2. OBJECTIVES OF THE SEDIMENT INVESTIGATION

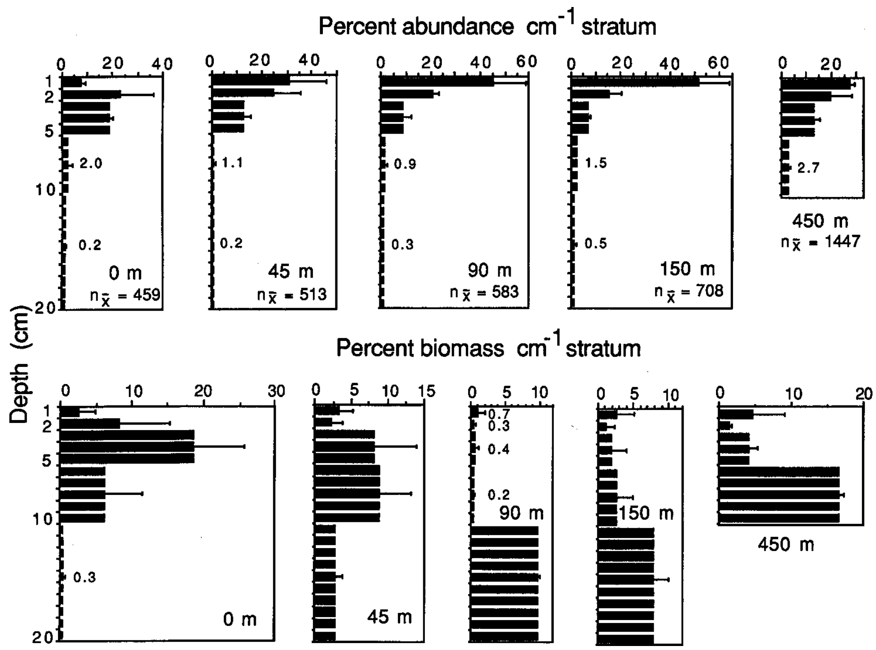
The overall goal of the sampling activities presented in this SAP is to develop enough information to support and complete a remedial investigation for the project site. The scope of data collection and evaluation activities for this phase are based on (1) a consideration of the overall objectives of the agreements among Ecology, the Lower Elwha Klallam Tribe (the Tribe), and Rayonier, and (2) the Deferral Agreement for the site (EPA, Ecology, and the Lower Elwha and KlallamTribe, 2000).

2.1 OVERALL DESIGN

The objective of the sediment investigation is to collect enough additional data to define the nature and extent of sediment contamination and to identify those areas, if any, where the sediments may pose a significant threat to human health and the environment. A phased approach is planned to characterize the COPCs in the sediments and to evaluate their impact on the environment. The general approach to be used in phase 1 is to assess the sediment quality in terms of the Washington State Sediment Management Standards (SMS). This includes the initial evaluation of sediment chemistry against the Washington State Sediment Quality Standards (SQS) and Cleanup Screening Level (CSL) standards followed by optional confirmational biological testing and ecological and human health food chain pathway evaluations as described in the sections below. Surface samples will be collected surrounding the existing areas with SQS exceedances so that the horizontal extent of the areas of concern can be delineated and any contaminant gradients can be established. The first phase focuses on surface sediments as this is the media of primary exposure to organisms (see related text box). However, subsurface sediment samples will be collected at select locations in the log pond and near the dock to provide a visual estimate of wood debris volume and possible evidence of historic accumulations of process-related materials. Subsurface sediment samples will be analyzed for conventional parameters (e.g., grain size, TOC, TVS). Additional sediment samples will be archived for possible future chemical analysis and could be triggered based on surface sample results. Based on the analytical results from Phase 1, the need for a Phase 2 sampling effort will be evaluated to supplement the characterization of the horizontal extent or to investigate contamination at depth. Characterization of wood waste impacts will be accomplished through a combination of chemical analyses and biological testing.

Topic Highlight: *Depth of Sampling*

For the determination of current and future risks of chemicals existing in sediments, the depth of sampling should be developed based on the vertical distribution of the organisms inhabiting the benthic habitat. "*Surface sediments*," as defined in the SMS (WAC 173-204-200), "*means settled particulate matter located in the predominant biologically active aquatic zone, or exposed to the water column*." The biologically active zone can be defined as the depth in the sediments where the majority of benthic infaunal organisms live. Typically this depth is considered to be between the surface and 10-20 cm. As documented by many researchers in a variety of subtidal soft-bottom benthic environments (e.g., Oliver et al. 1980, Weston 1990, Boyer and Whitlatch 1989, Aller and Dodge1974), the top 10-cm of sediment typically contains approximately 90 percent of the organisms by abundance. Organisms that are found below these depths are much less abundant and are typically larger burrowing forms, like clams (Rhoads, McCall and Yingst 1978). But even these life forms feed and have primary ingestion pathways to the surface sediments.



Vertical distribution (expressed as meters on the y axis) of total community abundance and biomass along a sampling transect.

Sampling and testing the top 10-cm of sediment evaluates potential impacts to the majority of benthic invertebrate community organisms. By ensuring that the surface sediments in the biologically active zone are not having adverse effects, the majority of the benthic infaunal organisms are also protected.

Historically, characterization of the benthic community and development of sediment quality values in the Puget Sound Region has been based primarily on surface samples using a van Veen or similar grab, which is capable of penetrating sediments to depths of about 17 cm. Thus, this methodology provides consistency in the approach to evaluate the sediments near this site, with past data and the data used as the scientific basis for the regulations.

In Puget Sound sediments, the average depth of the sediment mixed layer is 10 cm and the average residence time of particles in the mixed layer is 29 years (Carpenter et al. 1985). Thus, samples from the 10-cm mixed layer typically represent a time-integrated chemical concentration for about the last 29 years. For most of the Puget Sound region, there will be a 23 to 34 year lag[1] from the time of changes in anthropogenic activities to the time when chemical concentrations in well-mixed surface sediments fully reflect those changes. Thus, for the Rayonier facility, surface sediment samples from most locations will probably represent site conditions ranging from the present to as far back as the late 1960s to the mid 1970s.

In the past, Ecology and EPA have recommended chemical characterization of sediments in the upper 2 to 5 cm to ensure that relatively recent sediments are sampled, that sample volumes are adequate for analysis, and that data from different studies are comparable. However, more recent investigations, such as EPA's ESI for the Rayonier facility, sample the upper 10 cm for chemical characterization, which is the depth proposed for the sediment investigation in the Phase I RI.

Over half of the samples collected and analyzed by the EPA in 1998 during their Expanded Site Inspection (ESI) were from areas near the Rayonier facility or the Rayonier deepwater outfall. The survey of wood debris by Ecology (SAIC, 1999) included a number of sites in the vicinity of the Rayonier facility and a diver survey conducted by Rayonier in October 2000 provided additional data and observations on site conditions. These studies and data were reviewed, the areal extent of coverage was evaluated, and contaminant levels were compared to the SQS and CSL criteria. This evaluation identified the areas where additional sampling of sediments and wood debris is needed, as well as areas that appear to be adequately characterized. Four specific areas requiring additional sediment characterization data were identified. They are:

- An area surrounding the deepwater outfall (Outfall 001)
- An area around the dock including historical outfalls
- The log pond area
- Intertidal area

The sediment sampling program is designed to address these four areas. Sediment samples will be collected at the locations where previous COPC values were reported above the SQS or CSL guidelines. Samples will also be collected in the vicinity of these locations to better characterize the potential boundaries and gradients of potential contamination. Samples

[1] The 95 percent confidence interval for a sediment particle in the surface mixed layer is 23 to 34 years (Carpenter et al. 1985).

will be collected where prior conditions prevented sufficient coverage and in an area where recent operations may have had an impact. Finally, samples will be collected in the area where concentrated wood debris has been identified in both the Ecology study and the recent diver survey (Foster Wheeler Environmental, 2001).

At each sample location around the deep water outfall, dock, and log pond areas, surface and core samples will be collected and evaluated following the SMS guidelines. Specific chemical and physical analyses to be completed are discussed in Section 2.2 and sample locations are discussed in Section 2.4. Based on previous analytical results and the sample location design, there is the potential that, for a limited number of COPCs, the SQS or CSL criteria may be exceeded. At these locations, the next step of the analysis and characterization will be undertaken following the SMS guidelines. Bioassay tests, detailed in Section 2.3, will be performed to assess the toxicity of the sediment and its potential to adversely affect benthic communities. Select core samples may be analyzed for selected COPCs if the associated surface sample exceeds SQS.

The potential negative impacts to the marine environment of wood debris and chemicals associated with the degradation of wood debris must be evaluated separately from the standard COPC evaluation when undertaking the bioassay tests. To evaluate the effects of ammonia and sulfides on these tests, levels of these compounds will be reduced in samples prior to performing the test according to EPA protocols. This will be done for all samples subjected to the bioassay testing. However, characterization of the impact of wood debris is also an objective of this study. Consequently, bioassay testing of selected samples with high levels of wood debris will also be undertaken without the standard ammonia and sulfides reduction.

Based on the results of the diver survey and previous sampling, sediments in the vicinity of the deepwater outfall are not expected to have accumulations of wood debris. Consequently, bioassay testing, if needed at any locations near the outfall, is anticipated to include only standard COPCs. In the mill dock area, the results of the diver survey and Ecology (SAIC, 1999) study suggest there are scattered areas that may have accumulations of wood debris. Bioassay testing, if necessary, will include the standard testing procedure (i.e., purging if necessary) as well as testing without reduced ammonia and sulfide levels (i.e., non-purged). Samples subjected to both test protocols will be those with elevated total organic carbon (TOC) (e.g., generally >10 percent), elevated concentrations of resin and fatty acid constituents, or reported heavy accumulations of wood debris.

In the log pond area, results of sampling during the diver survey indicate there are elevated TOC levels compared to samples outside the log pond. During this survey, the diver observed significant amounts of wood debris intermixed with sediment in this area. The limited EPA ESI (EPA, 1998) sampling also suggest the log pond is an area where the accumulation of wood debris may be problematic. To better characterize the impact of the wood debris on the marine environment, the sediment investigation incorporates bioassay testing of selected samples from this area. This biological testing will be undertaken regardless of the analytical chemistry results. Concurrent bioassay testing (i.e., purged and non-purged) is planned for samples from the log pond in an attempt to separate the effects of COPCs and chemicals associated with the degradation of wood debris from the effects of the non-persistent conventional chemicals (e.g., ammonia and sulfide). Specific locations where this testing is planned are discussed in Section 2.4.

Once the results of the analytical chemistry and bioassay testing of surface samples, visual observations, and results of conventional parameters analyzed are available, an evaluation will be made to determine the need for a second phase of sampling. Phase II sampling will be undertaken to better define the potential horizontal and vertical (depth) extent of contamination around the stations where bioassay testing indicated adverse effects. A specific scope for the Phase II sampling will be developed, if necessary, following receipt and evaluation of the Phase I analytical and bioassay results.

Although future land use is uncertain, future exposure to intertidal sediments occur while recreating and harvesting clams. Information on the chemical concentrations of intertidal sediments is required to evaluate these potential human exposure pathways. Thus, sediments will be collected and analyzed for chemicals as discussed below.

2.2 CHEMICAL ANALYTES

The results of the 1998 EPA sediment investigation provide a basis for the selection of the chemical analytes to be considered in each of the three areas of investigation. Chemical constituents consistently not detected or consistently detected at levels below SQS levels will not be re-evaluated during this investigation. Analyses will focus on chemicals consistently detected, sometimes at elevated levels, during previous sediment investigations, as well as chemicals that may be associated with the natural degradation of wood materials. Proposed analytical testing is summarized in Table 2-1 and is discussed for each investigation area in the following sections.

2.2.1 Deepwater Outfall

Metals, volatile compounds, polynuclear aromatic hydrocarbon (PAH) compounds, and pesticides were either not detected or detected at levels below the SQS in all of the samples collected in the vicinity of the deepwater outfall. Testing will not be done for metals, volatile compounds, and pesticides in the current investigation. PAHs will be analyzed at outfall locations nearest to the diffuser (Stations OF-3, -4, -5) and will be archived at the remaining outfall stations.

Polychlorinated biphenyls (PCBs) were also not detected or well detected at low levels below the SQS at each of the previous outfall stations. However, in 1998 during the finishing room cleanup action, as reported by Rayonier to Ecology, a discharge of the wastewater and stormwater, potentially containing trace levels of PCBs, occurred through the deepwater outfall. Although the amount of PCBs discharged was unlikely to have been substantial enough to cause any detectable impacts, and because the actual amount of PCBs discharged was unknown, there is uncertainty about the potential impacts that this discharge may have had on the marine sediments. Consequently, each sample in the vicinity of the deepwater outfall will be analyzed for PCBs as Aroclors[2]®. Sufficient sediment sample from each location will also be archived for PCB congener testing, if necessary.

At station SD-59, located within 500 feet of the outfall diffuser, 4-methylphenol was detected at levels above the SQS. Consequently, selected outfall samples will be analyzed for phenolic compounds. Aliquots of the outfall samples will also be archived for potential analyses for selected resin acid, fatty acid, and guaiacols. Elevated TOC or phenols would trigger these additional analyses. Sufficient sediment sample will also be archived at each station for bioassay testing. Bioassays may be performed at any station where SQS chemical levels are exceeded.

Dioxin and furan levels in samples collected by EPA near the deepwater outfall were very low or not detected, these compounds with TEQ (TCDD equivalent) values being less than

[2] Sediment and biota samples will be archived and congener analyses will be performed if levels of PCBs as expressed by Aroclors are found in biota tissue that represent a significant human health or ecological risk .

Table 2-1. Marine Sediment Sample Summary

Station	Northing	Easting	Sample Type	Metals	SVOC	Selected Metals[h]	Selected Phenolics[a]	LPAHs	HPAHs	PCBs [b]	Selected SVOCs[c]	Selected Pesticides[d]	Dioxins/Furans	Selected Resin & Fatty Acids and Guaiacols	Bioassay Tests (Amphipod, Larval, Juvenile Polychaete)	Grain Size	TOC and TVS	Percent Moisture/ Total Solids	AVS	Total Sulfide, Ammonia	QA/QC[e]	Number of analyses	Archive (Yes or No)[i]	Trigger[f]	Analyses[g]
OF-01	423727	1015137	S							1					X	1	1	1				6	Yes	Exceedance of SQS or elevated TOC at nearest station	PAHs: selected phenolics, SVOCs, metals, and pesticides; selected Resin & Fatty Acids and Guaiacols
OF-02	422452	1016597	S							1					X	1	1	1				6	Yes	Exceedance of SQS or elevated TOC at nearest station	PAHs: selected phenolics, SVOCs, metals, and pesticides; selected Resin & Fatty Acids and Guaiacols
OF-03	421147	1018364	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		14	No		
OF-04	421132	1019409	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		14	No		
OF-05	421301	1021529	S			1	1	1	1	1	1	1	1	1	X	1	1	1	1	1		15	No		
OF-06	421239	1023343	S							1			1		X	1	1	1				7	Yes	Exceedance of SQS or elevated TOC at nearest station	PAHs: selected phenolics, SVOCs, metals, and pesticides; selected Resin & Fatty Acids and Guaiacols
OF-07	422667	1018948	S							1					X	1	1	1				6	Yes	Exceedance of SQS or elevated TOC at nearest station	PAHs: selected phenolics, SVOCs, metals, and pesticides; selected Resin & Fatty Acids and Guaiacols
OF-08	419627	1018810	S							1					X	1	1	1				6	Yes	Exceedance of SQS or elevated TOC at nearest station	PAHs: selected phenolics, SVOCs, metals, and pesticides; selected Resin & Fatty Acids and Guaiacols
MD-01	418328	1011758	S			1	1	1	1		1	1		1	X	1	1	1	1	1		12	No		
MD-02	418777	1011186	S			1	1	1	1		1	1	1	1	X	1	1	1	1	1		13	No		
MD-03	418555	1012116	S			1	1	1	1	1	1	1	1	1	X	1	1	1	1	1		14	No		
MD-03	418555	1012116	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	PAHs; selected phenolics, SVOCs, metals, and pesticides; PCBs; selected resin & fatty acids and guaiacols
MD-04	418341	1012584	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		
MD-05	418674	1012347	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		
MD-05	418674	1012347	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	PAHs; selected phenolics, SVOCs, metals, and pesticides; PCBs; selected resin & fatty acids and guaiacols
MD-06	419130	1011399	S			1	1	1	1		1	1		1	X	1	1	1	1	1		13	No		
MD-06	419130	1011399	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	PAHs; selected phenolics, SVOCs, metals, and pesticides; PCBs; selected resin & fatty acids and guaiacols
MD-07	419442	1011534	S			1	1	1	1		1	1		1	X	1	1	1	1	1		13	No		
MD-08	419351	1011830	S			1	1	1	1		1	1	1	1	X	1	1	1	1	1		14	No		
MD-08	419351	1011830	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	PAHs; selected phenolics, SVOCs, metals, and pesticides; PCBs; dioxins/furans; selected resin & fatty acids and guaiacols
MD-09	419240	1012167	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		

Table 2-1. Marine Sediment Sample Summary

Station	Northing	Easting	Sample Type	Metals	SVOC	Selected Metals[h]	Selected Phenolics[a]	LPAHs	HPAHs	PCBs [b]	Selected SVOCs[c]	Selected Pesticides[d]	Dioxins/Furans	Selected Resin & Fatty Acids and Guaiacols	Bioassay Tests (Amphipod, Larval, Juvenile Polychaete)	Grain Size	TOC and TVS	Percent Moisture/ Total Solids	AVS	Total Sulfide, Ammonia	QA/QC[e]	Number of analyses	Archive (Yes or No)[i]	Trigger[f]	Analyses[g]
MD-12	419630	1011932	S			1	1	1	1		1	1		1	X	1	1	1	1	1		13	No		
MD-13	418413	1012358	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		
MD-14	418568	1011823	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		
MD-15	418910	1012233	S			1	1	1	1	1	1	1		1	X	1	1	1	1	1		13	No		
MD-16	418757	1011700	S			1	1	1	1	1	1	1	1	1	X	1	1	1	1	1		14	No		
MD-17	418890	1011808	S			1	1	1	1	1	1	1	1	1	X	1	1	1	1	1		14	No		
MD-18	419147	1011710	S			1	1	1	1	1	1	1	1	1	X	1	1	1	1	1		14	No		
MD-18	419147	1011710	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	PAHs; selected phenolics, SVOCs, metals, and pesticides; PCBs; dioxins/furans; selected resin & fatty acids and guaiacols
LP-01	417881	1010019	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-02	417891	1010439	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-03	417817	1010685	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-04	418048	1010242	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-04	418048	1010242	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-05	418019	1010645	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-05	418019	1010645	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-06	417997	1011068	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-07	418258	1009603	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-08	418195	1010040	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-09	418181	1010480	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-10	418131	1010831	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-11	418365	1010231	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-11	418365	1010231	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-12	418312	1010663	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-12	418312	1010663	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols

Table 2-1. Marine Sediment Sample Summary

Station	Northing	Easting	Sample Type	Metals	SVOC	Selected Metals[h]	Selected Phenolics[a]	LPAHs	HPAHs	PCBs [b]	Selected SVOCs[c]	Selected Pesticides[d]	Dioxins/Furans	Selected Resin & Fatty Acids and Guaiacols	Bioassay Tests (Amphipod, Larval, Juvenile Polychaete)	Grain Size	TOC and TVS	Percent Moisture/ Total Solids	AVS	Total Sulfide, Ammonia	QA/QC[e]	Number of analyses	Archive (Yes or No)[i]	Trigger[f]	Analyses[g]
LP-13	418283	1010975	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-13	418283	1010975	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-14	418548	1010011	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-15	418525	1010452	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-16	418479	1010804	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-17	418780	1010058	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-17	418780	1010058	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-18	418674	1010608	S	1	1					1		1	1	1	1	1	1	1	1	1		12	No		
LP-18	418674	1010608	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
LP-19	418868	1010352	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-20	418044	1010927	S	1	1					1		1	1	1	X	1	1	1	1	1		11	No		
LP-20	418044	1010927	C													TBD	TBD	TBD				TBD	Yes	Exceedance of SQS in nearest surface sample	Metals, Selected Phenolics, PAHs, PCBs, Dioxins/Furans, Selected Resin & Fatty Acids and Guaiacols
IT-01	EST	EST	S		1	1				1		1	1	1		1	1	1	1	1		11	No		
IT-02	EST	EST	S		1	1				1		1	1	1		1	1	1	1	1		11	No		
IT-03	EST	EST	S		1	1				1		1	1	1		1	1	1	1	1		11	No		
IT-04	EST	EST	S		1	1				1		1	1	1		1	1	1	1	1		11	No		
IT-05	EST	EST	S		1	1				1		1	1	1		1	1	1	1	1		11	No		
HS-01	419558	1006534	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-02	419699	1006634	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-03	419913	1006787	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-04	420278	1007045	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-05	418932	1007165	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-06	419166	1007318	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-07	419772	1007713	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
HS-08	420238	1008017	S	1	1					1		1	1	1		1	1	1	1	1		11	No		
Count	Locations			28	33	26	21	21	21	53	21	54	41	54	9	59	59	59	54	54		684			

Table 2-1. Marine Sediment Sample Summary

Station	Northing	Easting	Sample Type	Metals	SVOC	Selected Metals[h]	Selected Phenolics[a]	LPAHs	HPAHs	PCBs [b]	Selected SVOCs[c]	Selected Pesticides[d]	Dioxins/Furans	Selected Resin & Fatty Acids and Guaiacols	Bioassay Tests (Amphipod, Larval, Juvenile Polychaete)	Grain Size	TOC and TVS	Percent Moisture/ Total Solids	AVS	Total Sulfide, Ammonia	QA/QC[e]	Number of analyses	Archive (Yes or No)[i]	Trigger[f]	Analyses[g]

S = Surface Grab
C = Core Sample
X = Archive sample and submit for bioassay testing if SQS exceeded.
EST = The locations of these stations will be established in the field; locations shown on Figure 2-2 are approximate.
TBD = To be determined. The number of samples from each core will be determined in the field based upon visual statification.
a = Selected Phenolics (Method 8270 SIM) -- Phenol, 2-methylphenol, 3-methylphenol, 4-methylphenol, 2,4 dimethylphenol, Pentachlorophenol
b = Archive PCB samples for possible congener analysis
c = Selected SVOCs includes pyridine
d = Selected pesticides include alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT
e = QA/QC samples will be collectd at a frequency of 5 percent to be assigned randomly in the field.
f = Indicates what analytical results will trigger additional chemical analyses.
g = Indicates what additional chemic alanalyses will be triggered by initial analytical results.
h = Selected metals include arsenic, cadmium, copper, lead, mercury, selenium, and zinc.
i = Refers to archeiving of surface or subsurface sediment samples for possible future chemical analyses based upon exceedence of SQS or elevated TOC in associated surface sediment sample or nearest associated surface sediment sample.
Sediment samples will also be archeived for possible PCB congener analyses (see footnote b) or for possible bioassay testing as noted.

1 part per trillion (ppt). Consequently, additional dioxin/furan testing in the areas already sampled is not necessary. However, EPA collected no samples to the east of the outfall. Dioxin/furan testing will be conducted at the two proposed outfall stations located furthest to the east (OF-5 and OF-6; see Table 2-1).

2.2.2 Dock

Previous samples from the dock area, including those near the historical nearshore outfalls, contained a greater number of COPCs than the deepwater outfall samples discussed above. A number of these COPCs were present at levels above the SQS or CSL. For this reason, sample spacing has been decreased in this area and more analytes will be considered in the chemical analyses of the samples collected near the dock.

Pesticides and PCBs were not detected or were detected at levels below the SQS in all of the 20 samples collected from the dock vicinity. For those samples nearest the Ennis Creek delta, PCBs were not detected or were well below (<10 percent) the SQS. Analysis for PCBs is proposed for surface sediment at sample locations on the east side of the dock (see Section 2.4).

Metals detected in the earlier samples were generally at levels significantly below (<50 percent) SQS levels at all stations in the vicinity of the dock. Analyses for metals in the dock samples are not proposed.

PAHs and phenolic compounds (i.e., 4-methylphenol) were detected at elevated levels, some exceeding the SQS or CSL guidelines, in several samples near the dock and historical outfalls. Each new surface sample will be analyzed for these compounds.

Wood debris has been reported by Ecology (SAIC, 1999) and observed during the diver survey in scattered areas surrounding the dock. Each of the surface sediment dock samples will be analyzed for selected resin acids, fatty acids, and guaiacols, as well as ammonia and total sulfides. Sufficient sample volume will be collected for bioassay testing, if necessary. Exceedance of an SQS will trigger the bioassay testing.

Dioxin and furan values in samples from the vicinity of the dock were low, with an average TEQ concentration equal to 1.42 ppt. Additional testing of the proposed dock samples for dioxins/furans is not proposed.

Core samples are proposed at select surface sample locations in the vicinity of the dock to evaluate the presence of accumulations of historic fiber deposits. Cores will be logged and visual observations of historic fiber deposits will be documented. In addition, cores will be analyzed for conventional analyses (grain size, TOC, TS, and percent TVS). Cores will be 6-8 feet long, and archived for sediment chemistry analysis associated with the surface sample. An exceedance of SQS in the surface sample will trigger analysis of the first core interval.

Cores will be sampled according to stratification found in the core. Each stratum will be treated as a different sample. The sample intervals will be determined in the field with change of statigraphic horizon. For example, woody debris in a silt-sand substrate changing to silt-sand without woody debris will be seen as two separate horizons and collected as two separate samples. A sample will need to incorporate at least a foot of the core for sufficient sample; therefore horizons that are very thin will not be separate samples.

Analytical results of TOC and percent TVS may be similar for natural organic debris horizons (e.g., algae deposits) compared to horizons with woody debris originating from mill processes. Notes will be taken to describe each horizon found in the cores on log forms. Organic rich horizons that contain woody debris such as twigs will be noted as different from woody debris horizons originating from the mill.

2.2.3 Log Pond

Sampling in the log pond during the EPA ESI study was limited to two intertidal and two subtidal samples collected near sunken logs that had accumulated throughout this area. Therefore, existing analytical results for sediment contaminants are limited for this area. For this reason, each surface sample proposed in the log pond area will be analyzed for the suite of SMS compounds (e.g., metals, semivolatile organic compounds [SVOCs], and PCBs). Analyses for dioxins/furans, resin and fatty acids, and guaiacols will also be conducted for the samples in this area. No pesticide analyses are proposed due to the limited detections seen in earlier sampling.

In 1999, Rayonier removed a significant number of logs to allow for sampling in the log pond area. Wood debris mixed with, and resting on the sediment, was observed during the diver survey (Foster Wheeler Environmental, 2001). Samples were collected during the diver survey and analyzed for TOC. Elevated (>10 percent) TOC levels were observed in much of the northern area of the log pond. For this reason, each of the surface sediment log pond samples will be analyzed for selected resin acids, fatty acids, and guaiacols, as well as ammonia and total sulfides and other conventionals.

Subsurface sediment samples will be collected in the log pond at eight locations to provide a feasibility study - level estimate of the volume of wood debris accumulation. These locations are in the area with the highest TOC levels from previous surface sampling. A few cores are placed out of this area to border suspected high wood concentration zones. Cores will be logged and visual observations of wood debris deposits will be documented. In addition, cores will be analyzed for conventional analyses (grain size, TOC, TS, and percent TVS). Core lengths will be 10-12 feet long, and archived for possible sediment chemistry analysis associated with the surface sample. An exceedance of SQS in the surface sample may trigger chemical analysis of core intervals.

Cores will be sampled according to stratification found in the core. Each stratum will be treated as a different sample. The sample intervals will be determined in the field with change of stratigraphic horizon. For example, woody debris in a silt-sand substrate changing to silt-sand without woody debris will be seen as two separate horizons and collected as two separate samples. A sample will need to incorporate at least a foot of the core for sufficient sample; therefore horizons that are very thin will not be separate samples.

Analytical results of TOC and percent TVS may be similar for natural organic debris horizons (e.g., algae deposits) as compared to horizons with woody debris originating from the log pond. Notes will be taken to describe each horizon found in the cores on log forms. Organic rich horizons that contain woody debris such as twigs will be noted as different from woody debris horizons originating from the log pond.

2.2.4 Intertidal Area

Surface sediment samples will be collected from the intertidal zone and analyzed for metals, SVOCs, PCBs, and dioxins/furans. For purposes of this intertidal sampling task, the intertidal zone is defined as extending from +2 to –2 feet MLLW and surface sediments are defined as extending from 0 to 1 foot below the sediment surface.

2.3 BIOLOGICAL TESTS

Bioassay testing for sediment toxicity will be undertaken following the SMS guidelines at any surface sample station where a COPC is above the SQS. As detailed in the SMS guidelines, bioassay testing can be undertaken to confirm the toxicity of specific samples that exceed the chemical SQS.

The purpose of the sediment toxicity testing is to evaluate the degree and nature of potential surface sediment toxicity to marine organisms resulting from historical activities and releases to the marine area surrounding the former Rayonier Mill Site. The design of the studies will provide data regarding the acute and chronic effects of sediments on both benthic and epibenthic organisms from the perspective of mortality, growth, and reproduction. The tests are also intended to provide data for evaluation of the toxic effects of chemicals (i.e., SMS and wood-related breakdown products) versus those of non-persistent natural compounds (e.g., ammonia, sulfides). The evaluation framework and decision criteria will follow the SMS procedures. The results of the toxicity tests will be used to identify areas that need additional characterization in Phase II and will be used to evaluate the potential toxicity of wood-related breakdown products. These results will also be used to evaluate potential impacts due to accumulations of wood debris in sediments.

2.3.1 Testing Program

SMS sediment biological testing, if conducted, will be performed following the tiered-testing protocols at stations that exceed the SQS. In addition, bioassay testing will be performed concurrently with the chemical analyses at selected surface sediment locations in the log pond where accumulations of wood debris are likely. These tests will consist of:

- Acute 10-day amphipod mortality
- Acute bivalve or echinoderm embryo larval mortality/abnormality
- Chronic 20-day juvenile polychaete mortality and growth

The bioassay framework is designed to incorporate: 1) seasonal variability in species availability/sensitivity, and 2) varying grain size distributions. Additional descriptions of bioassay protocols for each of these tests are provided in Section 6.2. Bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out sediment grain size effects on bioassay organisms. Guidance for selecting appropriate reference locations is provided by the Puget Sound Estuary Program (PSEP) and the Puget Sound Dredged Disposal Analysis (PSDDA) program (Corps et al., 2000). Sediment grain size is the primary determinant of a reference location. One of the approved reference sites (i.e., Sequim Bay, Carr Inlet, Samish Bay, or Holmes Harbor) will be selected. Sequim Bay is the most likely reference location due to its proximity to Port Angeles Harbor.

Sediments located within the log pond and potentially at other locations around the mill area have elevated organic carbon content, which may be associated with wood debris. Organic matter may be derived both from natural and anthropogenic sources. Regardless of the source, the decay of organic matter may produce non-persistent compounds such as ammonia and hydrogen sulfide that are toxic to benthic organisms. Consequently, the biological testing program is designed not only to understand the extent of adverse effects, but to also understand the cause of those effects (i.e., whether toxicity is derived from elevated contaminant concentrations or from organic enrichment).

Once a decision to conduct biological testing is made based on an SQS exceedance, bioassay test sediments will be chemically analyzed for both ammonia and sulfide concentrations. While both ammonia and hydrogen sulfide are known to be toxic to benthic organisms (Kohn et al., 1994; Knezovich et al., 1996), hydrogen sulfide is difficult to measure and toxicity trigger values are not in common use. Therefore, ammonia concentrations will be used to trigger additional tests to control the potential toxicity due to these non-persistent compounds. In addition to conducting the standard PSEP tests, a second set of toxicity tests will be performed with ammonia-reduction procedures. The protocols for ammonia and sulphur reduction will be conducted according to approved methods prior to or concurrent with conducting the toxicity tests. For the amphipod solid-phase test, an EPA-approved purging protocol (EPA, 1994) will be followed to reduce porewater ammonia concentrations to below 30 mg/l. For the larval test, the amphipod purging protocol will be used to reduce test solution ammonia concentrations below 0.5 mg/l (Ecology, 1995a). For the chronic polychaete test, the acute amphipod purging protocol will be followed to reduce ammonia concentrations below 20 mg/L. Use of more passive purging protocols (e.g., use of an alga to absorb the excess ammonia) will also be considered. The more passive protocol would reduce potential concerns associated with the purging protocol. These will be defined specifically in the Bioassay Laboratory SOQs when the laboratory is contracted. Ammonia will be measured in sediment porewater at the beginning of each test, and will be monitored in overlying water during the tests. At the termination of the tests, sediment porewater will only be retested in the acute amphipod and chronic polychaete bioassays. Porewater ammonia cannot be measured at the termination of the bivalve larva or echinoderm embryo bioassays because these tests use a low volume of sediment.

Concurrently, laboratory reference toxicant experiments will be performed on the bioassay test organisms to establish the toxicity of ammonia that would likely contribute to adverse effects in test organisms and possible failures of test criteria. The test will be conducted in a manner similar to the standard reference toxicant test (positive control), which is based on a dilution series. An LC50 (concentration lethal to 50 percent of the test population) or EC50 (adverse effect concentration in 50 percent of the test population) will be calculated based on the concentrations of ammonia in sediment interstitial water for the amphipod and on overlying water ammonia concentrations of the larval test. The results of the ammonia positive control tests (e.g., LC50s) will be compared with porewater (amphipod and polychaete tests) and overlying water (larval test) ammonia results and used in the interpretation of the test results.

2.3.2 Deepwater Outfall

Sufficient surface sediment samples will be collected for bioassay testing at all locations in the deepwater outfall area. Bioassay testing will only be undertaken on the outfall samples if the sediment concentration for one of the chemical analytes is found to be above the SQS. Based on the low TOC levels (<1 percent) observed in the EPA samples, bioassay testing for chemicals associated with wood debris degradation is not anticipated. Sediment sampling locations that may be tested for toxicity are described below in Section 2.4.

2.3.3 Dock

Sufficient sediment samples will be collected for bioassay testing at all locations in the dock area. If sediment concentrations of any chemical analytes in any sample are above SQS levels, bioassay testing will be performed for that sample. Additional bioassay testing to evaluate the impact of chemicals associated with wood debris degradation will be considered as well. The need for additional testing will be evaluated based on analytical results for TOC and the selected resin acids, fatty acids, and guaiacols as well as the bioassay testing results from the log pond area. Sediment sampling locations that may be tested for toxicity are described below in Section 2.4.

2.3.4 Log Pond

Sufficient sediment samples will be collected for bioassay testing at all 19 surface sample locations in the log pond area. To quantitatively evaluate the impact of wood debris on the marine environment, bioassay tests will be undertaken at nine sample locations (see Table 2-1) irrespective of analytical results for COPCs. To evaluate the effects of ammonia and sulfides on bioassay tests, levels of these compounds will be reduced in samples prior to performing the test according to EPA protocols. Both standard methods, and methods to reduce non-persistent compounds will be conducted to discriminate the effects of non-persistent compounds (e.g., ammonia, sulfides) from the effects of COPCs and chemicals associated with the degradation of wood debris. At the other 11 surface sample stations in the log pond area, bioassay tests will be performed for any sample with COPC concentrations above an SQS level. The need for bioassay testing at these additional locations will be evaluated based on analytical chemistry results, concentrations of non-persistent compounds, and other bioassay results. Sediment sampling locations that may be tested for toxicity are described below in Section 2.4.

2.4 SAMPLING STATION LOCATIONS

Figures 2-1 and 2-2 provide the proposed locations for the sediment sampling activities. These locations have been selected based on an evaluation of the data collected during the EPA ESI (EPA, 1998) and comments received from the Site Management Team.

2.4.1 Deepwater Outfall

For the area surrounding the deepwater outfall, previous sediment analytical results (ESE, 1998) indicate that, with one exception, COPC concentrations in the sediments are consistently below the SQS. The one exception was at station SD-59 (see Figure 2-1) where sediments contained 4-methylphenol in excess of the standard.

Initial modeling of the effluent particulate deposition around the outfall indicated previous sampling might not have extended as far from the outfall as necessary, especially in an easterly direction. In addition, release of potentially PCB-contaminated wastewater through the outfall in 1998 post-dates the EPA sampling in 1997. Sampling in the outfall area is designed to address these data gaps.

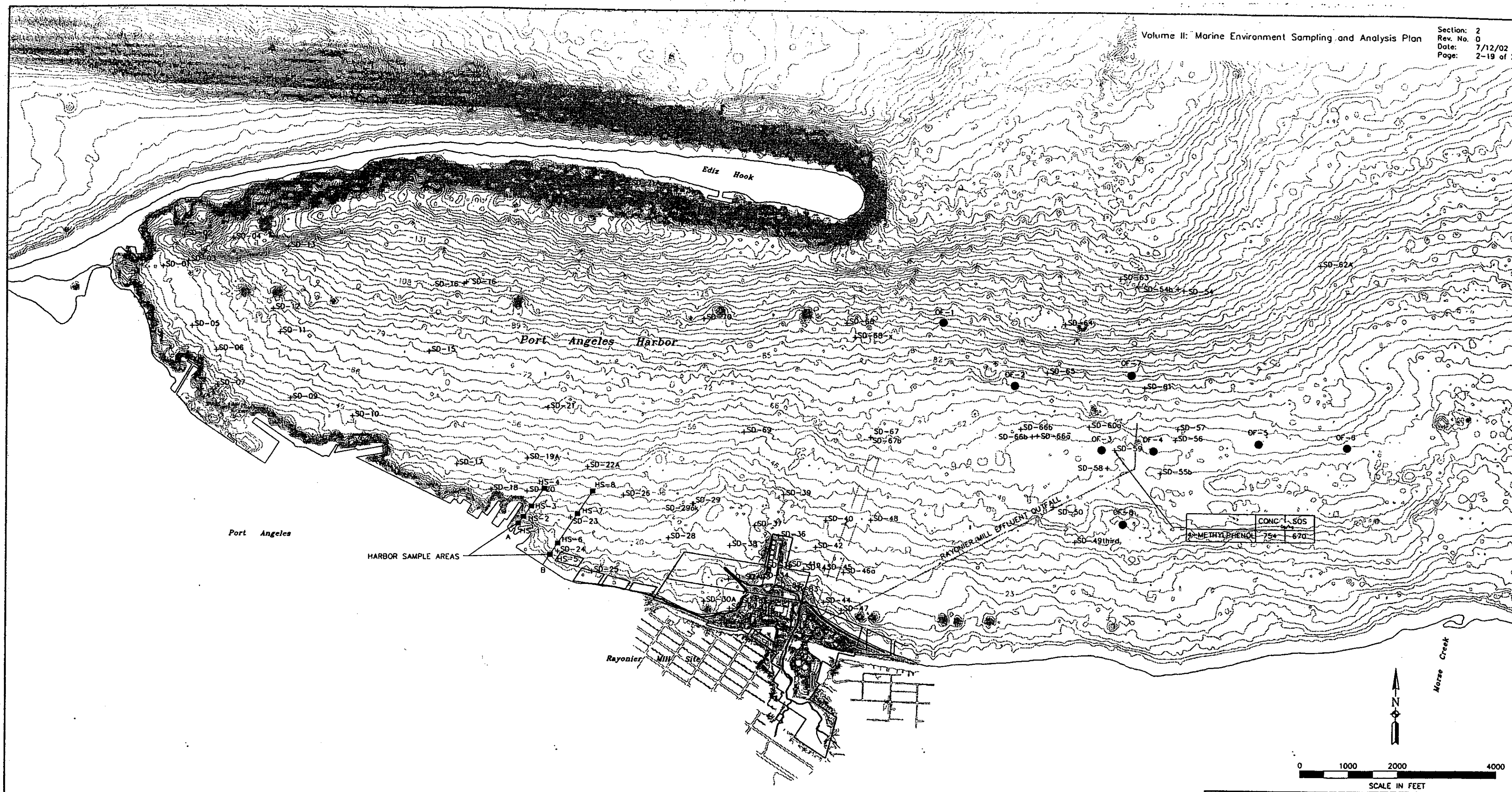
Preliminary effluent depositional modeling indicates the zone of highest solids deposition rates from the outfall extends roughly 1.1 miles in an east-west direction. The north-south axis is smaller, approximately 1,000 feet, due to the geometry of Port Angeles Harbor, current directions, and bottom slopes. Samples will be collected in this elliptical area surrounding the outfall diffuser field (see Figure 2-1).

A sample will be taken near the location of station SD-59 to replicate the earlier sample that showed an elevated concentration of 4-methylphenol. Other points are distributed in a systematic pattern within the sample area. Based on the analytical results as described in Section 2.1, the need for a Phase II sampling effort to characterize a wider area or to depth will be evaluated.

2.4.2 Dock

For the area surrounding the dock and extending into the harbor, previous sediment analytical results at 20 stations (EPA, 1998) revealed sediment quality concerns at four stations. Sediments from station SD-82, located in the intertidal area near historical outfall B (see Figure 2-2), had concentrations of seven PAH constituents that exceed the SQS or CSL. Sediments from stations SD-42 and SD-43, east of the dock, exceeded the CSL for 4-methlyphenol. Sediments from station SD-36, at the north end of the dock, had three PAH compounds that exceeded the SQS. Sediments from sampling stations to the west of the dock, near the historical nearshore outfalls C and D, the Ennis Creek delta, and further from the dock area have COPC concentrations below the SQS criteria (see Figure 2-2).

Sampling in the dock area will focus on those areas with observed values above SQS and CSL levels. New surface samples will be taken at each of the four stations with SQS exceedances in the ESI study. Additionally, core samples will be taken at those four locations to assess historical fiber deposits and archived for potential chemical analysis. Surface samples will also be collected surrounding those areas so that the horizontal extents of the areas of concern can be delineated and gradients for COPC can be established (Figure 2-2). Based on the analytical chemistry results and any biological testing performed, the need for a Phase II sampling effort will be evaluated.



LEGEND

- SD-45 = EPA ESI SEDIMENT SAMPLE LOCATIONS
- OF-1 = OUTFALL SAMPLES
- = DEPTH CONTOUR (3-FT INTERVAL)
- HS-1 = HARBOR SAMPLES

DATUM
HORIZ: NAD83, WA SPC N. ZONE

FIGURE 2-1

OUTFALL AND HARBOR SEDIMENT SAMPLE LOCATIONS

RAYONIER PORT ANGELES MILL SITE

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SCALE: AS NOTED	APPROVED	DATE: 11/15/01
DIVISION:		
DRAWN: KSK		
CHECKED:		

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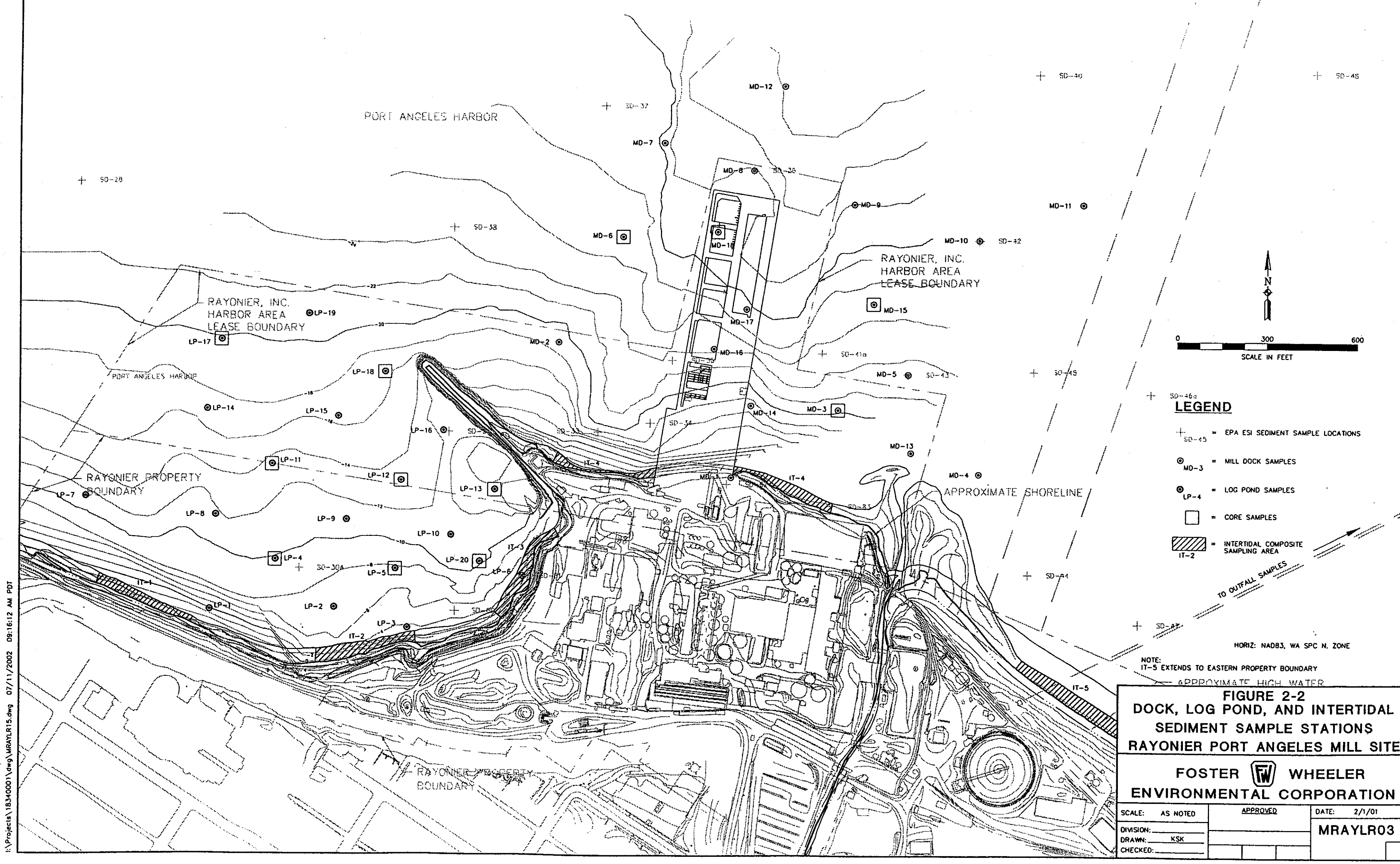

FIGURE 2-2
DOCK, LOG POND, AND INTERTIDAL SEDIMENT SAMPLE STATIONS
RAYONIER PORT ANGELES MILL SITE

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SCALE: AS NOTED	APPROVED	DATE: 2/1/01
DIVISION: DRAWN: KSK CHECKED:		MRAYLR03

2.4.3 Log Pond

Four samples were collected in the log pond area in EPA's previous sampling effort. Sediment from station SD-81, located in the intertidal area in the vicinity of the historical nearshore outfall E (see Figure 2-2), exceeded the CSL for 4-methlyphenol and the SQS for acenaphthene. Although all reported analytical values at SD-32 were below SQS levels, no semivolatile or pesticide/PCB data were available. For the remaining two stations, SD-80 near the shoreline and historical outfall E, and SD-30 located outside the historical log boom in the log pond area, the COPC concentrations did not exceed any of the SQS values.

The log pond is also an area where wood debris is potentially mixed with, and resting on, the sediment. An accumulation of sunken logs also limited sampling efforts by EPA in 1997 (EPA, 1998) and Ecology in 1999 (SAIC, 1999). A log removal effort was undertaken by Rayonier in 1999 and provided better access for future sampling efforts.

To address the limited amount of data in the log pond area and to characterize the extent of wood debris and potential wood debris-related contaminants, a more extensive set of samples will be collected in the log pond area. Stations SD-81 and SD-32 will be sampled again. An additional 17 surface samples, spaced on an approximate 250-foot grid will also be collected (Figure 2-2). Core samples will be collected at five stations located in the area of highest TOC results. Three additional cores are located outside the area with potential wood debris to give a better estimate on the extent of wood debris accumulation. Core samples will be analyzed for conventional parameters related to wood debris assessment, and archived for possible future chemical analysis based on surface sample results. Based on the analytical chemistry and biological testing results, the need for a Phase II sampling effort to characterize a wider area or to depth will be evaluated.

2.4.4 Intertidal Area

Intertidal sediment samples will be collected from five areas within the mill boundary as approximated in Figure 2-2. Three sample areas are located in the log pond, one around the base of the dock, and one along the beach east of Ennis Creek. Samples will be collected within the +2 to –2 MLLW tidal stage and from 0 to 1 foot below the sediment surface. The sediment sample from each area will be a composite of five individual grab samples.

2.4.5 Harbor Samples

Harbor samples will be collected from the nearshore area in the southeast section of Port Angeles Harbor (Figure 2-1). About one-third of the total number of samples used for site characterization in the vicinity of the dock and the log pond are proposed for harbor samples. Sample locations are shown in Figure 2-1. Two transects will be sampled within harbor area at the locations indicated. Within each transect, four sediment samples will be collected at the 5-ft, 15-ft, 25-ft, and 35-ft (MLLW) depth contours. These depths are selected because they represent:

- The range of depths that will be sampled in the vicinity of the dock, former nearshore outfalls, and the log pond;
- A range of physical oceanographic conditions, which can dynamically influence sediment movement, sorting, and grain size in the nearshore environment;
- Possible nearshore locations that may be influenced by human activities, but which are not related to site conditions;
- Habitats that are similar to those in the vicinity of the former Rayonier Mill Site.

Methods for sample collection, handling, transport, and chemical analyses are provided in Section 4 below.