The report will include the following elements, and will be provided to all of the consulting agencies. Inventory of cultural resources results, if any; Analysis of cultural resources, including a discussion of the integrity of the resources and determination of whether a resource is eligible for inclusion on the National Register of Historic Places or the Washington Heritage Register; Documentation of consultation with the LEKT regarding significance of any cultural resources encountered during the construction.

APPENDIX A

CONTACT INFO:

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Clallam County Coroner

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Appendix G
Detailed Cost Estimate Information

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
CY	Cubic yards
EMNR	Enhanced monitored natural recovery
Harbor	Port Angeles Harbor
RI/FS	Remedial Investigation/Feasibility Study
RMC	Residuals management cover
SCU	Sediment Cleanup Unit
SMA	Sediment Management Area

1.0 Introduction

This appendix presents the cost estimates for the remedial alternatives for the Western Port Angeles Harbor Sediment Cleanup Unit Remedial Investigation/Feasibility Study (RI/FS). This appendix documents the common assumptions for all remedial alternatives, including sediment removal, transloading, disposal, material placement, remedial design, permitting, monitoring, and construction support. The remedial approach, unit costs, and construction timeframes presented in this appendix are based on recent project experience at other sediment remediation sites in the Puget Sound region, considering the characteristics of Port Angeles Harbor (the Harbor). All costs assumptions presented in this appendix were developed only for the purpose of comparing alternatives; the final details associated with remediation will be revisited during remedial design and, as a result, estimated costs may be revised. Consistent with guidance for feasibility study-level costing (USEPA 2000), these costs are considered accurate to a range of approximately +50 to -30 percent.

The alternatives are developed and discussed in Section 14.0 of the RI/FS. Costs are developed for the alternatives for the three Sediment Management Areas (SMAs) developed in the RI/FS. This cost estimate assumes that the work for all SMAs will occur as a single project and thus reflects some efficiency associated with completing a larger project; if work in any SMA is to be conducted as an independent project, overall total costs would be higher. The general unit cost assumptions and unit cost notes are presented in Table G.1. Unit costs for monitoring are developed in Table G.2. The unit quantities and total costs for SMAs 1, 2, and 3 are presented in Tables G.3, G.4, and G.5, respectively. Tables G.6, G.7, and G.8 present the estimated dredging and placement surface areas, depths, volumes, and construction durations for the remedial alternatives for SMAs 1, 2, and 3, respectively. Table G.9 provides the total estimated cost for the preferred cleanup remedy.

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2.0 Development of Unit Costs

The following sections describe the unit costs presented in Table G.1.

2.1 MOBILIZATION AND DEMOBILIZATION

The contractor must perform numerous activities prior to and after construction of the remedial alternatives—referred to as mobilization and demobilization—including delivering equipment and barges to the Harbor and constructing support facilities. For the Western Port Angeles Harbor Sediment Cleanup Unit (SCU) remediation, the mobilization and demobilization are split into five line items described in the following paragraphs.

Annual mobilization/demobilization (line item 1.01) includes costs for: equipment preparation; procedural costs; special insurance; bonding; annual preparation of staging, transloading and material stockpile areas; implementation of site controls; project management labor; office space; and preparation of construction submittals. Construction activities will occur prior to the start of each construction season (the fish window for in-water work is assumed to be from July 15 to February 15). Based on costs in Puget Sound and considering the Harbor location, mobilization/demobilization are estimated to be $250,000 per construction season.

A key limitation to remedial construction in the SCU is procuring a property for transloading dredged sediment from the water to the shore for disposal, or transloading cap and cover materials from the shore to the water for placement. A conceptual transloading facility has been developed for this RI/FS (as described in Section 12.1.2 of the RI/FS), and the mobilization/demobilization cost estimates were developed reflecting the anticipated operational advantages and limitations of this specific conceptual transloading area. Line item 1.02 includes costs to develop the transload facility at the start of the project including costs to clear, improve, and install environmental controls. Line item 1.03 includes that cost to purchase and install a shoreline conveyor to move placement material from stockpiles to the barges. Finally, line items 1.04 and 1.05 include preliminary costs for lease of properties that will be used during construction calculated based on typical lease rates in the Port Angeles area.

2.2 DREDGING AND EXCAVATION

Sediment removal is a component of some remedial alternatives for SMAs 1 and 2. This cost estimate assumes different construction equipment would be needed in four different areas of the SCU. SMA 1 inner harbor intertidal areas are assumed to be accessed by standard earthwork equipment during low tide. Excavated material would be stockpiled or loaded directly into trucks for disposal without the need for a dewatering step because it is assumed inner harbor intertidal area sediments are granular materials that will drain quickly during excavation. Cost for inner harbor intertidal area excavation is estimated at $17 per cubic yard (CY) based on recent bids on similar projects (line item 2.01). In SMA 1 subtidal areas, removal is assumed to occur by dredging with mechanical marine equipment. Costs for dredging are estimated to be $25 per CY based on

recent bids (line item 2.02). In SMA 2 lagoon intertidal areas, shoreline access is more limited than for SMA 1, the lagoon intertidal area extends further from the bank, and sediments are soft. To account for these challenges, excavation costs are estimated to be $25 per CY using standard earthwork equipment, including removal and stockpiling or direct loading of trucks (line item 2.03). SMA 2 subtidal areas are the hardest to access due to the distance from the shoreline, soft lagoon intertidal area sediments, and lack of access to bring marine equipment in from the Harbor. Potential methods for accessing sediment in this area include constructing a portable barge, providing access by amphibious excavator, damming the lagoon and pumping water (including groundwater seepage) to perform work in the dry, and using a hydraulic dredge and constructing a settling pond. For RI/FS cost estimating purposes, it is assumed that a portable barge would be constructed and work would cost $40 per CY (line item 2.04). Sediment would be dredged directly to an adjacent stockpile area or directly loaded to trucks.

2.3 TRANSLOAD AND DISPOSAL

Following removal, sediment will be transloaded to trucks and transported for upland disposal. All SMA 2 sediments and SMA 1 inner harbor intertidal area sediments are assumed to be free draining and could, therefore, be loaded directly to trucks without a separate dewatering step as part of the unit cost for removal. Dredged sediment from subtidal SMA 1 is assumed to require a separate dewatering step (assumed in this case to be mixing with a drying additive) prior to transport and disposal, at an additional cost of $30 per CY, based on best professional judgment (line item 3.01).

Two disposal options were considered for the remedial alternatives cost development. Option 1 consists of trucking to a local landfill. For evaluation purposes, the location of this landfill is assumed to be the City of Port Angeles bluff landfill approximately 3 miles from the SCU. Preliminary discussions between the Western Port Angeles Harbor Group and the landfill administrators indicate that there is additional permitted capacity within the northeast corner of the landfill. Preliminary discussions indicate this project could potentially use this available capacity, but would require permitting and approval, and a total volume of material to be disposed that would balance the cost savings of local disposal with the expense of opening and reconstructing the existing landfill infrastructure (gas and leachate collection systems, cap, etc.). During the design phase, following remedy selection, local landfill disposal may be re-evaluated for applicability to this project. Given the uncertainty in the ability to obtain necessary permits and approvals, and the limited applicability of this disposal option to a subset of alternatives, for this cost estimate, the second option, off-site disposal at an established Subtitle D landfill was used.

Trucking material off-site from Port Angeles to Tacoma, Washington, where the material will be offloaded into railcars and transported to a Subtitle D commercial landfill located in Eastern Washington for disposal was assumed. This transportation and disposal method was recently used on another MTCA cleanup project in Port Angeles in 2015. The cost for transload of material from stockpiles or barges onto trucks is estimated to be $30 per CY (line item 3.01).

The total cost for transportation is estimated to be $34 per CY (line item 3.02) and tipping is estimated to be $90 per CY (line item 3.03), based on recent project experience for transport of material this distance.

2.4 SAND AND GRAVEL PURCHASE, DELIVERY, AND TRANSLOAD

Cap and cover material placement is included in some remedial alternatives for SMAs 1, 2, and 3. Material placement activities include the placement of backfill material (within the inner harbor intertidal areas of SMA 1 to an average thickness of 12 feet and within all areas of SMA 2 to an average thickness of 4 feet), capping material (2 feet average), enhanced monitored natural recovery (EMNR) material (6 inches average), and residuals management cover (RMC) material (6 inches average). All placement materials are expected to be sand or gravel, as determined during design. For FS purposes, the costs for sand and gravel are anticipated to be approximately $25 per CY, delivered to the SCU from a local commercial quarry (line items 4.01 and 4.02).

Like removal, the cost for material placement varies by area. In SMA 1 inner harbor intertidal areas, and all of SMA 2, material would be accessed from shoreline stockpiles and placed using standard upland construction equipment. In the subtidal area of SMA 1 and all of SMA 3, material would be transloaded to a barge and then placed using marine construction equipment. The cost for transloading to barge is estimated to be $3 per CY.

2.5 SAND AND GRAVEL PLACEMENT

The unit cost for placement is expected to be similar to removal because both activities use similar equipment and have similar constraints. Unit costs for placement are the same as for removal for the four areas of SMAs 1 and 2, as described above (line items 5.01 through 5.04), with the exception of subtidal placement. Due to the large area of placement for SMA 3, some economy of scale is expected, and unit cost is estimated at $20 per CY, consistent with experience performing similar work at other sites (line item 5.02).

2.6 PRODUCTION RATES

Production rates for removal are estimated to be 500 CY per day in all areas based on project experience in Puget Sound. Transloading throughput is expected to be a key constraint on the rate of subtidal dredging. Constraints on intertidal excavation include working around tides, truck loading, and shoreline access.

Production rates for placement activities depend on the transloading rate that is achievable in the SCU and the thickness of the placement. As for dredging, 500 CY per day is considered the maximum rate of placement for the project, due to stockpiling and transloading constraints. This production rate is the upper limit assumed for all backfilling and capping activities. For thin layer placement (EMNR and RMC), a slower production rate of 350 CY per day is assumed to account for frequent barge movements associated with the more precise tolerances for thin-layer placement, consistent with past experience on similar projects in Puget Sound.

2.7 ADDITIONAL COSTS

Table G.1 provides several other project cost assumptions, as described below:

- It is typical for remediation projects to have interim progress surveys throughout the project while removing or placing material. These surveys are assumed to cost $10,000 per week (line item 6).
- An eelgrass bed is present in the lagoon subtidal area that could require mitigation should the area be dredged. The cost to transplant and replace eelgrass is estimated to be $50,000 (line item 7).
- Sales tax is 8.4 percent of total base construction costs (line item 8.01).
- Design, permitting, and construction support includes pre-remedial design investigation, an engineering design report, and design, permitting, and construction management for the project duration. These costs are assumed to be 20 percent of the total base construction costs (line item 8.02).
- Environmental compliance during construction, including monitoring and reporting, is assumed to be $8,000 per week, consistent with past project experience (line item 8.03).
- Project contingency is estimated to be 30 percent of total base construction costs (including tax), consistent with other sediment remediation projects of this magnitude. This contingency includes uncertainty in unit cost assumptions as well as uncertainty in overall project scope (e.g., total removal volume; line item 8.04).
- Annual adaptive management monitoring will be performed during EMNR placement based on Appendix I, the Construction Quality Assurance and Adaptive Management Plan (line item 8.05).

2.8 MONITORING COSTS

Monitoring unit costs are built up in Table G.2 based on prior experience at the site and best professional judgment. Physical monitoring costs for SMAs 1 and 2 are presented in line items 9.01 and 9.02. Surfaces sediment sampling costs per event are developed based on daily rates, analytical unit costs per sample, and monitoring density for the SMAs (line item 9.03). Similarly, contingency source control investigation costs are estimated based on unit costs per sample and per event (line item 9.05). Finally, line items 9.04, 9.06, and 9.07 present lump sum estimates for reporting and Ecology coordination, contingency capping evaluations, and Sediment Recovery Zone management.

3.0 Alternatives Costs Summary

3.1 SEDIMENT MANAGEMENT AREA 1: INNER HARBOR

The total construction costs for SMA 1 alternatives are estimated to range from $1.5 million for Alternative 1-F to $197 million for Alternative 1-A (Table G.3).

Estimated surface area, volumes, and construction durations are provided in Table G.6. The removal volumes were estimated based on a simple depth multiplied by surface area equation for each area. For full removal of all impacted sediment, the dredge thickness was estimated to be 12 feet throughout SMA 1, based on available core data, including overdredging. For partial removal (followed by capping), the dredge thickness was assumed to be 2 feet. The production rate for removal is estimated to be 500 CY per day for all removal activities, with the primary limiting factor being the rate that material can be transloaded and removed from the SCU.

The material placement volumes were also estimated based on a simple thickness multiplied by surface area equation for each area. This estimate assumes that, following removal in intertidal areas, backfill would be placed to restore the original grade and conserve habitat. In addition, in subtidal dredge areas, an average 6-inch-thick layer (to achieve a minimum thickness of 4 inches) of RMC would be placed. However, during construction, chemical testing could be used to assess the need for RMC (e.g., if sediment concentrations are less than action levels, then RMC may not be necessary). Capping areas are assumed to require an average of 2 feet of placement (including overplacement) and EMNR areas are assumed to require an average of 6 inches of placement (also including overplacement). The production rate for removal is estimated to be 500 CY per day for placement layers 2 feet or more of thickness (capping or backfill), and 350 CY per day for 6-inch-thick placement (EMNR or RMC) to account for slower production rates during thin-layer placement.

3.2 SEDIMENT MANAGEMENT AREA 2: LAGOON

The total construction costs for SMA 2 alternatives are estimated to range from $7.0 million for Alternative 2-E to $59 million for Alternative 2-A (Table G.4).

Estimated surface area, volumes, and construction durations are presented in Table G.7. Like SMA 1, the removal volumes were estimated based on a simple depth multiplied by surface area equation for each area. For full removal of all impacted sediment, the dredge thickness was estimated to be 4 feet throughout SMA 2, including overdredging. Like SMA 1, for partial removal (followed by capping), the dredge thickness was assumed to be 2 feet, and the production rate was estimated to be 500 CY per day.

The material placement volumes were also estimated based on a simple thickness multiplied by surface area equation for each area using the same assumptions as SMA 1.

3.3 SEDIMENT MANAGEMENT AREA 3: WATERFRONT AND OUTER HARBOR

The total construction costs for SMA 3 alternatives are estimated to range from $2.8 million for Alternative 3-D to $22.5 million for Alternative 3-A (Table G.5). Estimated placement surface areas, volumes, and construction durations are presented in Table G.8 and use the same assumptions as discussed for SMAs 1 and 2.

3.4 PREFERRED CLEANUP REMEDY

The RI/FS determined that the preferred cleanup remedy consists of alternatives 1-D in SMA 1, 2-E in SMA 2, and 3-B in SMA 3. Costs for the preferred cleanup remedy were estimated for a combined project total in Table G.9. The total cost of $34.4 million is consistent with the total of the individual cost estimates for the alternatives. These costs are based on the best available information for FS-level costing, and are accurate to a range of approximately +50 to -30 percent.

4.0 References

U.S. Environmental Protection Agency (USEPA). 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Publication No. EPA 540-R-00-002/OSWER 9355.0-75. Prepared by the USEPA Office of Emergency Remedial Response and the U.S. Army Corps of Engineers Hazardous, Toxic, and Radioactive Waste Center of Expertise. July.

Appendix G
Detailed Cost Estimate Information

Tables

Table G.1
General Unit Costs

Cost Element ID	Cost Element	Unit Cost	Unit	Unit Cost Notes
1.00	**Mobilization/Demobilization and Transloading Setup and Maintenance**			
1.01	Annual Mobilization/Demobilization	$250,000	Annual	Best professional judgment considering alternative components. Includes mobilization and demobilization of removal and placement operations, barges, equipment preparation, upland equipment, staging areas, stockpile areas, implementation of site controls, ancillary equipment, procedural costs, special insurance and bonding, and preparation of submittals.
1.02	Transload Site Preparation	$330,000	LS	Estimated cost for site improvements. For alternatives: one third of lump sum costs to avoid triple-counting SMAs 1 through 3.
1.03	Transload Site Shoreline Conveyor	$100,000	LS	Approximately $100,000 for shoreline conveyor purchase and assembly. For alternatives: one third of lump sum costs to avoid triple-counting SMAs 1 through 3.
1.04	Transload (Port) Property Lease	$236,000	Annual	Approximate costs based on $0.10/sq ft*month unit cost for harbor-front property, and $0.0225/sq ft*month for upland property.
1.05	McKinley Property Lease	$61,000	Annual	Approximate costs based on $0.0225/sq ft*month for upland property (5.2 acres adjacent to the Lagoon). Applies to SMA 2 only.
2.00	**Removal and Dewatering**			
2.01	SMA 1 Inner Harbor Intertidal Area Excavation to Stockpile	$17	CY	Based on recent project experience. Includes both intertidal excavation and upland excavation for mitigation.
2.02	SMA 1 Subtidal Harbor Dredging to Barge	$25	CY	Based on recent project experience.
2.03	SMA 2 Lagoon Intertidal Area Excavation to Stockpile	$25	CY	Based on recent project experience. Includes both intertidal excavation and upland excavation for mitigation.
2.04	SMA 2 Subtidal Lagoon Dredging to Stockpile	$40	CY	Based on recent project experience and Engineer's estimate of potential construction methods for accessing soft subtidal sediments.
3.00	**Transload and Disposal**			
3.01	Transload Subtidal Material From Barge to Truck	$30	CY	Includes material transfer from subtidal dredge material barge onto offloading areas, water management with a drying additive (e.g., Portland cement), and loading trucks for off-site transportation to Tacoma.
3.02	Truck to Tacoma	$34	CY	Trucking estimate based on 212-mile round trip and average trucking rate of $138/hour with a 30-ton load for truck with pup. Includes load and off-load.
3.03	Transload and Disposal	$90	CY	Based on recent project experience. Includes transload of material from trucks to rail in Tacoma and transport by rail to the Roosevelt regional landfill in Western Washington for disposal. Includes both intertidal sediment, and upland material excavated for mitigation.
4.00	**Sand and Gravel Purchase, Delivery, and Transload**			
4.01	Purchase	$15	CY	Based on recent bids and project experience.
4.02	Truck to Stockpile	$10	CY	Trucking estimate based on 10 mile round trip over surface streets at a rate of $125/hour with a 15 ton load per truck. Includes load and off-load.
4.03	Transload to Barge for Subtidal Placement	$3	CY	Based on recent bids and project experience. Transload is only necessary for barge-mounted placement material (subtidal placement). This includes crossing the road on a conveyor or by truck.
5.00	**Placement**			
5.01	Inner Harbor Intertidal Area Sand and Gravel Placement From Stockpile	$17	CY	Based on recent bids and project experience.
5.02	Subtidal Harbor Sand and Gravel Placement from Barge	$20	CY	Based on recent bids and project experience.
5.03	Lagoon Intertidal Area Sand and Gravel Placement From Stockpile	$25	CY	Based on recent bids and project experience.
5.04	Subtidal Lagoon Sand and Gravel Placement from Stockpile	$35	CY	Engineers estimate considering possible methods for placing material on soft subtidal sediments.

Table G.1
General Unit Costs

Cost Element ID	Cost Element	Unit Cost	Unit	Unit Cost Notes
6.00	**Surveys and Monitoring (Contractor Daily Progress Surveys)**			
	Surveys and Monitoring (Contractor daily progress surveys)	$10,000	Week	Based on recent bids and project experience.
7.00	**Eelgrass Transplanting**			
	Eelgrass Transplanting	$50,000	LS	Assumed cost to replace eelgrass for subtidal capping and dredging options only.
8.00	**Additional Costs**			
8.01	Tax	8.4%		Percent of subtotal of pre-construction costs and construction base costs.
8.02	Design, Permitting, and Construction Support	20%		Includes pre-remedial design investigation, Engineering Design Report, design, and permitting.
8.03	Environmental Compliance and Construction Quality Assurance	$8,000	Week	Includes labor, equipment, materials, and field testing for Water Quality Monitoring; Owner's project management costs; and Agency review and construction oversight costs.
8.04	Contingency	30%		Percent of construction costs. Typical Conceptual-level Contingency; mid-range of USEPA Feasibility Cost Guidance (USEPA 2000) for contingency. Percent of pre-construction, construction, and tax.
8.05	Adaptive Management Monitoring During EMNR Placement (SMA 3)	$91,333	Annual	Based on the calculation in Table G.2.
9.00	**Monitoring**			
9.01	Post-Construction Physical Monitoring: SMA 1	$23,500	Event	Based on the calculation in Table G.2.
9.02	Post-Construction Physical Monitoring: SMA 2	$26,500	Event	Based on the calculation in Table G.2.
9.03	Post-Construction Sediment Quality Monitoring	$73,600 to $125,733	Event	Based on the calculation in Table G.2. Unit cost varies for each SMA.
9.04	Reporting and Ecology Coordination During Long-Term Monitoring	$10,000 to $30,000	LS	Based on the calculation in Table G.2. Unit cost varies for each SMA.
9.05	Contingency Sediment Trap Sampling to Assess Source Control in SMA 3	$52,000	Event	Based on the calculation in Table G.2.
9.06	Contingency Capping Evaluations (e.g., Coring)	$10,000	LS	Based on the calculation in Table G.2. Applies to SMA 1 and SMA 2 only.
9.07	Sediment Recovery Zone Management	$100,000	LS	Based on the calculation in Table G.2. Applies to SMA 3 only.

Abbreviations:

*	Multiplied by
CY	Cubic yards
EMNR	Enhanced monitored natural recovery
LS	Lump sum
SMA	Sediment Management Area
sq ft	Square feet
USEPA	U.S. Environmental Protection Agency

Table G.2
Monitoring Unit Costs

Element IDs	Monitoring Program Elements					
9.01	**Post-Construction Physical Monitoring: SMA 1**					
	Description	**Unit Cost**	**Unit**	**Notes**		
	Bathymetric survey	$18,500	survey	Based on project experience		
	Visual Inspection/Topo survey	$5,000	inspection	Best professional judgment		
	9.01 Subtotal	$23,500	event			
9.02	**Post-Construction Physical Monitoring: SMA 2**					
	Description	**Unit Cost**	**Unit**	**Notes**		
	Bathymetric survey	$16,500	survey	Based on project experience		
	Visual Inspection/Topo survey	$10,000	inspection	Best professional judgment		
	9.02 Subtotal	$26,500	event			
9.03	**Post-Construction Sediment Quality Monitoring**					
	Long-Term Monitoring Event Frequency Assumptions					
	SMA 1					
	Alternative	1-A	1-B	1-C	1-D	1-E	1-F
	Total Events	1	4	4	4	4	4
	Sampling Year (post-construction)	Year 0	Years 0, 2, 5, 10	Years 0, 2, 5, 10	Years 0, 2, 5, 10	Years 0, 2, 5, 10	Years 0, 2, 5, 10
	SMA 2					
	Alternative	2-A	2-B	2-C	2-D	2-E	
	Total Events	1	4	4	4	4	
	Sampling Year (post-construction)	Year 0	Years 0, 2, 5, 10	Years 0, 2, 5, 10	Years 0, 2, 5, 10	Years 0, 2, 5, 10	
	SMA 3						
	Alternative	3-A	3-B	3-C	3-D		
	Total Events	1	4	7	11		
	Sampling Year (post-construction)	Year 0	Years 0, 2, 5, 10	Years 0, 2, 5, 10, 15, 20, 25	Years 0, 2, 5, 10, 15, 20, 30, 40, 50, 60, 70		
	Surface Sediment Sampling Unit Cost Calculation						
	Sampling Task	**Unit Cost**	**Unit**	**Quantity**	**Total Cost**	**Notes**	
	Daily estimate for sampling vessel and staff	$7,000	day	8	$56,000		
	Analytical Tasks	**Unit Cost**	**Unit**	**Quantity**	**Total Cost**	**Notes**	
	Total Analytical	$1,900	sample	60	$114,000	Assumes analysis for TOC, grain size, total solids, dioxins/furans, PCB congeners, cPAHs, metals based on laboratory quotes.	
	Data validation	$2,000	group	7	$14,000	Assumes Level 4 for dioxins and PCBs, Level 1 for others.	
	Subtotal				$128,000		
	Unit Cost Per Sample (Calculated)	$3,067	sample				
	Surface Sediment Sampling Quantities and Cost Calculation per Long Term Monitoring Event						
	SMA	**SMA 1**	**SMA 2**	**SMA 3**	**Notes**		
	Locations	12	12	25			
	Samples	16	16	25	SMA 1 and SMA 2 samples include both 0- to 10-cm and 0- to 45-cm depth in intertidal areas.		
	Quality Control Samples (10%)	2	2	3	Assumes quality control samples (field duplicates and matrix spike duplicates) are required at a 10 percent rate.		
	Contingency Locations (50%)	6	6	13	Assumes that half of all locations will need further evaluation based on elevated concentrations.		
	Total Samples (roundup)	24	24	41			
	9.03 Cost / Event Subtotal	$73,600	$73,600	$125,733			

Table G.2
Monitoring Unit Costs

Element IDs	Monitoring Program Elements					
9.04	**Reporting and Ecology Coordination During Long-Term Monitoring**					
	SMA	**SMA 1**	**SMA 2**	**SMA 3**	**Notes**	
	9.04 Subtotal	$10,000	$10,000	$30,000	Lump sum cost per event based on best professional judgment	
9.05	**Contingency Sediment Trap Sampling to Assess Source Control in SMA 3**					
	Tasks	**Unit Cost**	**Unit**	**Quantity**	**Total Cost**	**Notes**
	Analytical	$1,600	sample	10	$16,000.00	Assumes analysis for cPAHs, dioxins/furans, and PCB congeners
	Data Validation	$2,000	sample	1	$2,000.00	
	Deployment	$6,000	event	4	$24,000.00	4 events - deployment, check traps twice, retrieval
	Reporting and Ecology Coordination	$10,000	event	1	$10,000.00	
	9.05 Subtotal		event		$52,000.00	Assume start sediment trap sampling at Year 5, and every surface sediment sampling event thereafter
9.06	**Contingency Capping Evaluations (e.g., Coring)**					
	SMA	**SMA 1**	**SMA 2**	**SMA 3**	**Notes**	
	9.06 Subtotal	$10,000	$10,000	n/a	Lump sum costs based on best professional judgment	
9.07	**Sediment Recovery Zone Management**					
	SMA	**SMA 1**	**SMA 2**	**SMA 3**	**Notes**	
	9.07 Subtotal	n/a	n/a	$100,000	Applies to Alternatives 3-C and 3-D, lump sum cost based on best professional judgment; Cost for renewal once every 10 years	

8.05	**Adaptive Management Monitoring During EMNR Placement (SMA 3)**					
	Tasks	**Unit Cost**	**Unit**	**Quantity**	**Total Cost**	**Notes**
	Sediment and Core Sampling	$3,067	sample	20	$61,333.33	Assume 20 samples/year
	Sediment profile imaging	$20,000	event	1	$20,000.00	Project Experience
	Reporting	$10,000	annual	1	$10,000.00	Assume 20 samples/year
	8.05 Subtotal				$91,333.33	Annual cost

Abbreviations:
cPAH Carcinogenic polycyclic aromatic hydrocarbon
Ecology Washington State Department of Ecology
EMNR Enhanced monitored natural recovery
n/a Not applicable
PCB Polychlorinated biphenyl
SMA Sediment Management Area
SRZ Sediment Recovery Zone
TOC Total organic carbon

Table G.3
Costs for SMA 1 Remedial Alternatives

Cost Element ID	Cost Element	Unit Cost	Unit	Quantities						Costs					
				1-A	1-B	1-C	1-D	1-E	1-F	1-A	1-B	1-C	1-D	1-E	1-F
1.00	**Mobilization/Demobilization and Transloading Setup and Maintenance**														
1.01	Annual Mobilization/Demobilization	$250,000	Annual	11.0	3.3	2.2	1.7	1.7	0.8	$2,744,469	$833,106	$543,826	$433,633	$435,991	$188,784
1.02	Transload Site Preparation	$330,000	LS	0.33	0.33	0.33	0.33	0.33	0.33	$110,000	$110,000	$110,000	$110,000	$110,000	$110,000
1.03	Transload Site Shoreline Conveyor	$100,000	LS	0.33	0.33	0.33	0.33	0.33	0.33	$33,333	$33,333	$33,333	$33,333	$33,333	$33,333
1.04	Transload (Port) Property Lease	$236,000	Annual	11.0	3.3	2.2	1.7	1.7	0.8	$2,590,779	$786,452	$513,372	$409,350	$411,576	$178,212
			Subtotal							**$5,478,582**	**$1,762,892**	**$1,200,532**	**$986,317**	**$990,901**	**$510,329**
2.00	**Removal and Dewatering**														
2.01	SMA 1 Inner Harbor Intertidal Area Excavation to Stockpile	$17	CY	25,942	4,324	3,307	4,324	3,307	3,307	$441,021	$73,503	$56,225	$73,503	$56,225	$56,225
2.02	SMA 1 Subtidal Harbor Dredging to Barge	$25	CY	606,742	101,124	27,104	0	0	0	$15,168,560	$2,528,093	$677,600	$0	$0	$0
			Subtotal	**632,685**	**105,447**	**30,411**	**4,324**	**3,307**	**3,307**	**$15,609,581**	**$2,601,597**	**$733,825**	**$73,503**	**$56,225**	**$56,225**
3.00	**Transload and Disposal**														
3.01	Transload Subtidal Material From Barge to Truck	$30	CY	606,742	101,124	27,104	0	0	0	$18,202,272	$3,033,712	$813,120	$0	$0	$0
3.02	Truck to Tacoma	$34	CY	632,685	105,447	30,411	4,324	3,307	3,307	$21,453,766	$3,575,628	$1,031,221	$146,614	$112,149	$112,149
3.03	Transload and Disposal	$90	CY	632,685	105,447	30,411	4,324	3,307	3,307	$56,941,632	$9,490,272	$2,737,020	$389,136	$297,660	$297,660
			Subtotal							**$96,597,670**	**$16,099,612**	**$4,581,361**	**$535,750**	**$409,809**	**$409,809**
4.00	**Sand and Gravel Purchase, Delivery, and Transload**														
4.01	Purchase	$15	CY	51,223	105,447	107,254	105,447	107,061	34,041	$768,350	$1,581,712	$1,608,816	$1,581,712	$1,605,912	$510,620
4.02	Truck to Stockpile	$10	CY	51,223	105,447	107,254	105,447	107,061	34,041	$533,576	$1,098,411	$1,117,233	$1,098,411	$1,115,217	$354,597
4.03	Transload to Barge for Subtidal Placement	$3	CY	25,281	101,124	101,317	101,124	101,124	27,911	$75,843	$303,371	$303,952	$303,371	$303,371	$83,732
			Subtotal							**$1,377,769**	**$2,983,494**	**$3,030,001**	**$2,983,494**	**$3,024,500**	**$948,949**
5.00	**Placement**														
5.01	Inner Harbor Intertidal Area Sand and Gravel Placement From Stockpile	$17	CY	25,942	4,324	5,937	4,324	5,937	6,131	$441,021	$73,503	$100,930	$73,503	$100,930	$104,221
5.02	Subtidal Harbor Sand and Gravel Placement from Barge	$20	CY	25,281	101,124	101,317	101,124	101,124	27,911	$505,619	$2,022,475	$2,026,347	$2,022,475	$2,022,475	$558,213
			Subtotal	**51,223**	**105,447**	**107,254**	**105,447**	**107,061**	**34,041**	**$946,639**	**$2,095,978**	**$2,127,277**	**$2,095,978**	**$2,123,405**	**$662,435**
6.00	**Surveys and Monitoring (Contractor Daily Progress Surveys)**	$10,000	Week	278	84	55	44	44	19	$2,778,971	$843,580	$550,663	$439,085	$441,473	$191,157
									Subtotal Construction Costs	**$122,789,213**	**$26,387,153**	**$12,223,658**	**$7,114,127**	**$7,046,311**	**$2,778,903**
8.00	**Additional Costs**														
8.01	Tax	8.4%								$10,314,294	$2,216,521	$1,026,787	$597,587	$591,890	$233,428
8.02	Design, Permitting, and Construction Support	20%								$24,557,843	$5,277,431	$2,444,732	$1,422,825	$1,409,262	$555,781
8.03	Environmental Compliance and Construction Quality Assurance	$8,000	Week	278	84	55	44	44	19	$2,223,177	$674,864	$440,530	$351,268	$353,178	$152,926
8.04	Contingency	30%								$36,836,764	$7,916,146	$3,667,097	$2,134,238	$2,113,893	$833,671
9.00	**Post-Construction Maintenance and Monitoring**														
9.01	SMA-Wide Bathymetric Survey, Shoreline Inspection, and Topographic Survey	$23,500	Event	0	4	4	4	4	4	$0	$94,000	$94,000	$94,000	$94,000	$94,000
9.03	Surface Sediment Sampling Events (Including Duplicates and Contingency Analysis)	$73,600	Event	1	4	4	4	4	4	$73,600	$294,400	$294,400	$294,400	$294,400	$294,400
9.04	Reporting and Ecology Coordination	$10,000	Event	1	4	4	4	4	4	$10,000	$40,000	$40,000	$40,000	$40,000	$40,000
9.06	Contingency Capping Evaluations (e.g., Coring)	$10,000	Event	0	1	1	1	1	1	$0	$10,000	$10,000	$10,000	$10,000	$10,000
									Subtotal Additional Costs and Post-Construction Costs	**$74,015,677**	**$16,523,361**	**$8,017,547**	**$4,944,318**	**$4,906,624**	**$2,214,205**
Total Costs															
									Project Costs	**$196,804,890**	**$42,910,514**	**$20,241,205**	**$12,058,445**	**$11,952,935**	**$4,993,108**
Rounded Total Costs															
									Project Costs	**$197,000,000**	**$42,900,000**	**$20,200,000**	**$12,100,000**	**$12,000,000**	**$5,000,000**

Abbreviations:
CY Cubic yard
Ecology Washington State Department of Ecology
LS Lump sum
SMA Sediment Management Area

Table G.4
Costs for SMA 2 Remedial Alternatives

Cost Element ID	Cost Element	Unit Cost	Unit	Quantities					Costs				
				2-A	2-B	2-C	2-D	2-E	2-A	2-B	2-C	2-D	2-E
1.00	**Mobilization/Demobilization and Transloading Setup and Maintenance**												
1.01	Annual Mobilization/Demobilization	$250,000	Annual	4.8	2.4	1.3	1.0	0.9	$1,203,263	$601,631	$318,934	$252,341	$218,874
1.02	Transload Site Preparation	$330,000	LS	0.33	0.33	0.33	0.33	0.33	$110,000	$108,900	$108,900	$108,900	$108,900
1.03	Transload Site Shoreline Conveyor	$100,000	LS	0.33	0.33	0.33	0.33	0.33	$33,333	$33,000	$33,000	$33,000	$33,000
1.04	Transload (Port) Property Lease	$236,000	Annual	4.8	2.4	1.3	1.0	0.9	$1,135,880	$567,940	$301,073	$238,210	$206,617
1.05	McKinley Property Lease	$61,000	Annual	4.8	2.4	1.3	1.0	0.9	$293,596	$146,798	$77,820	$61,571	$53,405
			Subtotal						**$2,776,072**	**$1,458,269**	**$839,727**	**$694,022**	**$620,797**
2.00	**Removal and Dewatering**												
2.03	SMA 2 Lagoon Intertidal Area Excavation to Stockpile	$25	CY	65,179	32,589	32,589	17,959	5,324	$1,629,467	$814,733	$814,733	$448,975	$133,100
2.04	SMA 2 Subtidal Lagoon Dredging to Stockpile	$40	CY	87,120	43,560	0	0	0	$3,484,800	$1,742,400	$0	$0	$0
			Subtotal	**152,299**	**76,149**	**32,589**	**17,959**	**5,324**	**$5,114,267**	**$2,557,133**	**$814,733**	**$448,975**	**$133,100**
3.00	**Transload and Disposal**												
3.02	Truck to Tacoma	$34	CY	152,299	76,149	32,589	17,959	5,324	$5,164,309	$2,582,155	$1,105,075	$608,973	$180,532
3.03	Transload and Disposal	$90	CY	152,299	76,149	32,589	17,959	5,324	$13,706,880	$6,853,440	$2,933,040	$1,616,310	$479,160
			Subtotal						**$18,871,189**	**$9,435,595**	**$4,038,115**	**$2,225,283**	**$659,692**
4.00	**Sand and Gravel Purchase, Delivery, and Transload**												
4.01	Purchase	$15	CY	152,299	76,149	43,479	41,034	45,415	$2,284,480	$1,142,240	$652,190	$615,510	$681,230
4.02	Truck to Stockpile	$10	CY	152,299	76,149	43,479	41,034	45,415	$1,586,444	$793,222	$452,910	$427,438	$473,076
			Subtotal						**$3,870,924**	**$1,935,462**	**$1,105,100**	**$1,042,948**	**$1,154,306**
5.00	**Placement**												
5.03	Lagoon Intertidal Area Sand and Gravel Placement From Stockpile	$25	CY	65,179	32,589	32,589	29,635	34,525	$1,629,467	$814,733	$814,733	$740,875	$863,133
5.04	Subtidal Lagoon Sand and Gravel Placement from Stockpile	$35	CY	87,120	43,560	10,890	11,399	10,890	$3,049,200	$1,524,600	$381,150	$398,965	$381,150
			Subtotal Placement	**152,299**	**76,149**	**43,479**	**41,034**	**45,415**	**$4,678,667**	**$2,339,333**	**$1,195,883**	**$1,139,840**	**$1,244,283**
6.00	**Surveys and Monitoring (Contractor Daily Progress Surveys)**	$10,000	Week	122	61	32	26	22	$1,218,389	$609,195	$322,943	$255,513	$221,626
7.00	**Eelgrass Transplanting**	$50,000	LS	1	1	0	0	0	$50,000	$50,000	$0	$0	$0
								Subtotal Construction Costs	**$36,579,508**	**$18,384,988**	**$8,316,501**	**$5,806,581**	**$4,033,805**
8.00	**Additional Costs**												
8.01	Tax	8.4%							$3,072,679	$1,544,339	$698,586	$487,753	$338,840
8.02	Design, Permitting, and Construction Support	20%							$7,315,902	$3,676,998	$1,663,300	$1,161,316	$806,761
8.03	Environmental Compliance and Construction Quality Assurance	$8,000	Week	122	61	32	26	22	$974,711	$487,356	$258,355	$204,411	$177,301
8.04	Contingency	30%							$10,973,853	$5,515,496	$2,494,950	$1,741,974	$1,210,141
9.00	**Post-Construction Maintenance and Monitoring**												
9.02	SMA-Wide Bathymetric Survey, Shoreline Inspection, and Topographic Survey	$26,500	Event	0	4	4	4	4	$0	$106,000	$106,000	$106,000	$106,000
9.03	Surface Sediment Sampling Events (Including Duplicates and Contingency Analysis)	$73,600	Event	1	4	4	4	4	$73,600	$294,400	$294,400	$294,400	$294,400
9.04	Reporting and Ecology Coordination	$10,000	Event	1	4	4	4	4	$10,000	$40,000	$40,000	$40,000	$40,000
9.06	Contingency Capping Evaluations (e.g., Coring)	$10,000	Event	0	1	1	1	1	$0	$10,000	$10,000	$10,000	$10,000
								Subtotal Additional Costs and Post-Construction Costs	**$22,420,744**	**$11,674,588**	**$5,565,591**	**$4,045,854**	**$2,983,443**
Total Costs													
								Project Costs	$59,000,253	$30,059,576	$13,882,093	$9,852,435	$7,017,247
Rounded Total Costs													
								Project Costs	**$59,000,000**	**$30,000,000**	**$13,900,000**	**$9,900,000**	**$7,000,000**

Abbreviations:
CY Cubic yards
Ecology Washington State Department of Ecology
LS Lump sum

Table G.5
Costs for SMA 3 Remedial Alternatives

Cost Element ID	Cost Element	Unit Cost	Unit	Quantities				Costs			
				3-A	3-B	3-C	3-D	3-A	3-B	3-C	3-D
1.00	**Mobilization/Demobilization and Transloading Setup and Maintenance**										
1.01	Annual Mobilization/Demobilization	$250,000	Annual	4.6	3.0	0.7	0	$1,138,074	$746,576	$186,644	$0
1.02	Transload Site Preparation	$330,000	LS	0.33	0.33	0.33	0	$110,000	$110,000	$110,000	$0
1.03	Transload Site Shoreline Conveyor	$100,000	LS	0.33	0.33	0.33	0	$33,333	$33,333	$33,333	$0
1.04	Transload (Port) Property Lease	$236,000	Annual	4.6	3.0	0.7	0	$1,074,342	$704,768	$176,192	$0
			Subtotal					**$2,355,749**	**$1,594,678**	**$506,169**	**$0**
4.00	**Sand and Gravel Purchase, Delivery, and Transload**										
4.01	Purchase	$15	CY	201,667	132,293	33,073	0	$3,025,000	$1,984,400	$496,100	$0
4.02	Truck to Stockpile	$10	CY	201,667	132,293	33,073	0	$2,100,694	$1,378,056	$344,514	$0
4.03	Transload to Barge for Subtidal Placement	$3	CY	201,667	132,293	33,073	0	$605,000	$396,880	$99,220	$0
5.00	**Placement**										
5.02	Subtidal Harbor Sand and Gravel Placement from Barge	$20	CY	201,667	132,293	33,073	0	$4,033,333	$2,645,867	$661,467	$0
6.00	**Surveys and Monitoring (Contractor Daily Progress Surveys)**	$10,000	Week	115	76	19	0	$1,152,380.95	$755,962	$188,990	$0
							Subtotal Delivery, Placement, and Monitoring	**$10,916,409**	**$7,161,164**	**$1,790,291**	**$0**
							Project Costs	***$13,272,157***	***$8,755,842***	***$2,296,460***	***$0***
8.00	**Additional Costs**										
8.01	Tax	8.4%						$1,114,861	$735,491	$192,903	$0
8.02	Design, Permitting, and Construction Support	20%						$2,654,431	$1,751,168	$459,292	$0
8.03	Environmental Compliance and Construction Quality Assurance	$8,000	Week	115	76	19	0	$921,905	$604,770	$151,192	$0
8.04	Contingency	30%						$3,981,647	$2,626,753	$688,938	$0
8.05	Adaptive Management Monitoring During EMNR Placement (SMA 3)	$91,333	Annual	4.6	3.0	0.7	0	$415,776	$272,749	$68,187	$0
9.00	**Post-construction Maintenance and Monitoring**										
9.03	Surface Sediment Sampling Events (Including Duplicates and Contingency Analysis)	$125,733	Event	1	4	7	11	$125,733	$502,933	$880,133	$1,383,067
9.04	Reporting and Ecology Coordination	$30,000	Event	1	4	7	11	$30,000	$120,000	$210,000	$330,000
9.05	Source control evaluations (Sediment Traps)	$52,000	Event	0	0	5	9	$0	$0	$260,000	$468,000
9.07	SRZ Management - Renewal every 10 years	$100,000	Event	0	0	2	6	$0	$0	$200,000	$600,000
							Subtotal Additional Costs and Post-Construction Costs	**$9,244,354**	**$6,613,864**	**$3,110,646**	**$2,781,067**
Total Costs											
							Project Costs	$22,516,512	$15,369,706	$5,407,106	$2,781,067
Rounded Total Costs											
							Project Costs	**$22,500,000**	**$15,400,000**	**$5,400,000**	**$2,800,000**

Abbreviations:
CY Cubic yards
Ecology Washington State Department of Ecology
EMNR Enhanced monitored natural recovery
LS Lump sum
SRZ Sediment Recovery Zone

Table G.6
Areas, Volumes, and Construction Timeframes for SMA 1

Area	1-A	1-B	1-C	1-D	1-E	1-F
a. Technology Assignment (acres)						
Intertidal Removal	1.34					
Subtidal Removal	31.3					
Intertidal Removal and Cap		1.34		1.34		
Intertidal Removal and Cap (Habitat)			0.5		0.5	0.5
Subtidal Removal and Cap		31.3	8.40			
Intertidal Cap			1.34		1.34	1.40
Subtidal Cap			23.0	31.3	31.3	1.1
Intertidal EMNR						
Subtidal EMNR						30.2
Total (rounded)	32.7	32.7	33.2	32.7	33.2	33.2
b. Average Removal Depth Including						
Intertidal Removal	12					
Subtidal Removal	12					
Intertidal Removal and Cap		2.0		2.0	2.0	
Intertidal Removal and Cap (Habitat)			4.1		4.1	4.1
Subtidal Removal and Cap		2.0	2.0			
c. Removal Volume (CY)						
Intertidal	25,942	4,324	3,307	4,324	3,307	3,307
Subtidal	606,742	101,124	27,104	0	0	0
d. Removal Production Rate						
All areas	500	500	500	500	500	500
e. Removal Construction Duration						
All areas	1,265	211	61	8.6	6.6	6.6
f. Average Placement Thickness						
Intertidal Removal	12					
Subtidal Removal	0.5					
Cap		2.0	2.0	2.0	2.0	2.0
EMNR						0.5
g. Placement Volume (CY)						
Intertidal	25,942	4,324	5,937	4,324	5,937	6,131
Subtidal	25,281	101,124	101,317	101,124	101,124	27,911
h. Placement Production Rate (350						
Intertidal	500	500	500	500	500	500
Subtidal	350	500	500	500	500	350 / 500
i. Placement Construction Duration						
Intertidal	52	8.6	12	8.6	12	12
Subtidal	72	202	203	202	202	77
j. Total Construction Duration for						
Days	1,389	422	275	220	221	96
Seasons	11.0	3.3	2.2	1.7	1.7	0.8

k. Construction Season Calculation	
Start of Construction Season	July 15, 2019
End of Construction Season	February 15, 2020
Total Days	215
Weekend Days	61
Holidays	7
Delays (Permitting, Contracting, Mob/Demob, etc.)	20
Total Production Days	127

Abbreviations:
CY Cubic yards
Ft Feet
EMNR Enhanced monitored natural recovery

Table G.7
Areas, Volumes, and Construction Timeframes for SMA 2

Area	2-A	2-B	2-C	2-D	2-E
a. Technology Assignment (acres)					
Intertidal Removal	10.1				
Subtidal Removal	13.5				
Intertidal Removal and Cap		10.1	10.1	1.8	
Intertidal Removal and Cap (Habitat)				0.5	0.6
Subtidal Removal and Cap		13.5			
Intertidal Cap				6.4	10.1
Intertidal Removal and EMNR				4.0	
Intertidal EMNR					
Subtidal EMNR			13.5	11.4	13.5
Total (rounded)	23.6	23.6	23.6	24.1	24.2
b. Average Removal Depth Including					
Intertidal Removal	4			Removals calculated in CADD (average depth 1.8 ft)	
Subtidal Removal	4				
Intertidal Removal and Cap		2	2		
Intertidal Removal and Cap (Habitat)					5.5
Subtidal Removal and Cap		2	0		
c. Removal Volume (CY)					
Intertidal	65,179	32,589	32,589	17,959	5,324
Subtidal	87,120	43,560	0	0	0
d. Removal Production Rate (CY/day)					
All areas	500	500	500	500	500
e. Removal Construction Duration					
All areas	305	152	65	36	11
f. Average Placement Thickness					
Intertidal Removal	4			Placement calculated in CADD	
Subtidal Removal	4				
Cap		2	2		2
EMNR			0.5		0.5
g. Placement Volume (CY)					
Intertidal	65,179	32,589	32,589	29,635	34,525
Subtidal	87,120	43,560	10,890	11,399	10,890
h. Placement Production Rate (350					
Intertidal	500	500	500	500	500
Subtidal	500	500	350	350	350
i. Placement Construction Duration					
Intertidal	130	65	65	59	69
Subtidal	174	87	31	33	31
j. Total Construction Duration for					
Days	609	305	161	128	111
Seasons	4.8	2.4	1.3	1.0	0.9

k. Construction Season Calculation	
Start of Construction Season	July 15, 2017
End of Construction Season	February 15, 2018
Total Days	215
Weekend Days	61
Holidays	7
Delays (Permitting, Contracting, Mob/Demob, etc.)	20
Total Production Days	127

Abbreviations:
CY Cubic yards
Ft Feet
EMNR Enhanced monitored natural recovery

Table G.8
Areas, Volumes, and Construction Timeframes for SMA 3

Parameter	3-A	3-B	3-C	3-D
EMNR Area (acres)	250	164	41	0
Placement volume (C) assuming 0.5 foot average placement thickness	201,667	132,293	33,073	0
Placement Production Rate (C/day)	350	350	350	350
Placement Construction Duration (Days)	576	378	94	0
Placement Construction Duration (Seasons) assuming 127 Construction Days/Season (refer to Table G.6.k)	4.6	3.0	0.7	0.0

Abbreviations:

CY Cubic yards
EMNR Enhanced monitored natural recovery
SMA Sediment Management Area

Table G.9
Costs for the Preferred Alternative (1-D, 2-E, and 3-B)

Cost Element ID	Cost Element	Unit Cost	Unit	Quantities for Preferred Alternative	Costs for for Preferred Alternative
1.00	**Mobilization/Demobilization and Transloading Setup and Maintenance**				
1.01	Annual Mobilization/Demobilization	$250,000	Annual	5.6	$1,399,084
1.02	Transload Site Preparation	$330,000	LS	1.0	$328,900
1.03	Transload Site Shoreline Conveyor	$100,000	LS	1.0	$99,667
1.04	Transload (Port) Property Lease	$236,000	Annual	5.6	$1,320,735
1.05	McKinley Property Lease	$61,000	Annual	0.9	$53,405
			Subtotal		**$3,201,792**
2.00	**Removal and Dewatering**				
2.01	SMA 1 Inner Harbor Intertidal Area Excavation to Stockpile	$17	CY	4,324	$73,503
2.02	SMA 1 Subtidal Harbor Dredging to Barge	$25	CY	0	$0
2.03	SMA 2 Lagoon Intertidal Area Excavation to Stockpile	$25	CY	5,324	$133,100
2.04	SMA 2 Subtidal Lagoon Dredging to Stockpile	$40	CY	0	$0
			Subtotal	**9,648**	**$206,603**
3.00	**Transload and Disposal**				
3.01	Transload Subtidal Material From Barge to Truck	$30	CY	0	$0
3.02	Truck to Tacoma	$34	CY	9,648	$327,146
3.03	Transload and Disposal	$90	CY	9,648	$868,296
			Subtotal		**$1,195,442**
4.00	**Sand and Gravel Purchase, Delivery, and Transload**				
4.01	Purchase	$15	CY	283,156	$4,247,342
4.02	Truck to Stockpile	$10	CY	283,156	$2,949,543
4.03	Transload to Barge for Subtidal Placement	$3	CY	233,417	$700,251
			Subtotal		**$7,897,136**
5.00	**Placement**				
5.01	Inner Harbor Intertidal Area Sand and Gravel Placement From Stockpile	$17	CY	4,324	$73,503
5.02	Subtidal Harbor Sand and Gravel Placement from Barge	$20	CY	233,417	$4,668,341
5.03	Lagoon Intertidal Area Sand and Gravel Placement From Stockpile	$25	CY	34,525	$863,133
5.04	Subtidal Lagoon Sand and Gravel Placement from Stockpile	$35	CY	10,890	$381,150
			Subtotal	**283,156**	**$5,986,128**
6.00	**Surveys and Monitoring (Contractor Daily Progress Surveys)**	$10,000	Week	142	$1,416,673
				Subtotal Construction Costs	$19,903,774
8.00	**Additional Costs**				
8.01	Tax	8.4%			$1,671,917
8.02	Design, Permitting, and Construction Support	20%			$3,980,755
8.03	Environmental Compliance and Construction Quality Assurance	$8,000	Week	142	$1,133,338
8.04	Contingency	30%			$5,971,132
8.05	Adaptive Management Monitoring During EMNR Placement (SMA 3)	$91,333	Annual	3.0	$272,749
9.00	**Post-Construction Maintenance and Monitoring**				
9.01	SMA 1 Bathymetric Survey, Shoreline Inspection, and Topographic Survey	$23,500	Event	4	$94,000
9.02	SMA 2 Wide Bathymetric Survey, Shoreline Inspection, and Topographic Survey	$26,500	Event	4	$106,000
9.03	Surface Sediment Sampling Events (Including Duplicates and Contingency Analysis) for Alternatives	$1,091,733	LS	1	$1,091,733
9.04	Reporting and Ecology Coordination	$200,000	LS	1	$200,000
9.06	Contingency Capping Evaluations (e.g., Coring)	$10,000	Event	2	$20,000
				Subtotal Additional Costs and Post-Construction Maintenance and Monitoring Costs	**$14,541,625**
Total Costs					
				Project Costs	$34,445,398
Rounded Total Costs					
				Project Costs	**$34,400,000**

Note:

Subtotals in the main text are rounded and may not match subtotals presented in this table.

Abbreviations:

CY Cubic yards
Ecology Washington State Department of Ecology
EMNR Enhanced monitored natural recovery
LS Lump sum
SMA Sediment Management Area

WPAHG

Western Port Angeles Harbor Group

Appendix H
Enhanced Monitored Natural Recovery Case Studies

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study

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Attachment H.1 *Ediz Hook Cap Pilot: Construction and 6-Month Post-Construction Monitoring Summary* (Anchor QEA 2018)

List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
COC	Chemical of concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CY	Cubic yards
EMNR	Enhanced monitored natural recovery
LEKT	Lower Elwha Klallam Tribe
MLLW	Mean lower low water
PAH	Polycyclic aromatic hydrocarbon
RI/FS	Remedial Investigation and Feasibility Study
SCU	Sediment Cleanup Unit
TEQ	Toxic equivalent
WPAH Group	Western Port Angeles Harbor Group

1.0 Introduction

Enhanced monitored natural recovery (EMNR; also referred to as thin-layer placement) is the application of a nominal (typically 6-inch-thick layer) of clean sand and/or gravel to accelerate sediment natural recovery (further described in Section 12.6 of the Remedial Investigation/Feasibility Study [RI/FS]). EMNR has been identified as an important component of the preferred remedy for the Western Port Angeles Harbor Sediment Cleanup Unit (SCU).

EMNR is often applied in areas with relatively low concentrations of chemicals dispersed over large areas. As described in Section 13.3 of the RI/FS, this is true of the subtidal areas of the SCU, which have relatively diffuse, lower-level carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalent (TEQ) and Total TEQ concentrations. EMNR is also often applied in relatively stable sediment environments where the rate of natural sedimentation is relatively slow (USEPA 2005, Ecology 2017). This is the case in most subtidal areas of the SCU, where net sedimentation rates average approximately 0.17 centimeters per year (refer to RI/FS Section 2.1.5). Therefore, EMNR is anticipated to be an effective and implementable remedial technology in subtidal areas in the SCU.

The purpose of this appendix is to summarize case studies throughout the Puget Sound and the United States in which EMNR has been applied successfully, further supporting the applicability and expected effectiveness of EMNR within the SCU. Nine EMNR case studies are summarized in this appendix,[1] presented in general order of their similarity and relevance to conditions in the SCU. These include:

- **Ediz Hook Pilot Testing (Port Angeles, Washington).** This project commenced in 2017 and data collection is ongoing. Data from this pilot project will directly inform the planning and design of EMNR placement in the SCU for habitat restoration and/or cleanup. The first post-construction monitoring of sediment stability, chemistry, and benthic community recolonization was performed 6 months after completion of construction; further post-construction monitoring is ongoing.
- **Port Gamble Bay (Port Gamble, Washington).** A large-scale EMNR layer was accurately and protectively placed in 2016 in broad areas of Port Gamble Bay to remediate sediment with low levels of toxicity and to accelerate polycyclic aromatic hydrocarbon (PAH) recovery. Post-construction verification monitoring of the EMNR remedy will commence in 2018.

[1] In addition to this appendix, eleven EMNR case studies were summarized in 2009, six of which were performed in Puget Sound (Merritt et al. 2009). The U.S. Army Corps of Engineers Engineering Research and Development Center also maintains a website summarizing thin-layer placement case studies (https://tlp.el.erdc.dren.mil/case-studies-by-project-type/), particularly with respect to habitat restoration.

- **Ward Cove (Ketchikan, Alaska).** A thin-layer cap was placed offshore of a former sulfite pulp mill in 2001 to remediate sediment with low levels of toxicity. Post-construction monitoring of sediment stability, chemistry, and benthic community recolonization was performed for 6 years.
- **East 11th Street Tideflats (Tacoma, Washington).** A thin-layer cap was placed in 2012 in an intertidal mudflat located adjacent to the Hylebos Waterway to restore sediment affected by wood debris, PAHs, and other chemicals of concern (COCs). Post-construction monitoring of sediment stability, chemistry, and benthic community recolonization was performed for 4 years.
- **Pier 53–55 (Seattle, Washington).** An EMNR layer was placed in 1992 in a nearshore area of Elliott Bay to address PAHs, mercury, and other COCs. Post-construction monitoring of sediment stability, sediment chemistry, and benthic community recolonization was performed for 10 years.
- **Duwamish/Diagonal (Seattle, Washington).** An EMNR layer was placed in 2005 around the perimeter of a dredging/capping area as part of an early action within the Lower Duwamish Waterway to address mercury, PAHs, and other COCs. Post-construction monitoring of sediment stability and chemistry monitoring was performed for 6 years.
- **Thea Foss Waterway (Tacoma, Washington).** An EMNR layer was placed in 2006 as part of site-wide remediation of the Thea Foss Waterway to address a wide range of COCs. Post-construction monitoring of sediment chemistry and benthic community recolonization abundance was performed for 10 years.
- **Bremerton Naval Complex (Bremerton, Washington).** An EMNR layer was placed in 2001 in stable subtidal sediment areas as part of site-wide remediation of Sinclair Inlet to address mercury and other COCs. Post-construction monitoring of sediment chemistry was performed for 13 years.
- **Georgia-Pacific Log Pond (Bellingham, Washington).** A thin-layer cap was placed in 2000 in a former embayment of the Whatcom Waterway to address mercury and other COCs. Post-construction monitoring of sediment stability, sediment chemistry, and benthic community recolonization was performed for 15 years.

Each of these case studies is briefly summarized in Section 2.0.

2.0 EMNR Case Study Summaries

The following subsections summarize nine different EMNR case studies performed within the Pacific Northwest that are relevant to the RI/FS. Literature references are cited that provide further detailed information.

2.1 EDIZ HOOK PILOT TESTING (PORT ANGELES, WASHINGTON)

In 2017, the Lower Elwha Klallam Tribe (LEKT) and the Western Port Angeles Harbor Group (WPAH Group) received permits to perform a pilot study and construct a thin-layer cap in shallow subtidal areas of Ediz Hook with the goal of verifying the effectiveness of placing a 6-inch-thick layer of clean capping material over wood debris to restore benthic habitat. The 0.1-acre Ediz Hook pilot cap was constructed between depths of approximately -10 feet mean lower low water (MLLW) and -14 feet MLLW. A summary of the construction and monitoring results 6 months after completion of construction is presented in Attachment 1 (Anchor QEA 2018).

Using silty, gravelly sand from the Elwha River that was previously stockpiled by the LEKT, in June 2017 an average of approximately 7 inches (approximately 110 cubic yards [CY]) of clean material was successfully placed over the pilot area by a marine contractor using a 6-CY rehandling bucket. The grain size of the stockpiled Elwha River material generally matched existing sediments in the pilot area (silty sand with fine gravel), accelerating benthic community recolonization (as discussed below). Minor turbidity increases in the water column occurred during placement of the silty material, but turbidity was highly localized (downcurrent) and ephemeral (remained for less than 1 hour). Shortly after construction was completed, the LEKT planted native eelgrass (*Zostera marina*) turions (harvested from the nearby U.S. Coast Guard facility) both on and off the pilot cap.

Initial performance monitoring was performed in December 2017, approximately 6 months after completion of construction. Probing and grab sampling verified the integrity of the thin-layer cap, with a stable average thickness of 7.3 ± 1.8 inches (range: 4 to 10 inches). Passive sampling of porewater in the top 4 inches of the cap also confirmed that surface sediments had non-detectable hydrogen sulfide concentrations (less than 0.01 parts per million) within the local reference area concentration range and below toxicity benchmarks, verifying the protectiveness of the thin-layer cap with respect to potential underlying wood debris degradation products. Finally, while subtle differences in benthic community structure were noted on parts of the new cap as it was being colonized, overall there were no statistically significant differences in the abundance of major taxa (Crustacea, Mollusca, or Polychaeta), and no differences in species richness, diversity, or evenness between benthic communities on the cap and those in a nearby local background area without wood debris. The monitoring data collected to date verify the effectiveness of the thin-layer cap in rapidly (within 6 months of completion of construction) restoring benthic habitat along Ediz Hook.

Follow-on performance monitoring is scheduled for June 2018, which will include further verification of the uniformity and stability of placed cap, porewater sulfide protectiveness, and benthic macroinvertebrate community restoration. In addition, the LEKT will survey transplanted and volunteer eelgrass turions on the cap. Based on the results of the forthcoming LEKT survey, the pilot cap may also support native eelgrass meadow development, building on successful capping/eelgrass restoration projects previously completed along Ediz Hook (Pentec Environmental 2001).

2.2 PORT GAMBLE BAY (PORT GAMBLE, WASHINGTON)

In 2016, Pope Resource successfully constructed a 6-inch-thick EMNR sand layer over nearly 80 acres of subtidal sediment in Port Gamble Bay. The EMNR material was placed by a marine contractor using both a 4-CY clamshell bucket and a 4.5-CY Bombay box with doors that open on the bottom, lowered to several feet above the mudline and then opened to place material. Large-scale EMNR placement (approximately 110,000 CY) was performed concurrent with other sediment cleanup activities at the site (Anchor QEA 2017). Cranes equipped with differential global positioning systems confirmed the location of EMNR placement. Hypack software provided the operator with real-time tracking for horizontal positioning of the barge and bucket relative to the EMNR placement areas, and were used along with progress surveys to accurately track progress and minimize overlapping placement or gaps in placement patterns. Information from construction of the Port Gamble EMNR layer was used to inform the RI/FS (e.g., costs and production rates).

Water quality monitoring was conducted throughout in-water construction. There were no turbidity or other water quality exceedances during EMNR material placement. Post-construction probing, coring, and grab sampling verified an average placed EMNR thickness of 6.2 ± 2.1 inches (range: 4 to 7 inches), consistent with the engineering design. The first round of performance verification monitoring is scheduled for summer/fall 2018, and will include sediment stability, chemistry, and bioassay analyses.

2.3 WARD COVE (KETCHIKAN, ALASKA)

Ward Cove, Alaska, is a deep-water harbor offshore of a former sulfite pulp mill. Prior to remediation, surface sediments at the site contained elevated concentrations of COCs (e.g., ammonia and 4-methylphenol), and low levels of toxicity attributable in part to COC diffusion from underlying sediment. In conjunction with other remedial actions, in 2001 the Ketchikan Pulp Company successfully placed a 6- to 12-inch-thick layer of fine- to medium-grained sand over 28 acres of native sediments, including on relatively steep slopes and at deep depths (Merritt et al. 2009).

Post-construction monitoring was performed in 2004 and 2007, and included evaluations of sediment chemistry, sediment toxicity, and benthic macroinvertebrate community development (Becker et al. 2009, Merritt et al. 2009, AECOM 2012). Concentrations of COCs in the thin-layer strata were low in 2004 and remained low in 2007, confirming the protectiveness of the EMNR

remedy. Sediment toxicity was also reduced and remained at local background levels in both 2004 and 2007. Benthic communities had begun recolonization by 2004 and total abundance increased substantially by 2007. Because remedial action objectives for the sediment remedy were achieved, monitoring was discontinued after 2007 (USEPA 2015).

2.4 EAST 11TH STREET TIDEFLATS (TACOMA, WASHINGTON)

In 2012, Occidental Chemical Corporation successfully placed a 6- to 14-inch-thick layer of sand on an intertidal mudflat between elevation 0 and +12 feet MLLW adjacent to the Hylebos Waterway. The objective of the East 11th Street Tideflats project was to restore benthic invertebrate prey resources that had been affected by wood debris, PAHs, and other COCs. Post-construction monitoring was performed in 2013 and 2016, verifying the stability of the EMNR layer and confirming that surface sediment COC concentrations were reduced to local background levels (Anchor QEA 2016). While the relatively lower fines content of the placed sand relative to baseline silty sand sediment conditions initially (i.e., in 2013) retarded colonization by certain crustaceans, natural deposition of fine sediment materials occurred over the next few years, such that by 2016 the abundance of crustaceans, mollusks, and polychaetes were not statistically different from local background. By 2016, the number of species, number of individuals, Shannon-Weiner diversity index, and Pielou's evenness metrics were also not statistically different from local background. The 2016 post-construction monitoring data verified that biological performance metrics were successfully achieved, and that no further monitoring was required.

2.5 PIER 53–55 (SEATTLE, WASHINGTON)

As part of the larger Pier 53–55 sediment remediation project in Elliott Bay, in 1992 the U.S. Army Corps of Engineers and King County successfully constructed a 12-inch-thick EMNR layer on 1.6 acres of subtidal sediment, as well as a thicker (3-foot-thick) cap on an adjacent 2.9-acre area. Post-construction monitoring was performed through 2002 (King County 2010). Monitoring parameters included physical stability, surface and shallow subsurface sediment COCs, and benthic recolonization metrics.

The EMNR layer remained physically stable throughout the 10-year post-construction monitoring period, and reduced surface sediment COC concentrations to local background levels, equivalent to concentrations on the adjacent cap (King County 2010). The benthic community recolonized the EMNR area within approximately 4 years following completion of construction, more rapidly than benthic community colonization of the adjacent cap area. Quicker benthic recolonization of the EMNR layer was attributable to greater construction-related losses of the benthic community in the capping areas due to the thickness of the cap compared to the EMNR areas.

2.6 DUWAMISH/DIAGONAL (SEATTLE, WASHINGTON)

In 2005, King County successfully placed a thin layer of sand (average 9 inches; minimum 6 inches) over 4 acres of subtidal sediment in the Duwamish Waterway to control contaminated sediment

residuals resulting from an adjacent dredging project (Anchor Environmental 2007, Stern et al. 2009, AECOM 2012). Sediment profile imaging and diver surveys verified the stability of the placed EMNR layer even in the active federal navigation channel. Similarly, surface sediment monitoring verified that COC concentrations were reduced to local background levels (King County 2016).

2.7 THEA FOSS WATERWAY (TACOMA, WASHINGTON)

As part of the larger Thea Foss Waterway sediment remediation project, the City of Tacoma successfully placed a minimum 6-inch-thick EMNR sand layer (approximately 6,000 CY) over a 2-acre subtidal area in 2005 (City of Tacoma et al. 2006). Post-construction EMNR monitoring was performed immediately after placement and in Years 2, 4, 7, and 10 post-construction (2006, 2008, 2010, 2013, and 2016). Surface sediment monitoring in the EMNR area verified that COC concentrations were reduced immediately following construction, and have been maintained at local background levels. Similarly, benthic recolonization of the EMNR layer occurred within several years of completion of construction (City of Tacoma and Floyd|Snider 2013).

2.8 BREMERTON NAVAL COMPLEX (BREMERTON, WASHINGTON)

As part of the larger Bremerton Naval Complex sediment remediation project, in 2001, the U.S. Navy successfully constructed EMNR layers in stable subtidal sediment areas to address mercury and other COCs. Post-construction monitoring of sediment chemistry was performed for 13 years, and confirmed the protectiveness of the remedy (Merritt et al. 2009, NAVFAC 2017).

2.9 GEORGIA-PACIFIC LOG POND (BELLINGHAM, WASHINGTON)

As part of an early sediment remediation action, in 2000, Georgia-Pacific successfully constructed intertidal and subtidal caps in a former embayment of the Whatcom Waterway to address mercury and other COCs, including 6-inch-thick caps around the project margins in areas where thicker cap placement would pose geotechnical risks (Merritt et al. 2009, Anchor QEA 2015). Post-construction monitoring of sediment stability, sediment chemistry, and benthic community recolonization was performed for 15 years, verifying the protectiveness of the remedy. The shoreline cap was recently augmented with focused debris and creosote pile removals, as well as shoreline stabilization.

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WPAHG

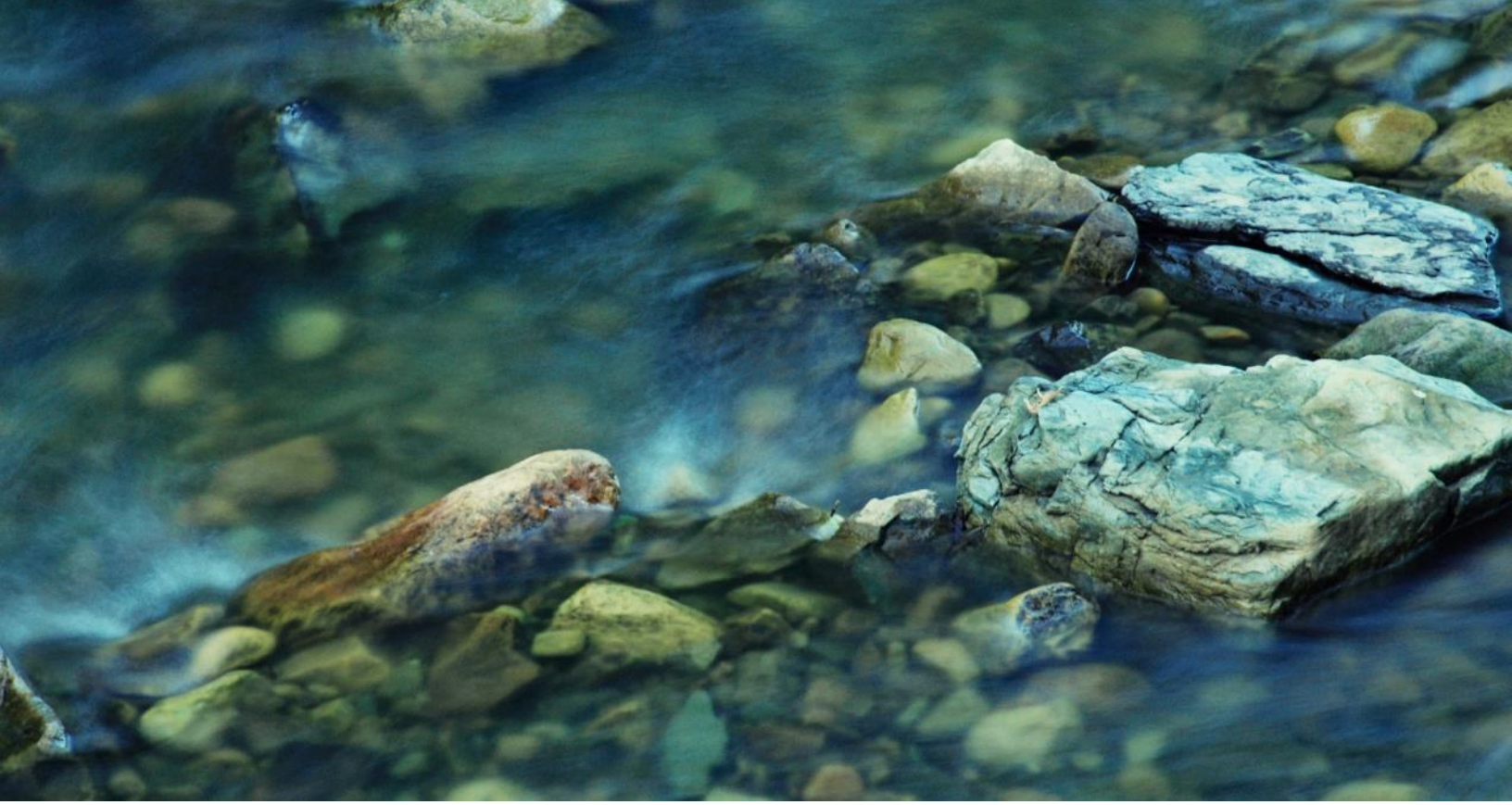
Western Port Angeles Harbor Group

Appendix H
Enhanced Monitored Natural Recovery Case Studies

Attachment H.1: *Ediz Hook Cap Pilot: Construction and 6-Month Post-Construction Monitoring Summary* (Anchor QEA 2018)

Western Port Angeles Harbor
Sediment Cleanup Unit

Remedial Investigation/Feasibility Study



February 2018

Ediz Hook Cap Pilot: Construction and 6-Month Post-Construction Monitoring Summary

Western Port Angeles Harbor Group

ANCHOR QEA

Ediz Hook Cap Pilot: Construction and 6-Month Post-Construction Monitoring Summary

Prepared for
Western Port Angeles Harbor Group

Prepared by
Anchor QEA, LLC
720 Olive Way
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Attachment B Sulfide Effects on Aquatic Organisms: Literature Review (D. Podger)

Attachment C Ediz Hook Cap Pilot: 6-Month Post-Construction Benthic Community Monitoring

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Table 1 Grain Size Distribution of Stockpiled Elwha River Capping Material

Table 2 Metals Concentrations in Stockpiled Elwha River Capping Material

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Figure 1 Ediz Hook Wood Debris Areas

Figure 2 Capping Pilot Sampling Locations

Figure 3 Water Quality Monitoring Location Schematic

ABBREVIATIONS

cy	cubic yard
DGT	diffusive gradient in thin-film
Ecology	Washington State Department of Ecology
Harbor	Western Port Angeles Harbor
H_2S	hydrogen sulfide
LEKT	Lower Elwha Klallam Tribe
mg/L	milligrams per liter
MLLW	mean lower low water
NTU	nephelometric turbidity unit
Trustee Council	Western Port Angeles Harbor Natural Resources Trustee Council
WPAHG	Western Port Angeles Harbor Group

1 Introduction

Promising restoration alternatives to settle alleged Natural Resource Damage liabilities in Western Port Angeles Harbor (Harbor) were identified in 2016 and 2017 during collaborative technical work group discussions between the Western Port Angeles Harbor Group (WPAHG) and the Western Port Angeles Harbor Natural Resources Trustee Council (Trustee Council). Based on initial evaluations of feasibility, effectiveness, magnitude of service gains, and probability of success, one of the more promising habitat restoration options identified by the WPAHG and Trustee Council was capping shallow and deep subtidal areas of Ediz Hook that have been historically degraded by anthropogenic wood debris (Figure 1). Restoration of these nearshore areas would also complement adjacent intertidal beach restoration actions recently completed in this area by the Lower Elwha Klallam Tribe (LEKT).

Building on successful capping projects completed in similar settings where wood debris had degraded benthic habitat (e.g., Becker et al. 2009, Anchor QEA 2016), in June 2017 LEKT and the WPAHG obtained permits to construct a pilot cap in a shallow subtidal area of Ediz Hook. The goal of the pilot project was to verify the effectiveness of placing a clean 6-inch cap layer over wood debris to restore benthic habitat in this area. The pilot project was authorized under a U.S. Army Corps of Engineers Nationwide Permit 27 (NWS-2017-325). Additional approvals were obtained from the Washington State Department of Ecology (Ecology), Washington State Department of Fish and Wildlife, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and City of Port Angeles.

This memorandum summarizes cap construction, water quality monitoring, and post-construction verification and performance monitoring performed through 6 months following completion of cap construction. An additional 12-month post-construction cap monitoring event is scheduled for June 2018 to verify the findings of the 6-month monitoring as described herein. Potential follow-on monitoring may be performed as appropriate to support restoration design.

2 Pre-Construction

Shortly before construction, LEKT performed a dive survey of the prospective pilot cap area to refine the placement area. Anchor QEA subsequently advanced five piston cores (driven by hand) in the pilot area to further characterize pre-project sediment conditions, focusing on the concentration and thickness of surficial wood debris in the placement area.

The dive survey delineated the target area for the Ediz Hook cap pilot located between depths of approximately -10 to -14 feet mean lower low water (MLLW), measuring approximately 280 feet long by 20 feet wide (roughly 0.1 acre), as depicted on Figure 2. Based on both the dive survey and piston core observations, prior to construction of the pilot cap, surface sediments in the pilot area consisted of a 0.7- to 2.0-foot-thick deposit of mixed bark and silty sand (ranging between approximately 20% and 100% wood debris by volume) resulting from legacy log rafting operations in the area. While similar wood debris deposits extend across other depths in the Ediz Hook area (Figure 1), the -10 to -14 feet MLLW depth range was selected for the pilot project for the following three reasons:

- Wood debris accumulations diminish above approximately -10 feet MLLW, likely due to winnowing of these materials from wind-wave forces
- Relative to wood debris accumulation in deeper waters, the -10 to -14 feet MLLW depth range experiences higher wind-wave forces; thus, cap designs that are stable within this elevation range would also be stable at deeper depths (construction methods would be tailored to address steeper slopes [Becker et al. 2009])
- Relative to wood debris accumulation in deeper waters, the Trustee Council identified higher functional improvements resulting from restoration of benthic habitat within in the -10 to -14 feet MLLW depth range

Stockpiled silty, gravelly sand from the Elwha River that was recently used by LEKT for beach nourishment along nearby intertidal areas of Ediz Hook was also used for construction of the shallow subtidal pilot cap. Grain size analysis of a representative composite sample of the stockpiles characterized these materials as approximately 51% sand, 39% gravel, and 9% fines (silt plus clay; Table 1), generally matching the grain size distribution of pre-construction sediments present in the pilot area (silty sand with fine gravel). Metals concentrations in stockpiled Elwha River materials were below natural background and Harbor sediment cleanup objective criteria (Table 2), further confirming the suitability of these materials for capping.

3 Construction

On June 14, 2017, Orion Marine Group transloaded the stockpiled silty gravelly sand cap material onto a derrick barge at Port of Port Angeles Terminal 6, and subsequently positioned the marine platform along the pilot area. Cap placement was performed using a 6-cubic-yard (cy) clamshell bucket operating from the derrick barge. Approximately 110 cy of cap material was placed in the pilot study area over 2 hours by an Orion Marine Group operator experienced in thin-layer cap placement. Capping material was placed by lowering the clamshell bucket close to the water surface, slowly opening the clamshell bucket, and sweeping the bucket across the pilot area along predetermined paths, maintaining the operator's visual and geographic positioning control of the bucket location to uniformly distribute the capping material. Cap material was placed along the 280-foot-long pilot area in two 10-foot-wide lanes. Based on construction records maintained by Orion Marine Group, an average thickness of approximately 7.0 inches of capping material was placed over the pilot area, slightly greater than the 6-inch average target thickness.

3.1 Water Quality Monitoring

Water quality was monitored during cap placement along four transects extending 150 to 900 feet down-current from the placement area and at a background station located approximately 1,000 feet up-current (east) of the pilot area (Figure 3). The focus of the water quality monitoring was on turbidity, with measurements obtained 3 feet below the water surface and 3 feet above mudline. While turbidity increases are common during capping operations and are currently characteristic of broad nearshore areas north of Ediz Hook following recent Elwha River dam removal projects, given the "excellent" water quality designation of the Ediz Hook area, in-water construction operations target a nominal turbidity increase of less than five nephelometric turbidity units (NTUs) over background (Washington Administrative Code 173-201A-210).

Water quality monitoring was initiated approximately 1 hour after the start of cap placement, when a visible turbidity plume began to migrate down-current (west; along nearshore Transect 4) of the pilot area during the ebb tide. Turbidity measurements were subsequently obtained along each transect, but focused on Transect 4, as this was the only transect to register turbidity increases exceeding 5 NTU above up-current background. Water quality monitoring data are summarized in Table 3. The maximum turbidity increase was 7.3 NTUs above background, measured 3 feet above mudline approximately 450 feet down-current from the placement area near the end of in-water construction. Turbidity was marginally elevated above the 5 NTU standard for approximately 900 feet down-current from the placement area along Transect 4, and for a duration of less than 1 hour.

Overall, the water quality monitoring data revealed that minor turbidity increases occurred during placement, and were highly localized (down-current) and ephemeral (less than 1 hour). The minor turbidity increases are unavoidable if capping materials are used that match the grain size

distribution of pre-construction sediments present in the area (silty sand with fine gravel; e.g., 9% fines) to accelerate benthic colonization and restoration (see Section 4.3). Moreover, extensive turbidity increases of greater magnitude are currently characteristic of broad nearshore areas north of Ediz Hook following recent Elwha River dam removal projects (M. Beirne, LEKT, personal communication).

3.2 Immediate Post-Placement Verification Monitoring

Within 4 hours of completion of placement activities, Anchor QEA measured the placed cap thickness using a combination of probing and coring methods that have been used routinely in Puget Sound to verify placed cap thickness. Cap thickness was measured at all 12 stations depicted in Figure 2 using a push-probe, with cap thickness at individual probing stations ranging between approximately 4 to 8 inches (Table 4). Cap thickness was also measured in five piston cores advanced through the cap, with cap thickness in individual cores ranging from 3 to 7 inches. These combined probing and coring measurements suggested an average cap thickness of approximately 5.3 ± 1.4 inches, roughly 25% less than the 7.0 inches indicated from construction records as discussed above. The discrepancy between these estimates could be attributable to measurement variability (i.e., there is no statistically significant difference between the 5.3 ± 1.4-inch and 7.0-inch estimates), as well as possible compaction of material during piston coring operations. Given these considerations, more robust cap thickness monitoring was performed during the follow-on 6-month monitoring event, as discussed in Section 4.1. Overall, the average thickness of the cap estimated immediately after placement (5.3 ± 1.3 inches) was only slightly less than the 6-inch target, and the minimum cap thickness of approximately 4 inches was achieved in approximately 90% or more of the cap probe/core measurements, consistent with the objectives of the pilot cap project.

3.3 Eelgrass Transplanting

Within approximately 1 week of completion of cap placement activities as described above, LEKT planted approximately 1,200 native eelgrass (*Zostera marina*) turions harvested from the nearby U.S. Coast Guard facility. Eelgrass turions were planted both on and off the pilot cap. Eelgrass transplanting operations are described in separate LEKT documents.

4 6-Month Post-Construction Performance Monitoring

Approximately 6 months after completion of cap placement activities as described in Section 3, the first post-construction performance monitoring event was performed, on December 7 and 8, 2017. Compared to the immediate post-placement verification monitoring discussed in Section 3.2, the 6-month post-construction performance monitoring included more robust monitoring of cap thickness (see below), as well as characterization of porewater hydrogen sulfide (H_2S) concentrations and benthic community development.

4.1 Cap Thickness and Stability

Cap thickness measurements were performed by push-probe using the same methods described in Section 3.2 for immediate post-placement verification monitoring, but three replicates were obtained at each station to improve the accuracy of these measurements. For the 6-month event, power-grab (hydraulic van Veen) sampling replaced piston coring to reduce potential compaction, improve recovery, and obtain sufficient sample volume for porewater H_2S and benthic community analyses.

Cap thickness was measured at all 12 stations using the push-probe. At each station, cap thickness was calculated as the average of the three replicates per station. Cap thickness at individual probing stations ranged from approximately 6.8 to 10 inches (Table 5). Cap thickness was also measured in five power-grab samples advanced through the cap, with cap thickness in individual grabs ranging from approximately 4.0 inches to greater than 6.0 inches. Based on the combined probing and grab sampling measurements, an average cap thickness of approximately 7.3 ± 1.8 inches is present over the pilot area, greater than the post-construction estimate (5.3 ± 1.4 inches), but similar to the placed thickness (7.0 inches). Compared to the immediate post-placement verification monitoring discussed in Section 3.2, the 6-month post-construction performance monitoring provided a more robust characterization of the placed cap thickness. Overall, these data verify the integrity and stability of the placed cap through approximately 6 months following construction; current cap thicknesses are consistent with the objectives of the pilot cap project (i.e., average thickness of greater than 6 inches and a minimum thickness of 4 inches).

4.2 Porewater H_2S Concentrations

Porewater H_2S concentrations were measured using ex situ diffusive gradient in thin-film (DGT) samplers deployed for 24 hours in surface sediments (e.g., upper 4 inches). DGTs were deployed in six representative cap stations and six reference area stations (Figure 2). Porewater H_2S concentrations were analyzed using methods described in Attachment A. Porewater H_2S concentrations in the six cap samples and five of the six reference samples were below the 0.01 milligrams per liter (mg/L) detection limit (Table 6). A porewater H_2S concentration of 0.04 mg/L was detected in one of the six reference samples.

As summarized in Attachment B, Ecology reviewed the scientific literature to evaluate potential injury from H_2S concentrations in porewater, and concluded that, of 22 different organisms that could potentially be exposed to marine sediment porewater for which sufficient toxicity data exists, shrimp *(Crangon* sp.) and amphipod (*Rhepoxynius* sp.) species are the most sensitive to H_2S exposure, exhibiting toxic responses to H_2S concentrations between approximately 0.072 and 0.18 mg/L. Because measured porewater concentrations on the cap are well below this benchmark range, the 6-month post-construction performance monitoring data confirm the protectiveness of the cap with respect to potential wood debris degradation products such as H_2S.

4.3 Benthic Community Development

Benthic community analyses were performed on six representative cap stations and six reference area stations (Figure 2). Similar grain size distributions (silty sand with fine gravel) and no wood debris (less than 5% by volume) was observed in the reference area sediments, confirming their suitability for comparison with cap samples.

Benthic enumeration data and biological evaluations prepared by Western Washington University are provided in Attachment C. While relatively subtle differences in benthic community structure were noted on parts of the new cap as it is being colonized (e.g., the polychaete *Platynereis bicanaliculata* was more abundant in the capped sites), overall there were no statistically significant decreases in the abundance of major taxa (Crustacea, Mollusca, or Polychaeta) on the cap versus those in the reference area, and also no differences in species richness, diversity, or evenness between benthic communities in these areas.

Consistent with criteria used at other similar sites (e.g., Biological Success Criterion 8 from Commencement Bay Natural Resource Trustees 2001, Anchor QEA 2016), and using Washington State Sediment Management Standards protocols, pilot project permit documents specified that benthic invertebrate restoration will be indicated if the mean abundance of invertebrates on the cap is ≥50% of the mean abundance in the reference area for major taxa (Crustacea, Mollusca, or Polychaeta), or if the cap abundance of these taxa are not statistically different (t-test, $p \leq 0.05$) from the reference area abundance. As described in more detail in Attachment C, the 6-month monitoring data already achieve this benthic community restoration success criterion, verifying the effectiveness of the cap in rapidly restoring benthic habitat along Ediz Hook.

4.4 12-Month Performance Monitoring

Follow-on cap performance monitoring is scheduled for June 2018, which will include further verification of the uniformity and stability of the cap, porewater H_2S concentrations, and benthic macroinvertebrate community development. In addition, LEKT will survey transplanted and volunteer native eelgrass (*Zostera marina*) turions on the cap. Potential follow-on monitoring may be performed as appropriate to support restoration design.

5 References

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Tables

Table 1
Grain Size Distribution of Stockpiled Elwha River Capping Material

Description	Phi Size	Percent
Gravel (> 2.00 mm)	<-1 Ø	39%
Sand, Very Coarse (1.00 mm to 2.00 mm)	-1 to 0 Ø	5.3%
Sand, Coarse (0.500 mm to 1.00 mm)	0 to 1 Ø	4.3%
Sand, Medium (0.250 mm to 0.500 mm)	1 to 2 Ø	14%
Sand, Fine (0.125 mm to 0.250 mm)	2 to 3 Ø	20%
Sand, Very Fine (0.0625 mm to 0.125 mm)	3 to 4 Ø	7.6%
Silt (0.0039 mm to 0.0625 mm)	4 to 8 Ø	7.2%
Clay (< 0.0039 mm)	> 8 Ø	2.0%
Total		100%

Table 2
Metals Concentrations in Stockpiled
Elwha River Capping Material (mg/kg dw)

Analyte	Natural Background[1]	Sediment Quality Objective	Capping Material
Arsenic	12	12	4.7
Cadmium	0.82	0.82	< 0.50
Chromium	N/A	260	28
Copper	N/A	390	27
Lead	N/A	450	7.6
Mercury	0.11	0.11	0.032
Silver	N/A	6.1	< 0.50
Zinc	N/A	410	72

Notes:

1. From Washington State Department of Ecology, 2016. North Olympic Peninsula Regional Background Sediment Characterization, Port Angeles – Port Townsend, Washington: Data and Evaluation Report. Publication No. 16-09-142. February 2016.

N/A - not available

Table 3
Construction Water Quality Monitoring Data

Transect	Distance from Placement Operation	Time	Distance from Placement Area (feet)	Water Depth (feet)	Turbidity Above Background (NTU)	
					Surface	Bottom
Background	1000	14:08	1,000	33	0.0	0.0
1	150	14:09	150	72	0.0	0.2
2	150	14:11	150	110	0.0	0.0
3	150	14:13	150	109	0.0	0.0
4	150	14:18	150	15	2.3	4.9
4	300	14:22	300	15	1.4	2.4
3	150	14:28	150	107	0.0	0.1
4	150	14:36	150	21	3.9	5.1
4	300	14:39	300	23	6.0	6.3
4	450	14:43	450	12	5.9	7.3
4	600	14:47	600	21	4.8	5.8
4	750	14:50	750	14	7.2	5.6
4	900	14:53	900	12	5.6	5.4
Background	1000	14:58	1,000	10	0.1	0.5
1	150	15:01	150	23	0.1	0.1
2	150	15:03	150	89	0.0	0.0
3	150	15:06	150	91	0.1	0.3
4	150	15:15	150	25	2.2	1.9
4	300	15:12	300	17	1.3	1.7
4	600	15:17	600	14	1.4	1.0

Notes:
Shaded measuremets exceeded 5 nephelometric turbidity units (NTUs) above background.
Placement activities occurred from 13:00 to 15:05

Table 4
Immediate Post-Cap Thickness Verification Monitoring Data

Location	Measured Cap Thickness (inches)	
	Probing	**Coring**
S-01	5.0	N/M
S-02	4.0	N/M
S-03	8.0	5.0
S-04	5.0	N/M
S-05	6.0	3.5
S-06	4.5	N/M
S-07	7.0	7.0
S-08	7.0	6.0
S-09	6.0	N/M
S-10	4.0	N/M
S-11	5.0	N/M
S-12	4.0	3.0
Overall Average	**5.3 ± 1.4**	

Notes:
N/M: not measured

Table 5
6-Month Post-Construction Cap Thickness
Verification Monitoring Data

Location	Measured Cap Thickness (inches)	
	Probing	**Power Grab**
S-01	8.6	> 6.0
S-02	7.2	N/M
S-03	7.6	N/M
S-04	6.8	4.5
S-05	8.0	N/M
S-06	7.2	N/M
S-07	7.2	> 5.0
S-08	7.6	4.0
S-09	10.0	N/M
S-10	9.2	> 5.5
S-11	10.0	N/M
S-12	7.6	4.5
Average	**7.3 ± 1.8**	

Notes:
N/M: not measured

Table 6
6-Month Post-Construction Cap Porewater H_2S Monitoring Data

Area	Location	H_2S (mg/L)
Cap	1	< 0.01
	4	< 0.01
	7	< 0.01
	8	< 0.01
	10	< 0.01
	12	< 0.01
Reference	1	< 0.01
	2	< 0.01
	3	0.04
	4	< 0.01
	5	< 0.01
	6	< 0.01

Figures

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LEGEND:

- Reference Sampling Location
- Sand Cap Pilot Area

Presence of wood debris:

- > 50%
- 21% to 50%

0 750

Feet

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ANCHOR QEA

Figure 1
Ediz Hook Wood Debris Areas
Summary of Construction and 6-Month Monitoring
Ediz Hook Restoration Sand Cap Pilot Project

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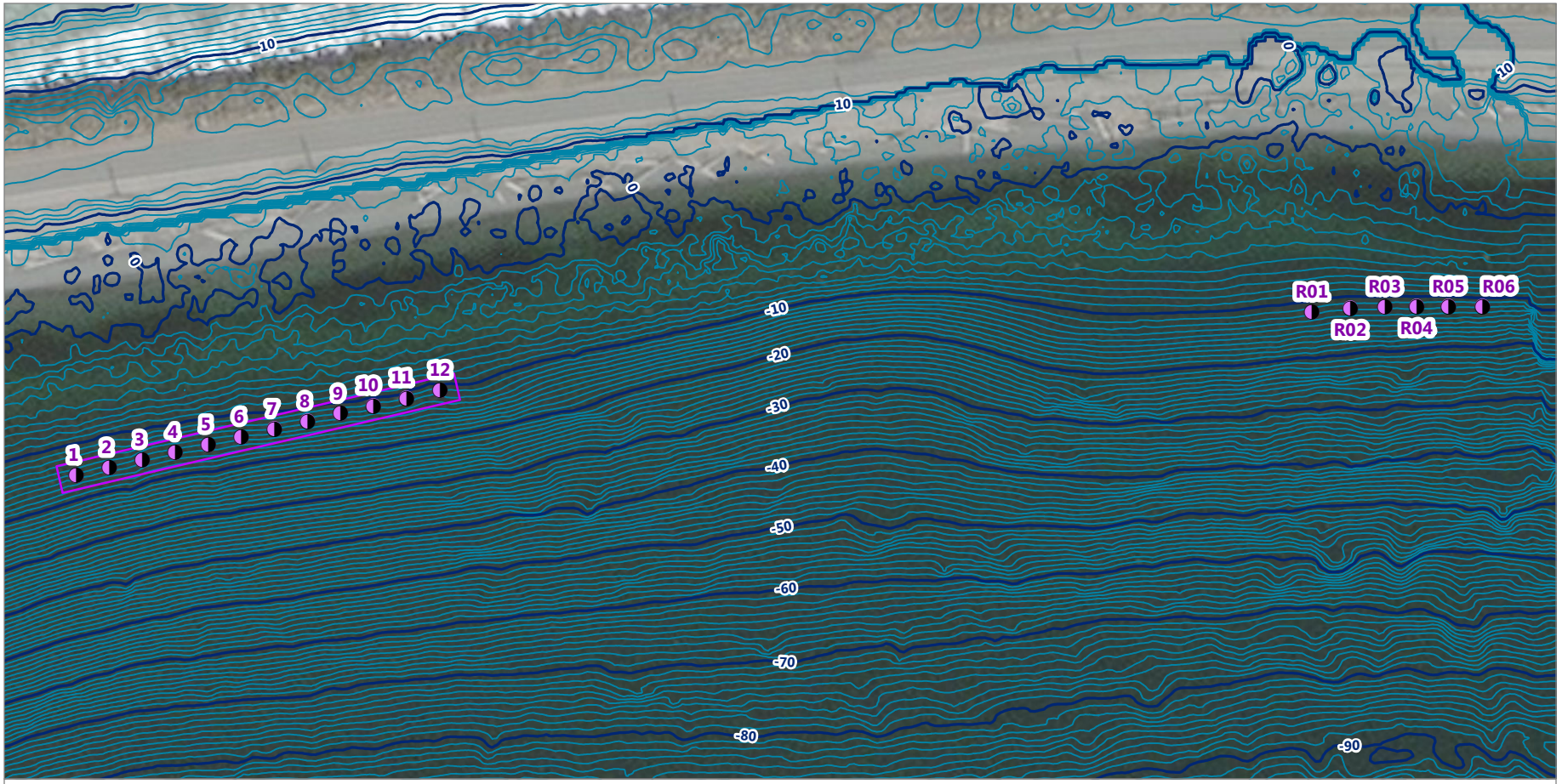

LEGEND:

- Sampling Location
- Sand Cap Pilot Area
- NOAA 1-foot Contours (MLLW)

NOTE:
1. Locations are diver-confirmed at -10 and -14 feet MLLW.

0 100
Feet

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Figure 2
Capping Pilot Sampling Locations
Summary of Construction and 6-Month Monitoring
Ediz Hook Restoration Sand Cap Pilot Project

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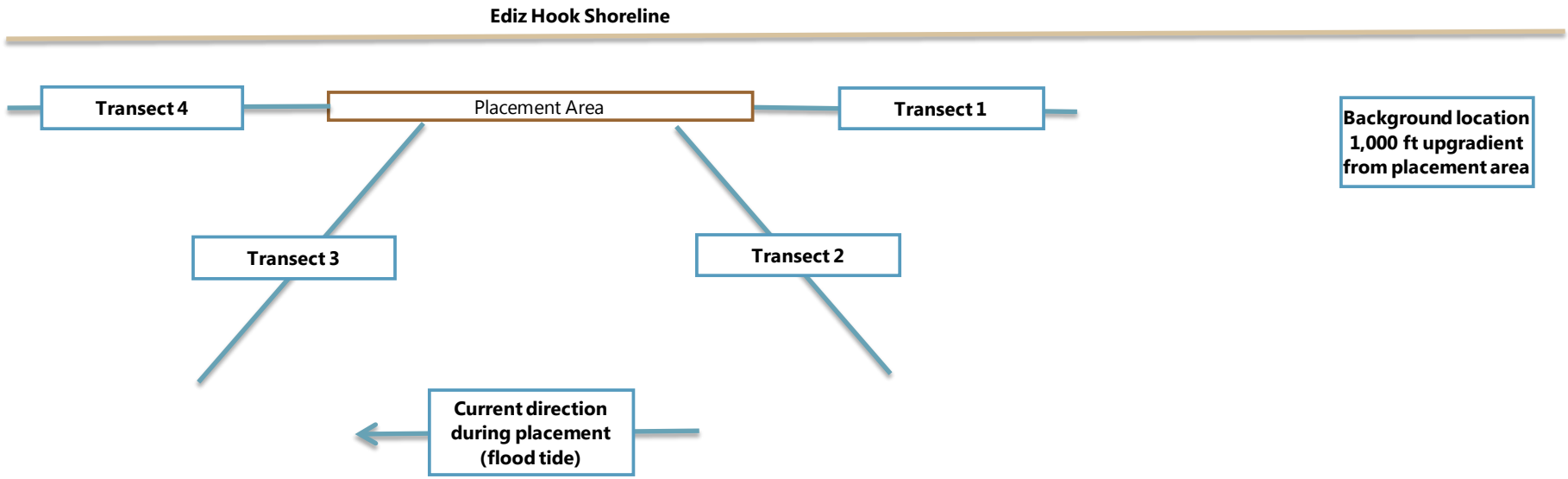

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Figure 3
Water Quality Monitoring Location Schematic
Construction and 6-Month Post-Construction Monitoring Summary
Ediz Hook Cap Pilot

Attachments

DRAFT

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Portland, Oregon 97204
503.688.5057

ANCHOR QEA

Memorandum

November 10, 2017

To: Clay Patmont

From: Masa Kanematsu, PhD; Dimitri Vlassopoulos, PhD

Re: Method Development and Verification Study for Sulfide Measurement in Porewater Using Diffusive-Gradients-in-Thin-Films (DGT)

This document presents the results of a laboratory verification study of a passive porewater sampling technique for dissolved sulfide using Diffusive Gradients in Thin-films (DGT). The method, developed over the last two decades (Teasdale et al. 1999; Rearick et al. 2005), is finding increasing use as a reliable in situ technique for quantifying sulfide levels in sediment porewater. The method is based on the reaction of sulfide with silver iodide (AgI), a white powder impregnated in a gel to produce silver sulfide (Ag_2S), a black solid. The intensity of the color developed is proportional to the amount of sulfide accumulated in the gel.

For this study, we developed a calibration curve using optical densitometry (OD) to quantify the amount of sulfide accumulated in the DGT device over a dissolved sulfide concentration range of 0 to 6 mg/L sulfide. To verify the DGT technique, sulfide was extracted from exposed DGTs and quantified using two different extraction and analysis methods:

- Extraction of chromium reducible sulfur (CRS) from the DGT gel and analysis by sulfide ion-specific electrode
- Extraction of the DGT gel by nitric acid/hydrogen peroxide (commonly used in selective sequential extraction schemes to quantify metals associated with sulfides) and analysis of total sulfur released by ICP-MS

Results from both methods were in excellent agreement and quantitative recovery of sulfide from the DGT gels was confirmed by comparison with the theoretical mass of accumulated sulfide calculated using a mass-transfer model. Sulfide recoveries from the DGT gels averaged 101.0% and 96.9% for the CRS and nitric acid/peroxide extraction methods, respectively.

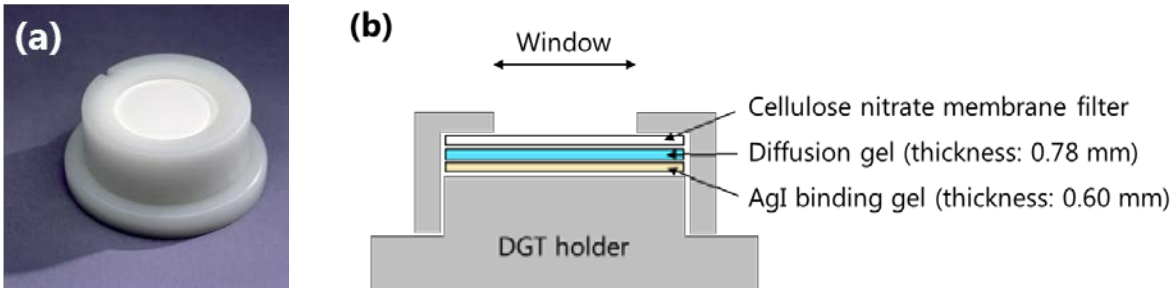
Materials and Methods

DGT Samplers

DGT piston devices for deployment in soil were obtained from DGT® Research (http://www.dgtresearch.com). The DGT samplers were preloaded for sulfide measurement and

consist of a standard DGT holder containing a 0.6 mm thick silver iodide (AgI) impregnated binding gel layer, overlain by a 0.78 mm thick polyacrylamide diffusive gel, and held in place by a 0.45 µm cellulose nitrate membrane filter (Figure 1). The window size of the DGT sampler is 2.54 cm^2. Prior to use, the DGT assemblies were deoxygenated by immersion in 0.01 M sodium nitrate purged with high-purity nitrogen gas for at least 2 days to remove any residual oxygen.

Figure 1
DGT piston assembly (a) and cross-section view (b)



* DGT® Research: http://www.dgtresearch.com/

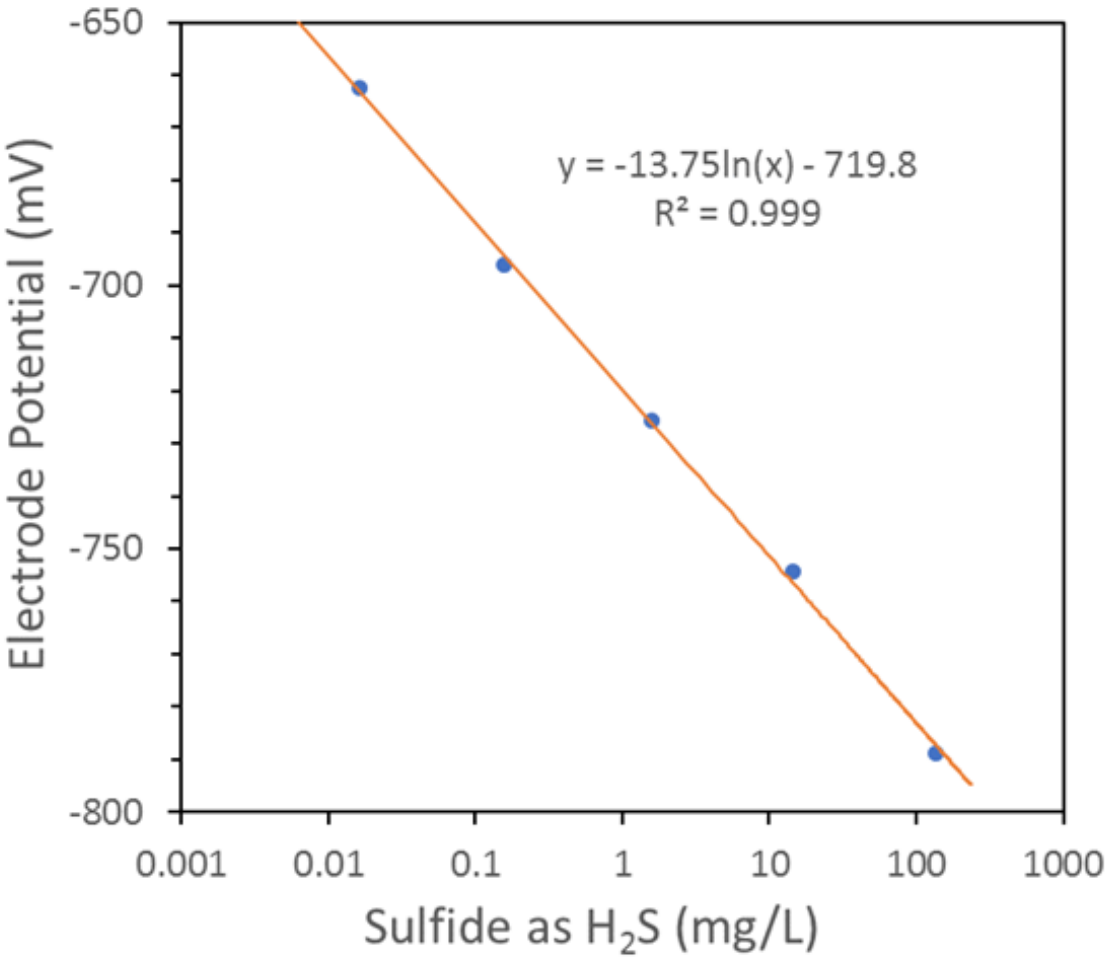
Preparation of Stock Sulfide Solutions

All sulfide solutions were prepared from a stock solution of approximately 1,000 mg/L as S (1,063 mg/L as H_2S). The stock solution was prepared by first washing a crystal of sodium sulfide nonahydrate ($Na_2S{\cdot}9H_2O$) with deionized (DI) water to remove oxidation products, blotting it dry on tissue paper, accurately weighing it, and dissolving it in deoxygenated DI water. Between uses, the stock solution was stored under nitrogen sealed in a Mylar bag with oxygen absorber packets to minimize exposure to oxygen. The sulfide stock solution was standardized daily by iodometric titration (Standard Method 4500-S2-F; APHA 2005).

Sulfide Measurement by Ion Selective Electrode

Dissolved sulfide concentrations were measured by Standard Method 4500-S2-G (APHA 2005) using a Thermo Scientific silver sulfide solid-state ion selective electrode (ISE) connected to a Thermo Scientific Orion Star A211 potentiometer. Alkaline anti-oxidant buffer (Thermo Scientific Orion 941609) was added to samples and standards to inhibit oxidation of sulfide by oxygen and to provide a constant ionic strength and pH during analysis. A five-point calibration curve was developed daily (Figure 2).

Figure 2
Example calibration curve for sulfide ISE



Calibration Curve for the Densitometric Determination of Sulfide

DGT sampler assemblies were exposed in duplicate to test solutions prepared at 8 different sulfide concentrations (0 to 6 mg/L as H_2S) for 24 hours. The solutions were prepared in 0.7 M sodium chloride to simulate seawater ionic strength. To minimize sulfide loss, tests were prepared in glass jars with cone seal caps, all solutions were purged with N_2 gas before addition of the sulfide stock solution, and headspace in the glass containers was minimized. Sulfide concentrations in the standard solutions were monitored by ISE before and after deploying the DGT assemblies.

Following the 24-hour exposure period, the DGT assemblies were retrieved and rinsed with DI water. The binding gel layers were removed and placed on blotting paper. The binding gels were then laid on a thin cellophane sheet (Bio-Rad), and covered with a second cellophane sheet. The sheet assembly was then placed in a vacuum gel dryer (Bio-Rad, Model 583) and dried for 2 hours at 60°C. The dried sheet was digitally scanned (Konica Minolta BizHub-C364) and saved as a gray-scale image. Gel analysis software (UN-SCAN-IT Gel Version 7.1) was used to measure and record the gray-scale intensity of each binding gel on the scanned image.

Extraction and Quantification of Sulfide in DGT Binding Gels

Sulfide was extracted from the exposed DGT binding gels by a modified CRS method (Burton et al., 2008) as well as a nitric acid/peroxide extraction method. Six replicate sulfide-exposed DGT samplers were prepared by exposing the devices to a 3.00 mg/L H_2S solution for 24 hours. Three DGTs were extracted by each method to quantitatively assess sulfide recovery and method reproducibility.

The modified CRS method developed by Burton et al. (2008) was adopted to this study. Briefly, an acidic chromium(II) solution was added to a gas-tight reaction vessel containing the sulfide-reacted binding gel to convert sulfide to hydrogen sulfide gas, which was trapped in an alkaline zinc acetate solution contained in a small centrifuge tube placed inside the reaction vessel. On completion of the extraction, dissolved sulfide concentrations in the trapping solutions were immediately measured by ISE.

A nitric acid/peroxide extraction is one of the steps employed in some selective sequential extraction procedures to quantify metals associated with organic matter and/or sulfides in soil and sediment (Tessier et al. 1979, Zimmerman and Weindorf 2010) and was used to extract sulfur from the DGT. In brief, the sulfide-reacted binding gel is extracted in acidic hydrogen peroxide followed by nitric acid. A detailed description of the procedure is provided in Appendix A. Sulfide released form the gel to the extraction fluid is oxidized to sulfate which is analyzed as total sulfur by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). ICP-OES analysis of the extracts was performed in the analytical geochemistry laboratory of the Geology Department at Portland State University. A procedural blank was also prepared and analyzed and sample results were blank corrected.

Results

Determination of Sulfide in DGT Samplers by Optical Densitometry

Dissolved sulfide concentrations in test solutions were measured before and after deployment of the DGT assemblies (Table 1). Sulfide losses from the solutions over the 24-hour exposure period ranged from 13 to 26 % and averaged 20 %. This is comparable to losses reported by Rearick et al. (2005)

due to oxidation, volatilization, or adsorption. The digital images of the sulfide-accumulated binding gels are shown in Figure 3 and the measured gray-scale intensities of the gels are given in Table 1.

Figure 3
Gray-scale images of DGT binding gels exposed to sulfide standard solutions for 24 hours

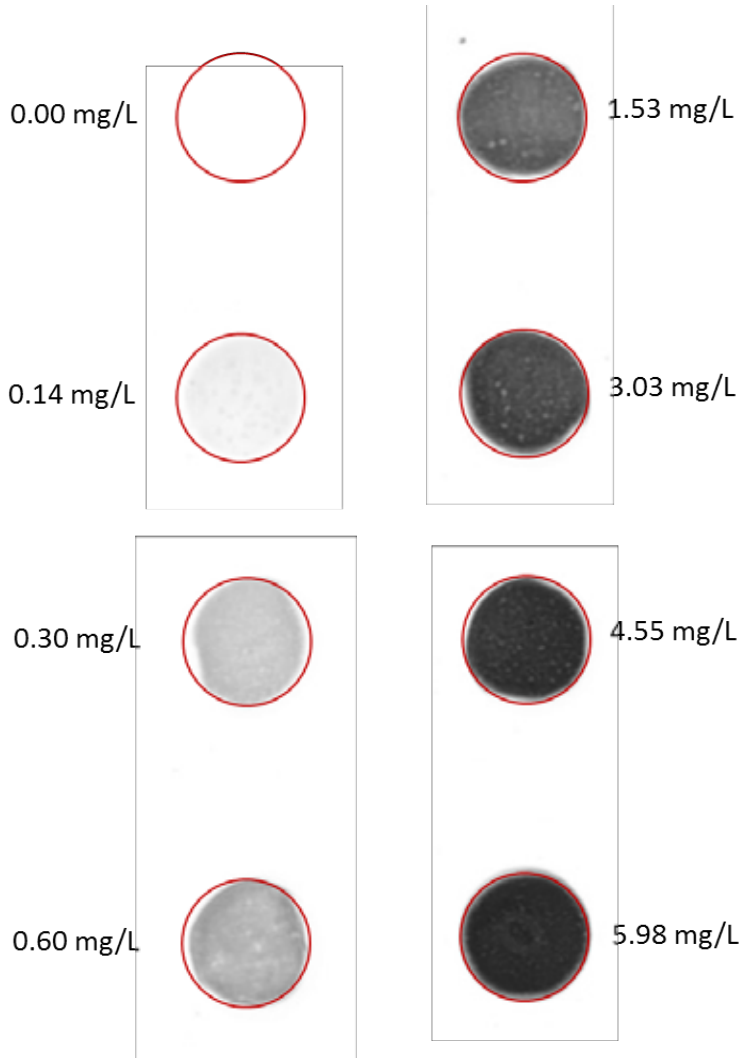


Table 1
Sulfide Mass Balance and Optical Densitometry Results

Solution	Target Concentration (mg/L as H_2S)	Measured Sulfide Concentration (mg/L as H_2S)[1]			Sulfide Loss[2] (%)	Gray-Scale Intensity[3]		
		Initial	Final	Average		1	2	Average
1	0.00	0.00	0.00	0.00	-	0	0	0 (0)
2	0.17	0.16	0.12	0.14	26%	6	14	10 (4)
3	0.34	0.33	0.26	0.30	23%	33	52	43 (10)
4	0.68	0.67	0.52	0.60	23%	100	77	89 (12)
5	1.70	1.70	1.35	1.53	21%	147	138	142 (5)
6	3.40	3.28	2.77	3.03	15%	171	155	163 (8)
7	5.10	4.86	4.24	4.55	13%	183	195	189 (6)
8	6.80	6.64	5.31	5.98	20%	194	193	194 (1)

Notes:

1. Measured by ISE.
2. Sulfide loss (%) during the experiments may be attributed to oxidation, volatilization, or adsorption.
3. Two DGTs were exposed at each sulfide concentration.

A calibration curve was developed by plotting the gray-scale intensity dissolved sulfide exposure concentrations and fitting the data to a function relating intensity to exposure sulfide concentration. As shown in Figure 4, the data were well fit by an exponential function (Equation 1) over the entire range of sulfide concentrations tested (0 – 6 mg/L as H_2S).

Equation 1 is useful for gray-scale intensities greater than about 10 (corresponding to sulfide concentrations greater than 0.15 mg/L). For lower concentrations, a three-point calibration curve was developed using the lowest concentration gel data. For the low range calibration, a power function was found to fit the data best (Equation 2).

Equation 1 is recommended for estimating porewater sulfide concentrations from DGT gels for gray-scale intensity greater than 10 and Equation 2 is appropriate for gray-scale intensity less than or equal to 10.

Equation 1. DGT calibration curve for sulfide concentration using optical densitometry (24-hour exposure)

$$S = 0.1156 \times \exp\{0.0196 \times I\}$$

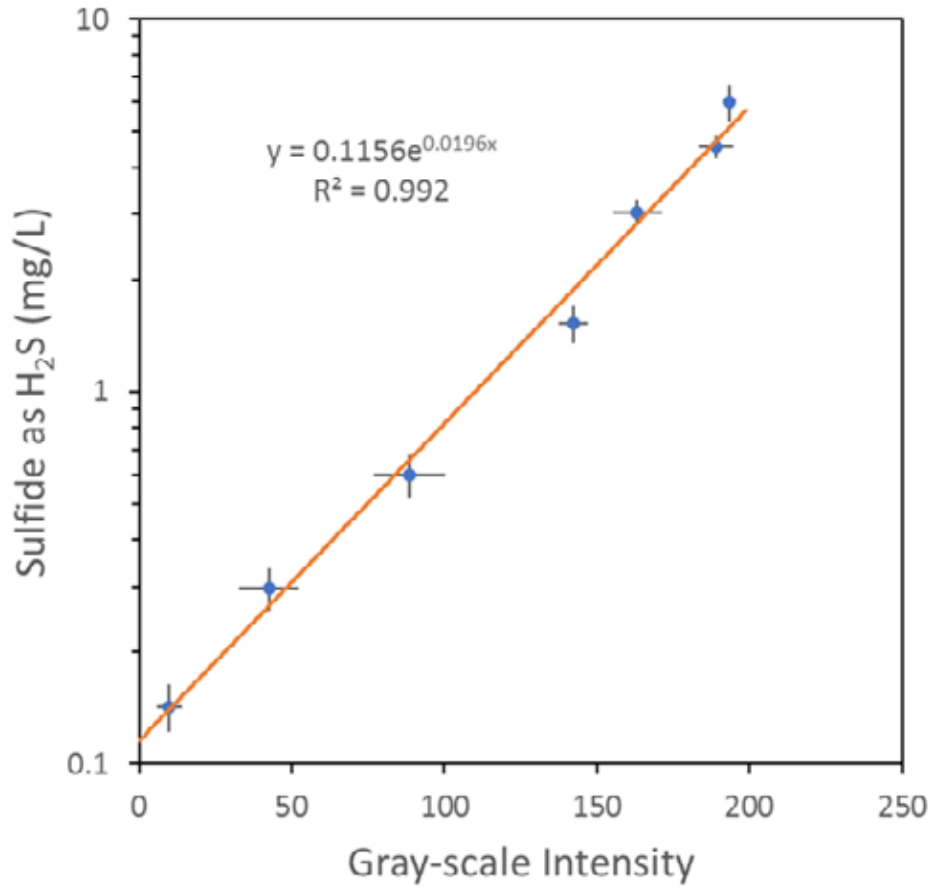
$$R^2 = 0.992$$

where:

S = sulfide concentration (mg/L as H_2S)

I = gray-scale intensity of binding gel image (10-256)

Figure 4
DGT calibration curve for a 24-hour exposure period



Equation 2. Low-range DGT calibration curve for sulfide concentration using optical densitometry (24-hour exposure)

$$S = 0.0304 \times I^{0.6298}$$

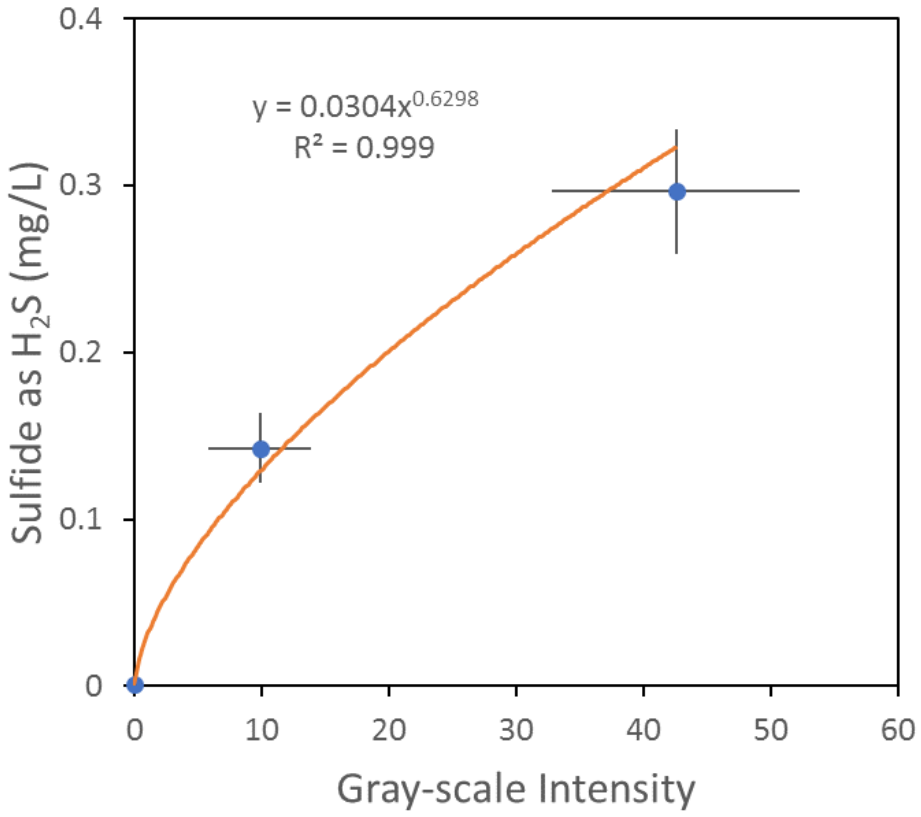
$$R^2 = 0.999$$

where:

S = sulfide concentration (mg/L as H_2S)

I = gray-scale intensity of binding gel image (0-10)

Figure 5
Low-range DGT calibration curve for a 24-hour exposure period



Verification of Sulfide Accumulation in DGT Samplers

Sulfide recovered from DGT binding gels after exposure to 3.00 mg/L H_2S solution for 24 hours by the CRS and nitric acid/peroxide extraction methods are summarized in Table 2. The sulfide mass extracted by the two methods is in very good agreement and excellent sulfide mass recoveries were obtained.

Table 2
Verification of Sulfide Accumulation in DGT

Extraction Method	Measured Sulfide Concentration (mg/L as H_2S)[1]			Mass of Sulfide Extracted from DGT (µg as H_2S)		Theoretical Mass of Sulfide Accumulated in DGT (µg as H_2S)[2]	Recovery (%)[3]
	Initial	Final	Average				
Chromium Reducible Sulfur	3.65 ±0.11	2.34 ±0.04	2.99	1	13.5	13.9	97
				2	13.6		98
				3	15.2		109
				Average	14.1		101
Nitric acid /Peroxide	3.65 ±0.11	2.36 ±0.01	3.00	1	12.9	13.9	92
				2	14.5		104
				3	13.4		96
				Average	13.6		98

Notes:

1. Measured by iodometric titration.
2. Calculated with Equation 2 using the average sulfide concentration, $D=1.65\times10^{-6}$ cm^2/s (derived from data in Teasdale et al. 1999), t=86,400 s, A=2.54 cm^2, and Δg=0.078 cm.
3. Recovery=100×(mass of sulfide extracted)/(theoretical mass of sulfide accumulated)

The extracted sulfide masses were compared to the theoretical amount accumulated calculated using the mass-transfer equation for sulfide accumulation in the DGT assembly (Equation 3) and used to calculate percent recoveries (Table 2).

Equation 3. Model equation for calculating sulfide mass accumulation in DGT binding gel (Teasdale et al. 1999)

$$M = \frac{CDtA}{\Delta g}$$

where:

M	=	mass of sulfide accumulated in binding gel (mg as H_2S)
C	=	sulfide concentration in solution (mg/cm^3 as H_2S)
D	=	effective diffusion coefficient of sulfide in DGT (cm^2/s)
t	=	exposure time (s)
A	=	cross-sectional area of DGT window (cm^2)
Δg	=	thickness of diffusion layer (cm)

The sulfide mass recoveries were in excellent agreement with the theoretical sulfide mass accumulated calculated by equation 3 and averaged 101 % of theoretical for the CRS method and 98 % for the nitric acid/peroxide extraction (Table 2).

Summary

The present study verified the DGT method for passive sampling of dissolved sulfide by establishing a quantitative relationship between dissolved sulfide concentrations in the range of 0 to 6 mg/L and the gray-scale intensity developed by the DGT binding gel after a 24-hour exposure period, and confirmed that the sulfide accumulated in the DGT gel agreed with the amount expected from theory. The results of this study show that the DGT method with quantification by optical densitometry gives accurate and reproducible results for dissolved sulfide concentrations and calibration curves were developed for field application of the DGT devices.

References

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Appendix A

Nitric acid/peroxide extraction procedure

Fluid 1: 0.02 M nitric acid
Fluid 2: 30% hydrogen peroxide adjusted to pH 2 with nitric acid
Fluid 3: 3.2 M ammonium acetate in 20% v/v nitric acid

1. Place a sulfide exposed DGT binding gel in a 50 mL centrifuge tube
2. Add 3 mL of fluid 1 and 5 mL of fluid 2 and heat in shaker-water bath at 85 ± 2 °C for 2 hours
3. 3. Add 3 mL of fluid 2 and heat for an additional 3 hours
4. After cooling, add 5 mL of fluid 3, dilute to 20 mL and agitate for 30 minutes at room temperature
5. Centrifuge at 10,000 rpm for 25 minutes (if solid is present)
6. Decant fluid
7. Repeat steps 3-6 with DI water (if solid is present)
8. Combine all decanted fluid, acidify with nitric acid to pH <2
9. Dilute with DI water to a final volume of 50 mL and submit for analysis

Sulfide Effects on Aquatic Organisms
Literature Review
D. Podger

Summary

The first section of this paper provides a summary of the scientific literature on sulfide environmental fate, and the toxic effects of hydrogen sulfide, which includes benthic organisms, freshwater and marine fish, and eelgrass. The second section of the paper focuses on sulfide toxicity in the pore water of marine sediments, and the relevant toxicity information for organisms that may be potentially exposed to porewater in Puget Sound marine sediment.

Hydrogen sulfide is a hazardous substance that is released from organic matter, such as wood residue, that is decomposing in an anoxic environment. Although low levels of hydrogen sulfide may naturally occur in the sub-surface sediment, an excess amount of organic matter causes excess amounts of hydrogen sulfide to accumulate causing toxicity in the sediment and in the water column close to the sediment.

Sulfide toxicity is primarily from the hydrogen sulfide (H_2S) form of sulfide. Sulfide ions may bind with available metals and precipitate out of solution. There is no information in the scientific literature regarding toxicity of solid phase sulfides. Bioavailable sulfide may exist in the pore water and its toxicity depends on pH. At pH 7, about half of the porewater sulfide is in the toxic form H_2S, while at pH 8, only about 9% of the total sulfide will be in the toxic form. H_2S is volatile and easily oxidized (converted back into sulfate or other non-toxic forms in the presence of oxygen). Due to these properties, special protocols are needed to collect sulfide porewater samples that are representative of field conditions. Also laboratory sediment bioassays using standard protocols may not be effective at determining sulfide toxicity because the aeration reduces sulfide concentrations (Wang & Chapman 1999).

In the scientific literature, sulfide toxicity is described at different pH levels and using different measurements (H_2S versus total dissolved sulfide and µM versus mg/l). To evaluate toxicity in consistent units, all µM concentrations were converted to mg/l. Figure 1 shows the relationship between µM and mg/l total dissolved sulfide. The proportion of toxic H_2S compared to total dissolved sulfides varies by pH. Therefore, all toxicity values expressed as total dissolved sulfides were converted to approximate H_2S concentrations, based on chemical equilibrium equations and the pH reported in the literature (see figure 2). Table 1 describes all toxicity thresholds based on a common metric of mg/l hydrogen sulfide, which is independent of pH. However, most site data are collected as total dissolved sulfide in porewater. Therefore, the hydrogen sulfide thresholds must be converted to total dissolved sulfides based on the proportion of hydrogen sulfide found at a particular pH. If available, the actual pH value of the porewater can be used to make this conversion.

Table 1 shows a range of sulfide toxicity values based on total sulfide at a particular pH, and the equivalent hydrogen sulfide concentration. Sulfide toxicity varies by species and life stage. Larval forms of oyster, crab and sea urchins displayed abnormal development at very low concentrations of sulfide (0.1 to 0.5 mg/l sulfide at pH 8), but this life stage is usually in the water column, so may not have exposure to the sediment porewater. Amphipods were more sensitive to sulfide (LC_{50} 1.4 to 5.2 mg/l sulfide) than polychaetes and clams (LC_{50} 5.7 to 16 mg/l sulfide). Most of these studies were laboratory experiments where both sulfide and dissolved oxygen concentrations were maintained in the water column.

Sulfide has been demonstrated to be toxic to eelgrass (*Zostera marina*), but eelgrass has a physiological adaptation to compensate for low levels of sulfide. Reduced light and low oxygen levels in the water column prevent the eelgrass from compensating for sulfide, so can exacerbate sulfide toxicity to eelgrass. One Puget Sound study showed that *Zostera* beds were healthy below 1.6 mg/l sulfide, impaired at 6.4 mg/l sulfide, and completely absent at 32 mg/l sulfide (Elliot 2006).

Sulfide toxicity studies have been done on freshwater fish and show that fish can survive short exposures of 0.3 to 0.4 mg/l sulfide. Since hydrogen sulfide has a strong odor, fish are likely to avoid areas with sulfide, if possible, before reaching toxic levels. Studies on freshwater fish embryos showed decreased hatching success at low levels of sulfide. Based on this USEPA recommended a freshwater water quality criteria of 2 ug/l (0.002 mg/l) undissociated sulfide (H_2S). Some marine fish have higher tolerance for sulfide, such as the California killifish (LC_{50} 9.6 mg/l H_2S), while other marine fish are quite sensitive, such as the speckled sand dab, which can die after 2 hours of exposure to 0.4 mg/l H_2S (Bagarinao 1991).

Figure 1: Relationship of uM sulfides to mg/l sulfides. Since molecular weight of H_2S(34 g/mole), HS^- (33 g/mole) and S^{2-} (32 g/mole) are similar, this chart can be used to approximate the relationship of uM to mg/l for any of the chemical forms of sulfide.

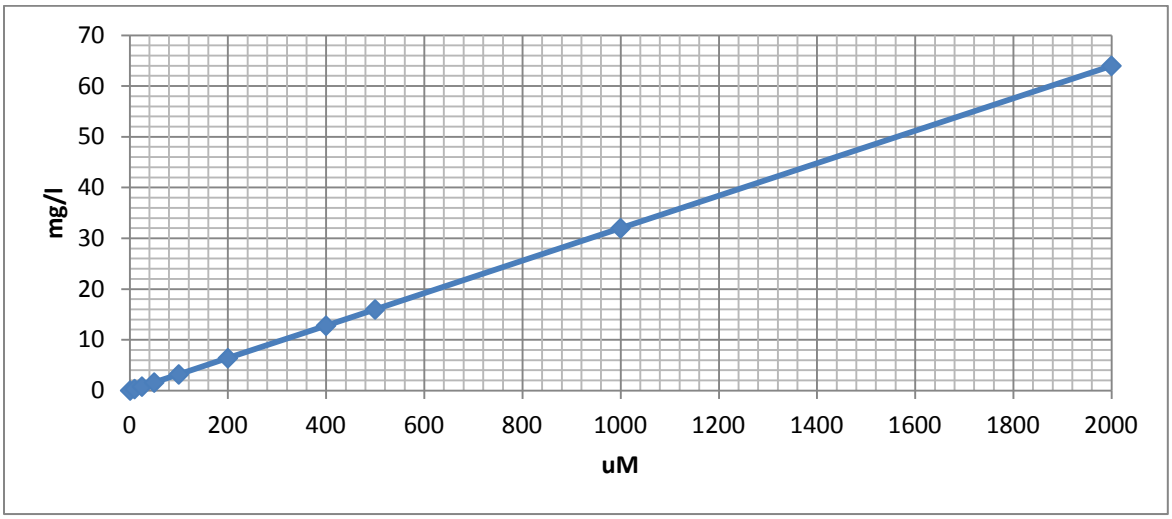


Figure 2: Proportion of H_2S species and SH^- species in total dissolved sulfides, depending on pH.

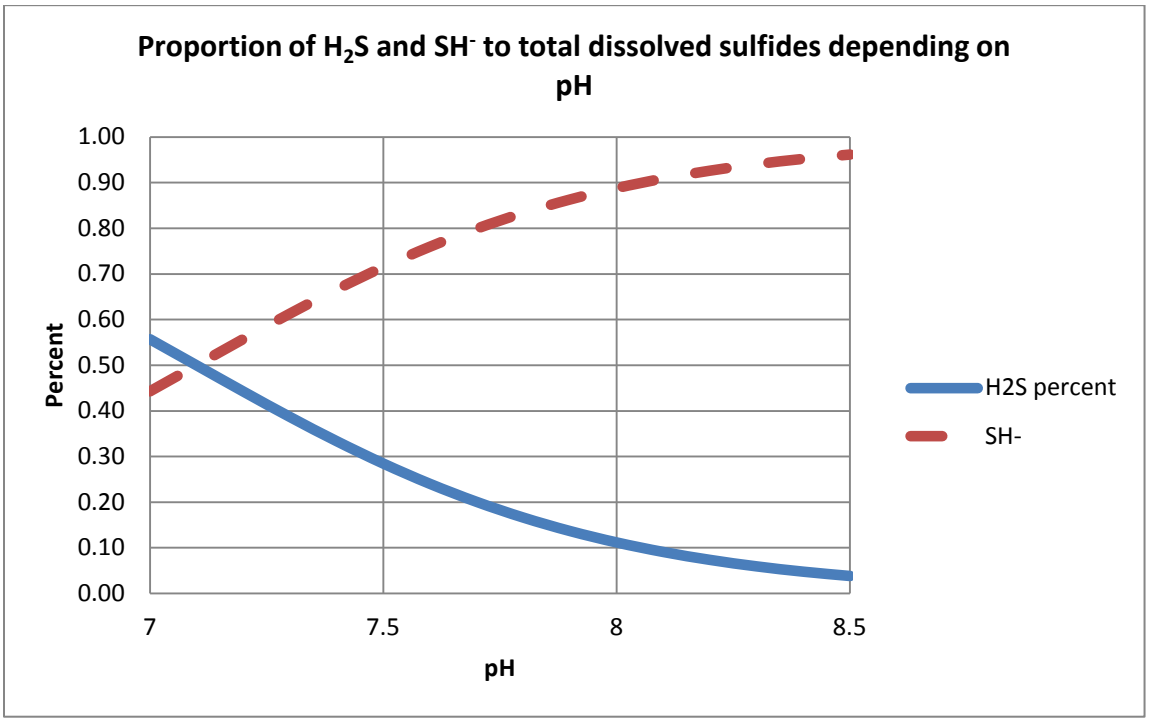


Table 1 Summary of sulfide toxicity values from scientific literature.

Organism	Total dissolved sulfides mg/l	pH	Estimated H_2S concentration mg/l	Endpoint	Reference
Mussel, *Mytilus* embryo	0.1	8	0.011	48-h EC50	Knezovich et al., 1996
Urchin *Strongylocentrotus, larvae*	0.13	8	0.015	48-h LOEC	Knezovich et al., 1996
Urchin *Strongylocentrotus, larvae*	0.19	8	0.021	48-EC50	Knezovich et al., 1996
Urchin Lytechinus pictus, mortality water column conc			0.048	LOEC, mortality from water column exposure	Thompson et al., 1991
Shrimp *Crangon*	0.64	8	0.072	1-h LT50	Vismann 1996
Amphipod *Rhepoxynius LOEC*	1.47	8	0.164	48-h LOEC	Knezovich et al., 1996
Amphipod *Rhepoxynius LC50*	1.6	8	0.179	48-h LC-50	Knezovich et al., 1996
Amphipod *Anisogammarus*			0.2	96-h LC50	Caldwell 1975
Mussel, *Mytilus*	1.9	8	0.212	96-h EC50	Abel 1976
Amphipod *Eohaustorius LOEC*	1.92	8	0.215	48-h LOEC	Knezovich et al., 1996
Amphipod *Eohaustorius LC50*	3.32	8	0.371	48-h LC-50	Knezovich et al., 1996
Chitharichthys stigameus, speckled sand dab			0.384	death in 2 hours	Bagarinao and Vetter, 1989

Organism	Total diss. sulfides mg/l	pH	Hydrogen sulfide mg/l	Endpoint	Reference
Crab *Cancer*, zoeae			0.5	96-h LC50	Caldwell 1975
Polychaete *Nereis*	5.76	8	0.644	24-D LT50	Vismann 1996
Oyster larvae development, *Crassostrea gigas*			0.56	Significant abnormal development after 2 hour H2S exposure	Caldwell 1975
Eelgrass *Zostera Marina,* reduced growth	6.4	*8*	0.716	No eelgrass in intertidal, reduced density in subtidal (200 uM)	Elliott et al., 2006
Crab *Cancer*, first instar			1.000	96-h LC50	Caldwell 1975
Fish, long-jawed mud sucker, Gillichthys mirabilis			1.024	96 hour LC_{50} at 16-20°C	Bagarinao and Vetter, 1989
Fish, California killifish, Fundudlus parvipinnis			1.344	96 hour LC_{50} at 16-20°C	Bagarinao and Vetter, 1989
Amphipod Corophium			1.400	24-h LC50	Caldwell 1975
Oyster *Crassostrea*			1.400	96-h LC50	Caldwell 1975
Polychaete Capitella	16	8	1.789	3-h LOEC in settlement time	Dubilier 1988
Clam *Arctica*	6.4	7.5	1.822	10-d LOEC	Oeschger et al., 1993
Urchin Lytechinus pictus, behavioral responses			2.900	Behavioral responses, sediment avoidance, time to turn over, growth reduction	Thompson et al., 1991
Urchin Lytechinus pictus, mortality 49 days			2.900	LOEC, mortality based on pore water concentrations	Thompson et al., 1991
Amphipod *Anisogammarus*			3.200	24-h LC50	Caldwell 1975
Eelgrass *Zostera Marina,* total inhibition	32	*8*	3.578	No eelgrass, Beggiatoa mats	Elliott et al., 2006
Amphipod *Gnorimosphaeroma*			5.200	96-h LC50	Caldwell 1975
Clam, *Macoma*			6.000	96-h LC50	Caldwell 1975
Fish, California killifish, Fundudlus parvipinnis			9.600	8 hour lethal concentration	Bagarinao 1991
Fish, long-jawed mud sucker, Gillichthys mirabilis			9.600	8 hour lethal concentration	Bagarinao 1991

underlined pH - pH was not given, assumed to be 8.0 for purposes of this exercise.

Sulfide production in a marine environment

Sulfide occurs in sediment due to microbial decomposition of organic matter in anoxic environment. Once oxygen and nitrates are depleted, bacteria use sulfate as the terminal electron receptor and produce sulfide as a byproduct. Sulfide is more common in marine environments than freshwater environments because marine water has significantly higher concentrations of sulfate that can be used by the bacteria.

Sulfide occurs naturally in the sediment horizon at the point where oxygen does not penetrate. Bioturbation or bioirrigation by sediment organisms may allow oxygen to penetrate deeper into the sediment horizon. The sulfide horizon is often characterized by black iron sulfide precipitates and the distinctive hydrogen sulfide smell (rotten eggs).

In areas with high organic loading, microbial activity can exceed the water body's capacity for oxygen supply, resulting in anoxia. High organic loading may result in increased sulfide production closer to the water/sediment interface, and higher concentrations of pore water sulfide.

Natural sources of sulfide in the aquatic environment include sulfur hot springs and geothermal vents, and hydrogen sulfide released from decay of non-anthropogenic organic matter. Human activities that can cause the release of hydrogen sulfide include petroleum refining, pulp and paper production, municipal sewage discharges, animal containment and manure handling, and other processes that discharge significant quantities of organic matter into the aquatic environment, such as sawmills, and canneries (ASTDR 2006).

Sulfide behavior in the environment

In water, sulfide exists in equilibrium of the following reaction.

$$H_2S \leftrightarrow H^+ + HS^- \leftrightarrow 2H^+ + S^{2-}$$

The pH of the water controls how much of each is present. H_2S is the most toxic form and is volatile. HS^- is ionized form, which may have some toxicity. The S^{2-} form rarely occurs at the pH of natural waters.

Sulfides can bind with metals and form insoluble precipitates such as iron sulfide and magnesium sulfide. The visible black in a sediment horizon is often iron sulfide precipitate. Thus the presence of sulfides can reduce soluble metals and their related toxicity (Wang 1999). There is no information in the scientific literature regarding toxicity of solid phase sulfide.

Hydrogen sulfide is volatile and accounts for the strong rotten egg smell of anoxic sediments. Volatile compounds can escape during sample collection, so handling and storage and may result in underestimating the actual *in situ* concentrations. Hydrogen sulfide also readily oxidizes, converting back into sulfate in the presence of oxygen. Samples must be protected from oxygen exposure and analyzed within a short amount of time to maintain sulfide levels (Chapman 2002).

Sulfide toxicity is greater in pore water than in the overlying water because concentrations of sulfide are higher and the pH is slightly lower so there is a greater proportion of the toxic form (Phillips 1997).

Oxygenated seawater can quickly oxidize hydrogen sulfide to a non-toxic form, with an oxidation ½-life of 20 minutes (Ostlund and Alexander 1963). In some cases, blue-green algae or other microorganisms colonize the surface of the sediment, and utilize hydrogen sulfide as an energy source creating an effective barrier to hydrogen sulfide entering the water column (Jorgensen and Fenchel 1974). This may also result in a diurnal variation in sulfide concentrations in the top 1 cm of the sediment, where higher sulfide concentrations accumulate at night when the algae do not photosynthesize and are reduced during the daylight hours (Hartman-Hansen 1978).

Vertical and horizontal gradients of sulfide concentrations are typically found in the sediment. The vertical gradients depend on the oxygen penetration in the sediment, which can also be affected by bioturbation or bioirrigation of benthic organisms. Horizontal spatial gradients may exist depending on organic content, water circulation patterns, and presence of bioturbating organisms.

Sulfide Toxicity

General

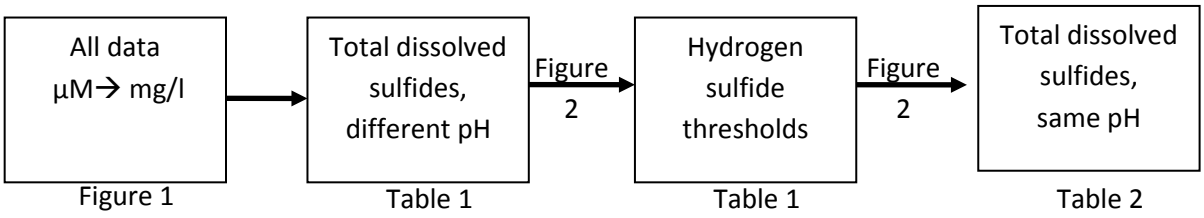
As stated previously, sulfide toxicity is dependent on pH because it is mainly the H_2S form of sulfide that is toxic. Lower pH water has a greater proportion of the toxic H_2S. At pH 7.0 about half of the aqueous sulfide exists as the toxic H_2S. At pH 8.0 only about 9% is H_2S. Toxicity values may be expressed as total sulfide for a particular pH, as shown in Table 1. (Wang 1999) The proportion of toxic hydrogen sulfide can be approximated by the equilibrium equation:

$[H_2S] = [\text{total } S^{2-}] \times (1-(1/(1 + 10^{(pK_a - pH)})))$ pKa = 7.1 (Phillips 1997)

Based on this equation, Figure 2 shows the proportion of HS^- and H_2S between pH 7 and pH 8.5, which encompass the pH range typically found in aquatic environments and porewater.

In the scientific literature reviewed for this paper, toxicity values were reported in various units, and measured different forms of sulfide. To develop a toxicity curve, the toxicity thresholds needed to be converted into units that could be compared to each other. First, all values were converted from µM to mg/l. Figure 1 shows the relationship between µM and mg/l. Some toxicity values were reported as the H_2S form, others as total dissolved sulfides at a particular pH. The equilibrium equation above was used to estimate toxic H_2S concentrations from total dissolved sulfides, as shown in Table 1. Once all toxicity values were in consistent units, the estimated total dissolved sulfide toxicity thresholds could be calculated at a particular pH using the equilibrium proportion of the toxic form, H_2S. Table 2 and Figure 4 shows toxicity thresholds as total dissolved sulfide concentrations at 2 different pH values that are typical for marine sediment pore water.

This diagram illustrates the steps described previously to report toxicity values that could be compared to environmental data. The diagram also describes the tables and figures in this paper where the information can be found.



Effects of H_2S are similar to hydrocyanic acid. Sulfide can fix iron in cytochrome and therefore reduce the oxygen intake of cells, especially nerve cells. The action of H_2S is that it first stimulates and then paralyzes nerve cells. The actions are reversible (Evans 1967). H_2S has also been shown to cause developmental abnormalities in early larval stages, such as abnormal shell development in oyster embryos (Caldwell 1975). H_2S affects cytochrome c oxidase and other enzymes, oxygen transport proteins, cellular structures, and consequently the physiological functions of organisms (Bagarinao 1992).

Toxicity thresholds for H_2S have been harder to develop than for other chemicals. Traditional sediment bioassays are aerated and therefore oxidize and volatilize H_2S and so are not always effective at determining sulfide toxicity. In addition, since it can be difficult to maintain stable levels of sulfide and oxygen, some effects may be due to oxygen depletion rather than sulfide toxicity. Some experiments have automated flow through systems and were able to maintain adequate oxygen levels, stable sulfide levels and constant pH to isolate the effects of sulfide alone (Wang 1999).

There are a wide range of sulfide toxicity levels, depending on the species. Some organisms have anaerobic respiration capabilities and are not affected by the presence of sulfides. Others are less affected because they get water from the overlying water column, where sulfide levels are lower (Caldwell 1975). Bagarinao explores a variety of adaptations against sulfide toxicity including symbiotic relationships with sulfide-oxidizing bacteria, anaerobic metabolism, and detoxification of sulfide by intracellular processes (Bagarinao 1992). In all the studies shown here, however, hydrogen sulfide was shown to be toxic to aquatic organisms.

Benthic & Epibenthic Invertebrate Toxicity

Caldwell (1975) tested a variety of organisms for sulfide toxicity and found LC_{50} concentrations ranged from 0.2 mg/l to 6.0 mg/l H_2S, with the most sensitive organisms being an amphipod. The stage of development was also an important consideration as bivalve larvae were sensitive to H_2S resulting in abnormal development. Seven day old velligers and bivalve adults, however, were relatively sulfide tolerant. Generally, amphipods and larval stages were most sensitive and bivalves and isopods were less sensitive to H_2S.

Caldwell tested amphipods, an isopod, and *Macoma* clams using a flow thru apparatus for up to 96 hours exposure with a freshly mixed seawater and sulfide solution. Five different sulfide concentrations were tested. Oyster larvae were too small to test in the flow-through apparatus, so were tested in static cultures limited to 2-hours of exposure to minimize oxygen depletion and sulfide oxidation, followed by exposure to normal seawater. The results are presented in Table 1. Different organisms showed different levels of sensitivity to H_2S with a 96-hour LC_{50} ranging from 0.2 mg/l (amphipod *Anisogammarus*) to 6.0 mg/l (*Macoma* clam).

In the Caldwell study, oyster larvae development was also a sensitive endpoint, where 2-hour exposure of 0.56 mg/l H_2S resulted in abnormal development in the majority of larvae. However, the oyster larval tests were performed at increased temperature (26°C), which has shown to increase sulfide toxicity sensitivity in other species. Oyster larvae were much more tolerant of H_2S once they had developed to 7-day old velligers (became inactive after 2-hour exposure to 3.2 mg/l sulfide, but recovered after 24 hours). Crab (*Cancer magister*) first instar zoeae were also sensitive to hydrogen sulfide exposure with 50% mortality after 24 hours exposure at 0.7 mg/l and slightly less sensitivity once they are post larval crabs. However, oyster larvae and first instar crab zoeae are planktonic and so less likely to be found in contact with the sediment pore water. Adult bivalves are some of the most sulfide tolerant organisms.

Knezovich (1996) also found that mussel and sea urchin larvae development were the most sensitive endpoints with effects at 0.1 to 0.2 mg/l total dissolved sulfide, although larvae are Planktonic and not likely to have much exposure to sediment pore water. Amphipod mortality occurred at slightly higher concentrations of sulfide. Knezovich tested four organisms; mortality for two amphipods *(Rhepoxynius abronius* and *Eohaustorius estuarius)* and embryo development in pore water *(Mytilus edulis* and *Strongylocentrotus purpuratus*). The study design was a 48-hour exposure using flow through test apparatus that maintained constant levels of sulfide, pH and dissolved oxygen. Knezovich found that larval development was the most sensitive endpoint for both purple sea urchin embryos (*Strongylocentrotus purpuratus*) and bay mussels (*Mytilus edulis*) with an total dissolved sulfide EC_{50} of 0.1 mg/l for *M. edulis* and 0.19 mg/l for *S. purpuratus*, and total inhibition of normal development at 0.25 mg/l for *M. edulis* larvae and 0.64 mg/l for *S. purpuratus* larvae. Amphipod survival was less sensitive to sulfide toxicity, with affects beginning at about 1.5 to 1.9 mg/l total dissolved sulfides and estimated total sulfide LC_{50} of 1.6 mg/l for *Rhepoxynius abronius* and 3.3 mg/l for *Eohaustorius estuarius*.

Fish toxicity

The USEPA Redbook (1975) summarizes available data on sulfide toxicity to fish at the time of its publication. The publication states that:

- The degree of hazard exhibited by sulfide to aquatic animal life is dependent on the temperature, pH and dissolved oxygen. At lower pH values a greater proportion is in the form of the toxic undissociated H_2S.
- When the pH is neutral or below, or when dissolved oxygen levels are low but not lethal to fish, the hazard from sulfides is exacerbated.

- Fish exhibit a strong avoidance reaction to sulfide, and if there is an escape route they are likely to be repelled by the odor before they are harmed.

Past data indicate that freshwater fish can survive short exposures of 0.3 to 0.4 mg/l H_2S (Van Horn 1958, Boon and Follis 1967, Theede et al., 1969). USEPA summarized a number of studies on freshwater fish that showed safe levels of H_2S between 2 ug/l (0.002 mg/l) and 15 ug/l (0.015 mg/l) for the freshwater species. USEPA recommended that concentrations exceeding 2.0 ug/l (0.002 mg/l) of undissociated H_2S would constitute a long-term hazard to fish. (USEPA 1976). Although USEPA has recommended water quality criteria of 2 ug/l H_2S for both freshwater and marine water (USEPA 1975), the state of Washington has not adopted this recommended criteria as a water quality standard. (Cheryl Niemi, personal communication).

Knezovich (1996) noted that sulfide concentrations are typically higher in marine environments, due to the abundance of sulfate in the water. Bagarinao (1992) also showed that generally marine fish are more tolerant of sulfide than freshwater fish, but there was a wide range of sulfide tolerance in marine fishes. The salt marsh fish, California kiilifish (*F. Parvipinnis*) is highly tolerant of sulfide (9.6 mg/l H_2S for an 8 hour lethal concentration)(Bagarinao 1991). The speckled sand dab (*Chithariachthys stigameus*), which resides in coastal areas, is more sensitive, with death occurring after 2 hours of 0.384 mg/l H_2S. (Bagarinao and Vetter, 1989)

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Eelgrass and sulfide toxicity

Sulfide has been demonstrated to be toxic to eelgrass *Zostera marina*. If *Zostera* is in areas with high levels of oxygen in the water column and high photosynthesis rates (clear water, no shading), it can deliver oxygen to the roots and mitigate for low levels of sulfide. Reduced photosynthesis makes sulfide toxic to eelgrass at lower concentrations. Sulfide may result in reduced plant growth or plant death. Porewater sulfide above 32 mg/l is associated with no eelgrass plants and filamentous algal mats. Porewater sulfide below 1.6 mg/l has been associated with healthy eelgrass growth in one location. Porewater sulfide above 6.4 mg/l has been associated with absence of eelgrass in the intertidal zone and reduced density in the subtidal zone(Elliot 2006).

Zostera marina eelgrass are adapted to live in mildly anaerobic conditions. The eelgrass have a lacunar system to deliver oxygen from the shoots to the roots and rhizomes in the anoxic sediments, thereby oxidizing the sulfide near the root zone and preventing sulfide intrusion into the plant tissue (Holmer 2005). The oxygen in the eelgrass may be derived from photosynthesis (Smith and Pregnall 1985), or from water column oxygen (Pedersen 2004). If the water column is anoxic at times, or photosynthesis is reduced due to shading or water clarity, the eelgrass is susceptible to sulfide toxicity at lower concentrations (Holmer 2001).

Goodman (1995) listed several mechanisms of sulfide toxicity in plants including inhibition of nutrient uptake, decrease in function of respiratory root mettalo-enzymes, and decreases in ATP that may affect

other metabolic processes, including photosynthesis. Holmer (2001) further demonstrated that *Zostera* have decreased rates of photosynthesis and decreased shoot biomass with increases in sulfide concentrations and anoxic water column conditions. With concentrations of sulfide between 100 µM (3.2 mg/l) and 1,000 µM (32 mg/l), the plants had 80% reduction in photosynthesis and 55% decrease in shoot biomass. Goodman (1995) showed that sulfide concentrations of 400-800 µM can reduce photosynthesis maximum by about 30%, and sulfide concentrations of 800-1000 µM can reduce photosynthesis by about 50%. So the presence of sulfide can itself reduce photosynthesis reactions, thereby reducing the plant's ability to mitigate for the sulfide.

Sulfide toxicity from exposure to marine pore water in Puget Sound

To use literature values to evaluate potential injury from hydrogen sulfide concentrations in pore water, two adjustments were made to the list of marine organisms toxicity thresholds.

- First, some species were removed from the list because either they are species or life stages that would not be typically exposed to sediment pore water, or they are species that are not commonly found in Puget Sound nor potential surrogates for Puget Sound species.
- Second, the hydrogen sulfide toxic thresholds are converted to estimated total dissolved sulfides concentrations based on equilibrium equations. Marine sediment pore water is typically more acidic than the overlying water (Phillips 1997). Total dissolved sulfide toxicity curves are presented in Figure 4 for 2 pH levels that would be typical for marine sediment pore water (7.6-7.9).

Table 2 and Figure 4 summarize the scientific literature for marine aquatic organisms that may be exposed to sulfide in sediment porewater. Table 2 presents the toxicity thresholds as H_2S concentrations, as well as estimated total dissolved sulfides concentrations at two pH levels. Figure 4 has a graph of the porewater toxicity values expressed only as total dissolved sulfides at the two pH levels, which are typical pH values found in marine sediment pore water.

If sediment pore water concentrations are measured at a particular site, the site-specific information can be used to estimate total dissolved sulfide concentrations from the hydrogen sulfide toxicity values.

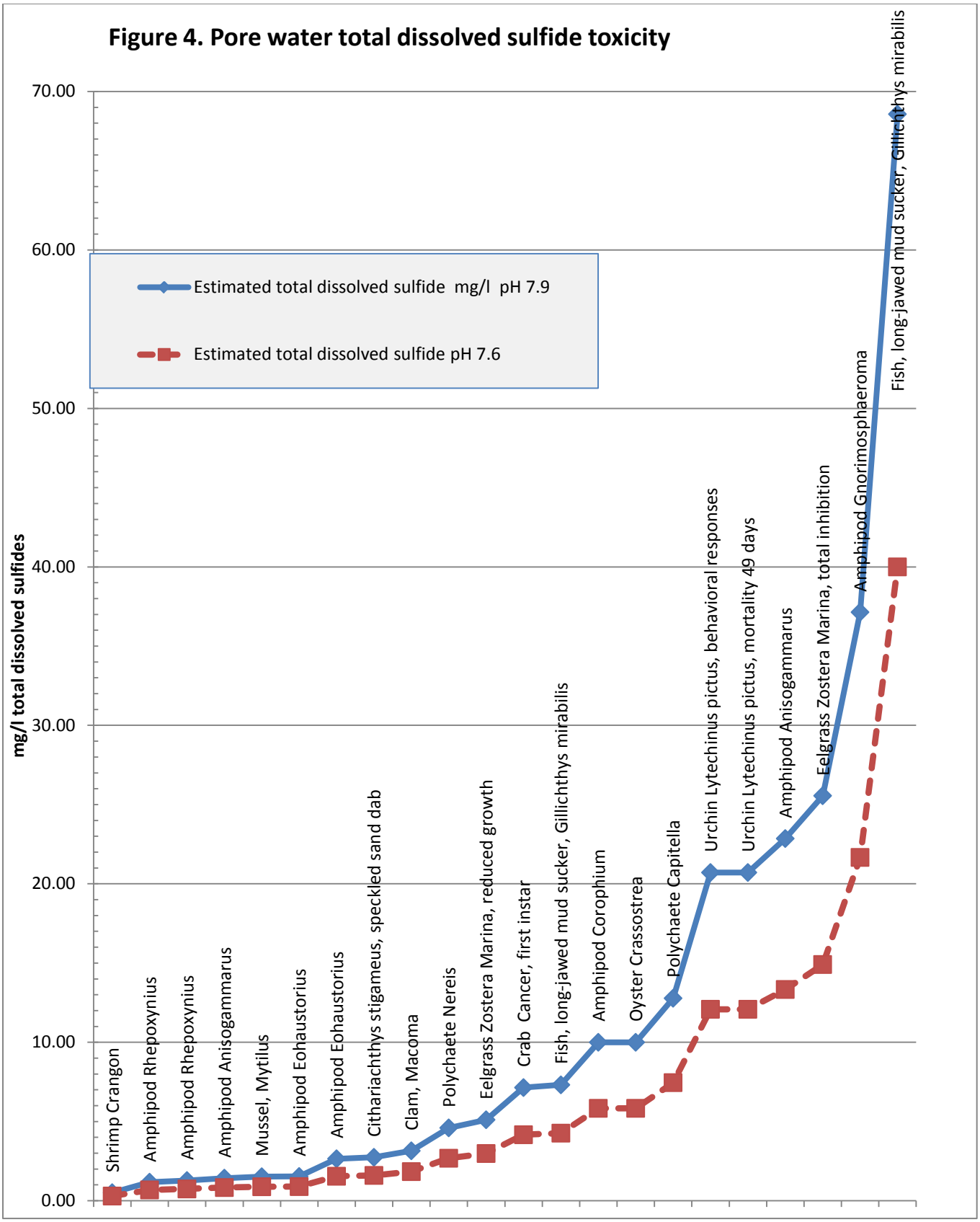
Figure 4. Pore water total dissolved sulfide toxicity
mg/l total dissolved sulfides
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Estimated total dissolved sulfide mg/l pH 7.9
Estimated total dissolved sulfide pH 7.6
Shrimp Crangon
Amphipod Rhepoxynius
Amphipod Rhepoxynius
Amphipod Anisogammarus
Mussel, Mytilus
Amphipod Eohaustorius
Amphipod Eohaustorius
Chatiachthys stigameus, speckled sand dab
Clam, Macoma
Polychaete Nereis
Eelgrass Zostera Marina, reduced growth
Crab Cancer, first instar
Fish, long-jawed mud sucker, Gillichthys mirabilis
Amphipod Corophium
Oyster Crassostrea
Polychaete Capitella
Urchin Lytechinus pictus, behavioral responses
Urchin Lytechinus pictus, mortality 49 days
Amphipod Anisogammarus
Eelgrass Zostera Marina, total inhibition
Amphipod Gnorimosphaeroma
Fish, long-jawed mud sucker, Gillichthys mirabilis

Table 2. Toxicity values from the literature converted to total dissolved sulfides concentrations at pH 7.6 and pH 7.9, which are in the range of typical marine porewater pH values.

Organism	Estimated H_2S concentration mg/l	Estimated total dissolved sulfide mg/l at pH 7.9	Estimated total dissolved sulfide mg/l at pH 7.6	Endpoint	Reference
Shrimp *Crangon*	0.072	0.51	0.30	1-h LT50	Vismann 1996
Amphipod *Rhepoxynius*	0.164	1.17	0.68	48-h LOEC	Knezovich et al., 1996
Amphipod *Rhepoxynius*	0.179	1.28	0.75	48-h LC-50	Knezovich et al., 1996
Amphipod *Anisogammarus*	0.2	1.43	0.83	96-h LC50	Caldwell 1975
Mussel, *Mytilus*	0.212	1.52	0.89	96-h EC50	Abel 1976
Amphipod *Eohaustorius*	0.215	1.53	0.89	48-h LOEC	Knezovich et al., 1996
Amphipod *Eohaustorius*	0.371	2.65	1.55	48-h LC-50	Knezovich et al., 1996
Chitariachthys stigameus, speckled sand dab	0.384	2.74	1.60	death in 2 hours	Bagarino and Vetter, 1989
Clam, *Macoma*	0.442	3.15	1.84	96-h LC50	Caldwell 1975
Polychaete *Nereis*	0.644	4.60	2.68	24-D LT50	Vismann 1996
Eelgrass *Zostera Marina,* reduced growth	0.716	5.11	2.98	No eelgrass in intertidal, reduced density in subtidal (200 uM)	Elliott et al., 2006

Organism	Estimated H_2S concentration mg/l	Estimated total dissolved sulfide mg/l at pH 7.9	Estimated total dissolved sulfide mg/l at pH 7.6	Endpoint	Reference
Crab *Cancer*, first instar	1.000	7.14	4.17	96-h LC50	Caldwell 1975
Fish, long-jawed mud sucker, Gillichthys mirabilis	1.024	7.31	4.27	96 hour LC_{50} at 16-20°C	Bagarino and Vetter, 1989
Amphipod Corophium	1.400	10.00	5.83	24-h LC50	Caldwell 1975
Oyster *Crassostrea*	1.400	10.00	5.83	96-h LC50	Caldwell 1975
Polychaete Capitella	1.789	12.78	7.45	3-h LOEC in settlement time	Dubilier 1988
Urchin Lytechinus pictus, behavioral responses	2.900	20.71	12.08	Behavioral responses, sediment avoidance, time to turn over, growth reduction	Thompson et al., 1991
Urchin Lytechinus pictus, mortality 49 days	2.900	20.71	12.08	LOEC, mortality based on pore water concentrations	Thompson et al., 1991
Amphipod *Anisogammarus*	3.200	22.86	13.33	24-h LC50	Caldwell 1975
Eelgrass *Zostera Marina,* total inhibition	3.578	25.56	14.91	No eelgrass, Beggiatoa mats	Elliott et al., 2006
Amphipod *Gnorimosphaeroma*	5.200	37.14	21.67	96-h LC50	Caldwell 1975
Fish, long-jawed mud sucker, Gillichthys mirabilis	9.600	68.57	40.00	8 hour lethal concentration	Bagarino 1991

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Ediz Hook Cap Pilot: 6-Month Post-Construction Benthic Community Monitoring

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Benthic sample collection

On 7-8 December 2017, benthic samples were collected from Western Port Angeles Harbor cap sites 1, 4, 7, 8, 10 and 12, and from reference sites 1- 6. A single 7.6-cm diameter corer was driven into the sediment to a depth greater than 10 cm. The cores were capped, placed on ice, and delivered to B. Bingham within 24 hr. Upon receipt, the top 10 cm of each core was removed and gently washed through a 1-mm sieve. All material retained on the sieve was preserved for 5 days in 10% buffered formalin, stained with rose bengal, then transferred to 70% ethanol. The samples were subsequently examining under a dissecting microscope (at least 10x magnification) and all invertebrates were picked from the samples and identified to the lowest possible taxonomic level.

Community analyses

The invertebrate communities in the reference and capped sites were evaluated through traditional indices including number of species, number of individuals, Shannon-Wiener diversity and Pielou's evenness. Two-sample t-tests were used to compare the reference and capped sites, doing separate analyses for each index. Prior to analysis, a Levene's test was done to verify equal variances for each index. Additionally, separate two-sample t-tests were done to determine whether the abundances of crustaceans, mollusks, or annelids were significantly different in the capped and reference samples.

Because they ignore the identity of individual species comprising the samples, community indices like Shannon-Wiener diversity can give inaccurate impressions about community similarity. To get a more complete view of the communities, the data were also analyzed using multivariate techniques (PRIMER software, Clarke and Warwick, 2001). We first used multidimensional scaling (MDS) to look for patterns in the data using Bray-Curtis similarity on fourth-root transformed data (the transformation increased the contribution of rarer species to the ordination).

The MDS plots allowed us to visualize the similarity of samples from the study sites. Samples with similar invertebrate communities (both in species composition and number of individuals of each species) appear closer together than do samples that are more different. We next used ANOSIM (analysis of similarity) to test for statistically significant differences between the reference and the capped sites. Finally, we used SIMPER (similarity percentages) to determine which species contributed most to the observed differences.

Results

Statistical analysis of the univariate indices found no significant differences in number of species, number of individuals, species diversity, or species evenness between reference and capped sites (Fig. 1, Tables 1-2). Separate 2-sample t-tests showed no significant decreased abundances of crustaceans, mollusks, or polychaetes in the capped sites, relative to the reference sites (Fig. 2).

Whole community analysis (incorporating identity and counts of individual species) presented a more complete view of the community. The MDS plot showed clear separation of some of the reference and capped sites (i.e., Ref 1, 4, and 5 vs. Cap 1 and 8), but there was a good deal of overlap in the other samples (Fig. 3). Despite the overlap, ANOSIM showed statistically distinct communities in the reference and capped sites (Global $R = 0.31$, $p = 0.009$). SIMPER analysis showed that the difference was driven primarily by the polychaete *Platynereis bicanaliculata* (which was much more abundant in the capped sites) followed by three foraminiferan species (all more abundant in the reference sites) and nematodes (more abundant in the reference sites; Table 3). Together, these five species accounted for 23.9% of the separation of the sites.

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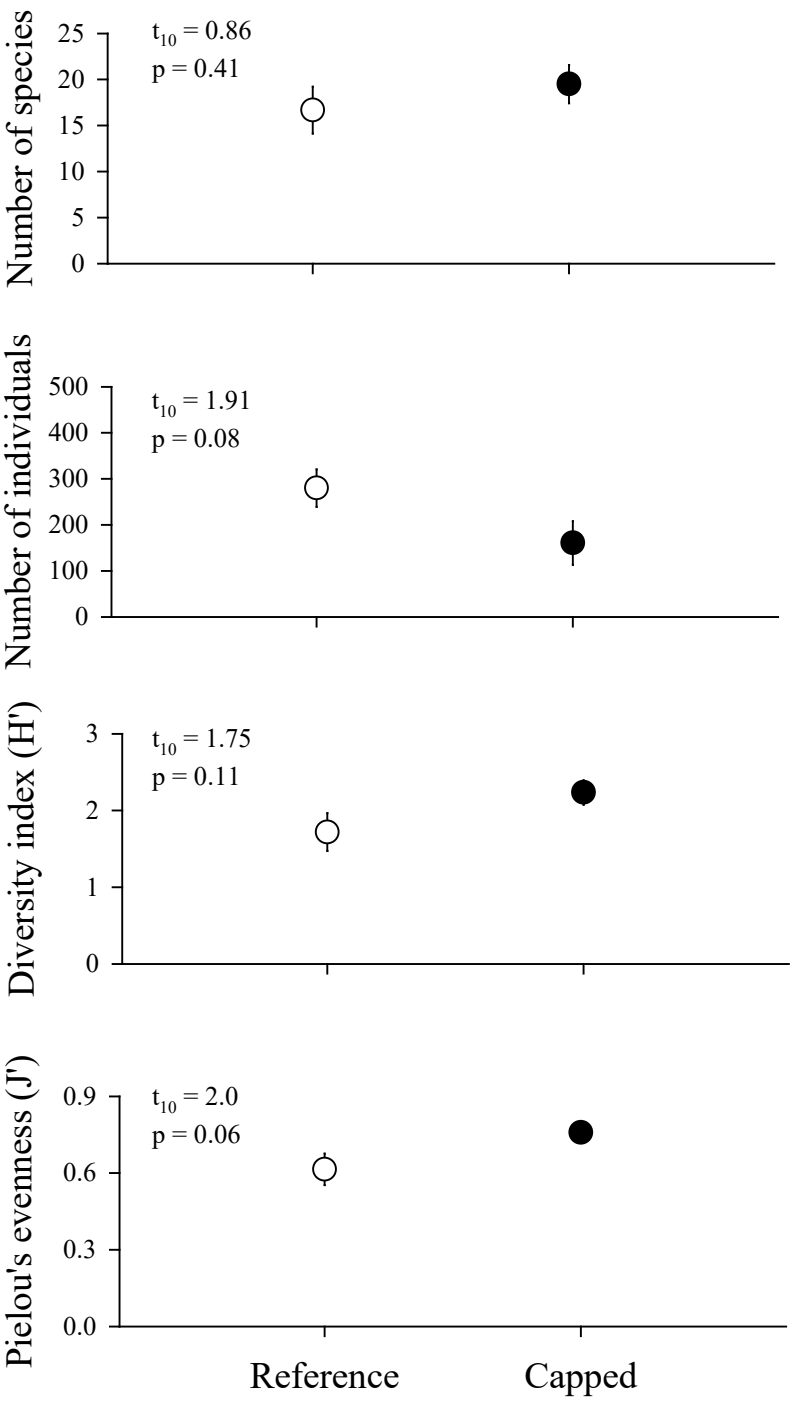

Figure 1. Invertebrate community indices for samples from the reference and capped sites. Results of 2-sample t-tests comparing the reference and capped samples are given. Standard errors are shown (n=6 for each treatment group).

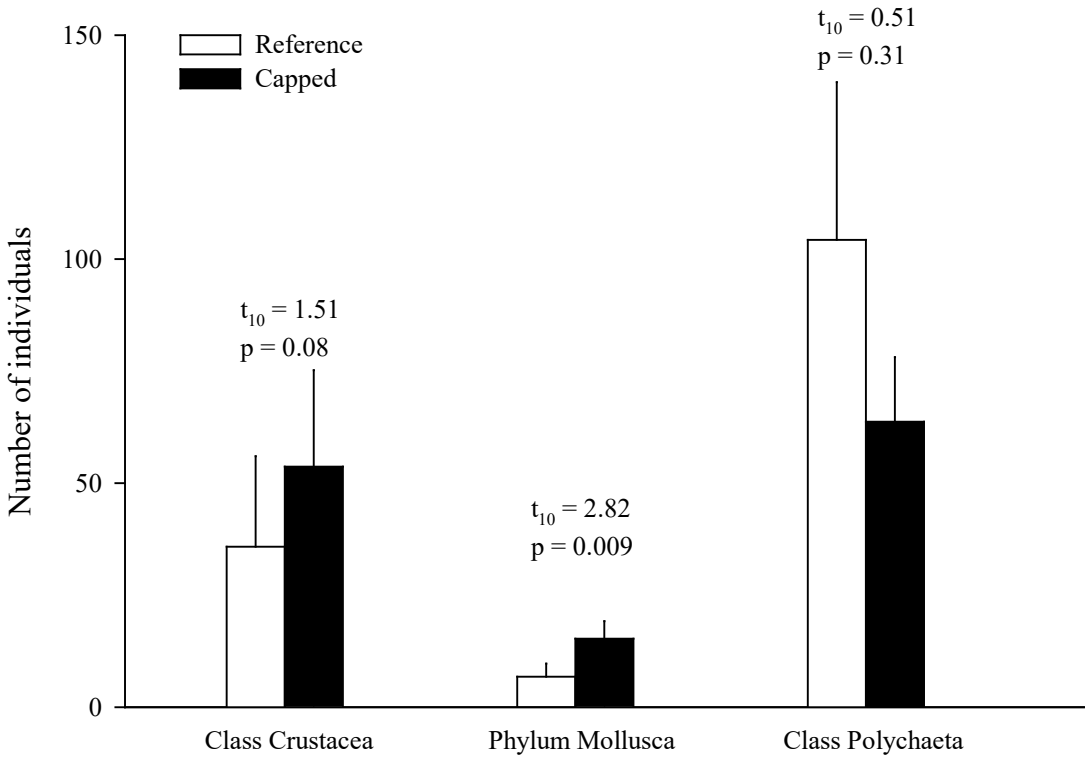

Figure 2. Abundances of crustaceans, mollusks, and polychaetes in the reference and capped sites. The statistical values over each bar are the results of 2-sample t-tests comparing the total abundance of that taxon in the reference and capped sites. Standard errors are shown.

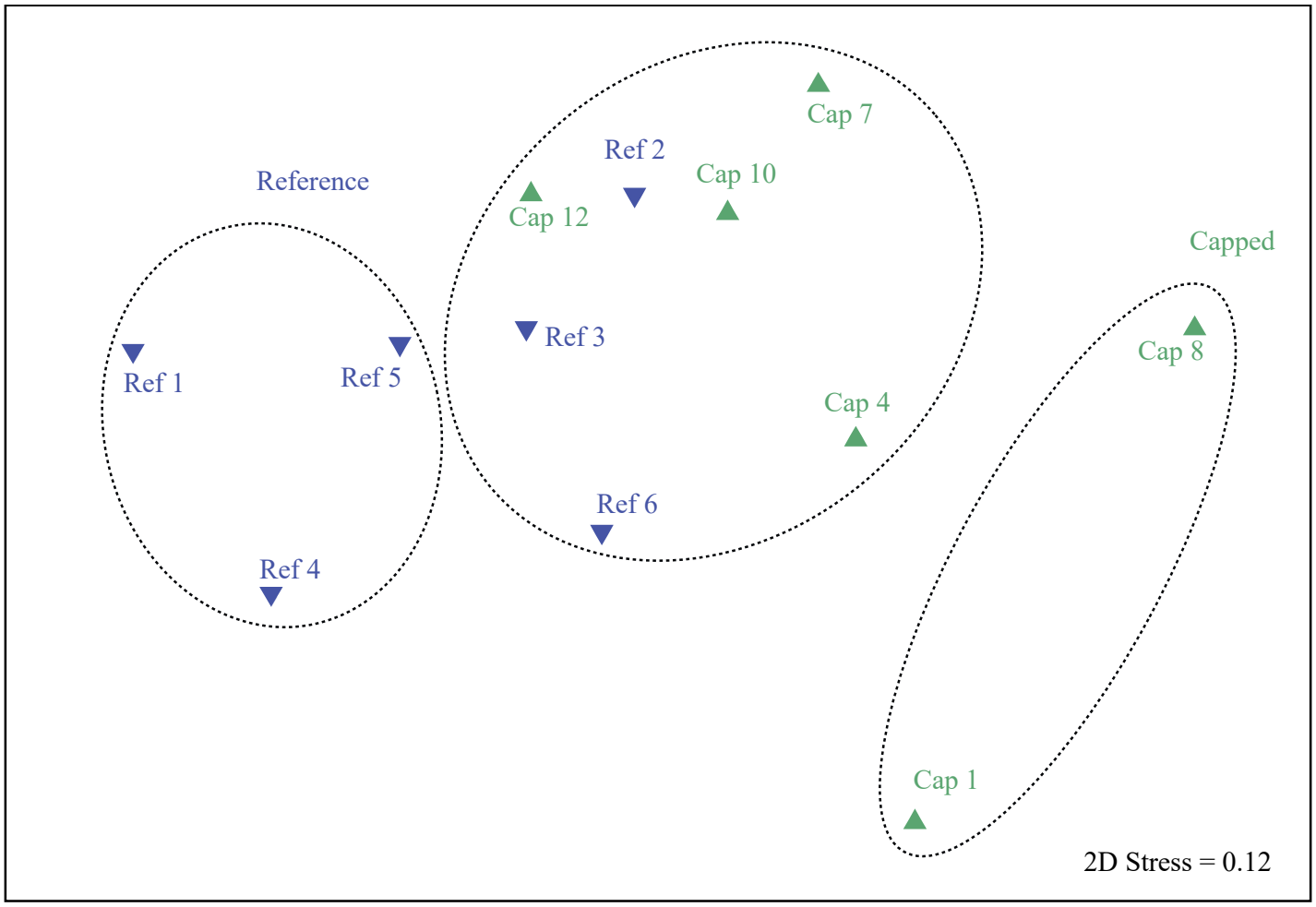

Figure 3. MDS ordination showing patterns in the invertebrate communities in the capped and reference sites. Each point represents a single core. Points that are closer on the plot had more similar invertebrate assemblages. The dotted boundaries indicate 50% community similarity as identified by an independent hierarchal cluster analysis. The stress value indicates that the MDS provided a good 2-dimensional representation of the multivariate community.

Table 1. Mean number of species, number of individuals, Pielou's evenness and Shannon diversity in the reference and capped sites

	Site	Mean	Std. Error
# species	Reference	16.7	2.5
	Capped	19.5	2.1
# individuals	Reference	279.8	40.5
	Capped	160.7	47.4
evenness	Reference	0.6	0.1
	Capped	0.8	0.0
diversity	Reference	1.7	0.2
	Capped	2.2	0.2

Table 2. Comparison of the total number of polychaetes, mollusks, and crustaceans in the capped sites to 50% of the counts of those same taxa in the reference sites.

	Polychaetes		Mollusks		Crustaceans	
	Capped Total	Reference 50%	Capped Total	Reference 50%	Capped Total	Reference 50%
Ref 1	21	7.5	7	2	33	2
Ref 2	82	32	12	6	14	67
Ref 3	74	15	15	9.5	44	14
Ref 4	24	81	7	0	4	3.5
Ref 5	69	58	18	1	81	16
Ref 6	112	121	33	2	146	5.5
Mean	64	52	15.3	3.4	54	18
SE	14	18	3.9	1.5	21	10

Table 3. SIMPER analysis indicating the top five species contributing to differences between reference and capped sites. Average abundances are given in individuals per sample.

	Average abundance	Average abundance	% contribution to site differences
Average dissimilarity = 51.8			
	Reference sites	**Capped sites**	
Platynereis bicanaliculatum	1.1	15.8	5.9
Elphidium excavatum	85.1	16.8	5.7
nematodes	32.5	8.0	4.2
Ammonia beccarii	8.0	2.6	4.1
Buccella frigida	7.1	0.5	4.0

Appendix I.

Species checklist for invertebrates collected in Western Port Angeles Harbor.

Phylum Sarcomastigophora
- Class Granuloreticulosea
  - Order Foraminiferida
    - Family Rotaliidae
      - *Ammonia beccarii* (Linne, 1758)
    - Family Elphidiidae
      - *Elphidium excavatum* (Terquem)
    - Family Discorbidae
      - *Buccella frigida* (Cushman)

Phylum Nematoda
- Unidentified species

Phylum Annelida
- Class Polychaeta
  - Order Capitellida
    - Family Capitellidae
      - Unidentified species
    - Family Maldanidae
      - Unidentified species
  - Order Eunicida
    - Family Dorvilleidae
      - *Schistomeringos pseudorubrocintata* (E. Berkeley, 1927)
    - Family Hesionidae
      - *Micropodarke dubia* (Hessle, 1925)
      - *Ophiodromus pugettensis* (Johnson, 1901)
  - Order Orbiniida
    - Family Orbiniidae
      - *Leitoscoloplos pugettensis* (Pettibone, 1957)
  - Order Opheliida
    - Family Opheliidae
      - *Armandia brevis* (Moore, 1906)
  - Order Phyllodocida
    - Family Glyceridae
      - *Glycera* sp.
    - Family Goniadidae
      - *Goniada* sp.
    - Family Nereidae
      - *Platynereis bicanaliculata* (Baird, 1863)
    - Family Phyllodocidae
      - *Eteone spetsbergensis* Malmgren, 1865
      - *Eulalia* sp.
    - Family Polynoidae
      - *Harmothoe imbricata* (Linnaeus, 1766)
  - Order Spionida
    - Family Spionidae
      - *Paraprionospio pinnata* (Ehlers, 1901)
      - *Pseudopolydora* sp.
      - *Pygospio elegans* Claparède, 1863

- Order Terebellida
  - Family Ampharetidae
    - *Hobsonia florida* (Moore, 1906)
  - Family Pectinariidae
    - *Pectinaria granulata* (Linneaus, 1767)
  - Family Terebellidae
    - Unidentified sp.

Phylum Mollusca
- Class Bivalvia
  - Order Mytiloida
    - Family Mytilidae
      - *Modiolus modiolus* (Linnaeus, 1758)
  - Order Veneroida
    - Family Cardiidae
      - *Clinocardium* sp.
    - Family Lasaeidae
      - *Rochefortia tumida* (Carpenter, 1864)
    - Family Tellinidae
      - *Macoma nasuta* (Conrad, 1837)
      - *Macoma* sp.
      - *Telina* sp.
    - Family Veneridae
      - *Nutricola lordi* (Baird, 1863)

Phylum Arthropoda
- Subphylum Crustacea
  - Class Cirripedia
    - Suborder Balanomorpha
      - *Balanus glandula* Darwin, 1854
  - Class Copepoda
    - Order Harpacticoida
      - *Harpacticus* sp.
      - *Ectinosoma* sp.
      - *Nannopus* sp.
  - Class Malacostraca
    - Superorder Eucarida
      - Order Decapoda
        - *Neotrypaea californiensis* Dana, 1854
    - Subclass Peracarida
      - Order Amphipoda
        - Suborder Gammaridea
          - Family Anisogammaridae
            - Unidentified species 1
            - Unidentified species 2
          - Family Corophiidae
            - Unidentified species
          - Family Hyalidae
            - Unidentified species
          - Family Hyperiidae
            - Unidentified species
          - Family Phoxocephalidae
            - Unidentified species
      - Order Cumacea
        - Family Nannastacidae
          - *Cumella vulgaris* Hart, 1930

Subclass Phyllocarida
Order Leptostraca
Family Nebaliidae
Nebalia pugettensis (Clark, 1932)
Class Ostracoda
Unidentified species 1
Unidentified species 2

Appendix II. Organisms collected from samples taken in Western Port Angeles Harbor.

Annelida	**Reference sites**						**Capped sites**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**4**	**7**	**8**	**10**	**12**
Armandia brevis	5	24	8	8	26	2	1	0	3	0	3	8
Family Capitellidae	0	1	0	0	0	0	0	0	0	0	0	0
Eteone spetsbergensis	0	0	0	0	0	0	0	0	1	0	0	0
Eulalia sp.	0	0	0	0	0	0	0	1	1	0	2	0
Glycera sp.	0	0	0	0	0	0	0	0	1	0	0	0
Goniada sp.	0	0	1	0	0	0	1	1	3	1	5	2
Harmothoe imbricata	0	0	0	0	0	0	1	0	1	0	0	1
Hobsonia florida	0	1	0	0	0	0	0	1	0	1	2	0
Leitoscoloplos pugettensis	0	2	0	0	0	0	2	0	0	0	0	0
Family Maldanidae	0	0	0	0	1	0	1	1	0	0	0	0
Mediomastus	9	20	16	153	83	230	8	68	30	20	42	39
Micropodarkia dubia	0	0	0	0	0	0	2	0	0	0	0	0
Ophiodromus pugettensis	0	0	0	0	0	0	0	0	5	0	2	4
Paraprionospio pinnata	0	6	5	0	3	8	0	0	7	0	0	4
Pectinaria granulata	0	0	0	0	0	1	1	0	0	0	0	0
Platynereis bicanaliculata	0	7	0	0	0	0	4	10	22	2	13	44
Pseudopolydora sp.	1	2	0	0	3	0	0	0	0	0	0	5
Pygospio elegans	0	0	0	0	0	0	0	0	0	0	0	0
Schistomeringos pseudorubrocintata	0	0	0	0	0	0	0	0	0	0	0	4
Family Terebellidae	0	0	0	0	0	0	0	0	0	0	0	1

Mollusca	**Reference sites**					**Capped sites**						
	1	**2**	**3**	**4**	**5**	**6**	**1**	**4**	**7**	**8**	**10**	**12**
Clinocardium sp	0	1	0	0	0	0	0	0	3	0	0	0
Macoma nasuta	0	2	3	0	0	2	0	0	0	0	1	3
Macoma sp.	2	4	8	0	1	1	2	1	8	7	16	20
Modiolus modiolus	1	0	0	0	1	0	0	0	0	0	0	0
Nutricola lordi	0	1	0	0	0	0	0	1	1	0	0	0
Rochefortia tumida	0	0	0	0	0	1	5	1	0	0	0	0
Telina sp.	1	4	8	0	0	0	0	9	3	0	1	10

Arthropoda	**Reference sites**						**Capped sites**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**4**	**7**	**8**	**10**	**12**
Family Anisogammaridae (sp. 1)	0	21	3	0	7	2	0	1	2	1	12	9
Family Anisogammaridae (sp. 2)	2	20	8	0	11	2	19	0	2	1	19	14
Balanus glandula	0	1	0	0	0	0	0	1	0	0	0	0
Family Corophiidae	0	3	0	0	0	1	1	0	0	1	3	0
Cumella vulgaris	0	2	0	0	1	0	0	1	1	0	0	0
Ectinosoma sp.	0	3	1	0	2	0	0	0	8	0	3	1
Harpacticus sp.	0	55	2	5	2	3	1	7	30	1	26	62
Family Hyalidae	0	0	0	0	0	0	1	0	0	0	0	0
Family Hyperiidae	0	0	0	0	0	0	1	0	0	0	0	0
Nannopsis sp.	0	0	0	0	0	2	0	0	1	0	0	0
Nebalia pugettensis	1	5	3	1	1	0	0	0	0	0	14	44
Neotrypaea californiensis	0	0	0	0	0	0	0	1	0	0	0	0
Ostracode sp. 1	0	1	0	1	0	0	1	2	0	0	0	3
Ostracode sp. 2	0	3	2	0	2	1	0	0	0	0	4	6
Family Phoxocephalidae	1	20	9	0	5	0	9	1	0	0	0	7

Protozoa (foraminiferans)	**Reference sites**						**Capped sites**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**4**	**7**	**8**	**10**	**12**
Ammonia beccarii	21	0	13	7	6	1	0	2	0	0	1	13
Buccella frigida	4	5	0	15	19	0	0	0	0	0	1	2
Elphidium excavatum	91	32	58	150	156	24	9	17	7	0	5	63

Miscellaneous	**Reference sites**						**Capped sites**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**4**	**7**	**8**	**10**	**12**
Nematoda (Phylum)	0	35	34	18	7	101	0	21	19	4	3	1

Appendix I
Construction Quality Assurance and Adaptive Management Plan Framework

Western Port Angeles Harbor
Sediment Cleanup Unit
Remedial Investigation/Feasibility Study

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
Contractor	Remedial Action Contractor
CQAAMP	Construction Quality Assurance and Adaptive Management Plan
CQAO	Construction Quality Assurance Officer
CQC	Construction Quality Control
CU	Certification unit
Ecology	Washington State Department of Ecology
EMNR	Enhanced monitored natural recovery
IHS	Indicator hazardous substance
MTCA	Model Toxics Control Act
NRC	National Research Council
NRC	Natural Research Council
OMMP	Operations, Maintenance, and Monitoring Plan
RAWP	Remedial Action Work Plan
RI/FS	Remedial Investigation/Feasibility Study
SCU	Sediment Cleanup Unit
SMS	Sediment Management Standards

Acronym/ Abbreviation	Definition
SPI	Sediment profile imaging
SWAC	Surface-weighted average concentration
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code
WPAH	Western Port Angeles Harbor

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1.0 Introduction

This document presents the preliminary framework of the Construction Quality Assurance and Adaptive Management Plan (CQAAMP) to verify protectiveness and optimize sediment cleanup actions within the Western Port Angeles Harbor (WPAH) Sediment Cleanup Unit (SCU). Further development of the CQAAMP will be informed by and finalized during remedial design; this preliminary framework provides supporting information relevant to the Remedial Investigation/Feasibility Study (RI/FS) and forthcoming Cleanup Action Plan (CAP).

Construction quality assurance includes protocols and methods to ensure that remedial actions in the WPAH SCU will be implemented in accordance with the remedial design approved by the Washington State Department of Ecology (Ecology), as well as to comply with federal and other regulatory approval/permitting requirements. Because sediment cleanup actions within the WPAH SCU are anticipated to extend over approximately 6 years, timely monitoring of the performance of completed actions provides an opportunity to learn from initial actions and adaptively manage designs over the course of project implementation. The objective is to evaluate and build on designs that work effectively during the early implementation process—and modify the approaches or methods that do not work or are not fully efficient—so that performance standards can be achieved and construction schedule/cost effectiveness are appropriately optimized.

Integrated construction quality assurance and adaptive management will be applied to the following remedial actions to be performed at the WPAH SCU:

- 1.3 acres of intertidal excavation
- 43 acres of intertidal and subtidal capping
- 178 acres of subtidal enhanced monitored natural recovery (EMNR)

As discussed in the RI/FS, cleanup standards are anticipated to be achieved throughout the WPAH SCU, including 949 acres of subtidal monitored natural recovery, within 10 years following completion of construction.

Because of the relatively large extent of EMNR construction, and to minimize uncertainties of post-construction protectiveness, this preliminary CQAAMP framework focuses on verification and adaptive management of EMNR designs over the first 5 years of in-water construction. The accompanying post-construction Operations, Maintenance, and Monitoring Plan (OMMP) describes monitoring to ensure the long-term protectiveness of the remedy after construction is determined by Ecology to be complete.

Implementation of this CQAAMP will be performed consistent with the requirements of the Model Toxics Control Act (MTCA), Chapter 70.105D in the Revised Code of Washington, as administered by Ecology under the MTCA Cleanup Regulation, Chapter 173-340 of the

Washington Administrative Code (WAC). Implementation of this CQAAMP will also comply with the Sediment Management Standards (SMS) Chapter 173-204 WAC.

Separate from this CQAAMP, and following Ecology approval of the remedial design and receipt of permits for the remedial action, the selected Remedial Action Contractor (Contractor) will develop detailed construction work plans that will more fully describe the construction schedule; construction health and safety plans; quality control plans; excavation, capping, and EMNR plans; borrow source characterization; environmental protection plans; cultural resource protection plans; inadvertent discovery plans; and other cleanup measures.

2.0 Project Organization and Responsibilities

The roles and responsibilities of the parties involved in the WPAH SCU cleanup action are described in the following sections.

2.1 ECOLOGY AND OTHER AGENCIES

Ecology is the regulatory authority and is the responsible agency for overseeing and authorizing cleanup actions in the WPAH SCU. In this capacity, Ecology will review information described in the remedial design and this CQAAMP for consistency with the cleanup standards set forth in the CAP, including applicable or relevant and appropriate requirements. The Ecology Project Coordinator, or a designee, will exercise project oversight for Ecology, coordinate comments developed by Ecology and other agencies, and communicate agency observations with the Owner (designated performing parties of the Western Port Angeles Harbor Group for this CQAAMP) and the Project Engineer. The Ecology Project Coordinator shall notify the Owner if he identifies any concerns regarding the implementation of the cleanup action. The Owner, or a designated representative, will propose response measures or recommendations, as appropriate, to the Ecology Project Coordinator. Ecology, as appropriate, will make final decisions to resolve such issues or problems that may change the cleanup action scope. Ecology will work cooperatively with other government agencies as necessary.

2.2 OWNER

The Owner is the designated performing party (or parties) responsible for implementing the cleanup action in accordance with the CAP and related binding agreements (e.g., a consent decree). The Owner, or a designated representative, will implement this CQAAMP, review Contractor work products, and be the point of contact with Ecology.

Monitoring activities will be the responsibility of the Owner, who will be acting in coordination with Ecology. Certain aspects of monitoring activities, however, may be performed by the Contractor but overseen by the Owner to ensure that the Contractor's construction and monitoring work is completed as stipulated by project permits, approvals, and contract documents.

2.3 PROJECT ENGINEER

The Project Engineer (retained by and answerable to the Owner) is responsible for two main tasks:

- Preparing a remedial design that can satisfy Ecology's performance requirements as specified by the CAP and be successfully implemented by the Contractor

- Providing consultation and observations during construction to assist with implementation of the remedial action in conformance with the Ecology-approved design documents

During implementation of the remedial action, construction activities will be reviewed by the Project Engineer. The Project Engineer will determine if construction is acceptable, unacceptable, or acceptable with a design modification. Ecology will have final authority to approve design modifications proposed by the Project Engineer.

2.4 CONSTRUCTION QUALITY ASSURANCE OFFICER

The Construction Quality Assurance Officer (CQAO; retained by and answerable to the Owner) will be responsible for overseeing the implementation of this CQAAMP. In this capacity, the CQAO is responsible for monitoring construction performance for compliance with construction performance standards and design requirements during implementation of the cleanup action and is responsible for overseeing the required inspection and verification activities. The CQAO will review documentation submitted by and work completed by the Contractor for adherence to performance standards and design requirements. The CQAO will be sufficiently familiar with the Ecology-approved design documents and the construction operations to recognize deviations from those documents. The CQAO will also manage and maintain the integrity of the data generated during implementation of the remedial action.

The CQAO will be responsible for identifying those field conditions that may warrant deviation from the Ecology-approved design documents. In such circumstances, the CQAO will coordinate with the Project Engineer and the Ecology Project Coordinator to identify and agree upon any necessary changes to meet the overall objectives of the design. Any agreed-upon changes will be documented in progress reports to Ecology.

The CQAO may use inspectors with the requisite expertise and experience to help perform the duties described above.

2.5 REMEDIAL ACTION CONTRACTOR

One or more construction contractors will be selected by the Owner to perform construction activities including excavation and disposal, placement of cap and EMNR materials, and other required cleanup activities. The selected Contractor will have demonstrable experience with these construction activities. The Contractor is responsible for its own means and methods in the execution of its work and is responsible for ensuring that the work complies with the requirements of the contract construction specifications and drawings pursuant to the remedial action and associated permits.

As part of the remedial action implementation, the Contractor will be responsible for developing and implementing the Construction Quality Control (CQC) Plan, including the required monitoring, sampling, testing, and reporting needed to implement the project in accordance with

the construction specifications and drawings. Independent of the Contractor's quality control program, the Owner (through the CQAO) will implement this CQAAMP to verify that the remedial action is implemented in accordance with the design.

The Contractor will use key personnel to help with the tasks described above, including an onsite superintendent, CQC supervisor, health and safety manager, and subcontractors as appropriate.

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3.0 Construction Quality Assurance

Construction quality assurance (CQA) is the planned and systematic means and actions that provide confidence that construction materials, methods, and results meet the design criteria and requirements. CQA activities provide for collection of independent third-party measurements of construction conditions, as well as review and confirmation of the quality of data collected as part of the Contractor's CQC activities. In the context of this CQAAMP, CQC refers to those actions taken by the Contractor (or their subcontractors) to verify compliance of the various components of the approved design specifications.

The CQA program is described in this section for each major construction activity. For each activity, the following is provided:

- Description of construction activities to be implemented
- Specific performance objectives and criteria for the activity
- Inspection and verification activities
- Contingency actions

Remedial action elements subject to the CQA program include the following:

- Intertidal sediment excavation, temporary upland stockpiling, and final placement of excavated materials in local uplands or approved upland disposal facility, as determined during remedial design and permitting
- Intertidal and subtidal capping using a protective layer of clean materials meeting gradation requirements as determined during remedial design
- Placement of a clean EMNR layer meeting gradation requirements as determined during remedial design

3.1 INTERTIDAL EXCAVATION

3.1.1 Intertidal Excavation Actions

Overview to be included in the final CQAAMP

3.1.2 Performance Objectives

The following performance objectives apply to intertidal excavation:

- Remove sediments from the required excavation prisms in accordance with the performance specifications determined during remedial design.
- Minimize impacts to cultural resources during excavation, in accordance with regulatory requirements.

- Minimize impacts to sensitive habitats (e.g., eelgrass beds) and biota (e.g., salmon) during excavation, in accordance with regulatory requirements.
- Minimize suspension of sediment into the water column, in accordance with regulatory requirements and performance specifications determined during remedial design.

3.1.3 Verification of Intertidal Excavation

- Verification of the completion of excavation will be performed on a certification unit (CU) basis[1] to assess statistical compliance with required excavation extents.
- CUs (to be determined during remedial design) will generally be sized to facilitate efficient excavation and backfill/capping and verification of construction completion within a manageable construction period.
- When electronic tracking methods are used (e.g., use of Hypack to track bucket locations), the Contractor will be required to provide this information to the Owner (through the CQAO).
- The Contractor will be required to track the daily volume and/or weight of material removed and make this information available to the Owner (through the CQAO) as part of the Contractor's daily reports.
- Pre-removal surveying will be performed to document pre-construction bathymetric elevations.
- Post-removal surveying will be performed to verify that minimum excavation requirements within a CU have been achieved.

3.1.4 Changes to Excavation Designs during Construction

- If potentially unstable conditions are encountered during construction, the Owner (through the Project Engineer) will assess whether such conditions may compromise the design. If necessary, excavation designs will be revised accordingly, subject to Ecology approval.
- If cultural resources are encountered, notification procedures will be followed in accordance with the inadvertent discovery plan; if continuation of excavation is not possible due to cultural discoveries, excavation designs will be revised accordingly, subject to Ecology approval.
- During construction, additional site conditions may be identified that could warrant location-specific modifications of excavation designs, subject to Ecology approval.

[1] A CU is a construction subarea within a sediment management area that will be used to assess compliance with design specifications for required remedial actions (e.g., sediment removal, capping, EMNR placement).

3.1.5 Contingency Actions

- If required excavation extents have not been achieved within the specified tolerance, the Contractor will be required to remove additional material to meet design requirements.

3.2 CAP AND EMNR PLACEMENT

3.2.1 Cap and EMNR Placement Actions

Overview to be included in the final CQAAMP

3.2.2 Performance Objectives

The following performance objectives apply to cap and EMNR placement:

- Place the minimum design thickness over cap and EMNR areas in accordance with the performance specifications determined during remedial design.
- Optimize construction methods to:
  - Minimize material loss to the water column and associated turbidity.
  - Minimize resuspension of underlying sediment.
  - Minimize mixing of placed cap and EMNR materials with underlying sediment.

3.2.3 Verification of Cap and EMNR Placement

- For selection of cap and EMNR materials, the Contractor must demonstrate that the proposed material meets chemical quality and gradation requirements presented in the construction specifications:
  - Specifications will list maximum allowable concentrations of indicator hazardous substances (IHSs) in cap and EMNR materials, as determined in remedial design.
  - Specifications will list gradation requirements, as determined in remedial design.
  - Samples must be collected and analyzed at a frequency identified in the approved plans and specifications.
- Verification of the completion of cap and EMNR placement will be performed on a CU basis to assess statistical compliance with specified minimum design thicknesses.
- CUs (to be determined during remedial design) will generally be sized to facilitate efficient capping and/or EMNR placement, and verification of construction completion within a manageable construction period.
- The Contractor will be required to conduct bathymetric and topographic surveys both before and after cap and EMNR placement; for multi-layer engineered caps (e.g., those that require a surface armor layer and/or a granular filter underlayment, as

determined in remedial design), interim surveys will be required to measure the thickness of each layer.

- When electronic equipment tracking methods are used (e.g., use of Hypack to track bucket locations), the Contractor will be required to provide this information to the Owner (through the CQAO).
- The Contractor will be required to track the daily volume and/or weight of cap and EMNR material placed and make this information available to the Owner (through the CQAO) as part of the Contractor's daily reports.
- If thickness verification is complicated by settlement of the cap layers or subgrade, the Contractor may need to supplement the post-construction bathymetric survey and as-placed volume information with targeted probing, grab/core sampling, or other techniques identified during remedial design that are able; in these cases, the Owner (through the Project Engineer and CQAO) will use a multiple-lines-of-evidence approach to verify cap and EMNR thickness and placement consistency, to be detailed during remedial design.

3.2.4 Contingency Actions

- If proposed cap or EMNR material does not meet the contract specifications, the Owner (through the CQAO) will reject these materials and require the Contractor to seek an alternative source for cap or EMNR material.
- If material placement has not been achieved within the specified tolerance, the Contractor will be required to place additional cap or EMNR material to meet design requirements.

4.0 EMNR Construction Phase Adaptive Management

As discussed in Section 1.0, timely monitoring of the performance of completed EMNR construction actions provides an opportunity to learn from initial actions and adaptively manage engineering designs over the anticipated 6-year in-water construction duration of the WPAH SCU project. Adaptive management in this application is intended to appropriately refine EMNR designs informed by data and experience gained during the early years of cleanup construction.

The adaptive management process described in this preliminary CQAAMP framework builds on recent U.S. Environmental Protection Agency (USEPA) recommendations to promote and broaden the application of adaptive management at complex sediment cleanup sites where construction may extend over multiple years. USEPA's working definition of adaptive management for complex cleanup sites is as follows (USEPA 2018):

> Adaptive management is a formal and systematic site or project management approach centered on rigorous site planning and a firm understanding of site conditions and uncertainties. This technique, rooted in the sound use of science and technology, encourages continuous re-evaluation and management prioritization of site activities to account for new information and changing site conditions. A structured and continuous planning, implementation and assessment process allows USEPA, states, other federal agencies, or responsible parties to target management and resource decisions with the goal of incrementally reducing site uncertainties while supporting continued site progress.

The three basic tenets of the adaptive management process are defined by the National Research Council (NRC) as follows (NRC 2004):

1. Monitor the performance of completed actions and evaluate performance.
2. Re-assess and revise engineering designs or construction methodologies as appropriate.
3. Continue to fold lessons learned into future designs.

There are three general outcomes or responses to WPAH EMNR design, construction, and monitoring that may result from the adaptive management process:

1. Continue with EMNR construction using approved project designs, and continue CQA verification and performance monitoring to further inform follow-on evaluations.
2. Refine the monitoring approach to further reduce uncertainty and collect additional data to refine the conceptual site model prior to adjusting design or construction methods.

3. Subject to Ecology approval, modify EMNR engineering designs to correct inefficiencies, or implement construction method improvements to optimize efficiencies in achieving CAP performance requirements.

Annual EMNR performance monitoring to be conducted during the construction period and possible adaptive management outcomes are discussed in the following sections.

4.1 ANNUAL EMNR PERFORMANCE MONITORING

In addition to the EMNR CQA program implemented throughout construction as described in Section 3.2, EMNR monitoring will be conducted to further inform adaptive management of EMNR designs and will include the following:

- Annual post-construction monitoring will be performed shortly after seasonal completion of EMNR construction (typically March of any given construction year).
- During each annual monitoring event, representative stations within completed EMNR areas will be surveyed using sediment profile imaging (SPI) to visually assess the degree of mixing of placed EMNR materials with underlying sediments.
- Based on a collaborative review of the SPI data by the CQAO and Ecology, representative core stations will be selected within completed EMNR areas for chemical verification.
- Multiple intervals will be collected from a single core (sliced vertically) at each sampling station (refer to Table I.1).[2] Collection of multiple cores may be required to provide sufficient sample volume.
- Each core section will be analyzed for IHSs identified in the CAP (Total TEQ, cPAH TEQ, cadmium, mercury, and zinc), along with conventional parameters (total solids, total organic carbon, and grain size).

[2] The preliminary framework of the post-construction Operations, Maintenance, and Monitoring Plan [OMMP; Appendix J] provides a description of the role of these depth intervals in performance monitoring and decision-making.

Table I.1
EMNR Performance Monitoring Core Intervals and Analysis Framework

Depth Interval	Analyzed or Archived	Data Objective
0 to 10 cm	Analyzed	Preliminary comparisons of concentrations to the subtidal cleanup standard[1]
0 to 2 cm	Archived[2]	Early indication of sediment deposition within the SCU
2 to 10 cm	Archived[2]	Early indication of potential mixing of EMNR material with underlying sediments

Notes:
1 The subtidal cleanup standard is the SCL measured over the 10-cm point of compliance interval.
2 Analyzed if IHS concentrations in the 0- to 10-cm interval are greater than the SCL.

Abbreviations:
cm Centimeters
SCL Sediment Cleanup Level

Validated data from the annual EMNR performance monitoring program outlined above will be reviewed by the Owner (through the CQAO) and Ecology and entered into Ecology's Environmental Information Management system. After each performance monitoring event, SCU-wide surface-weighted average concentration (SWAC) estimates will be calculated for each IHS using data obtained within constructed EMNR areas. These SWAC estimates will be compared with post-placement EMNR projections developed during remedial design for EMNR areas. Initial projections developed during the RI/FS, which assumed no mixing of the upper 10 cm of the placed EMNR layer with underlying sediments, will be refined based on annual performance monitoring data so that subsequent annual SWAC estimates can serve as a better indicator that corresponding cleanup levels will be met after the final construction season and 10-year natural recovery period.

4.2 POSSIBLE ADAPTIVE MANAGEMENT OUTCOMES

Adaptive management requires flexibility so that a technical approach in general, and the specifics of implementation, can be changed—when warranted—without cumbersome procedural hurdles. To ensure the success of this process, it is critical that the Owner and Ecology share data, engineering evaluations, and other information early and throughout the process. A preliminary adaptive management decision tree is presented in Figure I.1.

As presented in Figure I.1, there are three general outcomes or responses to EMNR design, construction, and monitoring that may result from review of the annual EMNR performance monitoring data:

4.2.1 Outcome 1

- If SPI and core analyses correlate and confirm limited mixing of the placed EMNR layer with underlying sediment during construction and limited post-construction bioturbation, and constructed EMNR layer SWAC trends in the 0- to 10-cm or 2- to 10-cm intervals within the WPAH SCU are on track to achieve post-placement EMNR projections developed during remedial design, EMNR construction will continue using approved project designs. EMNR verification and performance monitoring will also continue, potentially with minor modifications as appropriate to improve the statistical power associated with EMNR performance assessments.

4.2.2 Outcome 2

- If SPI and core analyses and SWAC trends within the constructed EMNR layers indicate that 0- to 10-cm or 2- to 10-cm intervals within the WPAH SCU are on track to achieve post-placement EMNR projections developed during remedial design, but constructed EMNR areas exhibit greater variability in mixing conditions compared to design projections, EMNR construction will continue using approved project designs. However, EMNR verification and performance monitoring will be modified as appropriate to reduce uncertainties and increase statistical confidence associated with EMNR performance assessments.

4.2.3 Outcome 3

- If SPI and core analyses and SWAC trends within the constructed EMNR layers indicate that the 2- to 10-cm interval within the WPAH SCU is not on track to achieve post-placement EMNR projections developed during remedial design as a result of greater mixing of the placed EMNR layer with underlying sediment, then, subject to Ecology approval, EMNR engineering designs for the next year's construction would be modified to optimize efficiencies in achieving CAP performance requirements, potentially including one or more of the following engineering refinements:
    - Increase the thickness of the EMNR layer to minimize construction and/or post-construction bioturbation of underlying sediments into the top 10-cm point of compliance defined in the CAP. EMNR layer thicknesses modifications would first be limited to subsequent construction years (i.e., the season immediately following a given adaptive management assessment); however, as the project progresses and more data are collected, areas completed in earlier construction seasons may also be evaluated for supplemental placement.
    - Modify EMNR placement techniques to minimize construction-related mixing of underlying sediments into the top 10-cm point of compliance defined in the CAP.

The adaptive management review cycle will occur annually following the first three construction seasons. The Owner (through the Project Engineer) will submit annual Remedial Action Work Plans (RAWPs), incorporating a summary of adaptive management elements as appropriate, to Ecology by May 1 of each year of remedial action. Each RAWP will present the annual performance monitoring data, and the results of the adaptive management evaluations conducted collaboratively between the Owner and Ecology. Each year's RAWP will assess progress toward meeting CAP performance standards and summarize any adaptive responses taken during the previous year. Each such report will also include recommendations, as appropriate, for additional adaptive response actions, continuation or revision of the annual performance monitoring program, termination of monitoring in certain areas, or revisiting the goals for specific areas. Prior to submittal of these reports, a comprehensive review of the prior years' activities and results will be evaluated, and relevant adaptive management recommendations will be brought forth through a collaborative Owner/Ecology process.

A minimum of three annual adaptive management review cycles will be implemented under this CQAAMP. If the first 3 years of post-placement EMNR monitoring reveal that the approach and construction methods are highly effective in achieving remedial goals and protectiveness can be demonstrated, then the Owner and Ecology may collaboratively determine to curtail the program.

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5.0 References

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Appendix I
Construction Quality Assurance and Adaptive Management Plan Framework

Figure

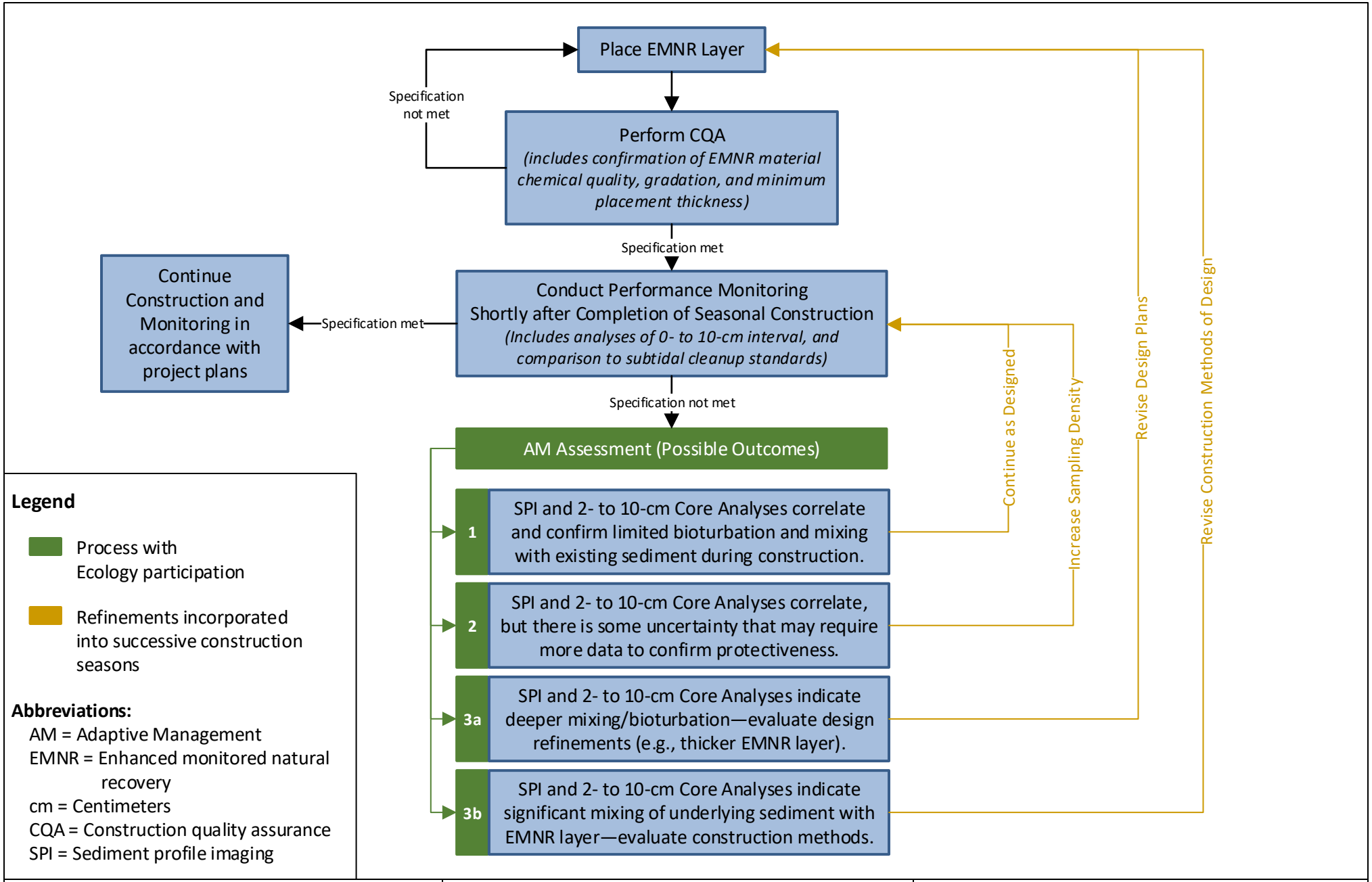

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Figure I.1
EMNR Construction Phase Adaptive Management Decision Tree

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Appendix J
Operations, Maintenance, and Monitoring Plan Framework

Western Port Angeles Harbor
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List of Acronyms and Abbreviations

Acronym/ Abbreviation	**Definition**
OMMP	Operations, Maintenance, and Monitoring Plan
WPAH	Western Port Angeles Harbor
SCU	Sediment Cleanup Unit
RI/FS	Remedial Investigation/Feasibility Study
CAP	Cleanup Action Plan
CQAAMP	Construction Quality Assurance and Adaptive Management Plan
MTCA	Model Toxics Control Act
Ecology	Washington State Department of Ecology
WAC	Washington Administrative Code
SMS	Sediment Management Standards
EMNR	Enhanced monitored natural recovery
MNR	Monitored natural recovery
USACE	U.S. Army Corp of Engineers
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SCL	Sediment cleanup level
HIS	Indicator hazardous substance
SWAC	Surface-weighted average concentration
QA/QC	Quality assurance and quality control
SPI	Sediment Profile Imagery
RPD	Relative percent difference

1.0 Introduction

This document presents the preliminary framework of the post-construction Operations, Maintenance, and Monitoring Plan (OMMP) that describes long-term compliance monitoring of the constructed remedial actions within the Western Port Angeles Harbor (WPAH) Sediment Cleanup Unit (SCU). The long-term monitoring described herein will be used to confirm that the constructed remedial action achieves cleanup standards. Potential contingency actions are also described in the event that the remedial actions do not achieve cleanup standards. Further development of the OMMP will be informed by and finalized during remedial design; this preliminary framework provides supporting information relevant to the Remedial Investigation/Feasibility Study (RI/FS) and forthcoming Cleanup Action Plan (CAP). The accompanying Construction Quality Assurance and Adaptive Management Plan (CQAAMP) describes protocols and methods to verify protectiveness and optimize sediment cleanup construction actions within the WPAH SCU over the anticipated 6-year in-water construction period. The construction is anticipated to be completed over a 6-year period to allow for intertidal excavation and placement of the cap and sand EMNR layer over a large area of the SCU.

Implementation of this OMMP will be performed consistent with the requirements of the Model Toxics Control Act (MTCA), Chapter 70.105D in the Revised Code of Washington, as administered by the Washington State Department of Ecology (Ecology) under the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC). Implementation of this OMMP will also comply with the Sediment Management Standards (SMS; WAC 173-204).

Integrated remedial actions proposed to be constructed within the WPAH SCU include the following:

- 1.3 acres of intertidal excavation
- 43 acres of intertidal and subtidal capping
- 178 acres of subtidal enhanced monitored natural recovery (EMNR)

As discussed in the RI/FS, sediment standards are anticipated to be achieved throughout the WPAH SCU, including 949 acres of subtidal monitored natural recovery (MNR), within 10 years following completion of construction.

Long-term performance monitoring, including physical integrity and sediment quality assessments, is anticipated to begin immediately following completion of construction (Year 0) and will continue during Years 2, 5, and 10. Physical integrity monitoring will be performed to verify cap integrity and protectiveness over time. Surface sediment chemistry monitoring will be performed to verify that the WPAH SCU achieves compliance with cleanup standards set forth in the CAP at Year 10, when cleanup standards are projected to be achieved.

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2.0 Project Organization and Responsibilities

The roles and responsibilities of the parties involved in the WPAH SCU cleanup action are described in the following sections.

2.1 ECOLOGY AND OTHER AGENCIES

Ecology is the regulatory authority and is the responsible agency for overseeing and authorizing cleanup actions in the WPAH SCU. In this capacity, Ecology will review information described in this OMMP for consistency with the cleanup standards set forth in the CAP, including applicable or relevant and appropriate requirements. The Ecology Project Coordinator, or a designee, will exercise project oversight for Ecology, coordinate comments developed by Ecology and other agencies, and communicate agency observations with the Owner (designated performing parties of the WPAH Group for this OMMP). The Ecology Project Coordinator shall notify the Owner if he identifies any concerns regarding the implementation of the long-term monitoring. The Owner, or a designated representative, will propose recommendations, as appropriate, to the Ecology Project Coordinator. Ecology will work cooperatively with other government agencies as necessary.

2.2 OWNER

The Owner is the designated performing party (or parties) responsible for implementing long-term monitoring in accordance with the CAP and related binding agreements (e.g., a consent decree). The Owner, or a designated representative, will implement this OMMP and be the point of contact with Ecology. Monitoring activities will be the responsibility of the Owner, who will be acting in coordination with Ecology.

2.3 PROJECT MANAGER

The Project Manager (retained by and answerable to the Owner), is responsible for overall implementation of the long-term monitoring plan, maintaining quality assurance, and ensuring that the monitoring objectives are met. The Project Manager will track monitoring activities and schedule and coordinate with the field team who will conduct the activities.

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3.0 Physical Integrity Confirmation Monitoring

Post-construction physical integrity confirmation monitoring of the engineered capped area will include the following elements:

- Bathymetric surveys
- Cap integrity monitoring (topographic surveys and cap surface visual inspections)
- Collection of sediment cores if cap settlement or erosion is observed

These methods may be used alone or in combination, as necessary, to provide a multiple line of evidence assessment of the physical integrity of the various engineered caps. Each of these physical integrity monitoring elements are described in the following sections.

3.1 BATHYMETRIC SURVEYS

As discussed in the accompanying CQAAMP, bathymetric surveys along with other monitoring elements will be used during construction to verify that engineered caps are successfully constructed in accordance with the remedial design. After all construction is complete, multi-beam bathymetric surveys will be performed in Years 0, 2, 5, and 10 along the same CQAAMP surveying transects to the extent practicable to track changes in engineered cap surface elevations. Multi-beam surveys will be conducted by a licensed surveyor and will meet or exceed the accuracy standards for a U.S. Army Corp of Engineers (USACE) Navigation and Dredging Support Survey as referenced in the USACE Hydrographic Surveying manual (USACE 2013). Additional details about bathymetric surveys will be defined in the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) *(to be developed with Ecology as part of the final OMMP)*.

3.2 TOPOGRAPHIC SURVEYS AND CAP SURFACE VISUAL INSPECTIONS

For intertidal cap areas not included in the bathymetric survey, both an upland topographic survey and concurrent visual inspection will be performed to evaluate the integrity of caps relative to as-built post-construction conditions. Topographic surveys will be performed using established control points as part of long-term monitoring to track changes in intertidal cap elevations. Topographic surveys will be conducted by a licensed surveyor and will meet or exceed the accuracy standards for a USACE Total Station Topographic Survey as referenced in the USACE Control and Topographic Surveying manual (USACE 2007). Additional details about upland topographic surveys will be defined in the SAP/QAPP *(to be developed with Ecology as part of the final OMMP)*. Concurrent with the topographic survey, cap inspections may be performed at low tide to potentially allow for visual inspection of the lower intertidal armored areas and toe of armored slope.

3.3 SEDIMENT CORING

Sediment cores will be collected at locations identified by the bathymetric/topographic surveys or inspections where possible cap settlement and/or erosion of cap thicknesses may have occurred. If necessary, cores will be advanced to a minimum depth of approximately 1 foot below the minimum required cap thickness. A preliminary evaluation of cap design proposes a 2-foot cap thickness (refer to Appendix K); therefore, sediment cores would be advanced to a minimum depth of 3 feet. The cores will be processed in the uplands and visually inspected to determine the thicknesses of the cap material.

If the coring verifies the cap thickness specification in that area (e.g., reductions in cap surface elevations are primarily attributable to sub-grade settlement), no further cap monitoring in that area will be required during that event. Conversely, if the coring reveals that cap thickness specifications in that area have not been maintained, additional contingency evaluations—including surface sediment chemistry monitoring and/or cap maintenance or repair—will be performed as appropriate to meet specifications, subject to Ecology approval.

4.0 Sediment Quality Confirmation Monitoring

Sediment quality confirmation monitoring in the cap, EMNR, and MNR[1] areas will include stratified random grab sampling of surface sediments for chemical monitoring at different depth intervals (e.g., 0 to 10 centimeters [cm], 0 to 2 cm, and 2 to 10 cm), described in the following sections. Confirmation monitoring will occur in Years 0, 2, 5, and 10 post-construction.

4.1 BIOACCUMULATIVE INDICATOR HAZARDOUS SUBSTANCES

Surface sediment chemical monitoring will be conducted SCU-wide to assess natural recovery and compliance with bioaccumulative sediment cleanup levels (SCLs). As discussed in the CQAAMP, performance monitoring and adaptive management of EMNR construction, including surface sediment monitoring in constructed EMNR areas, will be performed during the anticipated 6-year in-water construction period to verify the protectiveness of EMNR layers placed in the WPAH SCU.

Building on the CQAAMP performance monitoring data, and using interpolation and forecasting methods developed in the RI/FS process and refined during remedial design, projected time trends of bioaccumulative indicator hazardous substance (IHS; Total TEQ, cPAH TEQ, and mercury) surface-weighted average concentrations (SWACs) for the 0- to 10-cm sample interval will be calculated for the WPAH SCU. The measured SWACs will be compared with SCLs. Samples of the 0- to 2-cm and 2- to 10-cm sample intervals at each core sampling station will be collected and archived, and then analyzed if IHS concentrations in the 0- to 10-cm interval are observed above projected trends. The analytical approach for assessing bioaccumulative IHSs is provided as a flowchart in Figure J.1. IHS concentrations in the 2- to 10-cm interval can also be calculated by analyzing the 0- to 2-cm sample interval (or vice versa) in addition to the 0- to 10-cm interval, and then using mass balance, accounting for density differences between these intervals.

4.1.1 Sample Locations

- Target sampling location coordinates will be determined post-construction using a stratified random sampling approach.
- A total of 50 to 80 surface sediment sample locations will be identified across the SCU to evaluate compliance with bioaccumulative SCLs. Exact sample locations and numbers of samples to be collected in each of the following areas will be determined during remedial design. This will include the following:
  - Locations in the MNR area
  - Locations in the Sediment Management Area (SMA) 3 EMNR area
  - Locations in SMA 1 and SMA 2 subtidal areas
  - Locations in intertidal areas within SMAs 1 and 2

[1] The MNR area includes the area identified in SMA 3 and the no action areas identified throughout the SCU (refer to Figure 15.1).

4.1.2 Sampling Scheme

The following table presents a summary of the samples to be collected as part of the OMMP. Detailed procedures for field sampling, location control, number of samples, sample handling, and decontamination will be provided in the in the SAP (to be inclu*ded as an attachment in the final OMMP)*. Detailed field and laboratory quality assurance and quality control (QA/QC) criteria, including method specifications, detection limits, accuracy, and precision requirements, will be provided in the QAPP *(to be included as an attachment in the final OMMP)*.

Area	Sample Depth	Analytes	Compliance Methodology
SMA 1 and SMA 2 intertidal cap	• 0 to 45 cm • 0 to 10 cm • 0 to 2 cm, archived • 2 to 10 cm, archived • 2 to 45 cm, archived	Total TEQ, cPAH TEQ, cadmium, mercury, total solids, total organic carbon, and grain size	SWACs calculated separately for the intertidal cap area with 0- to 45-cm samples (per NewFields 2016) are compared against bioaccumulative SCLs.
SMA 1 subtidal cap	• 0 to 10 cm • 0 to 2 cm, archived • 2 to 10 cm, archived	Total TEQ, cPAH TEQ, mercury, total solids, total organic carbon, and grain size	SCU-wide SWACs calculated with 0- to 10-cm samples (per NewFields 2016) are compared against bioaccumulative SCLs.
SMA 2 EMNR			
SMA 3 EMNR			
MNR areas			

Note: The SWAC interpolation method will be consistent with the methodology described in NewFields (2016). The methodology may be adjusted in coordination with Ecology in the future, if needed due to data density and location.

4.2 BENTHIC INDICATOR HAZARDOUS SUBSTANCES

Chemical testing will be conducted to evaluate compliance with benthic SCLs. A total of 10 to 25 surface samples from 0 to 10 cm will be collected within the WPAH SCU to evaluate compliance with benthic SCLs; these samples will be collocated with remedial design toxicity testing locations. Samples will be analyzed for the benthic IHSs (cadmium, mercury, and zinc) and total organic carbon, with results compared point-by-point against benthic SCLs to evaluate compliance. Additionally, consistent with the sampling approach for the bioaccumulative IHSs, samples of the 0- to 2-cm and 2- to 10-cm sample intervals at each sampling station will be

collected and archived, and then analyzed if IHS concentrations in the 0- to 10-cm interval are greater than the benthic SCLs.

As with the bioaccumulative IHSs, detailed procedures for field sampling, location control, sample handling, and decontamination will be provided in the SAP *(to be included as an attachment in the final OMMP)*. Detailed field and laboratory QA/QC criteria, including method specifications, detection limits, accuracy, and precision requirements, will be provided in the QAPP *(to be included as an attachment in the final OMMP)*.

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5.0 Institutional Controls

To be determined in remedial design and included in the final OMMP.

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6.0 Potential Contingency Actions and Termination of Monitoring

6.1 POTENTIAL CONTINGENCY ACTIONS

In the event that monitoring indicates that remedial action performance standards may not be achieved 10 years post-construction, or have not been achieved at Year 10, the designated performing parties of the WPAH Group will evaluate the extent and significance of the exceedance in conjunction with Ecology. The determination of the need for additional response actions will take into consideration all monitoring results relative to an overall assessment of the successful performance of the remedial action. Through these discussions, an appropriate course of action will be developed and implemented, as necessary. The specific problem causing the need for a contingency will dictate which additional response actions may be most appropriate.

Possible additional response actions may include, but are not limited to, those listed for the following scenarios:

- Performance of engineered cap areas
  - Analyze 0- to 2-cm and 2- to 10-cm samples in areas contributing to elevated SWACs to identify source of elevated concentrations. If elevated concentrations are observed in the intertidal cap areas, analyze 0- to 2-cm and 2- to 45-cm samples.
  - Perform additional monitoring to further assess erosion and to determine the extent, cause, and potential solution to the verified erosion.
  - Perform additional sediment quality monitoring within those erosion or settlement areas where there may be a potential for underlying material to be exposed.
  - Investigate cause(s) of potential cap erosion or other instabilities and determine need for enhancement (e.g., increased size of erosion protection layer materials).
- Attainment of sediment cleanup levels within EMNR and MNR areas
  - Analyze 0- to 2-cm and 2- to 10-cm samples in areas contributing to elevated SWACs to identify source of elevated concentrations.
  - Collect additional surface grab samples in areas contributing to elevated SWACs.
  - Re-sample locations with SCL exceedances.
  - If a benthic SCL exceedance, conduct biological sediment toxicity testing to confirm or refute the occurrence of adverse ecological impacts.
  - Conduct Sediment Profile Imagery (SPI) to visually assess if mixing of EMNR materials with underlying sediment is occurring.
  - Conduct sediment trap monitoring if grab samples indicate bioaccumulative IHS concentrations in the top 0- to 2-cm layer exceed regional background-based SCLs. Sediment trap monitoring in this situation will characterize sedimentation rates

and the quality of depositional sediments. The duration of sediment trap deployment is expected to be a minimum of 3 months to collect sufficient sample volume for analysis; the length of deployment required will be determined during the first monitoring event.

- Place additional EMNR material.
- If exceedance indicates recontamination from ongoing sources, evaluate the applicability of, and if appropriate, revise the regional background values and/or other source control evaluations that may be conducted by Ecology.

6.2 POST-YEAR 10 EPISODIC PHYSICAL INTEGRITY MONITORING

Long-term monitoring of the physical integrity of the engineered cap is required for the life of the cap. Monitoring frequency will decrease as cap stability is demonstrated by the initial, routine monitoring. At a minimum, routine monitoring will be completed through Year 10. After Year 10, the monitoring results will be evaluated in cooperation with Ecology to assess the stability of the cap and the need for additional routine monitoring. When routine monitoring has sufficiently demonstrated stability, subsequent non-routine monitoring may be triggered by specific storm or seismic events (e.g., a wind event with a recurrence interval of 20 years or more, or a seismic event greater than a magnitude of 5.5). The identification of and process for determining major potential disturbance events that would trigger follow-on physical integrity monitoring will be developed with Ecology as part of the final OMMP.

6.3 TERMINATION OF SEDIMENT QUALITY MONITORING

Termination of the sediment quality monitoring in the OMMP program requires a weight of evidence justification. This weight of evidence is expected to include discussion of proper remedy installation, documented remedy stability, and achievement of SCLs at 10 years post-construction or clear trends indicating SCLs will be achieved in surface sediments (i.e., 0 to 10 cm). Achievement of SCLs will be evaluated consistent with the Sediment Cleanup User's Manual II, which states: "*Based on typical analytical relative percent differences (RPDs) and field variability, any individual or mean value within 20% of the cleanup standard is considered to be indistinguishable from the cleanup standard and in compliance*." (Ecology 2017):

- Chemical concentration trends will be established by examining data collected at 0, 2, 5, and 10 years. If chemical monitoring indicates that the SCLs have been achieved, monitoring (except physical integrity as noted above) will be terminated and the remedy will be considered complete.
- If chemical monitoring indicates that chemical concentrations are generally on a trajectory to achieve SCLs, monitoring may be terminated, in coordination with Ecology, if there is sufficient justification and other measures of remedy performance are acceptable.

- If chemical monitoring indicates that chemical concentrations are not achieving SCLs, and trend lines are indicating that the remedy may not reach SCLs by Year 10 post-construction, then several options may occur based on trends in the 0- to 10-cm, 0- to 2-cm, and 2- to 10-cm surface sediment concentrations collected during monitoring:
  - If the remedy is failing to meet SCLs due to elevated concentrations in the 0- to 2-cm interval, Ecology will revisit regional background and/or evaluate source control actions.
  - If the remedy is failing to meet the SCLs due to apparent remedy failure issues (e.g., physical integrity failure of a cap), discussions with Ecology will center on remedy modifications.

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7.0 References

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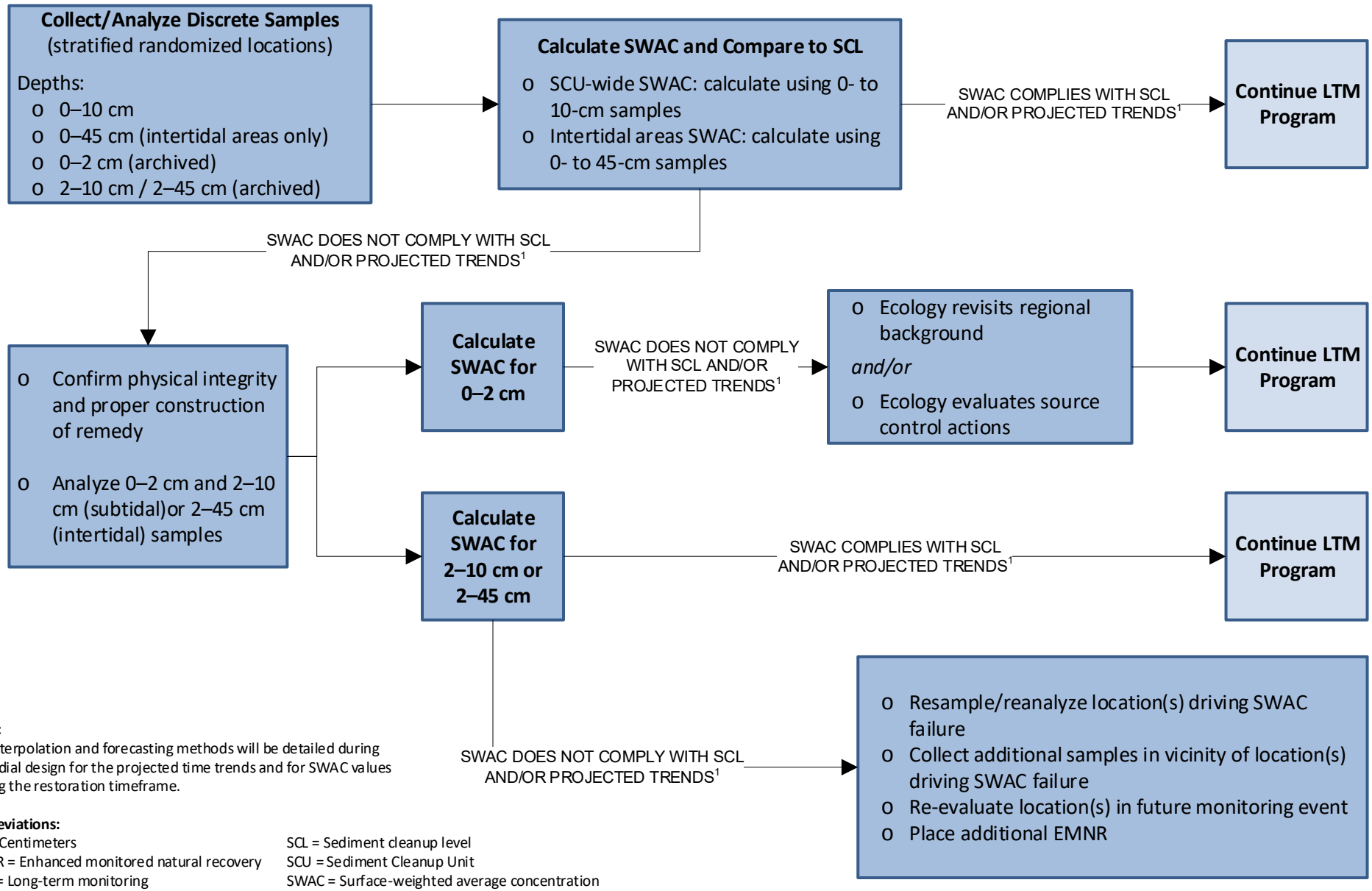
Appendix J
Operations, Maintenance, and Monitoring Plan Framework

Figure



Note:
1 = Interpolation and forecasting methods will be detailed during remedial design for the projected time trends and for SWAC values during the restoration timeframe.

Abbreviations:
cm = Centimeters
EMNR = Enhanced monitored natural recovery
LTM = Long-term monitoring
SCL = Sediment cleanup level
SCU = Sediment Cleanup Unit
SWAC = Surface-weighted average concentration

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Figure J.1
Bioaccumulative Compliance Monitoring Decision Tree

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Appendix K
Preliminary Cap Design Evaluation

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
ACES	Automated Coastal Engineering System
cm	Centimeters
ENE	East-northeasterly
MLLW	Mean lower low water
ng/kg	Nanograms per kilogram
RI/FS	Remedial Investigation/Feasibility Study
SCU	Sediment Cleanup Unit
SMA	Sediment Management Area
TEQ	Toxic equivalent
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WPAH	Western Port Angeles Harbor

1.0 Introduction

This appendix describes the preliminary cap design evaluation for the Western Port Angeles Harbor (WPAH) sediment cleanup unit (SCU), developed in accordance with the following U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE) state-of-practice guidance for in situ capping:

- *Guidance for Subaqueous Dredged Material Capping* (Palermo et al. 1998a)
- *Assessment and Remediation of Contaminated Sediments Program Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. 1998b)

These documents provide detailed procedures for cap design. Importantly, caps designed following the USEPA and USACE guidance have been demonstrated to be protective of human health and the environment (USEPA 2005). For the purposes of the WPAH remedial investigation/feasibility study (RI/FS), and consistent with USEPA and USACE guidance, a preliminary cap design was developed based on consideration of the two primary components of design that typically affect overall cap thickness:

- Chemical isolation and bioturbation
- Erosion protection

Each of these considerations are discussed in the following sections.

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2.0 Chemical Isolation and Bioturbation

A preliminary cap design analysis was conducted to identify cap chemical isolation layer requirements to maintain surface sediment Total toxic equivalent (TEQ) levels in Sediment Management Area (SMA) 1 within the SCU below the regional background level of 5.2 nanograms per kilogram (ng/kg). For this analysis, the fate and transport of all 17 dioxin/furan congeners were simulated, which includes the more-mobile IHSs present in the SCU. Data from the sampling station with highest dioxin/furan TEQ levels measured in the McKinley dock/berthing area (63 ng/kg TEQ) were input into the model to develop an upper-bound protective cap design. Therefore, cap designs that address TEQ levels in SMA 1 are anticipated to be protective of the range of chemicals of concern present in the SCU. If capping is selected as part of the WPAH cleanup remedy, more detailed cap design evaluations would be performed to develop final cap designs protective across the SCU.

Consistent with current USEPA and USACE sediment cap design guidance (Palermo et al. 1998a, 1998b; USEPA 2005), this preliminary cap design evaluation used the one-dimensional steady-state model of chemical transport within sediment caps developed by Dr. Danny Reible (Texas Tech University), based on the steady state analytical solution to the governing equations. Details on the model structure and underlying theory and governing equations for the steady-state model were published in "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments" (Lampert and Reible 2009). The steady-state model has been used to support the evaluation and design of sediment caps at Superfund sediment cleanup sites throughout the United States (e.g., Hudson River, New York; Lower Fox River, Wisconsin; Lower Willamette River, Oregon) and has been used at Model Toxics Control Act/Sediment Management Standards cleanup sites in Washington (e.g., Shelton Harbor, Port Gamble Bay, Bellingham Bay).

The steady-state model simulates the fate and transport of chemicals (dissolved and sorbed phases) under the processes of bioturbation, advection, diffusion, dispersion, biodegradation, and exchange with the overlying surface water, as generally depicted in Figure K.1. Steady-state predictions provide a useful means of assessing long-term contaminant profiles within a cap, although the time to reach the steady-state concentrations will vary depending on the chemical characteristics of the contaminant, sediment geochemical conditions, and subsurface hydrogeology.

For this analysis, the fate and transport of all 17 dioxin/furan congeners primarily contributing to Total TEQ were simulated. Model-predicted steady-state concentrations of the individual congeners at the cap surface were then used to calculate the dioxin/furan TEQ levels as follows (using dioxin/furan as an example):

$$D/F\ TEQ = \sum_{i=1}^{17} C_i \times TEF_i$$

where:
C = Model-predicted dioxin or furan congener concentration
TEF = World Health Organization toxic equivalent factor for each dioxin/furan congener (unitless) (Van den Berg et al. 2006)

The cap design model uses several input parameters that describe site-specific conditions, chemical specific properties, cap material properties, and chemical mass transport rates. These input parameters were based on site-specific data, information from literature, and cap designs successfully constructed at other similar sites.

This preliminary cap evaluation focused on McKinley dock/berthing area, where elevated surface sediment dioxin/furan TEQ levels overlap with potential propeller wash forces (see Section 3.0). Individual dioxin/furan concentrations contributing to the highest Total TEQ level measured in the McKinley dock/berthing area (Station IE09A; 63.2 ng/kg) were input into the model to ensure a protective cap design. A listing of model inputs is provided in Tables K.1 and K.2.

The steady-state model predicts that a 6-inch sand cap isolation layer with relatively low total organic content (0.1 percent) will maintain long-term Total TEQ levels within the top 10 centimeters (cm; vertical average) of the cap to below the regional background Total TEQ level of 5.2 ng/kg (Table K.1). As discussed in Section 2.1.5 of the RI/FS, site-specific radioisotope (lead-210) data collected in the WPAH SCU suggest that relatively little bioturbation and vertical mixing of sediment occurs over the top 10 cm, even though benthic community feeding voids were observed at depths greater than 10 cm in sediment profile imaging surveys. The 6-inch cap incorporates a 10-cm bioturbation layer.

3.0 Erosion Protection

In addition to chemical isolation, an erosion analysis was performed to calculate the stable grain size of capping material both within the McKinley dock/berthing area and the intertidal areas of SMA 1 and SMA 2 that would resist extreme hydrodynamic forces that could be exerted on the cap surface. The erosion protection analysis focused on resisting forces from wind waves and propeller wash forces, as outlined below. Erosion due to tidal currents was not explicitly evaluated for the cap because hydrodynamic forces due to wind-waves and propeller wash are expected to be significantly larger than forces due to tidal currents.[1]

3.1 WIND WAVE FORCES

Sustained winds over a waterbody impart energy to the water surface, which results in wave formation. The amount of energy transferred to the water determines wave height, which can be estimated based on wind speed, water depth, and distance over which the wind can act on the water (fetch distance). A wind-generated wave analysis was performed to assess erosive velocities associated with the 100-year return interval wind-generated wave and potential effects on the stability of the erosion protection material along shorelines within the SCU.

Wind data for the period between 1975 and 2018 were obtained for the Smith Island Coast Guard Light Station located northeast of Port Angeles, just off the western coast of Whidbey Island. A statistical analysis was performed for each of the cardinal and semi-cardinal directions (north, northeast, east, southeast, etc.) on the maximum yearly wind speed in each direction to estimate the 100-year return interval wind speed (Figure K.2).

Figure K.3 shows the directions that represent the greatest fetch distances that may generate the most extreme waves within the SCU: north, northeast and east. These directions represent the most important trajectories of wave attack in the inner Harbor and, therefore, were selected for further statistical analysis using probability distribution functions (Fisher–Tippett type I and Weibull distributions with exponent k varying from 0.75 to 2) to evaluate the maximum yearly wind speed. The 100-year return interval wind speed was calculated for each direction by applying the best fit distribution as shown on Figure K.4.

Nearshore wave heights and periods associated with the 100-year return period wind events were calculated using a wave transformation model and hindcasting methods (Table K.3). The most extreme waves in the SCU are expected to be generated by a sustained easterly wind.

Herrera (2011) estimated the maximum water depth of significant wind wave influence (i.e., the closure depth) to be 55 feet for areas influenced by the east-northeasterly (ENE) winds. The innermost portion of the SCU and the south shore of Ediz Hook are less impacted by ENE waves;

[1] Maximum tidal current velocities predicted by the National Oceanic and Atmospheric Administration in the Strait of Juan de Fuca offshore of Port Angeles are approximately 1 to 1.2 knots. Tidal currents are expected to be lower than these values within Port Angeles Harbor. Forces due to tidal currents will be considered further during remedial design.

therefore, the local closure depth is expected to be shallower. Building on the findings of this work and the wave hindcasting evaluation, an assessment of bottom shear stress and stable sediment grain size was performed to assess sediment stability within the water depth expected to represent the closure depth in the innermost portion of the SCU. The results indicate that waves generated by extreme wind events would not initiate scour of subtidal sediments composed of particles of approximately 5 mm (0.2 inches) in diameter (i.e., the break between coarse sand and very fine gravel) for water depths below approximately -15 feet mean lower low water (MLLW). The calculations for this assessment are included as Attachment K.1.

For engineered cap areas, evaluation of required material sizes and cap layer thickness for stability under predicted wind waves was performed using the methodology outlined in the USACE Coastal Engineering manual and Automated Coastal Engineering System (ACES) computer program (USACE 1992). These results are summarized in Table K.4. It is important to note that the armor stone sizing generated by this methodology is conservatively focused on relatively steep slopes of approximately 2 horizontal to 1 vertical (2H:1V) to 5H:1V; therefore, the resulting stable grain size is larger than what would be required for flatter slopes. Engineered cap designs would be refined during remedial design to develop appropriate slope protection for more gently sloping shoreline areas, such as those that occur along long shoreline stretches in the SCU.

3.2 PROPELLER WASH FORCES

For sediment caps located in the subtidal zone, a propeller wash analysis was conducted to determine the required minimum cap armor grain size to withstand erosive force from propeller induced currents. Those currents can extend down to the seabed and in front of and behind a vessel, as well as around berthing areas and under the dock itself.

The methodology used to evaluate propeller wash velocities and associated stable material sizes is described in Palermo et al. (1998b; Appendix A), which outlines USEPA-approved methods for conducting propeller wash evaluations to support cap design at sediment cleanup sites. The procedures use equations developed by Blaauw and van de Kaa (1978) to estimate the current velocity caused by the propellers and the stable sediment size required to resist the current velocities.

Current operations in the McKinley dock/berthing area consist of tug boat activities. The propeller was analysis was performed for two common vessels that operate at and around the berth. When operating immediately adjacent to the dock, where the water depth is approximately -32 feet MLLW, these boats navigate using up to 50 percent of their engine power. When operating away from the dock, in deeper water (i.e., greater than -45 feet MLLW), operating power is increased potentially up to 100 percent. Figure K.5 presents the results of the analysis and indicates the range of stable armor sizes for each operating scenario. The required medium armor stone diameter (D50) to ensure cap stability was determined to be 6 inches for these worst-case conditions.

4.0 Preliminary Cap Design Summary

Based on the site-specific cap design analyses summarized in Sections 2.0 and 3.0, preliminary cap design specifications used in SCU-specific remedial alternative development and costing are summarized in Table K.5. As discussed in Section 3.2, the most significant erosive forces are expected to occur during near-berth tugboat operations within the McKinley dock/berthing area. The reasonable worst-case propeller wash forces from those operations may require an armor stone of approximately 6 inches to ensure cap stability. For simplicity in developing and costing remedial alternatives, a single armor stone size was selected (i.e., D50 = 6 inches) for all cap areas including those along the gentle shorelines of SMA 2. Therefore, the selected cap is expected to be more than adequate to resist extreme wind waves within the SCU, even under a future climate change scenario.

If capping is selected as part of the SCU cleanup remedy, location-specific cap thicknesses and material specifications would be refined during remedial design. Other considerations, such as compatibility with habitat substrate requirements, would also be evaluated during design. For example, angular cap materials are often preferred by engineers because they provide greater erosion protection (e.g., facilitating interlocking) than round materials and, therefore, allow the use of smaller material for equivalent erosion protection. Smaller cap materials are preferred for habitat because they better match the existing sediment grain size in the cap area. Small angular cap materials provide the optimal balance between protectiveness, habitat function, and constructability, compared to larger rounded materials. Small angular cap materials improve erosion protection, cap stability, and chemical attenuation. These and other engineering and habitat considerations would be refined during remedial design and permitting of the remedy.

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Appendix K
Preliminary Cap Design Evaluation

Tables

Table K.1
Parameter Values and Model Output for Chemical Isolation Cap Modeling

Model Parameter	Value	Data Source
Chemical-Specific Properties		
OC partitioning coefficient, log K_{oc} (log L/kg)	See Table K.2	Log K_{oc} values were calculated from K_{ow} reported in Govers and Krop (Govers and Krop 1998) using Di Toro (1985) relationship; higher K_{oc} values (i.e., less mobility) were measured in the WPAH SCU (see Section 7.4.2 of the RI/FS), providing an additional level of cap protectiveness.
Water diffusivity (cm^2/s)	See Table K.2	Calculated based on the molecular weight of the compound using the correlation identified from *Environmental Organic Chemistry* (Schwarzenbach et al. 1993).
Chemical biodegradation rate	0	Assumed no degradation.
Chemical porewater concentration in underlying sediment (µg/L)	See Table K.2	Calculated from the highest OC-normalized surface sediment concentration measured in the McKinley dock/berthing area (Station IE09A).
Cap Properties		
Cap thickness (cm)	Design parameter	Assumed placement of 6 inches of sand; refined as necessary based on model results.
Porosity	0.4	Typical value for sand (e.g., Domenico and Schwartz 1990).
Fraction OC of cap material (%)	Design parameter	Assumed typical regional quarry value (0.1%); refined as necessary based on model results.
Fraction OC in bioturbation zone (%)	3.30%	Surface TOC level at Station IE09A; assumes surface sediment TOC levels re-equilibrate to existing conditions after completion of remedial construction.
Mass Transport Properties		
Boundary layer mass transfer coefficient (cm/hr)	0.75	Typical value used for capping design (e.g., Reible 2012); consistent with range of values measured in other systems (e.g., Thibodeaux et al. 2001).
Groundwater Darcy velocity (cm/d)	0.73	Based on regional hydrogeological investigations in shorelines adjacent to the WPAH SCU (average horizontal hydraulic conductivity of 12 feet per day; net horizontal gradient of 0.002 feet per foot).
Deposition rate (cm/yr)	0.17	Averaged measured value in WPAH is 0.17 ± 0.03 cm/yr.
Dispersion length (cm)	3	Representing tidal mixing with an increased dispersion coefficient is a common approach in groundwater modeling (e.g., La Licata et al. 2011); based on tidal range of approximately 10 feet (NOAA 2017), dispersivity is based on 20% of model domain length (cap thickness).
Bioturbation zone thickness (cm)	10	Typical value for cap design (e.g., Clarke et al. 2001); consistent with SMS (Ecology 2017).
Porewater biodiffusion coefficient (cm^2/yr)	940	Parameter represents bioturbation rate applied to dissolved phase; typical value used for capping design (e.g., Reible 2012).
Particle biodiffusion coefficient (cm^2/yr)	9.4	Parameter represents bioturbation rate applied to particulate phase; typical value used for capping design (e.g., Reible 2012).
Model Output		
Average dioxin/furan TEQ level within the 6-inch chemical isolation/bioturbation layer (ng/kg TEQ)	0.0029	Steady-state model result.

Abbreviations:

cm	Centimeters
cm/d	Centimeters per day
cm/hr	Centimeters per hour
cm/yr	Centimeters per year
cm^2/s	Square centimeters per second
cm^2/yr	Square centimeters per year
K_{oc}	Soil organic carbon-water partitioning coefficient
K_{ow}	Octanol-water partitioning coefficient
L/kg	Liters per kilogram
µg/L	Micrograms per liter
ng/kg	Nanograms per kilogram
OC	Organic carbon
RI/FS	Remedial Investigation/Feasibility Study
SCU	Sediment Cleanup Unit
SMS	Sediment Management Standards
TEQ	Toxic equivalent
TOC	Total organic carbon
WPAH	Western Port Angeles Harbor

Table K.2
Chemical-Specific Model Input Parameters

Chemical	log K_{OC} (log L/kg)	Molecular Weight (g/mol)	Dry Weight (cm^2/s)	Sediment Concentration (ng/kg dw)	Calculated Porewater Concentration (pg/L)[1]
2,3,7,8-TCDD	6.8	322	4.50E-06	2.61	0.0125
1,2,3,7,8-PeCDD	7.4	356.4	4.20E-06	5.19	0.00626
1,2,3,4,7,8-HxCDD	7.8	390.9	3.90E-06	6.18	0.00297
1,2,3,6,7,8-HxCDD	7.8	390.9	3.90E-06	103	0.0495
1,2,3,7,8,9-HxCDD	7.8	390.9	3.90E-06	23.8	0.0114
1,2,3,4,6,7,8-HpCDD	8.3	425.3	3.70E-06	2,360	0.358
OCDD	8.6	459.8	3.50E-06	17,300	1.32
2,3,7,8-TCDF	6.4	306	4.60E-06	5.03	0.0607
1,2,3,7,8-PeCDF	6.9	340.4	4.30E-06	3.55	0.0135
2,3,4,7,8-PeCDF	7	340.4	4.30E-06	4.52	0.0137
1,2,3,4,7,8-HxCDF	7.4	374.9	4.00E-06	18.7	0.0226
1,2,3,6,7,8-HxCDF	7.4	374.9	4.00E-06	8.85	0.0107
1,2,3,7,8,9-HxCDF	7.6	374.9	4.00E-06	1.05 J	0.000799
2,3,4,6,7,8-HxCDF	7.5	374.9	4.00E-06	8.7	0.00834
1,2,3,4,6,7,8-HpCDF	7.9	409.3	3.80E-06	651	0.248
1,2,3,4,7,8,9-HpCDF	8.1	409.3	3.80E-06	19	0.00457
OCDF	8.5	443.8	3.60E-06	2,190	0.21
Total Dioxin/Furan TEQ (U = 1/2)	--	--	--	62.9 J	0.0466

Note:

1 Calculated based on sample-specific TOC of 3.3% dw.

Abbreviations:

cm^2/s Square centimeters per second
dw Dry weight
g/mol Grams per mole
HpCDD Heptachlorodibenzodioxin
HpCDF Heptachlorodibenzofuran
HxCDD Hexachlorodibenzodioxin
HxCDF Hexachlorodibenzofuran
K_{oc} Soil organic carbon-water partitioning coefficient
L/kg Liters per kilogram
ng/kg Nanograms per kilogram
OCDD Octachlorodibenzodioxin
OCDF Octachlorodibenzofuran
PeCDD Pentachlorodibenzodioxin
PeCDF Pentachlorodibenzofuran
pg/L Picograms per liter
TCDD Tetrachlorodibenzodioxin
TCDF Tetrachlorodibenzodioxin
TEQ Toxic equivalent
TOC Total organic carbon

Qualifier:

J Chemical was detected; concentration is considered to be an estimate.

Table K.3
Summary of Wave Height and Period Hindcasting

Wind Direction	Fetch Distance (miles)	Windspeed (miles per hour)	Wave Height (feet)	Wave Period (seconds)
North	29.7	34.1	2.7	3.4
Northeast	42.2	28.7	2.2	3.1
East	32	36.6	3	3.6

Table K.4

Summary of Preliminary Armor Stone Sizing for Engineered Caps in SMA 1 and SMA 2 (1)

Cap Location	Wind Direction	Fetch Distance (miles)	Windspeed (miles per hour)	Wave Height (feet)	Wave Period (seconds)	Armor Stone D_{50} on 5H:1V Slope (inches)	Armor Stone D_{50} on 2H:1V Slope (inches)
SMA 1: East of the McKinley dock	South/Southeast	1.2	36.5	1.3	2.1	2.8	4.4
SMA 1: South of Lagoon Entrance	East	11	24.8	2.3	3	4.9	7.8
SMA 2: North Shore	South/Southeast	0.2	36.5	0.5	1.3	1.1	1.7
SMA 2: South Shore	North/Northwest	0.2	24.8	0.3	1	0.7	1.1

Note:

1 Results are based on 100-year return period.

Table K.5
Preliminary Cap Design Specifications for Alternative Development

Cap Layer	Assumed D_{50} Range (inches)[(1)]	Thickness (inches)
Erosion Protection	5 to 6	12
Chemical Isolation and Filter	0.1 to 0.2	6
Combined Construction	--	6
Total	--	**24**

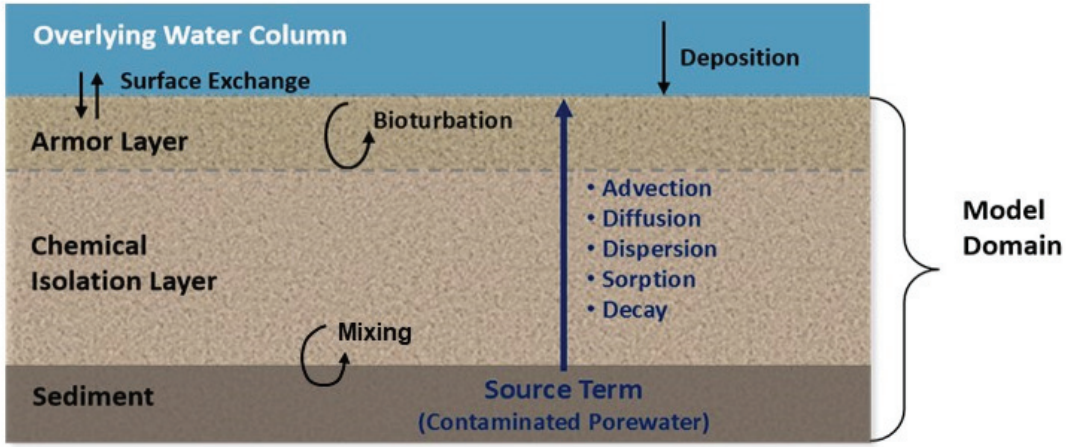
Notes:

-- Not applicable.

1 The most conservative erosion protection armor size was selected for all caps. It is expected that the final design for several caps, particularly within SMA 2, will require an erosion protection layer consisting of 6 inches of D_{50} = 1 inch of material.

Appendix K
Preliminary Cap Design Evaluation

Figures



WPAHG

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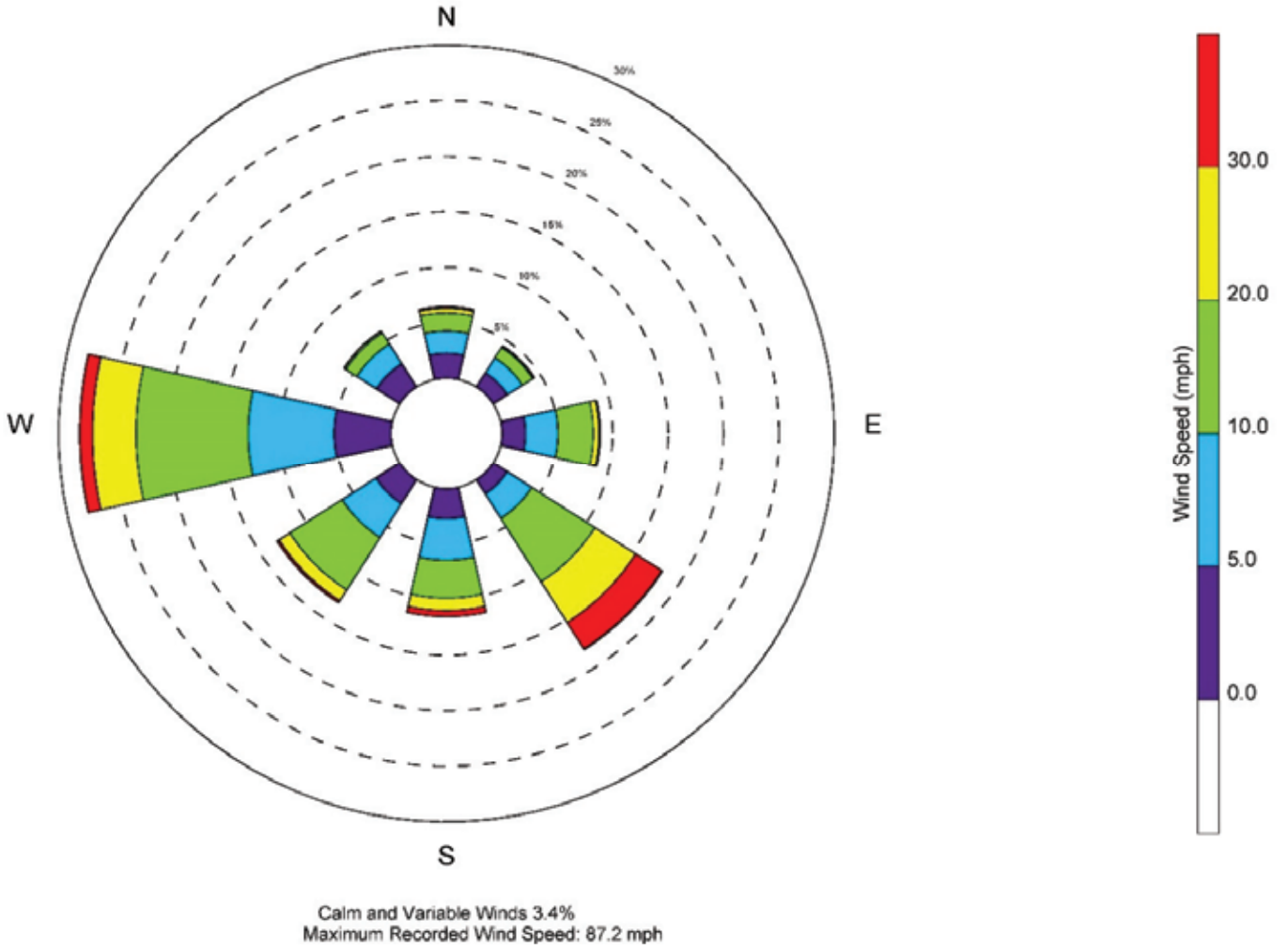
Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure K.1
Chemical Isolation Cap Model Domain and Processes



Note: Wind data are presented as the "blowing from" direction.

WPAHG

Western Port Angeles Harbor Group

Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

Figure K.2
Wind Rose Diagram:
Smith Island, 1975 to 2018

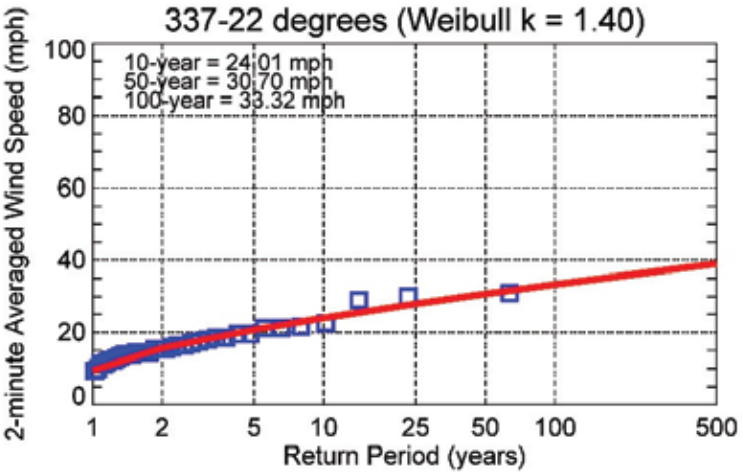
WPAHG

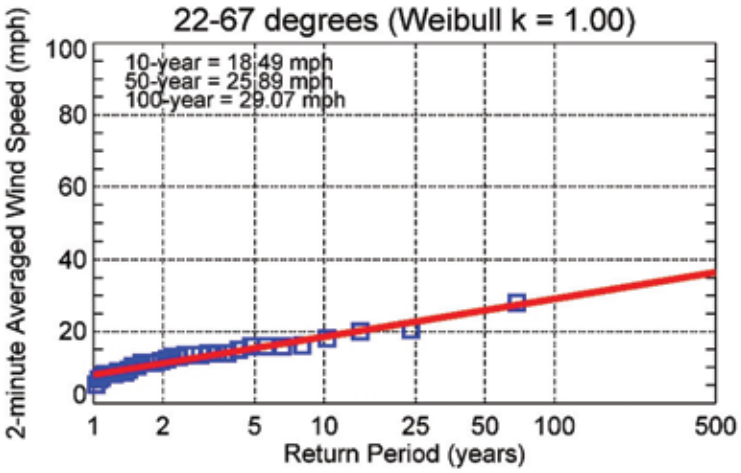
Western Port Angeles Harbor Group

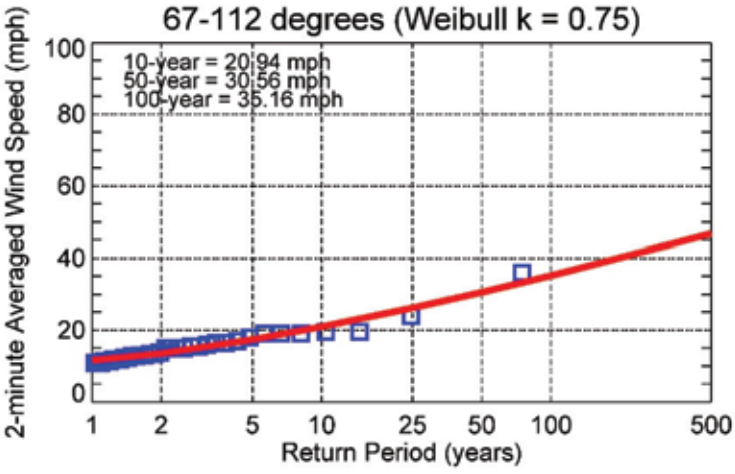
Western Port Angeles Harbor Sediment Cleanup Unit
Remedial Investigation/Feasibility Study
Port Angeles, Washington

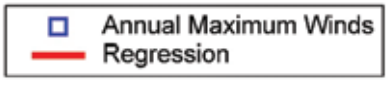
Figure K.3
Maximum Fetch Distances As a Function of Wind Direction

I:\GIS\Projects\WPAHG-RIFS\MXD\RIFS Final 2020\Figure K.3 Maximum Fetch Distances As a Function of Wind Direction.mxd
10/29/2020



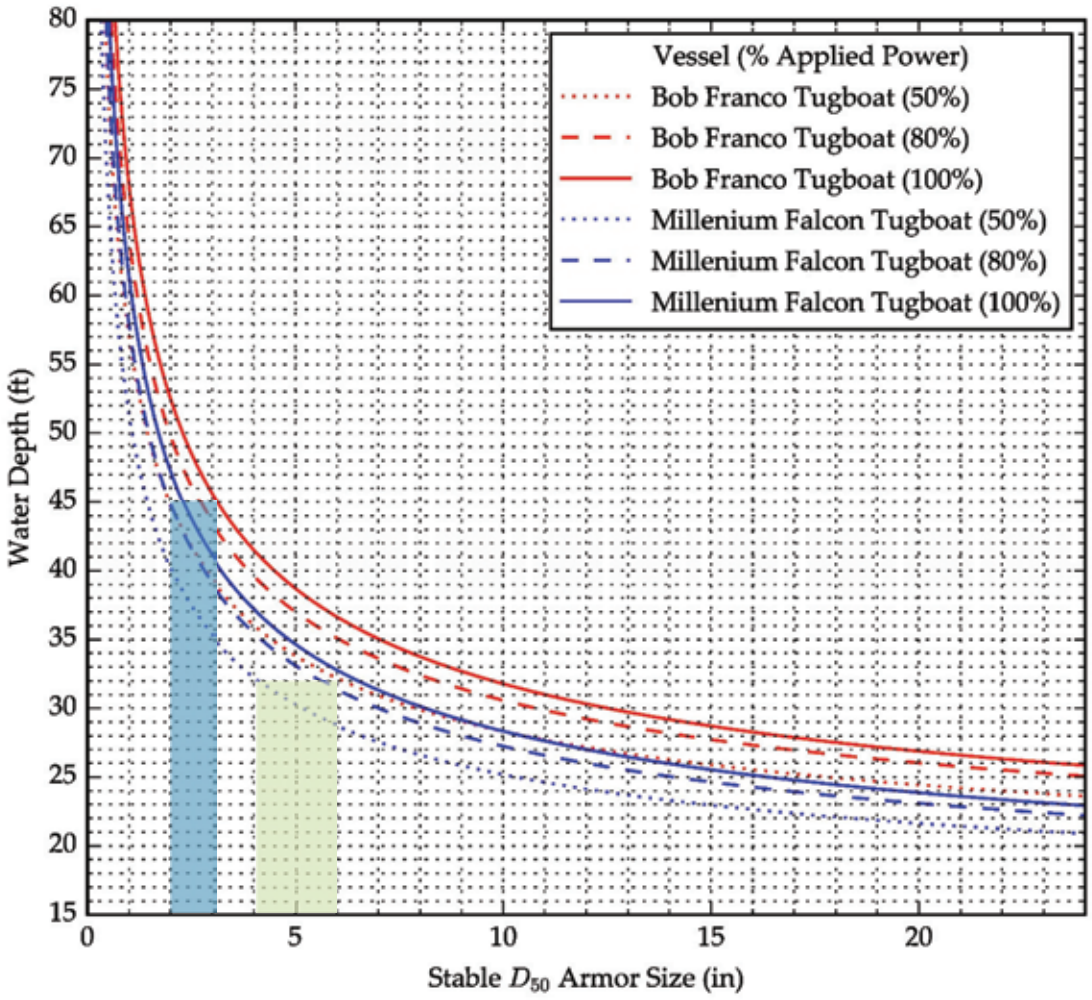






Note: results are shown from top to bottom for the North, Northeast, and East wind directions, respectively.

WPAHG Western Port Angeles Harbor Group	**Western Port Angeles Harbor Sediment Cleanup Unit Remedial Investigation/Feasibility Study Port Angeles, Washington**	Figure K.4 Return Interval Wind Speeds



Note: The range of stable armor sizes for near-dock and deeper water operations is highlighted in green and blue, respectively.

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Port Angeles, Washington

Figure K.5
Results of the Propeller Wash Evaluation

Appendix K
Preliminary Cap Design Evaluation

Attachment K.1: Stable Sediment Size Calculations for Non-Breaking Wave Conditions

Project: Port Angeles Feasibility Study
Calculation: Stable Sediment Size Calculations for non-breaking wave conditions
By: K.Ketteridge, Ph.D., P.E., Anchor QEA, 9/18/2018
References: Eckart (1952), Dean & Dalrymple (1992), USACE SPM (1984), Ketteridge (2001), Soulsby and Whitehouse (1997) as described in Whitehouse (1977), Madsen and Grant (1974)

Purpose of Calculation: Determine the median diameter of sediment that will not be mobilized by estimated 100-year wave conditions at Port Angeles at a bed elevation of -5 m MLLW. Based on estimated lowest tides at this site location (which could be around 3 feet lower than MLLW), the water depth used in the calculation was 4 m.

Variables:

$H_s := 3.0\text{ft}$ Significant wave height estimated by Anchor QEA as part of FS

$T_p := 3.6\text{s}$ Peak wave period estimated by Anchor QEA as part of FS

$h := 4\text{m}$ Water depth at location of interest

Calculate Wave Length:

Use Eckart (1952) approximation for wave length as opposed to iteration with the dispersion equation. Error maximum 10% when h/Lwave ~0.5.

$$L_{wave} := \frac{g \cdot T_p^{\,2}}{2 \cdot \pi} \cdot \sqrt{\tanh\left(\frac{4 \cdot \pi^2 \cdot h}{T_p^{\,2} \cdot g}\right)} \qquad L_{wave} = 18.607\,\text{m}$$

Calculate Wave Celerity and Orbital Velocities:

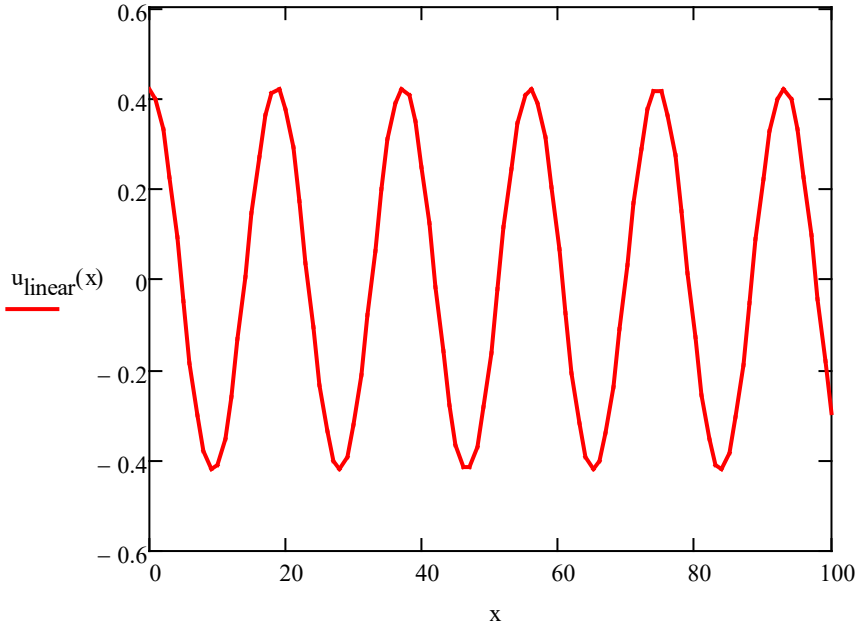
$$C_{wave} := \frac{g \cdot T_p}{2 \cdot \pi} \cdot \tanh\left(\frac{2 \cdot \pi \cdot h}{L_{wave}}\right) \qquad C_{wave} = 4.912\,\frac{\text{m}}{\text{s}}$$

$z := -h$ Vertical distance from water surface to seabed (defined as 0 at surface, -h at bed)

$x := 0\text{m}, 1\text{m} .. 100\text{m}$ Horizontal distance in direction of wave propagation (used for results graphs)

$t := 0\text{s}$ time held constant at 0 for use in calculations of wave orbital velocities

$$u_{linear}(x) := \frac{g \cdot T_p \cdot H_s}{2 \cdot L_{wave}} \cdot \frac{\cosh\left[2 \cdot \pi \cdot \left(\frac{h + z}{L_{wave}}\right)\right]}{\cosh\left(\frac{2 \cdot \pi \cdot h}{L_{wave}}\right)} \cdot \cos\left(\frac{2 \cdot \pi \cdot x}{L_{wave}} - \frac{2 \cdot \pi \cdot t}{T_p}\right)$$ Based on Linear Wave Theory



Horizontal Wave Orbital Velocities (m/s)

x is horizontal distance in direction of wave propagation

Calculate Stable Sediment Size due to Maximum Calculated Horizontal Wave Orbital Velocity.

Assumptions:
Methods by Soulsby and Whitehouse (1997) as described in Whitehouse (1977) developed an empirical equation for
the threshold grain diameter under waves (oscillatory flow) based on the following assumptions:
- The critical Shields Parameter under waves for typical sands (outside the surf zone) is approximately constant at 0.055
- The sea bed is flat with no significant bed forms (i.e. ripples)
- Grain roughness for calculation of wave friction factor taken as r = 2.5 d (Madsen and Grant 1974), where d is the diameter of the bed sediment (in this case, the stable sediment size for the entered wave condition)

$u_{max} := 0.435 \frac{m}{s}$ Maximum horizontal velocity calculated above

$s_{grain} := 2.65$ Ration of densities of sediment and water (standard accepted value for sands)

$\rho_w := 1000 \frac{kg}{m^3}$ $\rho_s := 1600 \frac{kg}{m^3}$ Density of water and quartz sand (approx)

$d_{initiate} := 5mm$ Initial value of sediment diameter. Stable diameter will result in grain roughness shields parameter (Θ 2.5_cr) calculated below to be equal to 0.055 (see assumptions above)

$$f_{2.5} := \exp\left[5.213 \cdot \left(\frac{5 \cdot \pi \cdot d_{initiate}}{T_p \cdot u_{max}}\right)^{0.194} - 5.977\right]$$

Wave Friction Factor:
Solved by replacing A and r in wave friction factor equation with equations using Tp, u(max) and d per listed references.

$\omega := \frac{2 \cdot \pi}{T_p}$ Angular frequency of wave $\omega = 1.745 \frac{1}{s}$

$A_{wave} := \frac{u_{max}}{\omega}$ Bottom wave excursion amplitide $A_{wave} = 0.249\,m$

$\psi := \frac{(A_{wave} \cdot \omega)^2}{[(s_{grain} - 1) \cdot g \cdot d_{initiate}]}$ mobility number $\psi = 2.339$

$\Theta_{2.5\_cr} := .5 \cdot f_{2.5} \cdot \psi$ $\Theta_{2.5\_cr} = 0.055$ Grain Roughness Shields Parameter, set to a constant value of 0.055 as described in assumptions above.

$d_{stable} := d_{initiate}$ when Θ 2.5_cr=0.055 above

$d_{stable} = 5 \cdot mm$