RESPONSIVENESS SUMMARY

Port Angeles Harbor Sediments Investigation

April 28—May 29, 2008 Public Comment Period

Public Review Draft Sampling and Analysis Plan

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Sediments Investigation Information

Location: Port Angeles Harbor, Clallam County
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The Washington State Department of Ecology (Ecology) is planning a study of pollution in the sediments of Port Angeles Harbor. Past sediment sampling has shown that levels of several toxic chemicals exceed state cleanup standards. This study will look at:

- Gaps in our current understanding of pollution in the harbor.
- The nature and extent of pollution in harbor sediments.
- How sediments and bottom currents move throughout the harbor.
- "Fingerprinting" pollutants to determine where they came from.
- The human health and ecological risk of the contaminants of highest concern.

Background

Port Angeles Harbor (see map on page 4) is one of several Puget Sound bays being targeted for priority cleanup by the Puget Sound Initiative. Ecology is using special funding from this initiative to investigate sediment pollution and develop a strategy for cleaning up the harbor. There are many types of pollutants in the Port Angeles Harbor that may pose a threat to human health and the environment. These pollutants also threaten fisheries, shellfish beds, and the people that depend on them.

Wood debris and pilings can be coated with toxic treatments, such as **creosote**, that leach out into the water. Decomposing wood often removes oxygen from the benthic (bottom) marine environment. Decomposition also produces ammonia and sulfides, which are harmful to plants and animals.

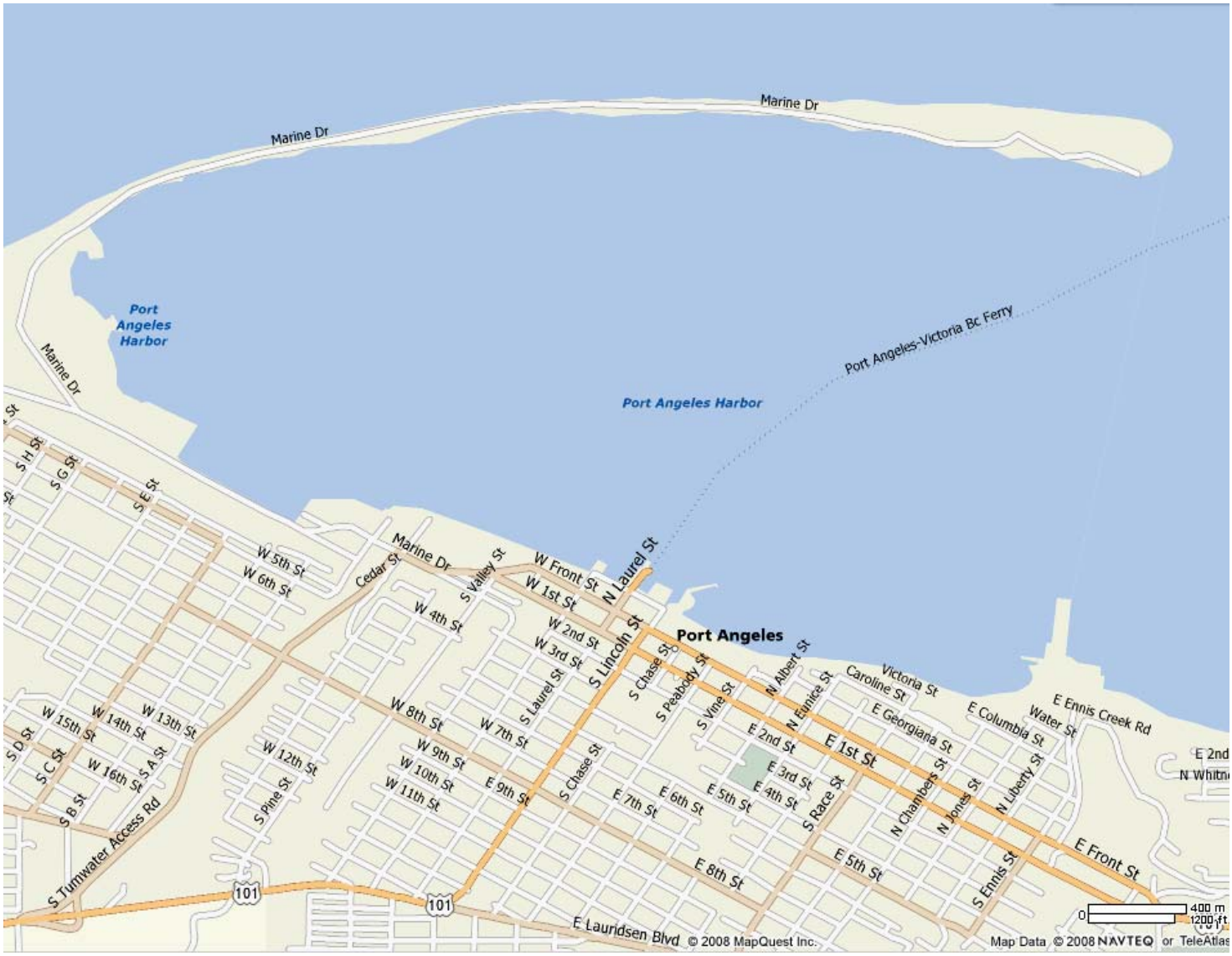
Dioxins and **furans** are toxic chemicals that can cause cancer and may cause reproductive and developmental effects. They are stored in fatty tissues and accumulate as they move up the marine food chain. They come from natural and manmade sources, such as:

- Forest fires.
- Burning seawater-soaked wood.
- Garbage burning.
- Industrial incinerators.
- Chlorine bleaching.
- Other industrial processes.

Polychlorinated biphenyls (PCBs) also accumulate in the marine food chain. These toxins pose a risk to humans eating fish from the harbor, and to organisms living in the harbor. Banned in 1977, PCBs were once used as coolants and lubricants in electrical equipment. Because of their stability, however, these chemicals still persist in the environment. Their health effects are similar to those of dioxins.

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals formed during the incomplete burning of coal, oil, gas, garbage, or other organic substances. They can accumulate in plants, animals, and breast milk. Animal studies have shown that PAHs can cause reproductive and immune system effects. They may also cause cancer in humans.

Port Angeles Harbor map



Comments Received and Ecology Responses

The following comments were received during the April 28 - May 29, 2008 public comment period for the Port Angeles Harbor Sediments Investigation Public Review Draft Sampling and Analysis Plan (SAP), April 2008. The document can be found on Ecology's web site. These comments will be added to the site file and made publicly available.

Comment #1 Daniel Lieberman

(letter in Appendix A)

This is an excellent opportunity for citizen and/or student science. As a teacher of high school students in Port Angeles, I (and my students) would appreciate being involved in data collection or other steps of the sampling procedures beyond simply making comments during a public comment period.

Ecology Response
Ecology appreciates the community's interest in this study. The nature of the sampling often requires field personnel to have 40-hour OSHA training for hazardous waste site operations due to the likely presence of hazardous substances in harbor sediments.

Comment #2 Peter DeFur on behalf of Olympic Environmental Council

(letter in Appendix A)

Olympic Environmental Council Comments on the Port Angeles Harbor Sediment Characterization Study Sampling and Analysis Plan
May 23, 2008

Summary of Issues and Recommendations

- Tributyltin (TBT) needs to be more widely sampled in the harbor and in the tissues of fish, crabs, and clams
- The purpose of the bioassays needs to be more clearly defined and researchers need to acknowledge that many contaminants of concern do not adversely affect invertebrates to the same extent as other organisms
- Tissue samples from crabs and shrimp should also be sampled in the study
- Bioassay should be performed on clams and oysters to evaluate dioxins and dioxin-like compounds
- Perform a bioassay that runs at least one biological system through a full reproductive cycle
- Increase fish tissue, clam types and invertebrate sampling numbers
- Data on benthic invertebrate assemblage composition should be collected

- Ecology should provide information on the combination of Harbor conditions (toxic chemicals, hypoxia, etc.) for RA and evaluation purposes
- Sampling of the intertidal area needs to be performed where people use beaches
- Scientific literature should be reviewed along with regulatory databases for current ecological toxicity values
- Ecology needs to account for the combination of stressors including hypoxia in its evaluations of the harbor.

Ecology Response
See comments identified below.

Comments on the Main Text
Overall the Work Plan addresses most of the major concerns from Rayonier activities and general harbor degradation. It delineates an appropriate spread of sampling and rightly focuses on the activities at the former Rayonier Mill. The Sampling Analysis Plan (SAP) also extends the sampling to the full harbor for characterizing conditions related to multiple activities over many decades. However, portions of the work plan need to be strengthened to include certain types of compounds and better screen samples for further analysis.

Comment 2.1 Given the long history of the harbor marine traffic, there should be at least as much emphasis on tributyltin (TBT), and related organotin compounds, as dioxins and furans. The study is designed to evaluate both contamination from Rayonier and conditions across the harbor. TBT has been used in anti-fouling ship paint in both recreational and commercial settings for decades, and contamination from this compound is widespread in harbors across the world. It is a well documented endocrine disruptor that can cause sex changes in invertebrates at incredibly low doses (deFur et al. 1999).To accurately measure these endpoints, more sampling for TBT is needed. TBT bioaccumulates, and therefore should be examined in tissue samples. Additional sediment samples are also required. Since TBT is listed as a constituent of potential concern in the risk assessment, as many samples as possible need to be collected. There is a known interaction between TBT and polychlorinated biphenyls (PCBs) that increases toxicity (Schmidt et al. 2004), making this sampling even more critical.

Some of the samples in the central harbor area should include organotin compounds like TBT. At the very least, the samples near the anchorage in the central harbor need to include organotin on the list. In light of the organotin contamination issues, the SAP should also collect snails and evaluate organotin in tissues, or provide some comment on how this problem may be addressed in future efforts.

Ecology Response
TBT samples are being collected at areas likely to have TBT contamination (Marina Area, Boat Launch Area, and K-Ply/Valley Creek Area). Additional samples were added in the K-Ply area near likely sources (see Table 4-3). Specifically, TBT has been added for analysis at locations KP02B, KP02C, KP07A, and KP08A. Sediment analytical data will be reviewed after analyzing archive samples. If data indicate that other neighboring samples should be run, it will be considered at that time. Tissue analysis for TBT has not been planned at this time, but may be considered if TBT is found in the Harbor sediment. Final sampling and analytical data will be reviewed and if the data indicate

additional sampling and analyses may be appropriate, a recommendation for this work will be included in the final report.

Comment 2.2 Section 4 explains the sediment sampling, sediment cores, bioassays and tissue sampling. The plan refers to compositing sediment samples and tissue samples. What is the plan for discrete sampling and composite sampling? Compositing samples over a large area does not provide the spatial resolution to determine if toxic chemicals accumulated in more localized areas, but only provides data on the larger areas as a unit. Samples need to be analyzed individually for chemical composition and contamination.

Ecology Response
The SAP does not propose collection of spatially composited surface sediment samples, or composite core samples--each core interval is treated as a discrete sample. Multiple surface grabs may be necessary to collect sufficient sample for analysis at discrete sample locations. Subsurface sample "composites" refer to combining each one foot interval into a sample. The tissue samples are "composites" of multiple individuals at a single location, as available; this is needed to get enough sample mass for laboratory analysis. The bivalve tissue samples will be treated as representing "discrete" areas of the harbor. The SAP has been modified to clarify Section 4.1.

Comment 2.3 Sampling for fish tissue refers to collecting two ling cod fillets and two whole fish. This sample size should be increased to cover a larger area and to better represent conditions. Two fish per sampling location would be a much better approach. Why are forage fishes not sampled for the purpose of assessing uptake/accumulation of chemicals?

Ecology Response
The study will use historical tissue data to assess site conditions, in addition to the tissue samples included in the SAP. Plant, fish, and shellfish tissue data collected during this study will be used with existing data as identified in Appendix D Table 5-1. Clam, crab, shrimp, sole and flounder data is available from the Rayonier Remedial Investigation. Forage fish collection was not seen as beneficial and sampling intensive for the risk assessments planned in this study. Forage fish move in and out of the harbor and are less subject to contaminants found in sediments. No change was made to the SAP in response to this comment.

Comment 2.4 Section 4.1.4 discusses the tissue sampling of clams, fish and plant materials. This plan is a good start, but there is the real possibility that important information will be missed with only these two clam species and one fish, coupled with the limited range of species used in the bioassay. The tissue sampling should include samples of all other clams, combined, and at least three samples of other invertebrates as well. The reason for additional tissues is to determine the extent to which other species or groups of invertebrates serve as avenues for uptake and accumulation of chemicals into a larger segment of the trophic system. The basic biological knowledge of invertebrates is not sufficiently comprehensive that it is possible to say all species

metabolize all chemicals in a similar fashion. Indeed, knowledge of fish biology provides evidence of great diversity in how toxic chemicals such as PCBs, dioxins and chlorinated pesticides are handled.

Ecology Response
See response to Comment 2.3. The invertebrate species chosen are long-lived species that would most reflect bioaccumulative chemicals, the same species as those collected by Rayonier during the Marine Remedial Investigation. They represent benthic invertebrate population, and supplement data already collected in Port Angeles Harbor. Plant materials collected will be used to assist with the ecological risk assessment.

Comment 2.5 The SAP needs to be cautious about inferences concerning specific effects of toxic chemicals on the biotic assemblages based single samples of animal tissues. The issue with this line of investigation not coupled with bioassay is the exclusion of data from animals not surviving *in situ* exposure, or that are otherwise impacted but not observed in collections. If the sediments are indeed toxic to a range of animals, or cause long term harm, then the affected animals may not survive to be collected, or may suffer an abnormality that is not measured via a limited set of samples.

Ecology Response
See response to Comment 2.3.

Comment 2.6 The harbor survey needs to collect samples of sediment for assaying benthic (bottom dwelling) invertebrate biotic assemblage composition. This information will indicate if the area is generally degraded or not. There are several excellent reviews indicating that benthic population diversity and abundance is responsive to low oxygen (Diaz and Rosenberg 1995, see volume by Nancy Rabalais) and these data should be collected.

Ecology Response
There are prior data on benthic invertebrate community assemblages from the 1999 SAIC wood waste study that will be addressed in the Sediment Investigation Report. The presence or absence of bottom dwelling invertebrates, and plant material are also noted during collection of surface and coring samples and may be used to supplement study data. No change was made to the SAP in response to this comment.

Comment 2.7 The specific reason for the bioassays is not clearly defined, and needs to be explained in more detail. What sort of toxicity are researchers interested in determining, specifically? The SAP should state if the intent is to identify toxic responses, uptake rates of contaminants, both, or something else. At least one bioassay should investigate toxicity effects over multiple generations. This type of assay is possible with many invertebrate species and would shed important light on the long term effects of toxic chemicals in the sediment. Multi-generational effects (impacts not on the exposed generation but their offspring) have been documented in a number of invertebrates exposed to endocrine disruptors.

Ecology Response
A clarifying sentence was added to Section 4.1.3 indicating the reasons for the bioassays. Bioassays to be used to confirm designation of Puget Sound marine sediments and their performance standards are defined in the Sediment Management Standards, Chapter 173-204 Washington Administrative Code (WAC), specifically, WAC 173-204-315 and 173-204-320(3). A sentence was added to Section 6.2 clarifying the SAP does not include multi-generation bioassays. Long term effects will be inferred from fish and bivalve tissue concentrations and the ecological risk assessment.

Comment 2.8 Bioassays must be tailored to the chemicals of concern. Invertebrates like amphipods and polychaetes do not seem to have the same receptor (Ah) as vertebrates and respond differently to dioxins and PCBs (Rice et al. 2003). Therefore, dioxin-like compounds do not exert the same influence on these organisms. Requiring a bioassay response as the prerequisite for additional analysis of archived sediments means that any limitation of the bioassay will prevent further analysis of the samples. Unless there is some compelling reason to not analyze archived samples, then these samples need to be used as a source of important information on conditions in the harbor sediments. At the very least, additional analysis should be performed if either the sediment is confirmed by bioassays to be toxic or if toxic chemicals (notably PCBs or dioxins) are detected in a corresponding surface sample.

Ecology Response
A sentence was added to Section 4.1.3 acknowledging that all the bioassay test species are not necessarily sensitive to all of the chemicals of concern (COCs). Based on the toxicity testing lab's input, the larval development acute toxicity test will use species that have been shown to be sensitive to the harbor COCs. Clarifying text was added to Sections 4.1, 4.1.1, and 4.1.3 that states multiple lines of evidence will be used to determine when archived samples will be analyzed. Bioassay results will not be the sole determination for analyzing archived samples.

Comment 2.9 Bivalves (clams and oysters) may be much more appropriate for bioassay work on dioxin-like compounds. Research by R. Van Beneden (University of Maine) has demonstrated toxic biochemical responses by the marine clams *Mya arenaria* and *Mercenaria mercenaria* to dioxin-like compounds. Additionally, recent research in the lab of J. Levine at North Carolina State University has demonstrated the sensitivity of freshwater bivalves to low level PCB exposure, and similar responses may occur in marine bivalves. These two lines of investigation indicate that bivalve bioassays may be better suited to detect responses of invertebrates to dioxin and PCB sediment contamination.

Ecology Response
See Response to Comment 2.8. A sentence was added to Section 4.1.3 acknowledging that not all the bioassay test species are necessarily sensitive to all of the COCs. Based on the toxicity testing lab's input, the larval development acute toxicity test will use species that have been shown to be sensitive to the harbor COCs.

Comment 2.10 Bioassays also need to include one biological system that is carried through a full reproductive cycle. Several compounds like TBT, dioxins, PCBs, bis-phenol-A (BPA), phthalates, and pesticides alter both reproductive function and structure in invertebrates. The appropriate endpoints need to be included in the assays. Including reproductive effects can be accomplished by selecting the correct assay and/or insuring that the assay extends through reproduction and assessing fertility, reproductive rates, and gonadal indices (see deFur et al., 1999 for more details).

Ecology Response
See Response to Comment 2.7. A sentence was added to Section 6.2 clarifying that the SAP does not include multi-generation bioassays. Long term effects will be inferred from fish and bivalve tissue concentrations and the ecological risk assessment.

Comment 2.11 The SAP should include assessments of the benthic invertebrate community diversity and abundance in the harbor for use in the ecological risk assessment. These samples should be collected on a transect from the inner to outer harbor using a grab sampler (van Veen, Ponar, etc.), sieved (0.45 mm) and preserved in the field and all organisms identified at least to family, if not genus and species. The purpose of these data is to assess the current condition of the benthic fauna, gauge the impact of multiple current conditions on the benthos, and estimate the food available to higher trophic levels that rely on the benthos as food. One of the consequences of the conditions in the harbor may likely be a diminished benthic biomass available as prey for benthic feeding fish, crabs, shrimp and even mammals. This reduction would be a serious risk factor in an ecological risk assessment.

Ecology Response
See Response to Comment 2.6.

Comment 2.12 Is the water in the Port Angeles Harbor clear enough to justify the intensity of light proposed in some of the bioassays in the work plan? The SAP is correct that some PAHs are activated by UV light and the opposite is true. Other organic compounds (including PCBs) are actually deactivated by UV light. Given that light does not penetrate more than a few centimeters into the sediment even in the most brightly lit of waters, this protocol may only apply to a few locations.

Ecology Response
This comment refers to the use of "full spectrum lighting" for bioassays. Full spectrum lighting is being used, in response to studies noted in the SAP which suggest photo-activation of certain contaminants of concern may lead to increased acute and chronic toxicity. Ecology's Sediment Sampling and Analysis Plan Appendix (Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards [Chapter 173-204 WAC], February 2008) {SSAPA} specifies that sediment bioassays containing polycyclic aromatic hydrocarbons (PAHs) should be conducted using full spectrum lighting.

The Port Angeles Harbor study area meets both site conditions specified in the SSAPA: (1) the site encompasses more than ½ acre of surface sediments which are 4 meters/12

feet or less sediment depth (MLLW) including intertidal and subtidal zones; and (2) one or more of the list of photoactivated PAHs identified in the SSAPA are present or presumed present at concentrations which exceed the SMS chemical criteria.

The attenuation of UV light is controlled to a great extent by the concentrations of "colored organic matter" in the water, although other factors influence the attenuation of UV light. No studies were available which identify the UV attenuation within Port Angeles Harbor. The SSAPA states "recent investigations have shown pronounced sensitivity to solar UV-B and effects throughout the top 10-15 m of the water column, indicating significant penetration to those depths".

Review of the Malcolm Pirnie Marine Remedial Investigation suggests that previous bioassays conducted on sediment samples from Port Angeles Harbor did not employ full spectrum lighting and so the impacts from PAHs may have been underestimated.

Based on guidance from Ecology, bioassays on Port Angeles Harbor sediment samples collected from 4 meters or less below mean lower low water (MLLW) will be conducted using full spectrum lighting. Full spectrum lighting will NOT be used in bioassays of sediment taken at depths greater than 4 meters below MLLW.

Section 6.2.4 was modified slightly to clarify the requirements for applying the UV methodology in the testing lab.

Comment 2.13 Table 6-6 does not clearly state the criteria of these bioassays.

Ecology Response
Text was added to Table 6-6 to clarify what constitutes failure of a bioassay test.

Comment 2.14 Are all tissues being sampled for total PCBs, or only whole animals? Text and tables do not match descriptions. Some portions of the text refer to only 10 congeners of PCBs being sampled but Table 6-3 lists total PCBs as an analyte.

Ecology Response
Fish and shellfish tissue will be analyzed for 12 coplanar dioxin-like PCB congeners. Referenced to Aroclors and total PCBs were removed from Table 6-3. The reporting limits and units for PCBs were corrected in the table. The reference to 10 congeners was changed to 12 congeners.

Comment 2.15 The SAP should seek to provide information on the combination of conditions in Port Angeles Harbor, hopefully for use in a risk assessment or other evaluation of the responses of the ecosystem. The harbor is stressed with both low oxygen and chemical contamination. The low oxygen is attributed to accumulation of excessive wood waste that decomposes and consumes oxygen. This condition is akin to (but not exactly the same as) eutrophication observed in many waterways around the country. Such conditions are set up by excessive nutrients fueling biological (usually algae) growth that cannot be sustained. When the biomass dies, it sinks, decays and the

decay process consumes oxygen. Presumably the wood waste decomposition fuels the process in Port Angeles. In eastern waters, the low oxygen is accompanied by production of carbon dioxide that depresses water pH, further stressing the biota. Thus, marine life in Port Angeles is exposed to chemical contamination, low oxygen, elevated carbon dioxide and low pH, all at once.

Ecology Response
Historical information on hypoxic conditions in the Harbor will be included in the Sediment Investigation Report. No change was made to the SAP in response to this comment.

Comment 2.16 Sampling in the near shore area in front of the Red Lion Inn needs to include samples in the intertidal area, if not already contemplated. The SAP does not indicate the tidal height of these sample locations and the public use of the beach requires sampling of the intertidal area where people recreate.

Ecology Response
The SAP includes samples in the Hollywood Beach area (RL01 and RL02). Text was added to Table 4-4 indicating these samples are intended to be in or very near the intertidal zone.

Comments on Appendix D- Human Health and Ecological Risk Assessment Plan

Comment 2.17 The risk assessment appendix gives far too much discretion in selecting Indicator Hazardous Substances. It is not enough to say that compounds with "low frequencies of detection" will be eliminated. Ecology needs to select a specific value for this sort of screening for consistency.

Ecology Response
Text was added to Section 3.3.1.3 of Appendix D to clarify that frequency of detection as well as use of screening values will be used to select Indicator Hazardous Substances.

Comment 2.18 Ecology should not just rely on government databases to establish ecological toxicity values. A review of the scientific literature should also be conducted. Many of the entries in the government databases have not been updated in many years and may not reflect the actual risks associated with compounds.

Ecology Response
Ecology intends to use peer reviewed literature in addition to available government databases for these values. No change was made to the SAP in response to this comment, as this is defined in Section 4.1 and 5.1.

Comment 2.19 Again, the plan suffers by not referring to or collecting data for crabs or shrimp. If the analysis will rely on existing data from earlier surveys, then the SAP needs to acknowledge this approach. This omission is a problem since there are no receptors

listed that actively consume larger benthic organisms and crabs are a significant component of seafood consumption for humans in the area. Shrimp forage on the bottom and are sensitive to both water and sediment quality. Notwithstanding the previous sampling efforts, crab and shrimp sampling in the harbor-wide investigation would indicate both presence/abundance and characteristics of the crustacean populations.

Ecology Response
Crab and shrimp data have been collected by Rayonier during the Marine RI studies. These data will be used in risk assessments. Plant, fish, and shellfish tissue data collected during this study will be used with existing data as identified in Appendix D Table 5-1. No change was made to the SAP in response to this comment.

Comment 2.20 The Ecological risk assessment will need to account for the combined stressors of toxic chemicals, low oxygen, altered biotic community and physical disturbance from deposition of materials such as wood waste. Low oxygen (hypoxia) causes metabolic stress, limits growth, reproduction and causes mortality. Chronic hypoxia reduces the abundance or benthic fauna and changes the species composition in a predictable pattern (Diaz and Rosenberg, 1995).

Ecology Response
See Response to Comment 2.15.

Comment #3 Bill Beckley, RIDOLFI, Inc. and Larry Dunn, Lower Elwha Klallam Tribe *(letter in Appendix A)*

LEKT Comments on *Port Angeles Harbor Sediment Characterization Study Sampling and Analysis Plan* (SAP), appendices, and supporting documents.

1. Comments on SAP

Comment 3.1 Section 3.2.2
"If an analyte is not detected in any samples for a particular medium, then it will be assumed that the chemical is not present, and it will not be considered further in the risk assessment"

Will this approach be used independently for harbor areas and background areas? For example, all 17 of the dioxin and furan congeners have been detected in sediments in the harbor, but only a subset of them (5) have been detected in any sediment samples in Freshwater Bay. Would these data sets be treated differently for evaluating sample TEQ concentrations?

Ecology Response
Text was added to Appendix D, Section 3.2.2, to clarify that this approach will be used for both harbor and reference/background areas. Section 8.1 of the main text also describes the approach with reference to Section 3.2.2 in Appendix D.

Comment 3.2 See Sec. 4.1.1, 4.1.2, 4.1.4
"The chemical analyte list, analytical methods, target detection limits, and comparative criteria are discussed in Section 5.1."

These are not discussed in Section 5.1; the reference should be to Section 6.1

Ecology Response
The text was changed to Section 6.0 to include Section 6.0 and 6.1.

Comment 3.3 Section 5.1 line 5 Page 67
Change the parenthetical reference "and set line fishing for the lingcod" to divers will be used to collect lingcod.

Ecology Response
Text was changed to indicate that divers will be used to spear fish for lingcod collections.

Comment 3.4 Section 8.1
"Non-detected values will be assessed as half of the sample reporting limit for data evaluation purposes, except for compliance calculations, which will be assessed as zero"

Can you explain this concept a little more? What are "data evaluation purposes"? Will the procedures described in Section 3.2.2 (discussed above) be employed when a particular analyte has not been detected in a particular medium? If non-detects will be assessed as zero for compliance calculations, getting adequately low detection limits for dioxins and furans will be critical.

Ecology Response
The language regarding treatment of non-detected results was clarified both in Section 8.1 of the SAP and further described in Section 3.2.2 of the risk assessment work plan. Additional considerations beyond MTCA WAC 173-340-740(7), as described in Section 3.2.2 , will pertain to dioxin/furan and dioxin-like PCB congeners and PAHs. Two approaches will be followed to describe concentrations. One approach is that dioxin/furan and dioxin-like PCB congeners and cPAH constituents that are not detected in any sample in the dataset are assigned a value equal to zero. The second approach is for non-detected congeners or cPAH constituents that are detected in one or more samples in the dataset, the detection limit is replaced with a value equal to one-half the method detection limit. Results of both approaches will be present in the risk assessment. This is an alternative statistical method under WAC 173-340-740(7)(f)(v) as described in the October 10, 2007 *Concise Explanatory Statement and Responsiveness Summary for the Amendment of Chapter 173-340 WAC, Model Toxics Control Act Cleanup Regulation Publication: 07-09-108.*

For other compounds, an analyte that is not detected but the detection limit exceeds numeric criteria (i.e., SQS and CSL), will be summarized with detected contaminants above numeric criteria (Section 8.1). For risk assessment, if an analyte is not detected in any investigative samples, for a particular medium, and detection limits are below numeric criteria, then it will be assumed that the chemical is not present and it will not be considered further in the risk assessment. In most cases, if the analyte is assumed to be present based on a detection limit above the numeric criteria, it will be assessed at one-half the detection limit (MDL, see Section 3.2.2 of the SAP).

2. Comments on SAP Appendix D

Comment 3.5 Section 2.2.6, p. 7
The whole first paragraph reference to the Shea et al. 1981 is incomplete and misleading. The Shea report states starting on the bottom of page 463 and continuing to page 464:

> "It is clear that a definite possibility exists that the plume separates into distinct components while in the near field region, and that certain of these components may travel in the subsurface waters, or precipitate out onto bottom sediments. Unfortunately, neither laboratory (separation and settling experiments) nor field (detailed subsurface and sediment sampling) studies have been carried out to investigate this phenomenon. It is important to note that the separation of the plume into components implies the possibilities that 1) toxic components may be present with little or no detectable SSL and 2) that toxic components may be carried by subsurface currents to areas much different than those indicated by surface current analysis."

The net flow in the harbor is in question and no conclusive studies have been done to map the bottom currents in the harbor, which we contend are significantly different than the surface currents. Our contention is based on observations in the harbor during dives, and they indicate that the bottom currents within the harbor are consistently clockwise and that this is unaffected by the tidal changes. It appears that the harbor bottom

currents are more affected by fluid dynamics and the harbor shape than anything else. Malcom Pirnie's conclusions are conjecture and are not supported so we don't believe it is appropriate to use their statements.

Ecology Response
The first paragraph was deleted. The Sediment Transport Analysis and Current Monitoring should further define bottom currents and sediment transport.

Comment 3.6 Section 3.3.1.4
"The reference area for this investigation is Dungeness Bay. Site-specific background samples from Dungeness Bay will be used to compare reference and site investigation data, as appropriate. Additional discussion of the use of any reference data will be provided in the risk assessment report."

The use of an area for reference sediment samples (as defined in the SMS) and as site-specific background, which may be the basis for setting cleanup levels, are not exactly the same thing. Is Dungeness Bay sediment intended to be used for both purposes? (See also comment below on SEIDG Sec. 3.1.3)

Ecology Response
Text was added to Appendix D, Section 3.3.1.4, clarifying that Dungeness Bay will serve as both reference and background locations. The discussion of the outer harbor area as background was removed from the text. Further discussion of the selection of Dungeness Bay as a background location is provided in Appendix C of this document (E&E 2008). Ecology will examine the outer harbor and eastern shoreline areas for their potential either as areal background areas for the Harbor, or as natural background areas with approximate levels associated with Dungeness Bay.

A group of federal and state agencies (Ecology, DNR, EPA, Corps, and the Puget Sound Partnership) are working together to identify non-urban area sediment concentrations for Puget Sound and compare them to project data. The project will include collection of all existing dioxin/furan data, as well as a field sampling effort to collect 70 additional dioxin/furan/PCB congener samples. Ecology will examine these data to determine whether Dungeness Bay is within this framework for Puget Sound.

Comment 3.7 Section 5.4.1.4, p. 36
The harbor seal is an opportunistic feeder and is not limited to bottom-dwelling fish, invertebrates and pelagic species. They also eat clams and crab, both of which are plentiful and known to be significant bioaccumulators of PCBs and dioxins in Port Angeles Harbor.

FOOD PREFERENCES AND RESOURCES :

1. Adult harbor seals eat squid, crustaceans, molluscs, and a variety of fish; including, rockfish, herring, flounder, salmon, hake, and sand lance.

2. A harbor seal's diet varies seasonally and regionally and often is subject to local prey availability. "Harbor seals don't chew their food. They swallow their food whole or tear it

into chunks. With their back molars, they crush shells and crustaceans."
SeaWorld/Busch Gardens Animals

"The harbor seal diet varies seasonally and regionally. They primarily feed on crustaceans, mollusks, squid, and fish. The food is torn into chunks swallowed whole. The molars crush shells and crustaceans for swallowing, but food is generally not chewed. Adults consume 5-6% of their body weight or 4 to 6 kg of food per day. The diet of Ungava seals has not been well studied, but they are known to prey on salmonids such as small Brook trout, feeding usually takes place near the shore in shallow water they dive to over 200m deep, most often 100m for periods of a few minutes. However, harbor seals have sometimes been known to dive more than 500m for more than 25 minutes."

/Phoca vitulina/ , Harbor Seal - MarineBio.org. Retrieved Wednesday, April 30, 2008, from http://marinebio.org/species.asp?id=158.

Ecology Response
Text added as suggested.

3. Comments on *Summary of Existing Information and Identification of Data Gaps* (SEIDG) *Report*

Comment 3.8 Section 3.1.3, p. 3-5
"Dungeness Bay is considered an appropriate reference area for dioxins in Port Angeles Harbor, as it has some of the lowest dioxin/furan concentrations sampled to date in the Strait of Juan de Fuca or Puget Sound"

Dungeness Bay was one of two background locations used in the Marine RI and Phase II Addendum sampling events; the other was Freshwater Bay. The Freshwater Bay location was added at the Tribe's request, as certain information existed (see Shea et al., 1981) that indicated Dungeness Bay may be within the area of influence of historic mill effluents. There do appear to be differences in sediment concentrations for both dioxins/furans and PCBs between these two locations. Concentrations of both dioxin TEQ and total PCBs are consistently lower in Freshwater Bay than in Dungeness Bay. Mean TEQ concentrations, based only on detected values, were more than 20 times lower in Freshwater Bay as compared to Dungeness Bay; mean TEQ concentrations, treating non-detects at half the detection limit, were three times lower at Freshwater Bay; and mean total PCB concentrations were four to five times lower in Freshwater Bay. (Note: at the 90th percentile [the value used for establishing background] the difference in values for these two locations is even greater.) For dioxins/furans, only 5 of the 17 congeners were detected in any sediment samples from Freshwater Bay, while 13 of 17 were detected at Dungeness Bay.

The Tribe continues to assert that Freshwater Bay is a more appropriate location for determining background sediment concentrations.

Ecology Response
A discussion and comparison of the use of Freshwater versus Dungeness Bays as reference and background locations is provided in the attached "white paper" addressing

this issue (Appendix C, E & E 2008). Based on the analysis provided in the white paper, the reference/background location of Dungeness Bay was not changed in the SAP.

Comment 3.9 Section 3.1.2, p. 3-5
"Concentrations for PCBs and dioxins/furans in tissue at the site increased from initial sample collections of the RI. This was most likely due to changes in tissue separation methodology and labs reporting lower detection limits for sediment."

While there were some differences in tissue separation methodologies, specifically for horse clams and geoduck, we believe there are other explanations for increased concentrations. The highest detected concentrations of dioxins/furans around the Mill site were found in log pond sediments. This area was used for rafting logs and was also the location of one of the historic nearshore outfalls. Following closure of the Mill, log rafting ceased in this area, and the existing log booms and part of the existing jetty structure were removed. This immediately resulted in significant erosion within the log pond and the adjacent shoreline. One of the first actions Rayonier took following site deferral was an emergency action to armor the log pond shoreline to address this issue.

In 2000, Rayonier's consultant conducted a survey of the log pond area, including collecting 6 sediment samples that were analyzed for dioxins and furans. The total TEQ for these samples ranged from 20 to 90 ppt, with an average concentration of 50 ppt (and an average TOC of more than 20%). During sampling for the Marine RI (2002), which was more extensive, TEQ concentrations ranged from 0.6 to 53 ppt (with an average of less than 10 ppt). Finally, during sampling conducted for the Phase II RI Addendum (2006) TEQ concentrations ranged from 0.4 to 46 ppt. Between these successive events, dioxin concentrations, as well as woodwaste accumulations have decreased significantly in all but the most protected areas of the log pond. We believe that if this material was re-suspended due to erosion, and available to be taken up by organisms in the harbor, this may be one explanation for increased concentrations.

Among the most significant increases between the RI and the Phase II sampling events were concentrations of dioxins/furans in Dungeness crab. There were not changes in tissue separation methodologies for Dungeness crab samples, and the increased concentrations are evident in samples analyzed by the same laboratory using the same analytical procedures. Also, it is not apparent that lower detection limits for sediment had any effect on increasing concentrations in tissue.

Ecology Response
The comment regarding increases in tissue concentrations was noted as an alternate hypothesis. Ecology chose laboratory facilities with appropriately low detection limits.

Comment 3.10 Section 2.1, Paragraph 2
"Prior to the advent of the CWA, untreated process effluent from the mill facilities was discharged to the harbor through the early 1970's (table2) (Shea et al. 1981). After passage of the CWA, industrial wastewater discharges to the harbor from mills required treatment. Pulp and paper mill treated effluents continue to be discharged in to the harbor until 2008…"

We are not aware that any pulp and paper treated effluents were discharged into the harbor subsequent to the closure of the Rayonier Mill. What treated pulp effluents are being discharged into the harbor currently? Nippon discharges pulp and paper effluents outside of the harbor; Fiberboard has been closed for decades; and Rayonier has been closed for nearly a decade now. K ply wasn't a pulp or paper mill and had no documented waste effluent discharge. We know of no other sources in the harbor, if there are we would be interested in their location and identity.

Ecology Response
The comment regarding effluent discharge was noted. The text in Appendix D, Section 2.2.1 inferring that Diashowa/Nippon mill effluent was discharged to Port Angeles Harbor after passage of the Clean Water Act was removed.

Comment 3.11 Section 3.2.1.1
"Nippon, formerly Diashowa and Georgia Pacific, still operates a large mill on the western end of the Harbor at the base of Ediz Hook. Process wastewater was discharged into the Harbor until the 1960s, at which point a new discharge pipe was built that redirected effluent to the Strait of Juan de Fuca."

1) Nippon has only had two previous owners according to records, one was Diashowa and the other was Zellerbach who founded the mill in 1921.

2) The waste stream for Zellerbach was split before the 1960's, according to a report: *Investigation of pollution in Port Angeles area; summer, 1957, Washington Pollution Control Commission*

> "Crown Zellerbach, Inc. Located on the north side of the closed end of the harbor, the Crown Zellerbach integrated mill produces approximately 450 tons of ground wood and 95 tons of sulfite pulp daily. About 12,000,000 gallons of water are used per day in the production of pulp and paper. Pulping process wastes are discharged on the Straits side of the mill; wastes from the paper mill are discharged on the harbor side. ... A recently constructed lagoon system effectively reduces solids losses from hydraulic barker wastes."

So it appears that Zellerbach was more knowledgeable about waste streams than Rayonier, discharging the pulping process wastes outside of the harbor, so their dioxin should have been dumped on the outside of the harbor, not in it. We wouldn't want chemical contamination from the pulping process blamed on Nippon or their predecessors if they didn't contribute to them.

Ecology Response
The comment regarding ownership and waste streams was noted. The text in Appendix D, Section 2.2.1 inferring that Diashowa/Nippon mill effluent was discharged to Port Angeles Harbor after passage of the Clean Water Act was removed. Other Lower Elwha Klallam Tribe comments relating to inaccuracies concerning Nippon will be addressed and corrected in the Sediment Investigation Report.

Comment #4 Eycke Strickland, Olympic Environmental Council

(*letter in Appendix A)*

PLAN STRENGTHS

- Overall the Work Plan is good.
- It calls for an appropriate spread of sampling and rightly focuses on the activities at the former Rayonier Mill.

PLAN GAPS

Comment 4.1 Omissions of certain types of compounds and screening of samples for further analysis.

- More sampling for tributyltin (TBT) is needed.
- Because of the Harbor's heavy marine industry, more sampling of TBT should be done.
- TBT builds up (bioaccumulates) in tissue samples and is listed as a constituent of potential concern in the risk assessment, so as much data as possible needs to be collected.
- Interaction between TBT and polychlorinated biphenyls (PCB) increases toxicity making this sampling critical.

Ecology Response

See response to Comment 2.1

Comment 4.2 The specific reason for the bioassays is not yet clearly defined.

- What toxicity are researchers interested in specifically?
- At least one bioassay should investigate toxicity effects over multiple generations.

Multi-generational effects have been documented in a number of invertebrates exposed to endocrine disruptors such as PBTs. This is possible with many invertebrate species and would shed important light on long term effects of toxins in the sediment

Ecology Response

See response to Comment 2.7

Comment 4.3 Bioassays must be tailored to the chemicals of concern.

- Amphipods and polychaetes do not contain the receptor to uptake dioxins and PCBs. Therefore they do not exert the same amount of influence on these organisms. Making this the requirement for additional analysis of archived sediments is unnecessary.
- Without supporting evidence, there is no reason that all archived samples shouldn't be analyzed. At the very least, additional analysis should be performed if either the sediment is confirmed by bioassays to be toxic or if PCBs or dioxins are detected in a corresponding surface sample.

Ecology Response
See response to Comment 2.8.

Comment 4.4 Is the water in the Port Angeles Harbor clear enough to justify the intensity of light proposed by the work plan? UV light deactivates most organic compounds (including PCBs). Given that light does not penetrate more than a few centimeters into the sediment even in the most brightly lit of waters, this protocol seems unnecessary.

Ecology Response
See response to Comment 2.12.

Comment 4.5 Are all tissues being sampled for total PCBs?
Text and tables do not match descriptions. Portions of the text refer to *only* 10 congeners of PCBs being sampled, but Table 6-3 lists *total* PCBs as an analyate. Table 6-6 does not clearly state the criteria of the bioassays.

Ecology Response
See responses to Comments 2.13 and 2.14.

Comments on Appendix D Human Health and Ecological Risk Assessment Plan

Comment 4.6 The risk assessment appendix Indicator Hazardous Substances. Ecology should select a *specific value* for hazardous substances for screening consistency, rather than saying compounds with "low frequencies of detection" will be eliminated.

Ecology Response
See response to Comment 2.17.

Comment 4.7 Ecology should not just rely on government databases to establish ecological toxicity values. A review of the scientific literature should also be conducted. Many of the entries in the government databases have not been updated in years and may not reflect the actual risks associated with compounds.

Ecology Response
See response to Comment 2.18.

Comment 4.8 Sampling crabs should be included. Crabs are a significant component of human seafood consumption in the area and there are no receptors listed that actively consume larger benthos organisms.

Ecology Response
See response to Comment 2.19.

Comment #5 Carla Yetter, Rayonier *(letter in Appendix A)*

Comment 5.1 The amount of sampling and analysis proposed in the SAP (Ecology 2008a) is unnecessary to accomplish the goals as set forth in Section 2.3.

5.1.1 Previous Sampling

Ecology Response
No change was made to the SAP in response to this comment. As identified in Rayonier's cover letter, Ecology requested further vertical and horizontal delineation of contaminants and wood waste and biological testing following review of the Marine Remedial Investigation documents in their January 9, 2008 letter (Appendix B). Rayonier did not sufficiently delineate contaminants and wood waste; bioasssays, background comparisons, and potential for buried contaminants were not adequately addressed. Secondly, the Interim Action performed at the base of Ennis Creek was not complete. Impacted sediment was left near the bridge piles and found in the Mill Dock area during the additional PCB/dioxin sampling. Movement of polychlorinated biphenyls (PCBs) and hydraulic oil containing hydrocarbons could be harmful to the environment and public health.

5.1.2 Precedents

Ecology Response
No change was made to the SAP in response to this comment. Note that some studies listed include screening level investigations and surface sample stations only. In these studies (Oakland Bay, Budd Inlet, Grays Harbor), recommendations included further sampling to determine the nature and extent of wood waste, follow-up action for chemical exceedances, bioassays, and more accurate mapping of wood waste distribution. There were exceedances of SMS criteria, including wood waste compounds. It was recommended that wood waste deposits be removed in some areas and best management practices be used. Final cleanup plans were not included in these documents.

5.1.3 Sediment cores

Ecology Response
The one foot interval for core samples was selected to define the distribution of contaminants in subsurface sediments to the finest interval possible, while still providing sufficient sediment volume for laboratory analysis. Note that a minimum of two of the four 1-foot intervals from each core will be analyzed in the harbor-wide investigation, and all four 1-foot intervals from the Rayonier deepwater outfall area will be analyzed. No change was made to the SAP in response to this comment. In addition, human and ecological removal of burrowing clams would expose receptors to contaminated sediments at depth.

The comment regarding samples proposed in Section 4.2.2 being unnecessary to delineate wood waste was noted. See January 9, 2008 letter (Appendix B) from Ecology

to Rayonier. See Ecology response to Comment 5.1.1. Rayonier took five cores in the Mill Dock area, which Ecology felt was insufficient, as subsurface chemistry was not performed. Cores are planned for the Rayonier Mill area in expectation of finding wood waste, and chemical characterization will be performed. Ecology requested that wood waste data obtained from the current study be used to supplement data from the Rayonier MRI. No change was made to the SAP in response to this comment.

5.1.4 Sediment Bioassays

Ecology Response
See Response to Comment 5.1.1. The comment regarding additional bioassays in the Mill Dock and Log Pond area being unnecessary was noted. Ecology did not feel that three bioassays in the Mill Dock area were sufficient to characterize the area. No bioassays were proposed for the Log Pond area. Ecology requested bioassays for the Mill Dock area for COPCs which did not have SMS criteria, including wood waste compounds, ammonia and sulfides. The one sampling location for the former nearshore outfall is intertidal and labeled C001. No change was made to the SAP in response to this comment.

The comment regarding bioassay testing at the deepwater outfall being unnecessary was noted. Further vertical and horizontal delineation of this area along the outfall was needed to understand transport of contaminants. Bioassays were requested for sediments without SMS criteria. Additional COPCs were identified in the January 9, 2008 (Appendix B) letter. Section 4.2.3 now refers the reader to Section 4.1.3 for description of the bioassays to be used.

5.1.5 Ennis Creek

Ecology Response
The comment about Ennis Creek samples being unnecessary to characterize PCBs and TPH in this area was noted. See January 9, 2008 (Appendix B) letter from Ecology to Rayonier, (Specific Comment #22). Not all residual contamination was dealt with in the interim action. PAHs remain near the bridge and PCBs may be present in the alluvial fan at the mouth of the Creek, which was not included in the RI sampling. No change was made to the SAP in response to this comment.

Regarding bioassays appearing to be on land, the figure was modified to show the creek line extending out into Harbor. However, the scale on this map makes it difficult to identify exact locations of samples. Bioassay samples will be collected from intertidal sediment areas which may be influenced by freshwater.

Regarding bioassays in Ennis Creek possibly requiring toxicity testing with freshwater species, the bioassay test methodology and lab procedures account for salinity variations in the sample material. Modifications to Section 6.2 or the SAP indicate that the toxicity laboratory will adjust the sediment sample upon receipt, if necessary, to appropriate salinities for bioassay testing to match reference samples. *Eohaustorius estuarius*, the species used in the amphipod test, is more tolerant of a wide range of

salinities. Use of the other tests for low salinity sediments can be considered on a case-by-case basis per SSAPA guidance (Ecology 2008).

5.1.6 Appendix D—Human Health and Ecological Risk Assessment

Ecology Response
The comment about the human health risk assessment being duplicative or prior work was noted. Ecology will evaluate the toxicity and assess the risks of chemical contaminants for the Port Angeles harbor area. No change was made to the SAP in response to this comment.

'East' Hook was changed to Ediz Hook.

Table 5-1 was modified to show the correct information in the correct table columns to accurately reflect the narrative description in Section 5.4.1.

Exposure duration may be important for migratory species that spend only a portion of the year in the site area. As such, the term will be retained. No change was made to the SAP in response to this comment.

Comment 5.2 Analytical Chemistry Approach

Ecology Response
The PCDD/PCDF reporting limits and units should be ng/kg (nanograms per kilogram [parts pet trillion]). Tables 6-2 and 6-3 were revised to show the proper units (ng/kg). While not noted in the comments, a similar error was made regarding detection limits for dioxin-like PCB congeners. The correct units should be ng/kg. This error was corrected.

A wide range in congener concentrations is expected. The laboratory will dilute sample extracts to keep congener concentrations within the linear range of each congener. Therefore, multiple instrumental analyses of a sample extract are possible, with data from these analyses being used for different congeners as appropriate. Analyses whose associated quality control criteria are within acceptable ranges are expected to have limited bias in the calculation of toxic equivalents (TEQs). If questions arise as to the differences in concentrations between instrumental analyses, which are not based on exceedances of linear ranges, the data will be reviewed. The data which best meet quality control parameters would be documented and used in further data analysis. No change was made to the SAP in response to this comment.

Comment 5.3 Absence of Information to Allow for Review

5.3.1 Fingerprinting

Ecology Response
Section 8.4 states that "A screening-level "fingerprinting" evaluation will be conducted to provide a preliminary indication of the *usefulness of the analytical data to differentiate*

between sources of contaminants" (emphasis added). The data being generated is "definitive" data. It is not possible at this time to specify exactly what types of statistical analyses may be performed. For example, data may be highly censored (large percentage of non-detect values) which may preclude statistically significant evaluation of the data. No change was made to the SAP in response to this comment.

5.3.2 Bivalves

Ecology Response
Ecology considered purging clams in seawater before processing for whole body analysis. The idea was to flush the grit containing any potentially contaminant-laden sediment from the clam gut ball. This approach would be appropriate for the HHRA, but not preferable for the ERA. Upon further investigation, purging the gut ball would substantially increase field time and introduce sample chain of custody complications.

There are both whole body and edible clam tissue data available from previous studies, so data comparability should not be an issue. The first Rayonier RI study used whole body analysis, while the Phase II RI addendum separated edible tissue and then analyzed both whole tissue and edible tissue. The Expanded Site Investigation (ESI) used whole body analysis, while the WDOH study used edible tissue analysis.

The final SAP specifies that clams not be purged and whole body analysis be conducted. Whole body would include viscera and body fluids, gut ball, and siphon/mantle sheath. Text was added to Sections 4.1.4 and 5.4 to describe this. Text was also added Appendix D Section 3.5, noting that exposure point concentration (EPC) calculations will take into account uncertainties associated with whole body analysis of clams.

5.3.3 Radioisotope Analyses in Cores

Ecology Response
The coring device for the radioisotope cores was modified. The text in Sections 4.1.2, 4.1.2.2, and 5.3.3 were changed accordingly.

The radioisotope processing and shipping procedure was changed in Sections 4.1.2.2, 5.3.2, and 5.3.3 to state that cores will be handled with care and stored in a stable position to avoid mixing sediments prior to processing. The radioisotope cores will be sectioned in the field and shipped as separate sample aliquots.

Subsections 4.2.2.1 through 4.2.2.4 were added to the text to distinguish collection of 4 foot and 12 foot cores in the Rayonier sampling area.

5.3.4 Current Meter Study

Ecology Response
The plan was added to the SAP in Appendix F.

5.3.5 Core Intervals and Archiving

Ecology Response
Section 5.3.2 was modified to include a field decision methodology for section of core intervals for laboratory analysis. The first (top most) core interval will be a 0.5-foot interval (approximately 6 inches to 1 foot) because the upper 6 inches will have been collected in the collocated surface grab sample. Text in the SAP has been modified to account for the fact that not all cores intervals are a full 1 foot in length.

5.3.6 Change Order

Ecology Response
Section 5.7 was modified to more clearly outline the approval and documentation process for changes to the SAP during field operations.

Comment 5.4 Other General Comments

Ecology Response
Section 4.2, last sentence, reference to Figure 2-4 changed to 4-2a.

Incorrect description of Table 5-1. Text was added to Section 5.3 to correctly identify the content of Table 5-1.

There are additional performance criteria for the polychaete test. Text was added to Section 7.3.1 referring the reader to Section 6.2 on bioassay performance standards.

Comment #6 Paul Perlwitz, Nippon Paper

(letter in Appendix A)

Comment 6.1 Limited Dioxin/Furan Source Analysis

Ecology Response
Dioxin/furan analyses were added to surface (A) samples of FT01 to capture CSO 6, FT04 to capture CSO 7 and 8, the waste water treatment outfall location WW01, and to FT13 for the full chemical analysis at this location. Two samples, RL03 and LP01 are archived or analyzed for dioxin/furans to potentially capture CSO 10 as shown in the final SAP (June 26, 2008). Tables 4-4 and 4-6 have been changed to reflect this rationale. Ecology does not expect residential burning to be a significant source of dioxin/furans in Port Angeles; Outer Harbor, Reference, and Eastern Intertidal samples will likely pick up these lower levels which may approach background conditions.

Comment 6.2 Representativeness of Radioisotope Dating Cores

Ecology Response
The results of these core samples will be carefully described in the Sediment Investigation Report and attention will be given to the spatial limitations of the data. The core data will be used with other collected sediment transport and current data to provide an overall understanding of sediment dynamics in the harbor. No change was made to the SAP in response to this comment.

Ecology changed the coring device to a gravity corer for better data collection. The text in Sections 4.1.2, 4.1.2.2, and 5.3.3 were changed accordingly.

Comment 6.3 Alternative Sampling for Fish Samples

Ecology Response
LEKT staff have assured Ecology that the locations for sampling identified in the SAP are known to be high concentration areas for the species identified for collection. Furthermore, the risk assessments will utilize benthic organism tissue and fin fish tissue data from previous investigations. No change was made to the SAP in response to this comment.

Comment 6.4 Use of Full Spectrum Lighting

Ecology Response
See response to Comment 2.12.

Comment 6.5 Appendix D, Human Health Ecological Risk Assessment Work Plan

6.5.1 Section 2.2.1. Inaccurate description of historical discharge stream from Diashowa/Nippon.

Ecology Response
The text in Appendix D, Section 2.2.1 inferring that Diashowa/Nippon mill effluent was discharged to Port Angeles Harbor after passage of the Clean Water Act was removed.

6.5.2 Section 2.2.2 Demographics and Land Use

Ecology Response
It is recognized that marine structures may have changed the shoreline over time. No change was made to the SAP in response to this comment.

Comment 6.6 Data Needs for the Human Health Risk Analysis
Need to conduct a current and independent shellfish habitat assessment/survey to evaluate locations/quantity of shellfish beds in Harbor, and ground truth proposed LEKT fish consumption rate.

Ecology Response
A shellfish habitat assessment and survey will not be part of the study. Existing information about shellfish beds will be used in the HHRA/ERA. THE HHRA/ERA report will include a discussion of uncertainties or limitations with using the existing data, particularly as it relates to site use factors/fraction of ingested fish and shellfish from the Harbor. This discussion will also address uncertainties about the fish/shellfish consumption rates for the recreational fisher/shellfisher and subsistence (LEKT) fisher/shellfisher. Additionally, the ERA will look at sediment habitat quality as impacted by wood waste distribution to help evaluate potential impacts to seagrasses/macroalgae and benthos (including shellfish). This is listed as a measure in Table 5-1. Hence, although we are not conducting a formal shellfish habitat assessment/survey, we are not ignoring impacts to potential shellfish habitat in the Harbor.

In addition to wood waste, there have been concerns associated with outfalls related to biological / chemical contamination that impacts shellfish and habitat quality. With the reductions in CSOs and discharges from pulp paper mills, observational diving shows that shellfish are beginning to repopulate the harbor. Documented shellfish areas are available from the Department of Fish and Wildlife and Commercial Fishing areas from Department of Health. Habitat exists for geoducks, clams, and hardshell clams.

No change was made to the SAP in response to this comment.

Comment #7 Heather Trim, People for Puget Sound

(letter in Appendix A)

Comment 7.1 Sampling analysis. Our experience has been that almost every sediment cleanup site in Puget Sound has had inadequate sampling that required more sampling to fill in later. We suggest that the sampling site selection be reviewed to ensure that this round of sampling will be definitive. We have had years of sampling in the Port Angeles Harbor area and the process should not drag out for many more years.

Ecology Response
This investigation is the beginning of several steps that will lead to fully identifying and cleaning up contamination in Port Angeles Harbor. The purpose of this first step is to fill in gaps in our knowledge of harbor contamination and determine where it came from. Those responsible for the contamination will need to do further investigation and complete any necessary cleanup. Ecology is leading this harborwide study to move the process forward and identify potentially liable persons. No change was made to the SAP in response to this comment.

Comment 7.2 CSO and sewage treatment plant. Special attention should be paid to these outfalls. We do not think that adequate sampling has occurred in these areas to date, especially for dioxin.

Ecology Response
See response to Comment 6.1. Dioxin/furan analysis has been added for CSOs in the Landings Pier area and the wastewater treatment plant outfall.

Comment 7.3 Biotic community. We believe that analysis of biotic community should be conducted as well as bioassays. This would yield better data about benthic long-term health.

Ecology Response
See responses to Comments 2.3, 2.6, 2.11, and 2.19. There are prior data on benthic invertebrate community assemblages from the 1999 SAIC wood waste study that will be addressed in the Sediment Investigation Report. The study will use historical tissue data to assess site conditions in addition to the tissue samples included in the SAP. Plant, fish, and shellfish tissue data collected during this study will be used with existing data as identified in Appendix D Table 5-1. Clam, crab, shrimp, sole and flounder data are available from the Rayonier Remedial Investigation. No change was made to the SAP in response to this comment.

Comment #8 North Olympic Timber Action Committee
(letter in Appendix A)

Ecology Response
Thank you for your comment. Wood waste byproducts include ammonia, sulfides, and resins which may be toxic to aquatic life. Wood waste is a concern because it can impact aquatic life and sediment quality when present in sufficient quantities. Excessive wood waste can lead to anaerobic sediment conditions (yielding ammonia and sulfides which are toxic to aquatic life), leach compounds toxic to aquatic life (e.g. phenols, benzoic acid, and benzyl alcohol), and may not provide an appropriate substrate for benthic organisms. Low dissolved oxygen has also been observed in high wood waste areas. No change to the SAP was made in response to this comment.

Appendix A
Comment Letters

DEPARTMENT OF ECOLOGY
State of Washington

Port Angeles Harbor Sediments Investigation
Public Comment Form

This form is for providing comments on the Sampling and Analysis Plan for Port Angeles Harbor. Your comments will be read by Cynthia Erickson, the Ecology Project Manager. Cynthia's response to your comments will be part of a responsiveness summary. The summary will be made public and sent to those who provided comments.

You can submit your formal comment tonight or complete it at home and mail it to Cynthia Erickson, Southwest Regional Office, Toxics Cleanup Program, PO Box 47775, Olympia, 98504-7775. E-mail comments can be sent to ceri461@ecy.wa.gov.

NAME: Daniel Lieberman

ADDRESS: 307 W. 6th St

CITY: Port Angeles, WA

ZIP: 98362

Thank you for your interest in the Port Angeles Harbor Sediments Investigation!

COMMENTS

(Please use back side of this form if you need more room)

This is an excellent opportunity for Citizen and/or Student Science. As a teacher of High School students in Port Angeles, I (and my students) would appreciate being involved in data collection or other steps of the sampling procedures beyond simply making comments during a public comment period.

Olympic Environmental Council Comments on the
Port Angeles Harbor
Sediment Characterization Study
Sampling and Analysis Plan
May 23, 2008

Summary of Issues and Recommendations

- **Tributyltin (TBT) needs to be more widely sampled in the harbor and in the tissues of fish, crabs, and clams**
- **The purpose of the bioassays needs to be more clearly defined and researchers need to acknowledge that many contaminants of concern do not adversely affect invertebrates to the same extent as other organisms**
- **Tissue samples from crabs and shrimp should also be sampled in the study**
- **Bioassay should be performed on clams and oysters to evaluate dioxins and dioxin-like compounds**
- **Perform a bioassay that runs at least one biological system through a full reproductive cycle**
- **Increase fish tissue, clam types and invertebrate sampling numbers**
- **Data on benthic invertebrate assemblage composition should be collected**
- **Ecology should provide information on the combination of Harbor conditions (toxic chemicals, hypoxia, etc.) for RA and evaluation purposes**
- **Sampling of the intertidal area needs to be performed where people use beaches**
- **Scientific literature should be reviewed along with regulatory databases for current ecological toxicity values**
- **Ecology needs to account for the combination of stressors including hypoxia in its evaluations of the harbor**

Comments on the Main Text

Overall the Work Plan addresses most of the major concerns from Rayonier activities and general harbor degradation. It delineates an appropriate spread of sampling and rightly focuses on the activities at the former Rayonier Mill. The Sampling Analysis Plan (SAP) also extends the sampling to the full harbor for characterizing conditions related to multiple activities over many decades. However, portions of the work plan need to be strengthened to include certain types of compounds and better screen samples for further analysis.

Given the long history of the harbor marine traffic, there should be at least as much emphasis on tributyltin (TBT), and related organotin compounds, as dioxins

and furans. The study is designed to evaluate both contamination from Rayonier and conditions across the harbor. TBT has been used in anti-fouling ship paint in both recreational and commercial settings for decades, and contamination from this compound is widespread in harbors across the world. It is a well documented endocrine disruptor that can cause sex changes in invertebrates at incredibly low doses (deFur et al. 1999).To accurately measure these endpoints, more sampling for TBT is needed. TBT bioaccumulates, and therefore should be examined in tissue samples. Additional sediment samples are also required. Since TBT is listed as a constituent of potential concern in the risk assessment, as many samples as possible need to be collected. There is a known interaction between TBT and polychlorinated biphenyls (PCBs) that increases toxicity (Schmidt et al. 2004), making this sampling even more critical.

Some of the samples in the central harbor area should include organotin compounds like TBT. At the very least, the samples near the anchorage in the central harbor need to include organotin on the list. In light of the organotin contamination issues, the SAP should also collect snails and evaluate organotin in tissues, or provide some comment on how this problem may be addressed in future efforts.

Section 4 explains the sediment sampling, sediment cores, bioassays and tissue sampling. The plan refers to compositing sediment samples and tissue samples. What is the plan for discrete sampling and composite sampling? Compositing samples over a large area does not provide the spatial resolution to determine if toxic chemicals accumulated in more localized areas, but only provides data on the larger areas as a unit. Samples need to be analyzed individually for chemical composition and contamination.

Sampling for fish tissue refers to collecting two ling cod fillets and two whole fish. This sample size should be increased to cover a larger area and to better represent conditions. Two fish per sampling location would be a much better approach. Why are forage fishes not sampled for the purpose of assessing uptake/accumulation of chemicals?

Section 4.1.4 discusses the tissue sampling of clams, fish and plant materials. This plan is a good start, but there is the real possibility that important information will be missed with only these two clam species and one fish, coupled with the limited range of species used in the bioassay. The tissue sampling should include samples of all other clams, combined, and at least three samples of other invertebrates as well. The reason for additional tissues is to determine the extent to which other species or groups of invertebrates serve as avenues for uptake and accumulation of chemicals into a larger segment of the trophic system. The basic biological knowledge of invertebrates is not sufficiently comprehensive that it is possible to say all species metabolize all chemicals in a similar fashion. Indeed, knowledge of fish biology provides evidence of great diversity in how toxic chemicals such as PCBs, dioxins and chlorinated pesticides are handled.

The SAP needs to be cautious about inferences concerning specific effects of toxic chemicals on the biotic assemblages based single samples of animal tissues. The issue with this line of investigation not coupled with bioassay is the exclusion of data from animals not surviving *in situ* exposure, or that are otherwise impacted but not observed in collections. If the sediments are indeed toxic to a range of animals, or cause long term harm, then the affected animals may not survive to be collected, or may suffer an abnormality that is not measured via a limited set of samples.

The harbor survey needs to collect samples of sediment for assaying benthic (bottom dwelling) invertebrate biotic assemblage composition. This information will indicate if the area is generally degraded or not. There are several excellent reviews indicating that benthic population diversity and abundance is responsive to low oxygen (Diaz and Rosenberg 1995, see volume by Nancy Rabalais) and these data should be collected.

The specific reason for the bioassays is not clearly defined, and needs to be explained in more detail. What sort of toxicity are researchers interested in determining, specifically? The SAP should state if the intent is to identify toxic responses, uptake rates of contaminants, both, or something else. At least one bioassay should investigate toxicity effects over multiple generations. This type of assay is possible with many invertebrate species and would shed important light on the long term effects of toxic chemicals in the sediment. Multi-generational effects (impacts not on the exposed generation but their offspring) have been documented in a number of invertebrates exposed to endocrine disruptors.

Bioassays must be tailored to the chemicals of concern. Invertebrates like amphipods and polychaetes do not seem to have the same receptor (Ah) as vertebrates and respond differently to dioxins and PCBs (Rice et al. 2003). Therefore, dioxin-like compounds do not exert the same influence on these organisms. Requiring a bioassay response as the prerequisite for additional analysis of archived sediments means that any limitation of the bioassay will prevent further analysis of the samples. Unless there is some compelling reason to not analyze archived samples, then these samples need to be used as a source of important information on conditions in the harbor sediments. At the very least, additional analysis should be performed if either the sediment is confirmed by bioassays to be toxic or if toxic chemicals (notably PCBs or dioxins) are detected in a corresponding surface sample.

Bivalves (clams and oysters) may be much more appropriate for bioassay work on dioxin-like compounds. Research by R. Van Beneden (University of Maine) has demonstrated toxic biochemical responses by the marine clams *Mya arenaria* and *Mercenaria mercenaria* to dioxin-like compounds. Additionally, recent research in the lab of J. Levine at North Carolina State University has demonstrated the sensitivity of freshwater bivalves to low level PCB exposure,

and similar responses may occur in marine bivalves. These two lines of investigation indicate that bivalve bioassays may be better suited to detect responses of invertebrates to dioxin and PCB sediment contamination.

Bioassays also need to include one biological system that is carried through a full reproductive cycle. Several compounds like TBT, dioxins, PCBs, bis-phenol-A (BPA), phthalates, and pesticides alter both reproductive function and structure in invertebrates. The appropriate endpoints need to be included in the assays. Including reproductive effects can be accomplished by selecting the correct assay and/or insuring that the assay extends through reproduction and assessing fertility, reproductive rates, and gonadal indices (see deFur et al., 1999 for more details).

The SAP should include assessments of the benthic invertebrate community diversity and abundance in the harbor for use in the ecological risk assessment. These samples should be collected on a transect from the inner to outer harbor using a grab sampler (van Veen, Ponar, etc.), sieved (0.45 mm) and preserved in the field and all organisms identified at least to family, if not genus and species. The purpose of these data is to assess the current condition of the benthic fauna, gauge the impact of multiple current conditions on the benthos, and estimate the food available to higher trophic levels that rely on the benthos as food. One of the consequences of the conditions in the harbor may likely be a diminished benthic biomass available as prey for benthic feeding fish, crabs, shrimp and even mammals. This reduction would be a serious risk factor in an ecological risk assessment.

Is the water in the Port Angeles Harbor clear enough to justify the intensity of light proposed in some of the bioassays in the work plan? The SAP is correct that some PAHs are activated by UV light and the opposite is true. Other organic compounds (including PCBs) are actually deactivated by UV light. Given that light does not penetrate more than a few centimeters into the sediment even in the most brightly lit of waters, this protocol may only apply to a few locations.

Table 6-6 does not clearly state the criteria of these bioassays.

Are all tissues being sampled for total PCBs, or only whole animals? Text and tables do not match descriptions. Some portions of the text refer to only 10 congeners of PCBs being sampled but Table 6-3 lists total PCBs as an analyte.

The SAP should seek to provide information on the combination of conditions in Port Angeles Harbor, hopefully for use in a risk assessment or other evaluation of the responses of the ecosystem. The harbor is stressed with both low oxygen and chemical contamination. The low oxygen is attributed to accumulation of excessive wood waste that decomposes and consumes oxygen. This condition is akin to (but not exactly the same as) eutrophication observed in many waterways around the country. Such conditions are set up by excessive nutrients fueling

biological (usually algae) growth that cannot be sustained. When the biomass dies, it sinks, decays and the decay process consumes oxygen. Presumably the wood waste decomposition fuels the process in Port Angeles. In eastern waters, the low oxygen is accompanied by production of carbon dioxide that depresses water pH, further stressing the biota. Thus, marine life in Port Angeles is exposed to chemical contamination, low oxygen, elevated carbon dioxide and low pH, all at once.

Sampling in the near shore area in front of the Red Lion Inn needs to include samples in the intertidal area, if not already contemplated. The SAP does not indicate the tidal height of these sample locations and the public use of the beach requires sampling of the intertidal area where people recreate.

Comments on Appendix D- Human Health and Ecological Risk Assessment Plan

The risk assessment appendix gives far too much discretion in selecting Indicator Hazardous Substances. It is not enough to say that compounds with “low frequencies of detection” will be eliminated. Ecology needs to select a specific value for this sort of screening for consistency.

Ecology should not just rely on government databases to establish ecological toxicity values. A review of the scientific literature should also be conducted. Many of the entries in the government databases have not been updated in many years and may not reflect the actual risks associated with compounds.

Again, the plan suffers by not referring to or collecting data for crabs or shrimp. If the analysis will rely on existing data from earlier surveys, then the SAP needs to acknowledge this approach. This omission is a problem since there are no receptors listed that actively consume larger benthic organisms and crabs are a significant component of seafood consumption for humans in the area. Shrimp forage on the bottom and are sensitive to both water and sediment quality. Notwithstanding the previous sampling efforts, crab and shrimp sampling in the harbor-wide investigation would indicate both presence/abundance and characteristics of the crustacean populations.

The Ecological risk assessment will need to account for the combined stressors of toxic chemicals, low oxygen, altered biotic community and physical disturbance from deposition of materials such as wood waste. Low oxygen (hypoxia) causes metabolic stress, limits growth, reproduction and causes mortality. Chronic hypoxia reduces the abundance or benthic fauna and changes the species composition in a predictable pattern (Diaz and Rosenberg, 1995).

References

deFur PL, M Crane, C Ingersoll, and L Tattersfield (Eds.). 1999. Endocrine Disruption in Invertebrates: Endocrinology, Testing, and Assessment. SETAC Press. Pensacola, FL.

Diaz RJ, Rosenburg R. 1995. Marine benthic hypoxia: A review of its ecological effects and the behavioral responses of benthic macrofauna. Oceanogr. Mar. Biol. Ann. Rev. 33: 245-303.

Garman G, R Hale, M Unger, and G Rice. 1998. Fish Tissue Analysis for Chlordecone (Kepone) and Other Contaminants in the Tidal James River, Virginia. Report to the Environmental Protection Agency. Center for Environmental Studies: Virginia Commonwealth University. Richmond, VA.

Nakayama K, Y Oshima, T Yamaguchi, Y Tsuruda, IJ Kang, M Kobayashi, N Imada, and T Honjo. 2004. Fertilization success and sexual behavior in male medaka, *Oryzias latipes*, exposed to tributyltin. Chemosphere. 55(10): 1331-7.

Rabalais N.N. and R.E. Turner (Eds). 2001. Coastal Hypoxia: Consequences for Living Resources and Ecosystems. American Geophysical Union. N.W. Washington D.C, USA.

Rice, CP, PW O'Keefe, and TJ Kubiak. 2003. Sources, Pathways, and Effects of PCBs, Dioxins, and Dibenzofurans. Handbook of Ecotoxicology: Second Edition. Ed. DJ Hoffman, BA Rattner, GA Burton Jr., and J Cairns Jr. Lewis Publishers. New York, NY. Pg 501-573.

Schmidt K, CEW Steinberg, S Pflugmacher, and GBO Staaks. 2004. Xenobiotic substances such as PCB mixtures (Aroclor 1254) and TBT can influence swimming behavior and biotransformation activity (GST) of carp (Cyprinus carpio). Environmental Toxicology. 19(5): 460-70.

Disclaimer:

Funding for this product was provided by a Public Participation Grant from the Washington State Department of Ecology. These materials were reviewed for consistency with the purposes of the grant only; grant funding does not constitute endorsement of opinions or recommendations expressed herein.

LEKT Comments on *Port Angeles Harbor Sediment Characterization Study Sampling and Analysis Plan* (SAP), appendices, and supporting documents.

1. Comments on SAP

Section 3.2.2

"If an analyte is not detected in any samples for a particular medium, then it will be assumed that the chemical is not present, and it will not be considered further in the risk assessment"

Will this approach be used independently for harbor areas and background areas? For example, all 17 of the dioxin and furan congeners have been detected in sediments in the harbor, but only a subset of them (5) have been detected in any sediment samples in Freshwater Bay. Would these data sets be treated differently for evaluating sample TEQ concentrations?

See Sec. 4.1.1, 4.1.2, 4.1.4

"The chemical analyte list, analytical methods, target detection limits, and comparative criteria are discussed in Section 5.1."

These are not discussed in Section 5.1; the reference should be to Section 6.1

Section 5.1 line 5 Page 67

Change the parenthetical reference "and set line fishing for the lingcod" to divers will be used to collect lingcod.

Section 8.1

"Non-detected values will be assessed as half of the sample reporting limit for data evaluation purposes, except for compliance calculations, which will be assessed as zero"

Can you explain this concept a little more? What are "data evaluation purposes"? Will the procedures described in Section 3.2.2 (discussed above) be employed when a particular analyte has not been detected in a particular medium? If non-detects will be assessed as zero for compliance calculations, getting adequately low detection limits for dioxins and furans will be critical.

2. Comments on SAP Appendix D

Section 2.2.6, p. 7

The whole first paragraph reference to the Shea et al. 1981 is incomplete and misleading. The Shea report states starting on the bottom of page 463 and continuing to page 464:

> **"It is clear that a definite possibility exists that the plume separates into distinct components while in the near field region, and that certain of these components may travel in the subsurface waters, or precipitate out onto bottom sediments. Unfortunately, neither laboratory (separation and settling experiments) nor field (detailed subsurface and sediment sampling) studies have been carried out to investigate this phenomenon. It is important to note that the separation of the plume into components implies the possibilities that 1) toxic components may be present with little or no detectable SSL and 2) that toxic components may be carried by subsurface currents to areas much different than those indicated by surface current analysis."**

The net flow in the harbor is in question and no conclusive studies have been done to map the bottom currents in the harbor, which we contend are significantly different than the surface currents. Our contention is based on observations in the harbor during dives, and they indicate that the bottom currents within the harbor are consistently clockwise and that this is unaffected by the tidal changes. It appears that the harbor bottom currents are more affected by fluid dynamics and the harbor shape than anything else. Malcom Pirnie's conclusions are conjecture and are not supported so we don't believe it is appropriate to use their statements.

Section 3.3.1.4

"The reference area for this investigation is Dungeness Bay. Site-specific background samples from Dungeness Bay will be used to compare reference and site investigation data, as appropriate. Additional discussion of the use of any reference data will be provided in the risk assessment report."

The use of an area for reference sediment samples (as defined in the SMS) and as site-specific background, which may be the basis for setting cleanup levels, are not exactly the same thing. Is Dungeness Bay sediment intended to be used for both purposes? (See also comment below on SEIDG Sec. 3.1.3)

Section 5.4.1.4, p. 36

The harbor seal is an opportunistic feeder and is not limited to bottom-dwelling fish,

invertebrates and pelagic species. They also eat clams and crab, both of which are plentiful and known to be significant bioaccumulators of PCBs and dioxins in Port Angeles Harbor.

FOOD PREFERENCES AND RESOURCES :

1. Adult harbor seals eat squid, crustaceans, molluscs, and a variety of fish; including, rockfish, herring, flounder, salmon, hake, and sand lance.

2. A harbor seal's diet varies seasonally and regionally and often is subject to local prey availability. "Harbor seals don't chew their food. They swallow their food whole or tear it into chunks. With their back molars, they crush shells and crustaceans."

SeaWorld/Busch Gardens Animals

"The harbor seal diet varies seasonally and regionally. They primarily feed on crustaceans, mollusks, squid, and fish. The food is torn into chunks swallowed whole. The molars crush shells and crustaceans for swallowing, but food is generally not chewed. Adults consume 5-6% of their body weight or 4 to 6 kg of food per day. The diet of Ungava seals has not been well studied, but they are known to prey on salmonids such as small Brook trout, feeding usually takes place near the shore in shallow water they dive to over 200m deep, most often 100m for periods of a few minutes. However, harbor seals have sometimes been known to dive more than 500m for more than 25 minutes."

***/Phoca vitulina/* , Harbor Seal - MarineBio.org. Retrieved Wednesday, April 30, 2008, from http://marinebio.org/species.asp?id=158.**

3. Comments on *Summary of Existing Information and Identification of Data Gaps* (SEIDG) *Report*

Section 3.1.3, p. 3-5

"Dungeness Bay is considered an appropriate reference area for dioxins in Port Angeles Harbor, as it has some of the lowest dioxin/furan concentrations sampled to date in the Strait of Juan de Fuca or Puget Sound"

Dungeness Bay was one of two background locations used in the Marine RI and Phase II Addendum sampling events; the other was Freshwater Bay. The Freshwater Bay location was added at the Tribe's request, as certain information existed (see Shea et al., 1981) that indicated Dungeness Bay may be within the area

of influence of historic mill effluents. There do appear to be differences in sediment concentrations for both dioxins/furans and PCBs between these two locations. Concentrations of both dioxin TEQ and total PCBs are consistently lower in Freshwater Bay than in Dungeness Bay. Mean TEQ concentrations, based only on detected values, were more than 20 times lower in Freshwater Bay as compared to Dungeness Bay; mean TEQ concentrations, treating non-detects at half the detection limit, were three times lower at Freshwater Bay; and mean total PCB concentrations were four to five times lower in Freshwater Bay. (Note: at the 90th percentile [the value used for establishing background] the difference in values for these two locations is even greater.) For dioxins/furans, only 5 of the 17 congeners were detected in any sediment samples from Freshwater Bay, while 13 of 17 were detected at Dungeness Bay.

The Tribe continues to assert that Freshwater Bay is a more appropriate location for determining background sediment concentrations.

Section 3.1.2, p. 3-5

"Concentrations for PCBs and dioxins/furans in tissue at the site increased from initial sample collections of the RI. This was most likely due to changes in tissue separation methodology and labs reporting lower detection limits for sediment."

While there were some differences in tissue separation methodologies, specifically for horse clams and geoduck, we believe there are other explanations for increased concentrations. The highest detected concentrations of dioxins/furans from around the Mill site were found in log pond sediments. This area was traditionally used for rafting logs and was also the location of one of the historic nearshore outfalls. Following closure of the Mill, log rafting ceased in this area, and the existing log booms and part of the existing jetty structure were removed. This immediately resulted in significant erosion within the log pond and the adjacent shoreline. In fact, one of the first actions that Rayonier took following site deferral was an emergency action to armor the log pond shoreline to address this issue.

In 2000, Rayonier's consultant conducted a survey of the log pond area, including collecting 6 sediment samples that were analyzed for dioxins and furans. The total TEQ for these samples ranged from 20 to 90 ppt, with an average concentration of 50 ppt (and an average TOC of more than 20%). During sampling for the Marine RI (2002), which was more extensive, TEQ concentrations ranged from 0.6 to 53 ppt (with an average of less than 10 ppt). Finally, during sampling conducted for the Phase II RI Addendum (2006) TEQ concentrations ranged from 0.4 to 46 ppt. Between these successive events, dioxin concentrations, as well as woodwaste accumulations have decreased significantly in all but the most protected areas of the log pond. We believe that if this material was re-suspended due to erosion, and available to be taken up by organisms in the harbor, this may be one explanation for increased concentrations.

Among the most significant increases between the RI and the Phase II sampling events were concentrations of dioxins/furans in Dungeness crab. There were not changes in tissue separation methodologies for Dungeness crab samples, and the increased concentrations are evident in samples analyzed by the same laboratory using the same analytical procedures. Also, it is not apparent that lower detection limits for sediment had any effect on increasing concentrations in tissue.

Section 2.1, Paragraph 2

"Prior to the advent of the CWA, untreated process effluent from the mill facilities was discharged to the harbor through the early 1970's (table2) (Shea et al. 1981). After passage of the CWA, industrial wastewater discharges to the harbor from mills required treatment. Pulp and paper mill treated effluents continue to be discharged in to the harbor until 2008…"

We are not aware that any pulp and paper treated effluents were discharged into the harbor subsequent to the closure of the Rayonier Mill. What treated pulp effluents are being discharged into the harbor currently? Nippon discharges pulp and paper effluents outside of the harbor; Fiberboard has been closed for decades; and Rayonier has been closed for nearly a decade now. K ply wasn't a pulp or paper mill and had no documented waste effluent discharge. We know of no other sources in the harbor, if there are we would be interested in their location and identity.

Section 3.2.1.1

"Nippon, formerly Diashowa and Georgia Pacific, still operates a large mill on the western end of the Harbor at the base of Ediz Hook. Process wastewater was discharged into the Harbor until the 1960s, at which point a new discharge pipe was built that redirected effluent to the Strait of Juan de Fuca."

1) Nippon has only had two previous owners according to records, one was Diashowa and the other was Zellerbach who founded the mill in 1921.

2) the waste stream for Zellerbach was split before the 1960's, according to a report: ***Investigation of pollution in Port Angeles area; summer, 1957, Washington Pollution Control Commission***

> **"Crown Zellerbach, Inc. Located on the north side of the closed end of the harbor, the Crown Zellerbach integrated mill produces approximately 450 tons of ground wood and 95 tons of sulfite pulp daily. About 12,000,000 gallons of water are used per day in the production of pulp and paper. Pulping process wastes are discharged on the Straits side of the mill; wastes from the paper mill are discharged on the harbor side. ... A recently constructed**

lagoon system effectively reduces solids losses from hydraulic barker wastes." (emphasis added)

So it appears that Zellerbach was more knowledgeable about waste streams than Rayonier, discharging the pulping process wastes outside of the harbor, so their dioxin should have been dumped on the outside of the harbor, not in it. We wouldn't want chemical contamination from the pulping process blamed on Nippon or their predecessors if they didn't contribute to them.

Comments provided by:
Larry Dunn, LEKT
Bill Beckley, RIDOLFI Inc.

From: Eycke Strickland [mailto:eycke1@olypen.com]
Sent: Sunday, May 18, 2008 4:31 PM
To: Aoyagi, Hannah (ECY)
Subject: Public Comment PA Harbor

Dear Dr. Aoyagi,

I believe that the Olympic Environmental Council has done an exhaustive study of the strength and gaps of the plan to clean

up our harbor. I therefore add my voice to theirs: See the talking points below:

Respectfully submitted.

Eycke Strickland

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PLAN STRENGTHS

•Overall the Work Plan is good.
•It calls for an appropriate spread of sampling and rightly focuses on the activities at the former Rayonier Mill.

PLAN GAPS

•Omissions of certain types of compounds and screening of samples for further analysis.
• More sampling for tributyltin (TBT) is needed.

•Because of the Harbor's heavy marine industry, more sampling of TBT should be done.

TBT builds up (bioaccumulates) in tissue samples and is listed as a constituent of potential concern in the risk assessment, so as much data as possible needs to be collected.

•Interaction between TBT and polychlorinated biphenyls (PCB) increases toxicity making this sampling critical.

•The specific reason for the bioassays is not yet clearly defined.

• What toxicity are researchers interested in specifically?

• At least one bioassay should investigate toxicity effects over multiple generations.

Multi-generational effects have been documented in a number of invertebrates exposed to endocrine disruptors such as PBTs. This is possible with many invertebrate species and would shed important light on long term effects of toxins in the sediment
•Bioassays must be tailored to the chemicals of concern.

•Amphipods and polychaetes do not contain the receptor to uptake dioxins and PCBs. Therefore they do not exert the same amount of influence on these organisms. Making this the requirement for additional analysis of archived sediments is unnecessary.

•Without supporting evidence, there is no reason that all archived samples shouldn't be analyzed. At the very least, additional analysis should be performed if either the sediment is confirmed by bioassays to be toxic or if PCBs or dioxins are detected in a corresponding surface sample.

Is the water in the Port Angeles Harbor clear enough to justify the intensity of light proposed by the work plan?
UV light deactivates most organic compounds (including PCBs). Given that light does not penetrate more than a few centimeters into the sediment even in the most brightly lit of waters, this protocol seems unnecessary.
Are all tissues being sampled for total PCBs?
Text and tables do not match descriptions. Portions of the text refer to *only* 10 congeners of PCBs being sampled, but Table 6-3 lists *total* PCBs as an analyate.

Table 6-6 does notclearly state the criteria of the bioassays.

Comments on Appendix D
Human Health and Ecological Risk Assessment Plan
The risk assessment appendix Indicator Hazardous Substances.
Ecology should select a *specific value* for hazardous substances for screening consistency, rather than saying compounds with "low frequencies of detection" will be eliminated..
Ecology should not just rely on government databases to establish ecological toxicity values.
A review of the scientific literature should also be conducted. Many of the entries in the government databases have not been updated in years and may not reflect the actual risks associated with compounds.
Sampling crabs should be included.
Crabs are a significant component of human seafood consumption in the area and there are no receptors listed that actively consume larger benthos organisms.

Rayonier

Corporate Headquarters

May 28, 2008

Ms. Cynthia Erickson, Project Manager
Washington Department of Ecology
SWRO Toxics Cleanup Program
P. O. Box 47775
Olympia, WA 98504-7775

Re: Port Angeles Harbor Sediment Characterization Study: Sampling and Analysis Plan

Dear Ms. Erickson:

Rayonier appreciates the opportunity to comment on Ecology's proposed Sampling and Analysis plan ("Plan").

As a threshold matter, Ecology proposed the additional sampling presented in the draft Plan for the "Rayonier Area" in a January 9, 2008 letter to the company. Our response then and now is that further sampling in the "Rayonier Area" is unnecessary because sufficient sampling and characterization has been completed to complete the feasibility study and prepare a cleanup action plan. EPA sampled and studied sediments in the Harbor in 1999. In 2002 and 2006 Rayonier performed two extensive sediment studies including preparation of a marine remedial investigation and ecological risk assessment under Ecology Agreed Order DE02SWFAPSR-4570.

We have raised and documented our objections and reasoning in previous letters and at a meeting with the Toxics Cleanup Program staff on March 14, 2008. Yet, Ecology continues to assert that the former mill area is not adequately characterized. After 159 samples collected in three separate sampling events, this Plan proposes to collect another 122 samples in the same areas previously sampled for a total of 281. At the same time, only 143 samples are proposed to characterize the "Harbor-wide" sediments – an area over three times as large as the "Rayonier Area."

We have provided technical comments from Malcolm Pirnie, Inc. on the specific content of the Sampling and Analysis Plan, as enclosed.

Sincerely,

Carla E. Yetter
Director, Environmental Affairs

50 N Laura Street • Jacksonville, FL 32202
Telephone (904) 357-9100 • Fax (904) 357-9101

Comments on the Sampling and Analysis Plan for the Port Angeles Harbor Sediment Characterization Study, Port Angeles, Washington (Ecology 2008a)

1. The amount of sampling and analyses proposed in the SAP (Ecology 2008a) is unnecessary to accomplish the goals as set forth in Section 2.3.

Previous Sampling

The "Rayonier Area" has been sampled and characterized multiple times; first by EPA in 1999, and then later is two separate studies by Rayonier in 2002 and 2006. The results of the proposed sampling may add data to an already abundant database, but is unnecessary to conduct a feasibility study and will not change the selected remedy as would be reported in the cleanup action plan for the area around the former Rayonier Mill. 159 samples have already been collected and analyzed and this study proposes an additional 122 samples taken over the same area.

Precedents:

Previous investigations by Ecology and EPA Region 10 in coordination with Ecology have finalized cleanup action plans and records of decision with substantially less data than this document proposes to collect around the former Rayonier Mill. For reference, see:

- EPA 2000. Asarco Site, Tacoma, Washington. Record of Decision.
- EPA 1999. Pacific Sound Resources, Seattle, Washington. Record of Decision.
- EPA 2000. Puget Sound Naval Shipyard, Bremerton, Washington. Record of Decision.
- Ecology 2001. Concentrations of selected chemicals in sediments from harbors in the San Juan Islands. Publication No. 01-03-007. Washington State Department of Ecology. March.
- Ecology 2000. Concentrations of chemical contaminants and bioassay response to sediments in Salmon Bay, Seattle: Results of phase III sampling. Publication No. 00-03-053. Washington State Department of Ecology. December.
- Ecology 2000. Reconnaissance survey of inner Shelton Bay harbor sediments. Chemical screening of nearshore sites and evaluation of wood waste distribution. Publication No. 00-03-014. Washington State Department of Ecology. May.
- Ecology 1999. Lower Budd Inlet sediment characterization study. Midwest site evaluation and chemical screening of selected point sources. Publication No. 99-305. Washington State Department of Ecology. February.
- Ecology 1999. Grays harbor estuary sediment evaluation. Chemical screening and station cluster analysis of selected locations. Publication No. 99-300. Washington State Department of Ecology. January.
- Ecology 1999. Investigation of chemical contamination at Whitmarsh landfill and Padilla Bay lagoon. Publication No. 99-306. Washington State Department of Ecology. February.
- Ecology 1997. Survey of petroleum and other contaminants in the sediments of Fidalgo Bay. Publication No. 97-338. Washington State Department of Ecology. November.
- Ecology 1996. Chemical contaminants in Salmon Bay sediments. Publication No. 96-343. Washington State Department of Ecology. November.

Sediment cores:

One-foot interval cores (as proposed in SAP Sections 4.1.2 and 4.2.2) are not required for determining subsurface exposure to chemicals that are in the sediments below the biologically active zone[i]. Subsurface exposures to human receptors will be unlikely to occur except in the intertidal areas where clams may be present and people may dig

below the surface In this exposure scenario, people are not exposed to discrete intervals during harvesting activities. This is particularly true assuming the exposure occurs over a period of years and a variety of areas within an intertidal zone for the harvesting of several species. In practice, data collected at discrete subsurface intervals are averaged together when risk assessments are performed to represent an upper bound estimate of the average exposure. This estimate can be as precise using larger core intervals, thereby reducing the number of samples required Many of the proposed sampling locations are depositional and subtidal. Human exposure to chemicals in sediments from these areas below the biologically active zone would be *de minimus* since access to these sediments would require divers wearing wet/dry suites and special breathing apparatus given the cold water temperatures characteristic of the region.

The biologically active zone for sediments is generally considered to be the top 10 cm. This corresponds with the presence of dissolved oxygen which is required for biological activity. While some organisms may exist below this interval, such organisms (e.g., horse clams, geoducks) have evolved adaptations to feed in the oxygenated layer and, therefore, the exposure to the chemicals occurs at there. Dermal exposure to subsurface bivalves is assumed to be minimal since the shell encloses and protects the siphon, and the external surface of the siphon protected by a relatively impermeable layer.

One-foot interval cores are not required for evaluating remedial alternatives. Dredging typically occurs within a tolerance of 18" intervals. In areas like the log pond near the former Rayonier Mill where the depth to glacial till appears to be three feet, one foot intervals are unnecessary for evaluating cleanup options In areas where more than three feet of sediments overlay glacial till, a larger interval of sampling could delineate the contaminant layer while significantly reducing costs.

The samples proposed for delineating wood debris around the former Rayonier Mill (SAP Section 4.2.2) are unnecessary since the wood debris has been characterized adequately for the purposes of developing a cleanup action plan by the following:

- Ecology led wood waste study in Port Angeles Harbor (SAIC 1999)
- Diver survey and video of the log pond (Foster Wheeler 2001)
- Summary of 29 surface samples collected from the log pond, 41 surface samples collected from around the mill dock, and characterization of 22 cores collected from the log pond and mill dock areas (see the former Rayonier Mill Marine Remedial Investigation (MRI) Section 6.2 – Sediment Physical Characteristics, MRI Table 6-1 for sample descriptions, Phase 2 MRI Section 3.2.2 – Sediment Cores, Appendix A – Sample Collection Forms, Appendix F – Sediment Sample Photo Log, and Appendix H – Sediment Core Processing Logs (Malcolm Pirnie 2007ab)).

Sediment Bioassays

Ecology and the Lower Elwha Klallam Tribe (LEKT) agreed to a sampling program to characterize risks around the former Rayonier Mill Site which included 15 bioassay test locations[ii]. All three of these previous bioassay tests performed around the mill dock

failed to identify risk. Therefore, additional bioassay testing in the vicinity of the mill dock is unnecessary. Furthermore, additional sampling in the log pond will not further delineate the area requiring remediation since only one sample is proposed and previous samples already indicated the need for remediation. Given that sediment investigations around the deepwater outfall have shown no SMS numeric exceedances or the presence of wood waste, further bioassay testing in this area is also unnecessary

Section 4.2 – There is no sub-section in this section that discusses the bioassay samples that are intended for collection and analyses.

Ennis Creek

Interim removal actions were performed at the former Finishing Room between August 9th and 12th 2002[iii]. As part of this action, soil and sediment samples from banks and streambed of Ennis Creek adjacent to the removal area were characterized for total petroleum hydrocarbons (TPH) and PCBs.

At the completion of both the Finishing Room removal action and the MRI for the former Rayonier Mill sediment sampling, two sediment samples were collected from the alluvial fan of Ennis Creek just north of the bridge. Analytical results showed that PCBs were not detected and TPH concentrations were below levels of concern[iv].

As part of the characterization of the Mill Dock area during the MRI, 12 surface sediment samples were collected between August 15th and 20th 2002[v] and analyzed for PCBs. In September 2006, an additional 16 surface sediment samples were collected east of the Mill Dock as part of the MRI Phase 2 Addendum[vi]. Collectively we believe these data support an adequate characterization of both PCBs and TPH in the marine environment related to operations of the former mill.

Figure 4-9. Sample locations "EC02", "EC03", and "EC05" appear to be terrestrial although presumably they are intended for collection in Ennis Creek. If this is the case the water of Ennis Creek as shown on the figure should be extended to cover these locations.

Section 6.2 – For the two samples in Ennis Creek where bioassay testing is proposed, salinity conditions may required toxicity testing with freshwater species. Additional reference sediments from similar freshwater areas may also need to be collected

Appendix D – Human Health and Ecological Risk Assessment

The ecological risk assessment CSM, sampling, and analyses as proposed in Appendix D is substantially duplicative of the work already provided to Ecology and is unlikely to provide information that would result in a different cleanup action. With respect to bioaccumulation, the additional modeling proposed uses largely the same receptors and any small variation in receptors (wildlife species) are nothing more than a theoretical change in a mathematical model and would not represent a "different" evaluation of these specific species than could be extrapolated from the previous assessment. Additionally, many of the tissue samples already collected and reported for the harbor (e.g., shrimp,

fish, crab) integrate exposure to harbor-wide contaminants spatially as both the receptor and the sediment-borne chemicals move throughout the harbor

Appendix D, Section 2.2.7, Fish, 5th ¶, 2nd sentence – "East" Hook should be changed to "Ediz" Hook

Appendix D, Table 5-1 – Information presented in the "Measures", "Data Needs", and "Are recent data available" columns of the table appear to be switched for carnivorous birds, omnivorous birds, and herbivorous birds. The information for omnivorous birds should be move to herbivorous birds, the information for herbivorous birds should be moved to carnivorous birds, and the information for carnivorous birds should be moved to omnivorous birds. The information in this table should match the narrative description provided in Section 5.4.1.

Appendix D, Section 5.4.2, Exposure equation – Exposure Duration (ED) is not a term commonly used in exposure modeling for wildlife receptors.

2. Analytical Chemistry Approach –

The QA/QC plan identifies Sediments and Tissue Reporting Limits in units of pg/Kg. We are unsure if this is a typo and was meant to be (ppt) or not. The unit pg/Kg is femtogram levels and describes reporting limits about a 1000 fold lower than published methods.

Assuming the plan meant pg/g, the levels noted will likely result in sediment validation issues as a result of instrument calibration for both PCBs and Dioxins in sediments as a result of the range of concentrations that will be detected for the specific congeners. For example, OCDD may be detected at concentrations above 1000 ng/Kg while 2,3,7,8-TCDD may be detected at levels of 0.01 ng/Kg in a sediment matrix. The instrument cannot be calibrated to meet the QA/QC requirements of EPA method 1668A for such a large range of concentrations. The plan does not specify if multiple runs are, therefore, proposed for each sample, and if so how biases associated with splitting the sediment samples for different dilutions and instrument runs will be interpreted in calculating the 2,3,7,8-TCDD TEQ for both PCBs and TCDD.

3. Absence of Information to Allow for Review –

In general we find the level of detail provided in several aspects of the SAP (Ecology 2008a) to be insufficient to allow for review and comment.

Fingerprinting

SAP Page 106. 3rd full Paragraph. In discussing the fingerprinting analyses, the text states that TPH, dioxins/furans, and PAHs will be evaluated from potential source areas, but notes: "...to provide qualitative screening for guidance regarding the utility of the data for source differentiation" and "quantitative evaluation of the data on a statistically significant basis will likely not be possible." Given the implications of any conclusions drawn from these data sets, Ecology should consider conducting these analyses in a

definitive approach stating clearly the methods for both collection and interpretation thereby facilitating a final path forward for Harbor cleanup.

Bivalves

Section 5.4, 2nd ¶, last sentence – Ecology should clearly state what is meant by "edible tissues" of clams. Since the risk assessment intends to evaluate multiple human receptors, Ecology needs to collect data that allows chemical exposure to be calculated for these different receptors. The bivalve siphons sheath, gut ball, and tissues inside the shell are not consumed by every receptor. Previous analyses showed that the majority of the chemicals in the bivalves, and, therefore, human exposure and excess risk would occur for only those receptors that consumed the gut ball. Thus, if the gut ball is not analyzed separately, the risks to shellfish harvesters following the preparation methods detailed at the Washington State Department of Wildlife's web site will be extensively overestimated as the gut ball is instructed to be discarded. Additionally, the siphon's sheath is composed of several metals which occur naturally in an organic form. However if the specific form of the metal is not quantified and the sheath is included as an edible tissue, significant risks may be erroneously determined following standard risk methodologies. Thus, there is insufficient information in the plan to know what exactly is meant by "edible tissues" and what specific forms of metals may be analyzed prevents agreement and suggests an inappropriate screening level approach which will raise additional questions requiring yet further investigation and thus slowing down the cleanup process.

Radioisotope Analyses in Cores

Section 4.1.2.2 –It is unclear what sampling apparatus will be used for the collection of these cores. A vibracore, through its shaking action will mix the top sediment intervals and hinder the delineation of the radioisotopes and chemical analytes. Furthermore, the core catcher apparatus may additionally disturb the sediment as it is being collected by transferring sediments along the sidewall from upper to lower layers. This will bias and confound radioisotope interpretation.

Section 5.3.2, 2nd ¶, general procedure #9 – The cores intended for radioisotope testing should be maintained in a vertical position while being shipped to the lab for processing so that the 2 cm intervals are not inadvertently mixed. This may be an unreasonable expectation given the cores will be shipped to Winnipeg, Manitoba, Canada.

Section 4.2.2, 1st ¶ – For clarity, as was done for the Harbor-wide investigation in Section 4.1.2, a substructure to this section should be provided that discusses the rationale for why these cores are collected and the differences in collection and analyses between the 4 ft cores and 12 ft cores. If the approach and analyses are the same as section 4.1.2, this section can be referenced rather than repeating the text.

Current Meter Study

In Malcolm Pirnie's meeting with Ecology on April 15, 2008 we learned that Ecology has initiated a current meter study in Port Angeles Harbor to supplement the data being collected as part of the Sediment Trend Analysis Implementation Plan (Ecology (2008a)

SAP Appendix E). This aspect of the study was not discussed in the SAP and, therefore, cannot be reviewed and commented on.

Core Intervals and Archiving

Sections 4.1.2 and 4.2.2 – The statement "based on sampler judgment" should be more clearly defined with regard to selecting sediment core intervals to represent individual samples. Without an objective and clearly defined set of criteria, a reviewer can not agree or disagree with the plan. Additionally, given the scope of sampling proposed, it is unlikely that the same person will collect and process each sample and, therefore, sampler bias can be introduced and be inconsistent between samples.

Section 4.2.2, 4th ¶, last sentence – The text is unclear. The depth of the first interval needs to be clarified.

Change Order

It is anticipated that from the large scope of the sampling plan, particularly the sediment core collection, that changes to the plan will need to be made by field personnel. The process for approval of these field change decisions is incompletely described in the SAP other than reference in SAP Appendix C (Standard Operating Procedures), Section 2.2 (Work Plan Changes/Deviation) which indicates that these changes will be documented in the field log book.

4. Other General Comments –

Section 4.2, last sentence – Reference to Figure 2-4 should be changed to 4-9, since there is no Figure 2-4.

Section 5.3, 3rd sentence – This sentence states that Table 5-1 lists the samples that will be collected , but no sample IDs are provided in this table. Also, bioassay sample information is excluded from this table.

Section 7.3.1 – There are additional performance criteria for the juvenile polychaete test: a mean individual growth rate of at least 0.72 mg dw/ind/day with a minimum individual growth rate of 0.38 mg dw/ind/day. However, rather than repeat these performance standards the reader could be referenced to Section 6.2 for performance standards as was done in section 7.3.2.

References

Ecology. 2008a. Port Angeles Harbor Sediment Characterization Study Sampling and Analysis Plan. Washington State Department of Ecology. Contract Number C0700036. April 25.

Ecology. 2008b. Letter dated January 9, 2008 from Marian L. Abbett, Washington State Department of Ecology to Carla Yetter, Rayonier Properties, LLC regarding Ecology

Comments on the Remedial Investigation for the Marine Environment, Port Angeles Rayonier Mill Site.

Malcolm Pirnie, Inc. 2007a. Remedial Investigation for the Marine Environment Near the Former Rayonier Mill Site, Port Angeles, Washington. Public Review Draft. February.

Malcolm Pirnie, Inc. 2007b. Phase 2 Addendum Remedial Investigation for the Marine Environment Near the Former Rayonier Mill Site, Port Angeles, Washington. Agency Review Draft. February.

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[i] From Ecology 2008. Sediment sampling and analysis plan appendix. Guidance on the development of sediment sampling and analysis plans meeting the requirements of the sediment management standards (Chapter 173-204 WAC) (Ecology publication No. 03-09-043):
" In SMS situations, the exposure potential and sediment unit of concern is generally the surface, specifically the **"biologically active zone" (often the top 10 cm)**." (page 11)
"Past studies in Puget Sound have demonstrated that the majority of benthic macroinvertebrates are generally found within the **uppermost 10 cm of the sediments**. While some species may be found at deeper depths below the sediment surface, **10 cm is generally assumed to represent a reasonable estimate of the biologically active zone**. Although information such as the vertical distribution of benthic macroinvertebrates or the depth to anoxic sediments could be gathered for each site to be investigated to attempt to delimit the biologically active zone, **this procedure is generally not practical**. In the absence of site-specific information to the contrary, **Ecology has routinely been requiring sampling of the uppermost 10 cm of sediments** for comparisons with the applicable criteria." (page 47 and 48)

[ii] Foster Wheeler Environmental Corporation. July 2002. Management Plans for the Remedial Investigation of the Marine Environment, Former Rayonier Pulp Mill, Port Angeles, Washington Volume I, Section 3, Page 3-32 identifies the following: 4-methylphenol, LPAHs, HPAHs, dioxins and furans, PCBs, resin and fatty acids, guiacols, arsenic, cadmium BHC isomers, PCBs, pentachlorophenol, Pyridine, copper, mercury, selenium, zinc, 2,4' DDT, DDE, and DDD

[iii] Based on confirmation samples collected on these dates as reported in Table 5-2 and the dates of sediment monitoring as reported in Table 5-4 of the Interim Actions Report.

[iv] Diesel range organics (DRO) were not detected and residual range organics (RRO) were detected in both samples at concentrations of more than an order of magnitude below the cleanup level (see Interim Action Report Table 5-4).

[v] With the exception of MD-16 sampled in August 6, 2002 and located under the mill dock.

[vi] One of the phase 2 addendum samples was collected from the same location where the PCB exceedance was found in the 2002 RI sampling.

NIPPON PAPER
INDUSTRIES USA

May 29, 2008

Cynthia Erickson
WA Department of Ecology
PO Box 47775
Olympia, WA 98504-7775

RE: Comments on Draft Sampling and Analysis Plan
Port Angeles Harbor, April 25, 2008

Dear Ms. Erickson:

Nippon Paper Industries USA thanks the Department of Ecology for the opportunity to provide comments on the Draft Sampling and Analysis for the Sediment Characterization of Port Angeles Harbor. We commend the Department for the active and thorough role they have taken in investigating the environmental condition and addressing technical issues in the harbor. We are pleased to be able to submit these comments and look forward to working with the Department not only in facilitating the investigation effort but on important matters of concern to our company.

In general the Sampling and Analysis Plan (SAP) is quite comprehensive and thorough in areal extent and data types. Since Ecology has diligently covered the bases our comments are quite focused on potential limitations that could impact data analysis.

1. Limited Dioxin/Furan Source Analysis

There is an under-emphasis on dioxin/furan analysis in areas with active combined sewer outfalls (CSOs). This will limit the understanding of source contributions of these compounds in the harbor. For example, the sampling and analysis plan (SAP) lists only "current CSOs" in the Landing Pier (Ferry Terminal) area of concern (AOC) as potential sources of interest (Table 4-4), which includes active CSOs #6, 7, and 8. However, there are no dioxin/furan samples for the Landing Pier (Ferry Terminal) AOC included in the sample location summary (Table 4-3). Sediments adjacent to CSO #10 are also not specifically listed to be sampled for dioxin/furan analysis. Additionally, the one other outfall area listed, the Port Angeles Waste Water Treatment Plant Outfall, does not include any dioxin/furan analysis, and only one sample has been proposed for collection within this AOC. Dioxins/furans are associated with CSOs, storm water overflows, and water pollution control facilities, and analysis of them should be included for a full understanding of the multiple possible sources of these contaminants in the harbor. The E&E data gaps report (2008) also does not include dioxins/furans as chemicals of concern associated with residential activities. Dioxins/furans are commonly associated

with backyard burning and other residential/anthropogenic activities. The under-emphasis of the dioxin/furan sampling at these other locations biases the outcome of the dioxin/furan source data by not including all possible (and common) sources of dioxin/furans to the harbor. As outlined in the SAP, only former CSO locations will be analyzed for dioxin/furans (inner harbor area, former CSO Outfalls #2 and #4), which does not provide a current estimate of dioxin/furan inputs from all CSO sources.

2. Representativeness of Radioisotope Dating Cores

The two sediment cores proposed to be collected for sediment age-dating and mixing are not likely to be representative of the entire harbor area. The results from locations in the northern section (i.e., Marina Area) and the southern section (i.e., Red Lion Area) of the harbor cannot be applied to the inner harbor area or other areas of the harbor where the bathymetry or currents alter sedimentation/mixing rates. The data from the proposed core locations may result in a skewed analysis of sediment accumulation in the harbor. It may be difficult to get sufficient Cs-137 and Pb-210 data using only 4 ft sediment cores, and, although the proposed locations are not within the documented wood waste areas, there may be wood pulp presence and gelatinous silt deeper than 4 ft.

3. Alternative Sampling for Fish Samples

There are no alternative plans included in the SAP in the event that no lingcod are caught. It is unclear whether Ecology will attempt to collect different fish species for chemical analyses if they cannot catch lingcod. In light of the current fish consumption issues and discussion about potentially changing the current Model Toxics Control Act default values, the four proposed sampling locations for fish tissue collection are important. There should be consideration for including pelagic as well as benthic fish species and additional biota samples, if necessary. Benthic and pelagic tissue concentrations will most likely become a critical component of the risk assessment.

4. Use of Full Spectrum Lighting

Ecology's approach of using full spectrum lighting for "most" of the bioassays may result in a high bias of toxicity in the bioassay samples. Selected PAHs become more toxic when exposed to UV light (i.e., photo-activation) and UV light penetrates only to a depth of approximately 12 ft. Many of the sampling locations are in water depths greater than 12 ft deep, even near-shore samples. The bathymetry of the inner harbor area indicates a steep drop-off relatively close to shore. The high-bias of toxicity in the bioassay samples will result in more chemical analysis from archived samples. Although not outlined in detail in the SAP, the inclusion of full-spectrum lighting for the bioassays should only be included when the measured water depth at the time of sediment sampling is less than 12 ft deep.

5. Appendix D, Human Health Ecological Risk Assessment Work Plan

Paragraph 2.2.1 History, refers incorrectly to pulp and paper mill discharges to the harbor continuing to 2008. Nippon Paper constructed a deep water outfall in 1971 that

discharges towards the northwest on the outside of Ediz Hook. The Rayonier mill ceased pulping operations on or about February 28, 1997.

Paragraph 2.2.2 Demographics and Land Use should recognize that throughout development of the marine harbor and the City of Port Angeles various infrastructure has been created that impacts intertidal uses. Structures such as wharfs, piers, a marina and shoreline armoring have changed the natural environment. Specifically, these developments may have impacts upon habitat productivity and type of biota available and may continue to impact biota availability for the foreseeable future.

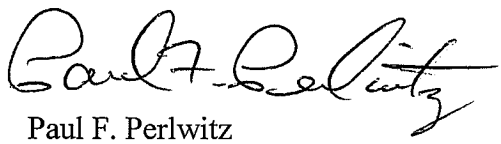
6. Data Needs for the Human Health Risk Analysis.

There is a need for a current, independent shellfish habitat assessment and survey to be conducted to evaluate the locations and quantity of shellfish beds in Port Angeles Harbor. This information could be used to determine whether a havestable and sustainable shellfish resource exists to support the proposed LEKT fish consumption rate.

There is no current plan included in the SAP for a shellfish habitat survey, despite the inclusion of a conceptual site model for human receptors in the Human Health and Ecological Risk Assessment Work Plan (Appendix D), which includes subsistence fishing by the LEKT.

My contact information is paul.perlwitz@npiusa.com and 360-565-7045.

Sincerely,



Paul F. Perlwitz
Environmental Manager

cc: Rebecca Lawson, Dept. of Ecology
Harry Grant, Riddell Williams
Mark Johns, Exponent

May 29, 2008

Cynthia Erickson - Project Manager
WA Department of Ecology
SWRO Toxics Cleanup Program
P.O. Box 47775
Olympia, WA 98504-7775
E-mail: ceri461@ecy.wa.gov

RE: Port Angeles Harbor Sediment Characterization Study: Draft Sampling and Analysis Plan

To Ms. Erickson,

We are writing to comment on *Port Angeles Harbor Sediment Characterization Study: Draft Sampling and Analysis Plan*, dated February 26, 2008.

People For Puget Sound is a nonprofit, citizens' organization whose mission is to protect and restore Puget Sound and the Northwest Straits.

The harbor is contaminated with wood debris/creosote, dioxins and furans, and polychlorinated biphenyls (PCBs). Our comments follow:

1. **Sampling analysis.** Our experience has been that almost every sediment cleanup site in Puget Sound has had inadequate sampling that required more sampling to fill in later. We suggest that the sampling site selection be reviewed to ensure that this round of sampling will be definitive. We have had years of sampling in the Port Angeles Harbor area and the process should not drag out for many more years.

2. **CSO and sewage treatment plant.** Special attention should be paid to these outfalls. We do not think that adequate sampling has occurred in these areas to date, especially for dioxin.

3. **Biotic community.** We believe that analysis of biotic community should be conducted as well as bioassays. This would yield better data about benthic long-term health.

Thank you for the opportunity to comment on the draft plan. Please contact me with questions at (206) 382-7007 X215.

Sincerely,

Heather Trim
Urban Bays and Toxics Program Manager

DEPARTMENT OF ECOLOGY
State of Washington

Port Angeles Harbor Sediments Investigation
Public Comment Form

This form is for providing comments on the Sampling and Analysis Plan for Port Angeles Harbor. Your comments will be read by Cynthia Erickson, the Ecology Project Manager. Cynthia's response to your comments will be part of a responsiveness summary. The summary will be made public and sent to those who provided comments.

You can submit your formal comment tonight or complete it at home and mail it to Cynthia Erickson, Southwest Regional Office, Toxics Cleanup Program, PO Box 47775, Olympia, 98504-7775. E-mail comments can be sent to ceri461@ecy.wa.gov.

NAME: North Olympic Timber Action Committee

ADDRESS: P.O. Box 1057

CITY: Port Angeles, WA. 98362

ZIP:

Thank you for your interest in the Port Angeles Harbor Sediments Investigation!

COMMENTS

(Please use back side of this form if you need more room)

Your Port Angeles Harbor sediment investigation is of interest to our industry because we use the waters of the Straits of Juan de Fuca and Puget Sound to transport logs. It is an integral part of log movement to control costs and reduce the carbon footprint by reducing the number of log trucks on our highways. At a recent PSP, Water Quality meeting, a statement was made "that wood waste is toxic". Naturally that would be a concern for several reasons: 1. Since the industry spends significant dollars placing large woody debris in rivers and streams which is required. 2. We must be able to move large volumes of logs by barge or log raft. The timber industry has made dramatic changes over decades to reduce wood waste with new log handling equipment and logs with less bark significantly reduce the amount of wood waste left on the ground and falling into the water as logs are transported by barge or log rafts.

We are interested in knowing the results of the harbor surveys.

Carol Johnson
Executive Director

RECEIVED
JUN 02 2008
Washington State
Department of Ecology

Appendix B
January 9, 2008 letter from Ecology to Rayonier

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300

CERTIFIED MAIL

January 9, 2008

Carla Yetter
Director, Environmental Affairs
Rayonier Properties LLC
50 North Laura Street
Jacksonville, FL 32202

Dear Ms. Yetter:

Re: Ecology Comments on the Remedial Investigation for the Marine Environment, Port Angeles Rayonier Mill Site

The Washington State Department of Ecology (Ecology) is responding to the Response to Comments provided by Rayonier Properties LLC (Rayonier) on September 9 and 13, 2007 on the following documents:

- Remedial Investigation for the Marine Environment Near the Former Rayonier Mill Site Port Angeles, Washington, Public Review Draft, February 2007 (MRI)
- Phase 2 Addendum Remedial Investigation for the Marine Environment Near the Former Rayonier Mill Site Port Angeles, Washington, Agency Review Draft (Public Review Draft proposed with comments provided September 2007), February 2007 (MRI Ph 2), and
- Ecological Risk Assessment for the Marine Environment Near the Former Rayonier Mill Site Port Angeles, Washington, Agency Review Draft, (Public Review Draft proposed with comments provided September 2007), March 2006 (ERA).

While these documents were developed outside of the new Agreed Order, Ecology is operating under the spirit of the order. After review of Rayonier's Response to Comments, Ecology has determined that the documents are insufficient for release for public review. Data gaps still exist which have not been adequately addressed. These inadequacies must be addressed by Rayonier prior to release for public review, and are based on specific comments provided by Ecology and the Lower Elwha Klallam Tribe (LEKT). Enclosed are specific comments as to what changes and additional information is needed in order for Ecology to approve the documents for public review.

As you will note in the enclosed comments, Ecology has determined that additional sediment sampling is necessary to address the data gaps. Hence, a Sampling and Analysis Plan (SAP) detailing the additional sampling must be submitted for Ecology review and approval within 45 days of receipt of this letter. Ecology expects a schedule for completion of the Marine Remedial Investigation (MRI) and Ecological Risk Assessment (ERA) to be included in the SAP submitted as response to this letter. A request for an extension of schedule for submittal of these documents, as outlined in sectionVIII. K. of Agreed Order 08-TC-S DE5341, shall also be included. Sampling should begin as early as possible in 2008. As we are all striving for completion of the MRI and ERA as quickly as possible, Ecology will commit to review of the draft SAP within 28 calendar days or sooner.

The enclosed comments also note specific revisions needed in the documents. Ecology is not looking for responses to these comments except as full incorporation into the deliverables. All revisions to documents (past and future) must be fully integrated into the documents (i.e., no revision pages). Ecology expects the revisions and incorporation of new data to be submitted in a single comprehensive Marine Remedial Investigation Report, and an Ecological Risk Assessment. To be clear, we expect the information of the Phase 2 MRI to be incorporated into the MRI and ERA, along with the new data so there are just two comprehensive documents. We will consider these two documents to be the revised Public Review draft. Our expectation is submittal in October 2008

We look forward to completing the Marine Remedial Investigation and Ecological Risk Assessment for the Study Area. As our comments are extensive, I suggest a meeting or conference call to discuss any questions or concerns you may have. I may be reached at (360)407-6257.

Sincerely,

Marian L. Abbett, P.E.
Project Coordinator
Toxics Cleanup Program
Southwest Regional Office

MLA/CME/ksc:MRI Cover Letter

Enclosure

cc: Rebecca S. Lawson, P.E., LHg, Ecology
Roy Hummell, Malcom Pirnie
Larry Dunn, Lower Elwha Klallam Tribe
Bill Beckley, Ridolfi Inc.

General and Specific Comments:

Review of Response to Comments Provided by Rayonier on the Remedial Investigation, Phase 2 Addendum, and Ecological Risk Assessment for the Marine Environment Near the Former Rayonier Mill Site (Public Review Drafts), September 2007

General Comments:

The following general comments detail major issues to be addressed. Ecology has provided specific actions needed to fully address the deficiencies in the documents.

1) **Study Area Delineation Incomplete.** Rayonier has not sufficiently delineated the marine environment portion of the Study Area as now defined in Agreed Order 08-TC-S DE5341 signed by Rayonier in November 2007. In particular, the vertical extent of contamination is lacking, and there is insufficient characterization in the areas near the mouth of Ennis Creek, east of Ennis Creek, the Log Pond area, the Mill Dock area, and areas near outfalls. In addition, the EPA ESI (ENE 1998) data, while described in the MRI, was not used as part of the analysis in the ERA.

   With regard to sediment core analysis:

   a. Section 5.1, MRI states, "...within Puget Sound, the residence time of particles from the top 10 cm is 29 years (Carpenter et al., 1985)." If samples for the MRI were collected in 2006, sampling is sufficient for the 1977-2006 timeframe. Rayonier has been operating since 1937 and analysis of subsurface sediments likely affected from runoff, outfalls, and air emissions as stated in the MRI has therefore not been performed. Core sampling in the Study Area is necessary. Depth of the wood debris around the Mill Dock and Log Pond areas has not been delineated and should be investigated using a hammered piston corer or similar device.

   b. The statement "Deeper subsurface sediments, which are represented in core samples, are areas that support few organisms and experience very little disturbance. Therefore, chemicals present in these areas do not have completed exposure pathways to organisms, and thus do not present risks, unless future actions such as dredging expose the subsurface sediments." (MRI, Section 5.1, page 5-2) is invalid. Geoducks and horse clams, highlighted on Table 3-1 (MRI) and used in the ERA, are a known prey species to both humans and ecological receptors, particularly to the LEKT and local residents, and are known to burrow 3-4 feet. The presence of these two species alone suggests a pathway to subsurface sediments exists.

   c. Sampling sediment cores only if surface samples exceeded the SMS (Section 5.1.2, page 5-5, second paragraph) is scientifically invalid, inconsistent with MTCA, and scientific reasoning unsupported in MRI documentation. Lack of erosion in this area has not been adequately documented in the MRI.

ACTION:

1. A Sampling and Analysis Plan (SAP) should be prepared to include:

   a. Surface sediment and sediment cores to be taken in the Study Area and analyzed for contaminants of potential concern (COPCs, MRI Section 5.1.2) and conventionals. The data will be used to understand contaminant levels, potential risk to ecological and human health receptors, and potential remedial alternatives to be evaluated in the Feasibility Study. Ecology's expectation –

      - Twenty to thirty cores total within the Study Area as defined in Agreed Order 08-TC-S DE5341 to characterize the Log Pond, Mill Dock, Ennis Creek, east of Ennis Creek, outfall areas, and deep water outfall. Five to seven core samples to be collected and analyzed in each area to further vertically and horizontally delineate the site.

      - Core samples should be taken as outlined in the MRI and analyzed for every foot of depth to the depth of penetration. Ecology expects core depth to be a minimum of four feet to represent burrowing clam depths and defined deposition rate in Port Angeles Harbor.

   b. Additional sampling at the mouth of Ennis Creek around the bridge pilings and alluvial fan, the area east of the Mill Dock, and the area east of Ennis Creek. TPH and PCBs should be analyzed in these areas to characterize the areas influenced by Ennis Creek and the fuel release which occurred during the interim action performed in this area. Ecology's expectation –

      - Five to ten surface samples east of the mouth of Ennis Creek, with at minimum five co-located core samples, analyzed to include TPH and PCBs and collected as described above.

      - Five surface samples east of the Mill Dock area and three to five co-located core samples based on SMS exceedances, wood debris, or COPCs lacking an SMS. Core samples should be taken as outlined in the MRI and analyzed for every foot of depth thereafter to the depth of penetration and include TPH and PCBs. Ecology expects core depth to be a minimum of four feet to represent burrowing clam depths and defined deposition rate in Port Angeles Harbor.

      - Three surface and core samples around the bridge pilings and alluvial fan area, to include TPH and PCBs.

c. Depth of the wood debris around the Mill Dock and Log Pond areas has not been delineated. It is important to understand the depth of the wood debris in order to evaluate remedial alternatives that include wood debris removal. Ecology's expectation -

- Five core samples for each the Log Pond and Mill Dock areas to characterize the depth of the wood debris, and any additional areas found to have a significant accumulation of wood debris. A hammer-equipped piston corer or similar device should be used to ensure penetration.

2. Data obtained should be incorporated into the revised MRI and ERA as appropriate. In addition, the EPA ESI (ENE 1998) data should be incorporated in the ERA.

2) **Evaluation of Pathways Incomplete.** The groundwater to sediment pathway, and the air emissions to surface water/sediment pathway has not been sufficiently modeled in the Conceptual Site Model of the ERA. The MRI identifies these as potential sources, but modeling that source has not been adequately characterized. In the MRI Ph2 Technical Document, a single 1995 ash stack emission characterization is used. Other available source data from the Uplands RI should be included in this fingerprinting analysis.

ACTION: Groundwater to sediment and air to sediment/surface water must be properly characterized in the ERA if identified as a potential source in the MRI. The **SAP** and MRI should include modeled isopleths predicting depositional loading from historic stack emissions beyond the shoreline to the marine environment (e.g. into Port Angeles Harbor) as well as the potential risk from these sources; this data should be included in the revised MRI and ERA as appropriate. In addition, Ecology directs that Upland site depositional soil data for dioxin/furans should be used for the fingerprinting analysis in absence of sufficient stack emission data. The plan for use of this information should be included in the **SAP** and result in **document revisions**.

3) **Fingerprinting Analysis Insufficient.** Ecology is not convinced that dioxins/furans have been appropriately fingerprinted at the Site to potentially affected area wide sediments. Rayonier mentions on more than one occasion in the MRI Ph 2 Section 4 that the dioxin congener pattern is highly reproducible: within the log pond >91%, the west end of the harbor >95%, and that the correlation between the average patterns in the two areas is greater than 99%. There does appear to be a distinct, highly reproducible pattern among the likely impact areas around the site.

ACTION: Ecology directs a reanalysis of sources at Rayonier and impacted areas of the site using the site depositional soil data as indicated above in General Comment #2. Five samples should be used at minimum for appropriate statistical power. Rayonier should also utilize dioxin data for site sources including ash, hog fuel

boilers, and others, collected and reported in the Current Situation/Site Conceptual Model Report (Foster Wheeler, 1997), if applicable. If the data is not appropriate or applicable for use, Rayonier must state why this data is not usable for this fingerprinting analysis. A statistical approach to consider is the Polytopic Vector Analysis approach which appears to have greater discerning power among potential sources and in tracing fate of contaminants over time and space. It has the advantage of not depending on *a priori* assumptions regarding separate sources and can track apparent linking between dechlorinated signatures and the parent signature/sources that gave rise to it. The process may aid in distinguishing different sources in tissues as well. EPA's fingerprinting method, FALCON, requires *a priori* assumptions regarding different sources which may lead to biased testing/comparisons. **Document revisions** should include reanalysis using the new soil source data and the statistical analysis used.

4) **Subsurface Current, Sediment Fate and Transport Investigation not Characterized.** Ecology is not convinced that Port Angeles Harbor is out of the area of influence of Rayonier runoff, former outfalls, and effluents. A bottom current study has not been performed; surface water transport is not adequate to describe transport of sediments and currents at depth, particularly at the deep water outfall over the years. Local evidence from the LEKT suggests deeper currents move in a clockwise, not counterclockwise fashion, in the Harbor. Deposition areas have not been sampled as identified in the Modeling conducted by Battelle (Section 7.5 MRI).

ACTION: Ecology will be conducting an investigation into sediment fate and transport, and subsurface and bottom current strength and direction as part of the Harbor Wide Investigation. Ecology will make every effort to have our study run concurrent with the Rayonier sediment data collection so as to not cause further delays. Ecology directs that Rayonier utilize the information gained from this study to completely understand the marine processes occurring in Port Angeles Harbor, and include analysis and use of the data in the **document revisions**.

5) **Reference, Natural and Area Background Inappropriate or Inconsistent across Documents.** The difference between Reference Areas, Natural Background, and Area Background needs to be consistent across all three documents. Selection of Port Angeles Harbor as an Area Background as defined by MTCA is not appropriate; lack of influence of Rayonier operations on the Harbor has not been adequately demonstrated in the MRI. Natural Background and Reference Areas, including Freshwater Bay, Dungeness Bay, and Sequim Bay are appropriate.

ACTION: Ecology directs that all references to Port Angeles Harbor as an Area Background or background, and therefore comparison to Study Area sediments, be removed from all documents. Consistency across documents in use of the term background or Reference Area should be made when referring to the three areas investigated (Freshwater Bay, Dungeness Bay, and Sequim Bay). Comparison of Site sediment bioassays to the designated Reference Area (Sequim Bay) and Site sediment chemical analysis to the local, appropriate natural background areas (Freshwater

and/or Dungeness Bay) as defined by grain size and TOC as an evaluation step should be performed in **document revisions.** Call outs to these three areas in documents should be consistent as either reference areas (Sequim Bay) or natural background (local bay areas).

6) **Bioassay Analyses Insufficient**. Bioassays are needed to determine contaminant affects of sediment to benthic populations since many contaminants of potential concern (COPCs) do not have SMS/CSL criteria. Bioassays were only conducted in the Log Pond for purposes of determining wood debris affects initially. Using bioassays only where SMS were exceeded in surface sediments is inadequate to characterize the site (see General Comment #1).

   ACTION: Ecology directs that bioassays be conducted across the Study Area to determine: 1) the effects of Rayonier COPCs not having an SMS, such as resins and fatty acids; 2) the effects of COPCs which exceed the Reference Area sediment concentrations; and 3) the effects of wood debris in other areas such as the Mill dock, and the Ennis creek influence area (described in General Comment #1).

   The **SAP** should include plans for this bioassay study. Bioassays should not be purged as this removes ammonia and sulfates which may be present from wood debris. All references to past purged bioassay data should be removed from the documents as well. Ecology expects that bioassays (as defined in WAC 173-204-310 through 315) will be taken to further characterize surface samples (0-10 cm) and include co-located sampling areas identified in General Comment #1. Bioassays should be taken where SMS are exceeded, where no SMS exist for COPCs, and in wood debris areas. Ecology expects approximately the following number of bioassay samples to be collected in the indicated areas:

   - Five to seven bioassays in the Mill Dock area.
   - Five bioassays in the deeper outfall area.
   - Five bioassays east of the Mill Dock area.
   - Five to seven bioassays east of the Ennis Creek area, to include the alluvial fan and bridge area.
   - Three to five bioassays in the Reference Area, Sequim Bay.

   Details of sampling these co-located areas should be detailed in the **SAP** submitted to Ecology.

7) **Additional Analysis of COPCs**. Ammonia, sulfides, TVS, and TOC were not investigated as potential hazardous substances caused from wood debris accumulation and degradation. High TOC surface samples with 95% wood debris as typically found in some areas of the Study Area as compared with high TOC surface samples in the Reference Area due to fine silt/clay fraction sediments may be influencing analysis of results.

ACTION: Rayonier shall include ammonia, TVS and sulfides as COPCs in wood debris areas, and high TOC descriptions between high wood debris areas vs. sediment reference areas should be described in the uncertainty section of the ERA and MRI as appropriate. Any additional COPC sampling needs should be included in the **SAP** provided to Ecology and aligned with sampling needs identified in General Comments #1 and #6. Bioassays should not be purged of these compounds and reference to these data should be removed from the documents.

8) **Benthic Community Analysis Incomplete.** A benthic community analysis has not been adequately performed for the MRI and ERA. Video conducted by Foster Wheeler (2002) suggests benthic habitat is of low quality in some areas, typically in the wood debris areas. This is supported by a very shallow (1cm) aerobic layer and the OSI investigation. Sea lettuce is abundant and sea fans/pens are some of the species described. Invertebrates found other than shellfish have not been adequately identified in the MRI or ERA. Citations of the marine environment in Port Angeles Harbor (Shea et al., 1981) are over 20 years old.

ACTION: Ecology directs that a more comprehensive assessment of the benthic community structure in the Study Area and Harbor be provided in **document revisions**, particularly in the MRI and ERA, including a scientific names and description of invertebrates currently in the area of Port Angeles Harbor investigated as appropriate for a more thorough and complete understanding of Sediment Quality Triad data and ERA for benthos. Ecology believes existing data can be used for this assessment; data descriptions, species identification and community analysis just need to be more complete and incorporated into a full risk characterization in the ERA and benthic habitat description in the MRI. Consider use of more recent sources (i.e. Shaffer, A. 2001. "Nearshore Marine Habitats," Summary Report: Clallam County Marine Resources Committee Interactive Workshop #5. http://www.clallammrc.org/CCMRC/InteracitveWorkshops_file/keyelements.htm. May 7, Washington.).

9) **Human Health Tissue Comparisons Inappropriate, Discard of Older Clams in the Study Area.** EPA Region 3 human health risk-based concentrations (RBCs) are inappropriate for use as a benchmark due to the low consumption rates used by EPA nationally. Additionally, preferentially selecting against older clams (apparently over 900 g Mill Dock) in the Study Area (MRI Ph 2) for analysis may bias and underestimate the ecological and human health risk at the Site. Reference areas had similarly aged/weight clams that were analyzed.

ACTION: A screening level approach comparing tissue data against natural background tissue data from Freshwater and Dungeness Bay should be performed, eliminating the R3 RBC comparison in the **document revisions** as a basis for assessment. Analysis of data should be adequately conservative for subsistence tribal consumers and consistent with MTCA. Additional older horse clam data in the Study Area (such as the Log Pond, Mill Dock, and Ennis Creek areas in General Comment #1) should be identified in the **SAP** and collected and analyzed for COPCs to

compare with natural background tissue data similarly collected and evaluated in the ERA, as a conservative estimate of risk and potential exposures that could occur to ecological and human receptors. Ecology expects that two to three horse clam tissue samples of the older age class in each of the Log Pond, Mill Dock, Ennis Creek and the deepwater outfall areas be collected and analyzed appropriately for COPCs.

10) **Ecological Tissue Comparisons and Receptors of Concern.**

ACTION: Fish and benthos/shellfish need to be added to the ecological receptors of concern in the **document revision** to the ERA, and risks for fish and shellfish further identified by comparison to Tissue Residue data. This comparison should be included in a new section of the ERA. An assessment of the risk to benthos from COPCs at the Site needs to be more complete including sediment chemistry, bioassays, and benthic community analysis per MTCA, and should include vertical delineation at the Site and new data collected as indicated in General Comments #1, #6, and #8 above.

Specific Comments:
Listed comment numbers reflect the numerical system used in the Response To Comments tables prepared by Rayonier.

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1. Comment not addressed. This information is needed to interpret the results of the RI and should be summarized here.

4. Comment not addressed. The characterization of salmonid presence at and near the site should have been completed early in the RI process and is important because of the human consumption and ecological relevance of these species. Ennis Creek supports populations of coho salmon, steelhead, bull trout, and coastal cutthroat trout.

6. Comment response is satisfactory.

7. Comment not addressed. The response relies completely on predictions of a hydrodynamic model that has not been field verified at the specific location of the outfall diffusers, and new information was presented during the RI regarding the result of model predictions. The only way to characterize the presence of buried contaminated sediment at this location is to collect core samples. This remains a major data gap that we recommend be addressed in the future.

14. Comment not addressed. The basis for determining if concentrations of chemicals without SMS numeric chemical criteria are elevated is a comparison to background concentrations. Note, this is not necessarily an identification of risk, just a statement that they are elevated. The approach used in the RI, if not

followed up further, is not consistent with the Sediment Management Standards, which requires use of bioassays in areas where chemicals are present that do not have numeric chemical criteria, in order to determine if risk to benthos is present. In addition, the response does not address the central issue of potential buried sediment contamination, specifically in the mill dock area.

22. Comment not addressed. It is important to understand the linkages between upland contaminant sources/releases and the marine environment to make informed risk management decisions prior to the Feasibility Study stage of the cleanup. This does not entail full linkage of the two reports, but some linkage must occur in order to accurately understand the RI results and the adequacy of sampling. The Ennis Creek report was reviewed, leading to the questions here, as it was clear that not all residual contamination was dealt with during the interim hot spot removal. PAHs remain near the bridge and PCBs may be present in the alluvial fan at the mouth of the Creek, which was not included in the RI sampling. Interim benchmarks were not adequate to address potential bioaccumulation risks from the PCBs.

23. Comment not addressed.

12. Comment response is satisfactory.

15. Comment response is satisfactory.

16. Comment not fully addressed. Evaluation of the bioassay results must be fully consistent (not "largely" consistent) with Ecology's direction. Ecology has the authority to interpret its own guidelines, rules, and interpretation procedures and give appropriate direction.

17. Comment not accepted/addressed. See response to 16. WAC 173-204-560(4)(b)(ii) requires identifying alternative site boundaries at the point at which the SQS or the CSL will be met (including risk-based values for chemicals without numeric chemical criteria). Therefore, stations clusters based on bioassay results must include SQS stations as well as CSL stations, and must be marked as uncertain in areas not tested or areas where the existing stations at the edge of the area tested exceed these standards. This is a critical deficiency of the report as it stands.

18. Comment not addressed. All stations with any SQS exceedence should be included in the area of concern depicted in the RI report. WAC 173-204-570(4) states that site-specific cleanup standards are to be set as close as practicable to the SQS, which is defined by any one of the three bioassay tests exceeding the applicable SQS, in addition to risk-based criteria for bioaccumulative chemicals or chemicals without numeric criteria. A weight-of-evidence approach is not used for the SQS level of effects, which represents no adverse effects to benthos. Risk management decisions will be used at a later time to refine the area of concern

requiring remedial response. Furthermore, the response does not address the comment's suggestion to add symbols to the diagram indicating where uncertainty exists in the delineated area of concern.

19. Comment not addressed. We recommend that the Axys data be presented in the RI report, however this is less important now with the Phase 2 dioxin data and associated detection limits. We disagree with the stated reason for not including the Axys data. On the contrary, the Axys data set appears to have the fewest quality assurance issues of the various dioxin data sets available.

20. Comment response is satisfactory.

24. Comment response is satisfactory.

27. Comment response is satisfactory.

29. Comment response is partially satisfactory. Regarding larval quality assurance guidelines, Ecology is authorized to apply alternate technical methods instead of or in addition to those in the rule under certain conditions (see WAC 173-304-130(4). For the larval performance standard, these public notice conditions were met through the Sediment Management Annual Review Meeting public notice and comment process in 1994 and have been in place since that year. Similarly, comparison to control was discussed in a SMARM paper in 1997 and has been applicable to the SMS process since that time. Both of these program modifications were made well before this sampling program began. Under WAC 173-340-130(4), the Department, determines when the use of alternative technologies is appropriate, subject to the required notice and comment as discussed above. Therefore, it is not appropriate for Rayonier to make independent determinations on the applicability of these guidelines.

2. Comment response is satisfactory.

3. Comment response is satisfactory.

5. Comment not addressed. The report needs to reflect the most current information, and orca whales should be added to the table.

8. Comment response is satisfactory.

9. Comment response is satisfactory.

10. Comment not addressed. The purpose of collecting reference samples was not only for interpreting bioassay results, and regardless of why they were collected, they can be used for any RI-related purpose. Reference area chemical concentrations are used along with source information to identify chemicals of concern that may not have chemical criteria, and to guide further bioassay and/or

risk assessments in areas where these chemicals are elevated above background to determine if these concentrations present a risk. This approach is used at all sites where CoPCs are present that do not have numeric chemical criteria.

11. Comment not addressed; the definitions continue to be inaccurate and misleading. Revise as directed.

21. Comment response is satisfactory.

25. Comment not addressed. We feel that the extent of sediment contamination in Port Angeles Harbor has not been adequately delineated, and models put forth by Rayonier suggest the presence of depositional areas that have not been sampled. The report should acknowledge this data gap.

26. Comment not addressed. See response to #19.

28. Comment not addressed. Rayonier's position is that the chronic bioassay test performed meets the requirements of SMS. However, if the bioassay test does not account for site-specific factors, then alternative analyses are a logical next step to provide the necessary "weight of evidence" to support risk management decisions. As noted above, Ecology has the authority to require specific tests if site-specific conditions warrant it.

30. Comment response is inadequate. No information is provided to support the statement that the 14-day period selected would result in the high deposition rate, given seasonal factors and changes in stratification known to occur in the Strait of Juan de Fuca area.

31. Comment not addressed. It is not likely that a change in deposition rate would not change the pattern of deposition; at the very least, there would be much greater shoreline dispersion away from the site of lighter material. The extent to which effluent traveled away from the site along the shoreline is one of the key questions that needs to be answered during the RI, and shoreline sampling to date is inadequate to assess that.

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32. Comment response is satisfactory.

33. Comment not addressed. The intent of the RI is to collect data that will be used to assess potential exposures to human and ecological receptors. By discarding older clams, the data is biased low and is not representative of exposures that could occur from human consumption of shellfish.

34. Comment response is satisfactory.

35. Comment response is satisfactory.

36. Comment response is satisfactory.

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38. Comment not addressed. See response to #28.

40. Comment not addressed. Minor comment that would be easy to incorporate.

51. Comment not addressed. The response suggests that sediment sample data collected for the ESI was part of the reason for collecting so few intertidal sediments during the RI. However, the ESI data are not incorporated into the risk assessment. Furthermore, much of Rayonier's response is related to human health exposures. Our comment related to the acceptability of sediment characterization for ecological receptor exposures, and sample frequency has not been adequately addressed for this purpose.

60. Comment not addressed. The response indicates that a non-conservative approach is being applied. Ecology is authorized to apply alternate technical methods instead of or in addition to those in the rule under certain conditions (see WAC 173-304-130(4). For the larval performance standard, these public notice conditions were met through the Sediment Management Annual Review Meeting public notice and comment process in 1994 and have been in place since that year. Similarly, comparison to control was discussed in a SMARM paper in 1997 and has been applicable to the SMS process since that time. Both of these program modifications were made well before this sampling program began. Under WAC 173-340-130(4), the Department, not the project proponent, determines when the use of alternative technologies is appropriate, subject to the required notice and comment as discussed above. Therefore, it is not appropriate for Rayonier to make independent determinations on the applicability of these guidelines.

37. Comment not addressed. The noted marine species are important resources to the LEKI. Top trophic level receptors as assessment endpoints characterize worst case risk for bioaccumulative COPCs, not all COPCs. In addition, the site use factors proposed by Rayonier would lessen the risk to higher trophic levels compared to mid-trophic levels, which have higher site fidelity.

If there is sufficient tissue data to assess risks to higher order consumers, there is sufficient tissue data to characterize body burdens for assessing the risks to organisms themselves. While bioassay testing may assess the risks to one of these receptors, these data need to be presented and discussed in the risk assessment in this context. Benthic toxicity assessment procedure in SMS are not intended to be applied to evaluation of risks to fish and crab species; alternative methods are required for this portion of the risk assessment.

39. Comment response is satisfactory.

41. Comment not addressed. The re-analysis of ecological risks needs to be incorporated into the pubic review draft of the ERA.

42. Comment response is satisfactory.

43. Comment not addressed. This issue is significant enough to warrant holding this document back from public review.

44. Comment response is satisfactory.

45. Comment response is satisfactory.

46. Comment response is satisfactory.

47. Comment response is satisfactory.

48. Comment not addressed.

49. Comment not addressed. There are too many problems with the exposure model, including poor selection of prey species, and biased samples of clams due to elimination of older individuals from the sample set. We recommend the entire exposure assessment for plovers be re-designed.

50. Comment response is satisfactory.

52. Comment not addressed. 52A – It is true that sufficient data are not yet available to identify the boundaries of the site and the concentrations beyond the areas previously sampled. This is a deficiency in the RI that has been noted in our comments. Until these data are available, an ERA cannot be finalized. If these areas were included, exposure would increase, not decrease, as currently the area use factor used results in an assumption that exposure is non-existent outside the area included in the risk assessment. 52B – Response is satisfactory, assuming other parts of this comment are addressed. 52C – The point was not to assume 100% marine exposure for the raccoon, but to combine upland and marine exposures for this receptor, since is would be exposed to both areas of the site. 52D – Ecology does not agree that Port Angeles Harbor represents area background for this site, as there are many possible routes for contaminants to have reached the harbor from the site. It is within Ecology's authority to determine, on a site-by-site basis, whether area background will be used and if so, how it would be calculated. In the absence of concurrence by Ecology, Rayonier may not assume, for the purposes of risk assessment or any other use, that Port Angeles Harbor constitutes area background.

53. Comment response is satisfactory.

54. Comment response is satisfactory.

55. Comment not addressed. These comments and all similar directive comments by Ecology staff are not optional.

56. Comment not addressed.

57. Comment response is satisfactory.

58. Comment not addressed. Previous comments on the same topic also not addressed, contrary to this response. Rayonier must use the data interpretation approaches required by Ecology for this and all other sediment sites, as discussed in Response 60.

59. Comment not addressed. See comment 55 and 60.

61. Comment not addressed. See comment 55 and 60. It is within Ecology's authority to conduct final interpretations of the data, define the area of concern and select cleanup boundaries.

62. Comment not addressed. The risk assessment needs to account for other deleterious substances. SMS does not limit risk assessments or remedial investigations to only the chemicals for which numeric chemical criteria exist.

63. Comment not addressed. It is appropriate to acknowledge uncertainties.

65. Comment not addressed. It is appropriate to compare to the benchmarks in the risk assessment. The response is acceptable for DDTs, but not for dioxins/furans or other compounds that do not have NOAA criteria.

67. Comment response is satisfactory.

68. Comment response is satisfactory.

69. Comment response is satisfactory.

70. Comment response is satisfactory.

Appendix C
Analysis of Appropriate Sediment Background and Reference Area for Port Angeles Harbor, Washington
(Ecology and Environment, 2008)

Analysis of Appropriate Sediment Background and Reference Areas for Port Angeles Harbor, Washington
June 9, 2008

Introduction

As part of public comment on the Port Angeles Harbor Sampling and Analysis Plan (SAP), questions have arisen regarding reference and background areas for the Harbor. The terminology and regulatory uses of the various kinds of background and reference areas are often complex, and the kinds of information needed to select appropriate background and reference areas are different. This paper addresses the types of background and reference areas that may be used and how they will be defined and the rationale for selection for the Port Angeles Harbor sediment investigation.

Definitions and Uses of Background and Reference Areas

Three types of areas are defined and used by various regulatory programs:

- **Natural Background –** Natural background is defined by the Model Toxics Control Act (MTCA) at WAC 173-340-200. It includes concentrations of chemicals that are naturally occurring, as well as concentrations of man-made chemicals that are globally distributed at low levels, such as PCBs, dioxins, and some radioactive isotopes.

  Natural background concentrations are used for a variety of purposes. For example, if a bioaccumulative chemical has a risk-based concentration that is below natural background, the cleanup standard for that chemical under the Sediment Management Standards is set at natural or "nonanthropogenic" background. Because risk-based standards for dioxin are typically below background, this is particularly important for Port Angeles Harbor and the Rayonier site.

- **Area Background –** Area background is also defined by the Model Toxics Control Act at WAC 173-340-200. It includes somewhat higher levels of contaminants "consistently present in the environment in the vicinity of a site which are the result of human activities unrelated to releases from that site."

  Area background can be used under MTCA as a cleanup standard if it can be demonstrated that area background is higher than natural background, and that cleanup to natural background cannot be achieved. Institutional controls and monitoring may be required if area background is used to set cleanup levels. There is no equivalent concept in the Sediment Management Standards.

- **Reference Area –** Reference areas are not defined in the Model Toxics Control Act or the Sediment Management Standards by rule. Reference areas were originally identified by the Puget Sound Estuary Program (1991) for the purposes of identifying clean comparison areas for bioassay testing. While few specific areas have been agreed upon in the scientific community, several important characteristics of potential

reference samples have been agreed on (MMC 1988; Ecology 1988; Michelsen & Striplin 2000; SEA 1996, 2003). These include:

1. The site should be located away from significant anthropogenic activity
2. Anthropogenic chemicals of concern should be below the Washington State SQS
3. The physical characteristics of the reference site must be similar to that seen in the test area (e.g., points, headlands, water depth, currents, wave action)
4. The sediment grain size and organic carbon content at the reference site must be similar to that at the test site

While reference areas have not been established or defined in the SMS, a definition of a reference sediment sample corresponding to the above four points is included in the definitions section at WAC 173-204-200(22).

Identification of Natural and Area Background Concentrations for Port Angeles Harbor

Natural and area background concentrations are critical for understanding the distribution of and setting cleanup standards for dioxins/furans and other bioaccumulative compounds in Port Angeles Harbor. These two types of background will be assessed as follows:

- **Natural Background.** By definition, natural background is not a site-specific or area-specific concentration. It includes only natural concentrations (such as dioxins from forest fires) or globally distributed concentrations (such as those carried atmospherically from other areas of the world). A group of federal and state agencies (Ecology, DNR, EPA, Corps, and the Puget Sound Partnership) are currently working together to collect all existing dioxin/furan data, and are conducting a field sampling effort in August, 2008 to collect 70 additional dioxin/furan/PCB congener samples (as well as other standard chemicals of concern) from reference areas and non-urban areas of Puget Sound. These efforts will provide a data set that will assist in defining non-urban, reference, and background concentrations in Puget Sound and the Strait of Juan de Fuca.

- **Area Background.** As part of the Port Angeles Harbor Sampling and Analysis Plan (SAP), stations have been placed along the outer edge (eastern part) of the harbor, as well as in the reference areas described above, to evaluate area-wide concentrations of dioxins/furans and other CoCs. These stations will help determine whether there are area-wide elevations of these compounds above the natural background concentrations being developed as described above, or whether concentrations outside the Harbor and localized site sources approach natural background levels.

Selection of a Reference Area for Port Angeles Harbor Studies

The current issue is whether Dungeness Bay, Freshwater Bay, or Sequim Bay would provide the best reference site for Port Angeles Harbor. It should be noted that reference

areas are used for **bioassay testing only**. They are not relevant to bioaccumulative compounds such as dioxins/furans, which are assessed through tissue concentrations and risk assessments rather than bioassay tests. Dioxins/furans in particular are not toxic to benthic invertebrates, which lack the Ah receptor through which dioxin/furan toxicity is expressed, and therefore the concentrations of dioxins in these bays is not an issue for selection of a reference area for bioassay testing.

Comparing the sites to the first criterion it is clear that both Freshwater and Dungeness Bays are located away from significant anthropogenic activity, and both locations have large rivers that empty into the surrounding marine environment. Sequim Bay, while not influenced by industrial activity, receives road runoff, is surrounded by private homes that are serviced by onsite septic systems, and is the location of the John Wayne Boat Marina. While Sequim Bay has been used as a site to collect reference sediment for toxicity testing in the past, the presence of the marina, non-point sources, and on-site septic systems, and the restricted flow of seawater at the entrance to the Bay, suggest that it is not an optimal sediment reference location for Port Angeles Harbor. In addition, the existence of mats of the filamentous bacteria *Beggiatoa* spp. has been reported in Sequim Bay. These bacterial mats tend to grow in nutrient rich sediments where low dissolved oxygen levels have led to the formation of sulfide compounds that could confound toxicity testing results.

The third criterion suggests that the reference and test areas have similar physical characteristics. Dungeness Bay is physically very similar to Port Angeles Harbor. Both embayments are protected by a spit of land from the strong currents in the Strait of Juan de Fuca and both have inputs of water and organic rich sediment from creeks and rivers. While Freshwater Bay also has a source of sediment from the Elwha River, the sediment tends to be coarse and the fines that are present are carried away by the longshore current into the Strait of Juan de Fuca. Sequim Bay is a semi-enclosed embayment with no rivers or creeks entering it, thus recent sediment arrives through runoff from the surrounding hillsides. Due to poor water circulation, portions of the Bay periodically experience low dissolved oxygen, unlike Freshwater and Dungeness Bays.

The fourth criterion calls for the test and reference locations to have similar grain size and organic carbon content. This is perhaps the most important criterion, because benthic invertebrate communities are highly structured by sediment type and the amount of organic material available as a food source. The ultimate goal of a reference area is to provide samples/data that may be protective of these benthic invertebrate communities and the demersal fish populations which use them as a food source. These groups, which represent two of the lowest trophic levels, may be the first to be affected by anthropogenic activity, thus the reference area should reflect the condition of the test area prior to the introduction of the activity that caused the impact. While no quantitative data are available to characterize the sedimentary environment in Port Angeles Harbor prior to its industrialization, inferences can be made by examining its physical characteristics and those of the proposed reference sites and then by examining sediment grain sizes and organic carbon content to find similarities among the proposed locations.

Statistical Comparison of Conventional Parameters in Potential Reference Areas

To this end, data from sediment sampling stations in Port Angeles, Freshwater, Sequim, and Dungeness Bays were examined to determine whether there are statistically significant differences in the percent fines (combined percent of silt and clay) and in the total organic carbon content of the sediment (Zar 1984; MS Excel 2003; Systat 2004).

To reduce the inherent variability in the data, each station in an embayment was considered to be a replicate sample from that embayment and summary statistics were calculated accordingly. This enables us to generally characterize a large area with a greater certainty than the variability is being accounted for. A similar approach was used to characterize the chemical and biological conditions at potential reference areas in Puget Sound (SEA 1996); by the Capital Regional District of the City of Victoria, B.C. to identify reference areas for comparison to chemical and biological conditions at their sewage outfall in the Strait of Georgia (SEA 2001, 2002); and is currently being used by the Department of Ecology's Sediment Ambient Monitoring Program to characterize benthic infaunal communities over large areas in Puget Sound.

The stations within each study area were not located based on a random sampling design, but were located to specifically identify areas were chemicals of concern may be located or to characterize sediment conditions for a potential reference site. However the spatial distribution of these stations encompassed large portions of their respective study areas, allowing a better characterization of the areas as a whole. The exceptions to this were the samples from Sequim Bay. The majority of data for sediments from Sequim Bay were taken from an area that was specifically located to act as control sediment for fine grained sediment toxicity tests. Thus the use of the Sequim Bay data would unduly bias the results of any analysis in favor of Sequim Bay. Even though these sediments have been used as control sediments there have been SQS hits and toxicity test control failures in Sequim Bay sediments (Michelsen 2008). For this reason and the presence of the marina, on-site septic systems, the restricted seawater circulation at the entrance to the Bay, and the presence of mats of the filamentous bacteria *Beggiatoa* spp. it was decided to remove Sequim Bay from further consideration as a potential reference site.

***t*-Test Results**

The tests conducted included a two sample t-test assuming unequal variances between the following categories:

Dungeness Bay versus Port Angeles Harbor
Freshwater Bay versus Port Angeles Harbor
Dungeness Bay versus Freshwater Bay

Table 1 shows the results of the t-test comparing the parameters of interest among the embayments.

Area	Freshwater Bay	Port Angeles		

	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.36	3.75	0.0000	0.0000
Percent fines	1.75	61.8	0	0
Area	Dungeness Bay	Port Angeles		
	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.7	3.8	0.0000	0.0000
Percent fines	28.2	61.8	0.006	0.011
Area	Dungeness Bay	Freshwater Bay		
	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.7	0.36	0.031	0.0621
Percent fines	28.2	1.75	0.017	0.034

The results in Table 1 indicate that Freshwater Bay, located to the west of Port Angeles, has a much coarser sedimentary environment than Port Angeles or Dungeness Bay. The mean TOC at Freshwater Bay was 0.36 percent with a percent fines of 1.75; compared to 0.7 percent TOC and 28.2 percent fines at Dungeness Bay, and 3.8 percent TOC and 61.8 percent fines at Port Angeles. Typically low amounts of TOC and percent fines characterize erosional environments where wave action and tidal currents do not allow fine particulate material to settle from the water column; and greater amounts of each reflect anthropogenic activity at Port Angeles Harbor and the accumulation of organic material and sediment trapped behind the spit at Dungeness Bay.

Regression Analysis

Multiple regression analysis was conducted to examine the relationship between the organic content in the sediment and the percent fine grained material in each study area. A strong regression coefficient indicates a close relationship between the amount of TOC and percent fines. For example, a high coefficient may indicate a thorough mixing of TOC with silts and clays in the environment and that the input of this material is constant/consistent in arrival at the site; while a weak relationship may indicate that the organic material and/or silts and clays arrive in the area sporadically or that the organic material is larger thus physically and chemically difficult to break down. The regression relationship between percent fines and total organic carbon was strongest at Dungeness Bay with an r^2 of 0.865. This indicates that 86.5 percent of the variability in the organic carbon content of the sediment can be explained by percent fines. The regression coefficients at Freshwater Bay and Port Angeles were much lower. The r^2 value at Freshwater Bay was 0.102 and at Port Angeles was 0.026. In Port Angeles Harbor, the lack of correlation between percent fines and TOC may be related to the large amounts of anthropogenic woody debris present in that harbor.

In addition to percent fines the amount of sand at the potential reference sites were examined to further characterize the sites. Freshwater Bay contained a higher percentage of coarse and medium sand than was seen at the other locations, Port Angeles Harbor consisted of fine sand while Dungeness Bay of medium and fine sand.

Table 2 shows the regression relationship between Percent TOC and percent fines.

Regression Statistics	Dungeness Bay	Freshwater Bay	Port Angeles
Multiple R	0.930	0.319	0.454
R Square	0.865	0.102	0.206
Adjusted R Square	0.850	0.002	0.166
Standard Error	0.179	0.287	1.913

Chemicals of Concern

Low concentrations of several metals, PAHs, and PCBs have been detected in both Freshwater and Dungeness Bay sediments (E & E 1998; Malcolm Pirnie 2007). Chemical contaminants adsorb to sediment particles based on the composition of the sediment and on its surface to volume ratio. The smaller a particle, the greater the amount of a chemical that can be adsorbed to its surface based on its volume. This implies that an area with predominantly silt and clay sediments would adsorb larger amounts of a chemical than an area with gravel and sand sediments. Thus it is not surprising that some chemicals of concern were detected in the finer grained sediments at Dungeness Bay.

The large particle sizes of sediment found in Freshwater Bay indicate an extremely dynamic environment where levels of chemicals of concern should be undetected. Yet, available data indicate that PCBs and some dioxin compounds have been found there in the past. The herbicide 2,4,5-T (agent orange), which contains dioxin as an impurity, was reportedly used to clear vegetation around facilities associated with the Elwha River dams (Gardner, W. 2008 pers. comm.). In addition, trace concentrations of PCBs have been found in previous investigations around some of the Elwha Dam facilities (E & E 1999) and the Elwha River is listed as an impaired waterway under Section 303(d) of the Clean Water Act for PCBs. This information suggests that the Elwha River is a possible source of PCBs and dioxins to Freshwater Bay. Furthermore, assuming that the plan to remove the Elwha River dam facilities proceeds, the possibility exists that Freshwater Bay could become more contaminated through flushing of river sediment material and therefore, the bay would be lost as a future reference location.

Current Tendencies

To quantify the transport of potential contaminants from sources in Port Angeles Harbor to Dungeness Bay is a difficult undertaking. A simple estimate of transport between these two points requires numerous assumptions about tidal characteristics, freshwater input from large adjacent rivers (Fraser & Skagit), mixing, stratification, wind and waves. Recent research indicates that strong eastward currents are common along the north shore of the Olympic Peninsula, termed the Olympic Peninsula Countercurrent (Thomson et al. 2007). However, there several factors that make efficient transport of concentrated contaminants from Port Angeles Harbor to Dungeness Bay unlikely:

Tidal eddies - Both Port Angeles Harbor and Dungeness Bay exhibit tidal eddies. These eddies have been documented by several earlier studies. These studies have shown that the eddies have a tendency to isolate the waters of the harbor and bay from water in the outer Strait of Juan de Fuca. To transport contaminants from Port Angeles Harbor to Dungeness Bay, contaminated water must leave the Port Angeles Harbor eddy, join the main current in the Strait of Juan de Fuca, and then leave that main current to enter the eddy in Dungeness Bay. While possible, this would require unusual timing of different physical processes. The process of transport between these eddies would coincide with intense mixing, significantly diluting any potential contaminants in the water column.

Geomorphic evidence of westward transport - At depths influenced by waves (depths < 50 feet), transport is dominantly westward at the mouth of Port Angeles Harbor. This condition was observed during the Sediment Trend Analysis fieldwork conducted in April, 2008 for the Port Angeles Harbor sediment investigation, and is consistent with additional observations made by team geomorphologists of sediment transport in the intertidal and shallow subtidal areas of the Harbor.

Reversibility of the current field - The same work that discovered the Olympic Peninsula Countercurrent, also documents the extreme temporal variability in the currents in the Strait of Juan de Fuca. It is not uncommon for the current to reverse its direction or stop altogether. Because the strong eastward current is ephemeral, it would take an unlikely sequence of events to advect water column pollutants the approximately13 miles from Port Angeles Harbor to Dungeness Bay via this mechanism alone.

Strait sill - Finally, the Olympic Peninsula Countercurrent was documented in the Strait of Juan de Fuca west of Port Angeles. The countercurrent encounters a sill (a topographic high) immediately west of Dungeness Bay -- in between Dungeness Bay and Port Angeles Harbor. Thomson et al. (2007) suggest that the current likely changes structure dramatically at or near the sill. For instance, at depths greater than the sill, it is unlikely water-borne contaminants would be transported east of the sill because they would have to ascend in the water column (unlikely given that the Strait of Juan de Fuca is highly stratified). At water depths above the sill, the flow is generally westward as a result of the large freshwater effluent from the Fraser and Skagit Rivers (and other large rivers draining to the Strait of Georgia and Puget Sound). In this case, the contaminants would be mixed with this fresher water and forced west, back towards Port Angeles Harbor.

Conclusions

Dungeness Bay sediment, in conjunction with sediment sample stations in the outer (eastern) part of Port Angeles Harbor are expected to generate appropriate data to characterize area background concentrations. Sequim Bay and Freshwater Bay are less desirable background areas because of documented anthropogenic influences and grain size differences.

The use of Sequim Bay and Freshwater Bay as sediment reference sites would be problematic for the following reasons:

- Sequim Bay has a sediment grain size similar to Port Angeles Harbor; however it is not suitable as a reference location due to its extremely different geomorphology, and the presence of anthropogenic influences in an embayment with poor water circulation.
- The sediment grain size distribution and average TOC levels in Freshwater Bay are significantly different than Port Angeles Harbor.

The physical and geomorphological characteristics of Dungeness Bay, combined with the analysis of long-shore current tendencies along the north Olympic Peninsula, suggest that Dungeness Bay is the most appropriate area background and reference site for Port Angeles Harbor.

References

Ecology. 1988. Puget Sound Ambient Monitoring Program Marine Sediment Quality Implementation Plan. Prepared by Striplin, P. Prepared for the Washington State Department of Ecology and Puget Sound Water Quality Authority. Pp. 57. Publication No. 88-37

Ecology and Environment, Inc. (E & E), 1999, Glines Canyon Dam Level 2/3 Environmental Site Assessment Report, Prepared for the National Park Service, Olympic National Park.

Ecology and Environment, Inc. (E & E), 1998, Rayonier Pulp Mill Expanded Site Inspection, Prepared for EPA Region 10 – Superfund Technical Assistance and Response Team, TDD No. 97-06-0010.

Evans-Hamilton. 1987. Puget Sound Environmental Atlas. Prepared for the US Army Corps of Engineers, US Environmental Protection Agency, and Puget Sound Water Quality Authority, Seattle, WA. Evans-Hamilton, Inc., Seattle, WA.

Malcolm Pirnie. 2007. Phase 2 Addendum Remedial Investigation For the Marine Environment Near the Former Rayonier Mill Site, Port Angeles Washington. Prepared by Malcolm Pirnie Seattle, WA for Rayonier, Jacksonville, FL. Pp. 157 + Appendices.

Michelsen, T. and P.L. Striplin. 2000. Development of Warning Levels and Adverse Effects Levels for the Clover and Macaulay Point Outfalls. Attachment B to the Clover Macaulay Point Management Plan. Prepared for the Vancouver Island Capital regional District. pp 60.

Michelsen, T. 2008. Pers. Comm.

Microsoft Corp. 2003. Microsoft Excel for Windows: Tools: Data Analysis Module. Redmond, WA

Monitoring Management Committee. 1988. Puget Sound Ambient Monitoring Program. Final Report. Seattle, WA.

PSEP. 1991. Reference Area Performance Standards for Puget Sound. Prepared by PTI Environmental Services for the Washington State Department of Ecology, Olympia, WA. 73 pp. + Appendices

PTI. 1993. Recommendations for assessing adverse benthic effects in Puget Sound. Prepared for Washington Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA. 21 pp. + appendices.

Systat. 2004. SYSTAT for Windows: Statistics, Vers. 11. Evanston, IL. 750 pp.

Striplin Environmental Associates. 1996. Development of Reference Value Ranges for Benthic Infauna Assessment Indices in Puget Sound. Prepared for the Washington State Department of Ecology. January 1996. 45 pp + appendices.

Striplin Environmental Associates. 2001. Development of Reference Range Values for Benthic Infaunal Communities Surrounding the Macaulay Point Outfall. Pp.15

Striplin Environmental Associates. 2002. Benthic Infaunal Communities Surrounding The Macaulay Point Outfall. Pp. 20 + Appendices

Tetra Tech. 1990. Puget Sound ambient monitoring program: Marine sediment monitoring, Final Report. Prepared for the Washington Department of Ecology, Ambient Monitoring Section, Olympia, WA by Tetra Tech, Inc., Bellevue, WA. 262 pp.

Thomson RE, Mihaly SF, Kulikov EA. 2007. Estuarine versus transient flow regimes in Juan de Fuca Strait. Journal Of Geophysical Research-Oceans Volume: 112 Issue: C9 Article Number: C09022 Published: Sept. 27, 2007

Zar, J. H. 1984. Biostatistical Analysis. Second Edition. Prentice-Hall, Inc., Englewood Cliffs, NJ. 718 pp.

Analysis of Appropriate Sediment Background and Reference Areas for Port Angeles Harbor, Washington
June 9, 2008

Introduction

As part of public comment on the Port Angeles Harbor Sampling and Analysis Plan (SAP), questions have arisen regarding reference and background areas for the Harbor. The terminology and regulatory uses of the various kinds of background and reference areas are often complex, and the kinds of information needed to select appropriate background and reference areas are different. This paper addresses the types of background and reference areas that may be used and how they will be defined and the rationale for selection for the Port Angeles Harbor sediment investigation.

Definitions and Uses of Background and Reference Areas

Three types of areas are defined and used by various regulatory programs:

- **Natural Background –** Natural background is defined by the Model Toxics Control Act (MTCA) at WAC 173-340-200. It includes concentrations of chemicals that are naturally occurring, as well as concentrations of man-made chemicals that are globally distributed at low levels, such as PCBs, dioxins, and some radioactive isotopes.

  Natural background concentrations are used for a variety of purposes. For example, if a bioaccumulative chemical has a risk-based concentration that is below natural background, the cleanup standard for that chemical under the Sediment Management Standards is set at natural or "nonanthropogenic" background. Because risk-based standards for dioxin are typically below background, this is particularly important for Port Angeles Harbor and the Rayonier site.

- **Area Background –** Area background is also defined by the Model Toxics Control Act at WAC 173-340-200. It includes somewhat higher levels of contaminants "consistently present in the environment in the vicinity of a site which are the result of human activities unrelated to releases from that site."

  Area background can be used under MTCA as a cleanup standard if it can be demonstrated that area background is higher than natural background, and that cleanup to natural background cannot be achieved. Institutional controls and monitoring may be required if area background is used to set cleanup levels. There is no equivalent concept in the Sediment Management Standards.

- **Reference Area –** Reference areas are not defined in the Model Toxics Control Act or the Sediment Management Standards by rule. Reference areas were originally identified by the Puget Sound Estuary Program (1991) for the purposes of identifying clean comparison areas for bioassay testing. While few specific areas have been agreed upon in the scientific community, several important characteristics of potential

reference samples have been agreed on (MMC 1988; Ecology 1988; Michelsen & Striplin 2000; SEA 1996, 2003). These include:

1. The site should be located away from significant anthropogenic activity
2. Anthropogenic chemicals of concern should be below the Washington State SQS
3. The physical characteristics of the reference site must be similar to that seen in the test area (e.g., points, headlands, water depth, currents, wave action)
4. The sediment grain size and organic carbon content at the reference site must be similar to that at the test site

While reference areas have not been established or defined in the SMS, a definition of a reference sediment sample corresponding to the above four points is included in the definitions section at WAC 173-204-200(22).

Identification of Natural and Area Background Concentrations for Port Angeles Harbor

Natural and area background concentrations are critical for understanding the distribution of and setting cleanup standards for dioxins/furans and other bioaccumulative compounds in Port Angeles Harbor. These two types of background will be assessed as follows:

- **Natural Background.** By definition, natural background is not a site-specific or area-specific concentration. It includes only natural concentrations (such as dioxins from forest fires) or globally distributed concentrations (such as those carried atmospherically from other areas of the world). A group of federal and state agencies (Ecology, DNR, EPA, Corps, and the Puget Sound Partnership) are currently working together to collect all existing dioxin/furan data, and are conducting a field sampling effort in August, 2008 to collect 70 additional dioxin/furan/PCB congener samples (as well as other standard chemicals of concern) from reference areas and non-urban areas of Puget Sound. These efforts will provide a data set that will assist in defining non-urban, reference, and background concentrations in Puget Sound and the Strait of Juan de Fuca.

- **Area Background.** As part of the Port Angeles Harbor Sampling and Analysis Plan (SAP), stations have been placed along the outer edge (eastern part) of the harbor, as well as in the reference areas described above, to evaluate area-wide concentrations of dioxins/furans and other CoCs. These stations will help determine whether there are area-wide elevations of these compounds above the natural background concentrations being developed as described above, or whether concentrations outside the Harbor and localized site sources approach natural background levels.

Selection of a Reference Area for Port Angeles Harbor Studies

The current issue is whether Dungeness Bay, Freshwater Bay, or Sequim Bay would provide the best reference site for Port Angeles Harbor. It should be noted that reference

areas are used for **bioassay testing only**. They are not relevant to bioaccumulative compounds such as dioxins/furans, which are assessed through tissue concentrations and risk assessments rather than bioassay tests. Dioxins/furans in particular are not toxic to benthic invertebrates, which lack the Ah receptor through which dioxin/furan toxicity is expressed, and therefore the concentrations of dioxins in these bays is not an issue for selection of a reference area for bioassay testing.

Comparing the sites to the first criterion it is clear that both Freshwater and Dungeness Bays are located away from significant anthropogenic activity, and both locations have large rivers that empty into the surrounding marine environment. Sequim Bay, while not influenced by industrial activity, receives road runoff, is surrounded by private homes that are serviced by onsite septic systems, and is the location of the John Wayne Boat Marina. While Sequim Bay has been used as a site to collect reference sediment for toxicity testing in the past, the presence of the marina, non-point sources, and on-site septic systems, and the restricted flow of seawater at the entrance to the Bay, suggest that it is not an optimal sediment reference location for Port Angeles Harbor. In addition, the existence of mats of the filamentous bacteria *Beggiatoa* spp. has been reported in Sequim Bay. These bacterial mats tend to grow in nutrient rich sediments where low dissolved oxygen levels have led to the formation of sulfide compounds that could confound toxicity testing results.

The third criterion suggests that the reference and test areas have similar physical characteristics. Dungeness Bay is physically very similar to Port Angeles Harbor. Both embayments are protected by a spit of land from the strong currents in the Strait of Juan de Fuca and both have inputs of water and organic rich sediment from creeks and rivers. While Freshwater Bay also has a source of sediment from the Elwha River, the sediment tends to be coarse and the fines that are present are carried away by the longshore current into the Strait of Juan de Fuca. Sequim Bay is a semi-enclosed embayment with no rivers or creeks entering it, thus recent sediment arrives through runoff from the surrounding hillsides. Due to poor water circulation, portions of the Bay periodically experience low dissolved oxygen, unlike Freshwater and Dungeness Bays.

The fourth criterion calls for the test and reference locations to have similar grain size and organic carbon content. This is perhaps the most important criterion, because benthic invertebrate communities are highly structured by sediment type and the amount of organic material available as a food source. The ultimate goal of a reference area is to provide samples/data that may be protective of these benthic invertebrate communities and the demersal fish populations which use them as a food source. These groups, which represent two of the lowest trophic levels, may be the first to be affected by anthropogenic activity, thus the reference area should reflect the condition of the test area prior to the introduction of the activity that caused the impact. While no quantitative data are available to characterize the sedimentary environment in Port Angeles Harbor prior to its industrialization, inferences can be made by examining its physical characteristics and those of the proposed reference sites and then by examining sediment grain sizes and organic carbon content to find similarities among the proposed locations.

Statistical Comparison of Conventional Parameters in Potential Reference Areas

To this end, data from sediment sampling stations in Port Angeles, Freshwater, Sequim, and Dungeness Bays were examined to determine whether there are statistically significant differences in the percent fines (combined percent of silt and clay) and in the total organic carbon content of the sediment (Zar 1984; MS Excel 2003; Systat 2004).

To reduce the inherent variability in the data, each station in an embayment was considered to be a replicate sample from that embayment and summary statistics were calculated accordingly. This enables us to generally characterize a large area with a greater certainty than the variability is being accounted for. A similar approach was used to characterize the chemical and biological conditions at potential reference areas in Puget Sound (SEA 1996); by the Capital Regional District of the City of Victoria, B.C. to identify reference areas for comparison to chemical and biological conditions at their sewage outfall in the Strait of Georgia (SEA 2001, 2002); and is currently being used by the Department of Ecology's Sediment Ambient Monitoring Program to characterize benthic infaunal communities over large areas in Puget Sound.

The stations within each study area were not located based on a random sampling design, but were located to specifically identify areas were chemicals of concern may be located or to characterize sediment conditions for a potential reference site. However the spatial distribution of these stations encompassed large portions of their respective study areas, allowing a better characterization of the areas as a whole. The exceptions to this were the samples from Sequim Bay. The majority of data for sediments from Sequim Bay were taken from an area that was specifically located to act as control sediment for fine grained sediment toxicity tests. Thus the use of the Sequim Bay data would unduly bias the results of any analysis in favor of Sequim Bay. Even though these sediments have been used as control sediments there have been SQS hits and toxicity test control failures in Sequim Bay sediments (Michelsen 2008). For this reason and the presence of the marina, on-site septic systems, the restricted seawater circulation at the entrance to the Bay, and the presence of mats of the filamentous bacteria *Beggiatoa* spp. it was decided to remove Sequim Bay from further consideration as a potential reference site.

***t*-Test Results**

The tests conducted included a two sample t-test assuming unequal variances between the following categories:

Dungeness Bay versus Port Angeles Harbor
Freshwater Bay versus Port Angeles Harbor
Dungeness Bay versus Freshwater Bay

Table 1 shows the results of the t-test comparing the parameters of interest among the embayments.

Area	Freshwater Bay	Port Angeles		

	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.36	3.75	0.0000	0.0000
Percent fines	1.75	61.8	0	0
Area	Dungeness Bay	Port Angeles		
	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.7	3.8	0.0000	0.0000
Percent fines	28.2	61.8	0.006	0.011
Area	Dungeness Bay	Freshwater Bay		
	Mean	Mean	p (1-tail)	p (2 tail)
Total Organic Carbon	0.7	0.36	0.031	0.0621
Percent fines	28.2	1.75	0.017	0.034

The results in Table 1 indicate that Freshwater Bay, located to the west of Port Angeles, has a much coarser sedimentary environment than Port Angeles or Dungeness Bay. The mean TOC at Freshwater Bay was 0.36 percent with a percent fines of 1.75; compared to 0.7 percent TOC and 28.2 percent fines at Dungeness Bay, and 3.8 percent TOC and 61.8 percent fines at Port Angeles. Typically low amounts of TOC and percent fines characterize erosional environments where wave action and tidal currents do not allow fine particulate material to settle from the water column; and greater amounts of each reflect anthropogenic activity at Port Angeles Harbor and the accumulation of organic material and sediment trapped behind the spit at Dungeness Bay.

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Multiple regression analysis was conducted to examine the relationship between the organic content in the sediment and the percent fine grained material in each study area. A strong regression coefficient indicates a close relationship between the amount of TOC and percent fines. For example, a high coefficient may indicate a thorough mixing of TOC with silts and clays in the environment and that the input of this material is constant/consistent in arrival at the site; while a weak relationship may indicate that the organic material and/or silts and clays arrive in the area sporadically or that the organic material is larger thus physically and chemically difficult to break down. The regression relationship between percent fines and total organic carbon was strongest at Dungeness Bay with an r^2 of 0.865. This indicates that 86.5 percent of the variability in the organic carbon content of the sediment can be explained by percent fines. The regression coefficients at Freshwater Bay and Port Angeles were much lower. The r^2 value at Freshwater Bay was 0.102 and at Port Angeles was 0.026. In Port Angeles Harbor, the lack of correlation between percent fines and TOC may be related to the large amounts of anthropogenic woody debris present in that harbor.

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References

Ecology. 1988. Puget Sound Ambient Monitoring Program Marine Sediment Quality Implementation Plan. Prepared by Striplin, P. Prepared for the Washington State Department of Ecology and Puget Sound Water Quality Authority. Pp. 57. Publication No. 88-37

Ecology and Environment, Inc. (E & E), 1999, Glines Canyon Dam Level 2/3 Environmental Site Assessment Report, Prepared for the National Park Service, Olympic National Park.

Ecology and Environment, Inc. (E & E), 1998, Rayonier Pulp Mill Expanded Site Inspection, Prepared for EPA Region 10 – Superfund Technical Assistance and Response Team, TDD No. 97-06-0010.

Evans-Hamilton. 1987. Puget Sound Environmental Atlas. Prepared for the US Army Corps of Engineers, US Environmental Protection Agency, and Puget Sound Water Quality Authority, Seattle, WA. Evans-Hamilton, Inc., Seattle, WA.

Malcolm Pirnie. 2007. Phase 2 Addendum Remedial Investigation For the Marine Environment Near the Former Rayonier Mill Site, Port Angeles Washington. Prepared by Malcolm Pirnie Seattle, WA for Rayonier, Jacksonville, FL. Pp. 157 + Appendices.

Michelsen, T. and P.L. Striplin. 2000. Development of Warning Levels and Adverse Effects Levels for the Clover and Macaulay Point Outfalls. Attachment B to the Clover Macaulay Point Management Plan. Prepared for the Vancouver Island Capital regional District. pp 60.

Michelsen, T. 2008. Pers. Comm.

Microsoft Corp. 2003. Microsoft Excel for Windows: Tools: Data Analysis Module. Redmond, WA

Monitoring Management Committee. 1988. Puget Sound Ambient Monitoring Program. Final Report. Seattle, WA.

PSEP. 1991. Reference Area Performance Standards for Puget Sound. Prepared by PTI Environmental Services for the Washington State Department of Ecology, Olympia, WA. 73 pp. + Appendices

PTI. 1993. Recommendations for assessing adverse benthic effects in Puget Sound. Prepared for Washington Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA. 21 pp. + appendices.

Systat. 2004. SYSTAT for Windows: Statistics, Vers. 11. Evanston, IL. 750 pp.

Striplin Environmental Associates. 1996. Development of Reference Value Ranges for Benthic Infauna Assessment Indices in Puget Sound. Prepared for the Washington State Department of Ecology. January 1996. 45 pp + appendices.

Striplin Environmental Associates. 2001. Development of Reference Range Values for Benthic Infaunal Communities Surrounding the Macaulay Point Outfall. Pp.15

Striplin Environmental Associates. 2002. Benthic Infaunal Communities Surrounding The Macaulay Point Outfall. Pp. 20 + Appendices

Tetra Tech. 1990. Puget Sound ambient monitoring program: Marine sediment monitoring, Final Report. Prepared for the Washington Department of Ecology, Ambient Monitoring Section, Olympia, WA by Tetra Tech, Inc., Bellevue, WA. 262 pp.

Thomson RE, Mihaly SF, Kulikov EA. 2007. Estuarine versus transient flow regimes in Juan de Fuca Strait. Journal Of Geophysical Research-Oceans Volume: 112 Issue: C9 Article Number: C09022 Published: Sept. 27, 2007

Zar, J. H. 1984. Biostatistical Analysis. Second Edition. Prentice-Hall, Inc., Englewood Cliffs, NJ. 718 pp.