

4 WORK PLAN RATIONALE

The following section outlines the general approach to the remedial investigation. A discussion of data quality objectives and the process used to identify data gaps and approaches to collect the data necessary to fill those gaps is presented in Section 5.1. Each subsequent section provides an overview of data gaps by media type, and the approach to collecting the necessary information in the remedial investigation. Specific sampling locations, analytes, and methods are documented in Volume II.

4.1 DATA QUALITY OBJECTIVES NEEDS

DQOs are qualitative and quantitative statements that specify the characteristics of the data necessary to support decisions and the required quality of the data collected (EPA QA/G4, 2000). Through the development of DQOs, the objectives and methods to be used in the field investigations are clearly defined.

DQOs are specified for each activity associated with the RI/FS and are typically developed through a seven-step process:

- State the problem.
- Identify the decision.
- Identify inputs to the decision.
- Define the study boundaries.
- Develop a decision rule.
- Specify limits on decision errors.
- Optimize the design for obtaining data.

For the data collection activities, these steps are condensed into an interactive, three-stage process including identification of decision types, identification of data uses and needs, and design of a data collection program. These three stages may be further detailed as described in the following sections.

4.1.1 IDENTIFICATION OF DECISION TYPES

This stage of the DQO process identifies the project scope and guides the development of the management plans. The key components are the identification of project objectives, major decisions, data users, and available data.

4.1.1.1 Objective and Major Decisions

The objective of this study is to develop an RI report that can be used in an associated FS and risk assessment (RA) to determine the appropriate actions for the former Rayonier

Mill Site. The major decisions on actions will control, contain, stabilize, and remediate areas of potential concern at the former Rayonier Mill Site and associated marine and off-site locations. This activity will require the identification of potential areas of concern, associated COPCs, potential receptors, and exposure (migration pathways). These aspects are discussed in detail in other sections of the Work Plan.

4.1.1.2 Data Users

The data users will include both primary and secondary users. Primary users are involved in ongoing site activities and include lead decision makers. Secondary users rely on the data for supporting review and external activities. Primary data users include members of the former Rayonier Mill Site Management Team (SMT) consisting of representatives of Ecology, Rayonier, Inc., and the Tribe. Secondary users include members of the Regulatory Technical Advisory Group (RTAG), organized public groups, as well as EPA and the public at large.

4.1.1.3 Evaluation of the Available Data

The SMT has held a series of meetings to discuss and review available data. This effort has culminated in a series of public information meetings and development of briefing papers, which are available for public review. These efforts compiled the previous site data, including the recent ESI conducted by E&E. The existing data provide substantial information on the nature and extent of contamination, although there are specific data gaps requiring additional work. An initial site conceptual model has been developed, which provides a preliminary understanding of the possible sources of contamination, potential migration pathways, and the potential receptors. This initial model will be refined as part of the ongoing effort. The existing data, data gaps, and conceptual model are discussed in detail in other sections of this Work Plan.

4.1.2 IDENTIFICATION OF DATA USES AND NEEDS

This stage of the DQO process involves identification of data uses and needs, data types, and data quality needs. The elements of this stage are interrelated and undergo refinement as more data become available, and scoping is refined.

4.1.2.1 Data Uses and Needs

The data generated from the field investigations will be used to 1) fill existing data gaps, including the extent of contamination; 2) support a risk assessment (determine risk); 3) prepare the RI report; 4) develop remedial options through a feasibility study. Data gaps are discussed in detail in other sections. Selected requirements include determination of background levels in soils and groundwater, additional sampling to determine extent of potential contamination in soils and levels in the former log yard area, additional sampling to determine potential levels in biota; a refined site conceptual model, and an ecological and human health risk assessment to evaluate the potential

risk posed by the former Rayonier Mill Site to public health and the environment, including the aquatic marine biota.

4.1.2.2 Data Types

Several types of data are required for the investigation: physical parameters (including location information); and chemical contaminant distributions in soil, groundwater, sediment, and biota. This will require both field measurements and off-site laboratory analyses. The SAP (Volume II) and Table 3-1 of the QAPP (Volume III) provide detailed information on the data types and matrices for collection.

4.1.2.3 Data Quality Needs

The necessary level of data quality must be determined when the data uses and types are identified. In general, to support the data uses identified above, one must develop “definitive data” as defined in EPA 540-R-93-071 (EPA, 1993). This level of data quality corresponds to older EPA definitions of DQO Level III and DQO Level IV data quality (EPA 540/G-87/003, EPA, 1987). Field measurements and certain elementary analyses will generally correspond to the EPA definition of “screening data” (EPA, 1993). The data quality requirements are discussed further and presented by matrix in the QAPP (Volume III), including Table 3-1. The data quality needs will also help define the appropriate analytical methods. These are also detailed in the QAPP (see Tables 3-2 to 3-5)

4.1.3 DESIGN OF THE DATA COLLECTION PROGRAM

The intent of this DQO stage is to compile the existing information and requirements, including task-specific DQOs, into a comprehensive program design for data collection. A detailed list of data to be collected includes phase, media, sample type, mass/volume of collected sample, number of samples, location of samples, analytical methods, and QA/QC samples. In addition, a rationale for sampling and analyses should be included, together with documentation and reporting requirements. Details on the procedures must also be identified. The basic rationale is presented elsewhere in this volume, and is expanded in the associated SAP (Volume II). The detailed listings of the DQOs and data collection requirements are presented in the QAPP (Volume III), especially in Tables 3-1 through 3-6.

RI data needs generally fall into three major categories:

- Data to define the nature and extent of contamination
- Data to define potential pathways of contaminant migration
- Data to determine whether, or to what extent, threats to human health and the environment exists

4.2 GENERAL APPROACH AND OVERVIEW TO THE WORK PLAN

The following sections discuss, by media, the data that are needed to complete an RI for the uplands at the former Rayonier Mill Site. The following sections discuss the data gaps and overall approach to the RI for each medium identified for further sampling.

4.2.1 SOIL

The objectives of the soil investigation parallel those of the overall RI; that is, to determine the nature and extent of chemicals of concern in order to assess the current and future risks to human health and the environment. More specifically, the goal of the soil investigation is to ensure that adequate, representative data are collected, and are then used to conduct risk assessments at each of the areas comprising the site to reliably evaluate potential upper-bound risks based on current conditions at the site. The soil investigation design has been prepared to meet this project goal. The soil investigation design is based on knowledge of the historical use of the site and previous site inspections. Soil samples will be collected from a number of potential on-site source areas.

Based on previous sampling investigations at the site, several different potential source areas have been identified. The purpose of the on-site soil investigation is to further define, through a judgment-based sampling process, the extent of chemical concentrations at the site. The sampling approach will integrate results from previous sampling and judgment based on known or suspected contamination, the kind of industrial activities that were conducted in this area, and data needs for risk assessment. The spatial distribution of samples was selected to screen areas not previously sampled and to further characterize areas where previous sampling indicated elevated chemical concentrations. Table 4-1 outlines the existing data gaps and the sampling activities to address these needs.

Table 4-1. Upland Soil Data Needs and Planned RI Activity (Part 1 of 3)

Existing Data Gap	Remedial Investigation Activity
<p>1. Subsurface soils are not adequately characterized for associated surface COPCs in several site areas.</p>	<p>Conduct subsurface soil sampling and analysis for selected COPCs in specific areas as indicated:</p> <ul style="list-style-type: none"> • Bone Yard – arsenic • Log Yard – inorganics, dioxins/furans, and PAHs • Main Process Area: • Recovery Boiler – arsenic • Finishing Room – dioxins/furans • Screening Room – dioxins/furans • Blowpits – dioxins/furans • Pulp Warehouse – dioxins/furans
<p>2. Soils in the Wood Mill area are not characterized.</p>	<p>Conduct surface and subsurface soil sampling and analysis for inorganics, PCBs, petroleum hydrocarbons, and dioxins/furans.</p>
<p>3. Existing Data Gap: Soil below the SSL Lagoon left in place following the removal action has not been adequately characterized.</p>	<p>Remedial Investigation Activity: Collect a surface and subsurface soil sample from immediately above the groundwater table and analyze for metals, PAHs, dioxins/furans, and PCBs.</p>
<p>4. Historical information suggests the SSL pipeline may have leaked. Associated soil under the line has not been adequately characterized. Also, surface soil conditions have not been adequately characterized in this area.</p>	<p>Conduct surface and subsurface soil sampling adjacent to the line. Analyze for metals, PAHs, and dioxins/furans.</p>
<p>5. The extent of elevated contaminants in surface soils is not adequately bounded in certain areas.</p>	<p>Conduct surface soil sampling and analysis for selected COPCs in specific areas as indicated:</p> <ul style="list-style-type: none"> • Bone Yard , north and east – arsenic • Log Yard, west end – dioxins/furans • Log Yard, southern end, unpaved – dioxins/furans • Recovery Boiler, north and south – arsenic • Finishing Room, north and south – dioxins/furans
<p>6. The extent of elevated dioxin levels near the screening room is not clearly delineated.</p>	<p>Conduct surface (and subsurface as noted above) sampling and analyze for dioxins/furans in the surrounding area.</p>
<p>7. The spatial coverage of samples in the Log Yard area is not adequate to address selected COPCs.</p>	<p>Conduct surface (and subsurface as noted above) sampling and analyze for inorganics, dioxins/furans and PAHs at additional locations in the Log Yard area.</p>

Table 4-1. Upland Soil Data Needs and Planned RI Activity (Part 2 of 3)

Existing Data Gap	Remedial Investigation Activity
<p>8. The spatial coverage of samples analyzed for dioxins/furans in suspect source areas within the main process area is inadequate.</p>	<p>Conduct surface sampling and analyze for dioxins/furans in selected location vicinities as follows:</p> <ul style="list-style-type: none"> • Bleach Plant • Blow Pits • Chip Surge • Dock • Pollution Control Equipment • Pulp Warehouse • Recovery Boiler
<p>9. Surface and subsurface soils are not characterized for petroleum hydrocarbons.</p>	<p>Conduct surface and subsurface soil sampling in areas of likely petroleum contamination as noted below. Analyze for petroleum hydrocarbons (NW TPH-G and NW TPH-Dx, and VPH/EPH fractions, if found) and PAHs.</p> <ul style="list-style-type: none"> • Fuel Oil Day Tank • Fueling area (vicinity of above ground 550 gallon tanks) • Fuel Oil pipeline (dock to fuel Tanks 1 and 2) • Power House • Wood Mill
<p>10. An anomalous detection of copper occurs near the Pre-Fab Building</p>	<p>Inspect the surface soil for obvious copper oxide discoloration. Collect surface soil samples from any such areas and analyze for copper. Resample the original location, and analyze for copper to confirm or negate its presence. Also analyze the sample from the original location for dioxins/furans to enhance the characterization in this area of the site.</p>
<p>11. Arsenic is detected at elevated levels near the Recovery Boiler area, where there was no obvious source.</p>	<p>Resample selected surface soil locations, and analyze for arsenic to confirm levels (in addition to sampling described above).</p>
<p>12. Previous investigations reported total arsenic in soils; only the inorganic form contributes to toxicity.</p>	<p>Evaluate all arsenic results (including additional identified samples) against comparable Ecology background soil concentrations. If further evaluation is required, employ phased approach, which may include bioavailability testing, or analytical speciation of arsenic forms.</p>

Table 4-1. Upland Soil Data Needs and Planned RI Activity

(Part 3 of 3)

Existing Data Gap	Remedial Investigation Activity
13. Sampling in the undeveloped portion of the site is inadequate to support an ecological risk assessment.	Conduct supplemental ecological sampling in following areas: <ul style="list-style-type: none"> • East Coastal Bluff – upland forest habitat • West Coastal Bluff – upland forest habitat • Ennis Creek Corridor – riparian habitat • Site Entrance Woodland – upland forest habitat Collect surface soil, plant and earthworm samples. Analyze samples for potential contaminants associated with stack and fugitive dust emissions (inorganics, PAHs, and dioxins/furans). Because of historical releases, add semi-volatile organic chemicals and PCB analyses to the lower Ennis Creek samples.
14. Sampling in the developed portion of the site is inadequate to support an ecological risk assessment.	Conduct ecological sampling in selected open-ground areas where wildlife exposure to soil-borne chemicals is a potential concern. Collect surface soil, plant, and earthworm samples and analyze for dioxins/furans, PAHs, PCBs, and metals.
15. Soils in the East Roll Storage area have not been adequately characterized.	Conduct surface and subsurface soil samples and analyze for inorganics, PAHs, and dioxins/furans.
16. Evaluation of off-site soil	During Phase I, an air deposition model, dioxin congener analysis, and evaluation of existing off-site soil data will be conducted. Based upon Phase I results, additional off-site soil sampling may be required as part of Phase II.

4.2.2 GROUNDWATER

Previous investigations at the former Rayonier Mill Site have generated a significant volume of data relating to groundwater quality. As a result, the existing data set is, to a large extent, sufficient to evaluate contaminant pathways and assess potential risks to human health and the environment. However, the collection of some additional information is necessary to close existing data gaps and complete an RI at the former Rayonier Mill Site. A discussion of each of the existing data gaps relating to groundwater at the former Rayonier Mill Site and the RI activities needed to obtain the information required to close each data gap are outlined in the following sections and summarized in Table 4-2.

As discussed in Section 3.2.2, drinking water standards are not applicable to groundwater on the mill site. As part of the RI/FS, groundwater data will be compared to state and federal ambient surface water criteria protective of aquatic organisms and humans consuming aquatic organisms.

Table 4-2. Summary of Existing Data Gaps for Groundwater Pathway and Planned RI Activities

Existing Data Gap	Remedial Investigation Activity
1. Physical characteristics of the fill aquifer: <ul style="list-style-type: none"> • Determination of current water table surface using data from all existing and newly installed monitoring wells. • Determination of hydraulic conductivity. • Determination of groundwater flow directions, gradient, and velocity. • Evaluation of water balance across the former Rayonier Mill Site. • Evaluation of tidal influence across the former Rayonier Mill Site. • Determination of aquifer matrix characteristics: bulk density, grain size distribution, effective porosity, organic carbon content, and cation exchange capacity. 	Activities to close data gaps relating to the physical parameters of the water-bearing zone will include the following: <ul style="list-style-type: none"> • Water level elevation measurements in all monitoring wells. • Development of water level contour maps inclusive of all existing and newly installed well data. • Performance of slug tests and grain size evaluation to estimate hydraulic conductivity. • Performance of 24-hour manual water level measurement across the site to identify wells with greater than 0.1-foot tidal influence followed by pressure transducer and data logger in affected wells to assess tidal influence and determine mean values. • Calculation of water balance. • Laboratory analyses of soil samples collected within aquifer for geotechnical parameters.
2. Current groundwater quality data set does not meet EPA requirements for usability.	Collection and laboratory analysis of groundwater samples from selected existing monitoring wells on site.
3. Detection limits exceed screening criteria for some nondetected analytes.	Use of analytical methods capable of indicating concentrations at or below screening criteria, where possible.

4.2.2.1 Physical Characteristics of Fill Aquifer

Knowledge of the hydraulic gradient, conductivity, degree of tidal influence in any new wells that are constructed at the former Rayonier Mill Site, groundwater flow direction, and other physical characteristics of the fill aquifer is necessary to complete the overall groundwater evaluation. Some of these data were obtained during previous investigations. Because significant demolition activity has taken place at the former Rayonier Mill Site since this information was collected and stormwater practices have been altered, additional data acquisition is required during the RI.

Two methods will be used to verify groundwater gradient and flow patterns: 1) measurement of the depth to groundwater in all viable existing and newly installed wells with electronic water level probes during the terrestrial field program; 2) at least one 72-hour tidal influence survey, with water-level measurement data recorded from dedicated, constant-reading pressure transducers.

Data from both collection methods will be interpreted through the preparation of a series of water table surface maps and flow nets. Conclusions concerning the groundwater gradient and flow patterns will be obtained from these graphic displays. The depth to the highest effective low-permeability layer will also be confirmed.

General water quality parameters that influence the effectiveness of groundwater treatment technologies will be evaluated during the RI. The efficacy of treatment technologies is affected by groundwater quality characteristics such as hardness, alkalinity, total dissolved solids, specific conductivity, presence of certain anions and cations, etc. These parameters will be measured in groundwater samples collected from representative wells.

4.2.2.2 EPA Requirements for Usability

The groundwater data set used in the preparation of the RI Work Plan is derived from groundwater sampling events that took place from 1997 to 1999. Additional groundwater samples will be collected from 20 existing groundwater monitoring wells (PZ-3, PZ-4, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, MW-23, MW-29, MW-51, MW-52, MW-53, MW-54, MW-55, MW-56, MW-57, MW-58, MW-59).

Groundwater samples collected from the existing wells will be analyzed for the presence of selected trace metals (arsenic, chromium, copper, lead, nickel, selenium, and zinc), VOCs (EPA Method 8260 target analyte list), SVOCs (EPA Method 8270 target analyte list), chlorinated pesticides (EPA Method 8081), PAHs (EPA Method 8270 and/or EPA Method 8310), diesel (Northwest -TPH Dx), and conventional parameters including ammonia and pH.

4.2.2.3 Nondetected Analytes with Detection Limits Exceeding Screening Criteria

As noted previously, analytical detection limits for a number of chemicals were found to exceed established screening criteria. Because of this, a nondetect result for any of the analytes shown in Table 3-1 cannot be unambiguously interpreted to mean the concentration of the analyte in groundwater is below screening criteria.

The analyses of groundwater samples collected during the RI will use laboratory methodologies that achieve detection limits at or below screening criteria where technically feasible.

4.2.2.4 Groundwater Conditions Beneath the Former Main Operations Areas

Because a number of facilities, buildings, and structures occupied the interior process areas of the former plant, GMWs were not installed in the active process areas of the former Rayonier Mill Site during previous investigations. Removal of these structures as part of plant dismantling activities make it possible to access the former operational and process areas with mechanical drilling and sampling equipment.

Three GMWs (MW-57, MW-58, and MW-59 on Figure 3-4) were recently installed to assess the nature and extent of groundwater containing COPCs beneath the former operational areas.

GMW MW-57 was located in the area formerly occupied by the acid plant, digester building, and power boilers. GMW MW-58 was positioned to evaluate groundwater conditions beneath the former locations of the bleach plant, screen room, and machine room. Groundwater samples collected in GMW MW-57 and MW-58 will be analyzed for the presence of selected trace metals (arsenic, chromium, copper, lead, nickel, selenium, and zinc), VOCs (EPA Method 8260 target analyte list), SVOCs (EPA Method 8270 target analyte list), chlorinated pesticides (EPA Method 8081), PAHs (EPA Method 8270 and/or EPA Method 8310), diesel (Northwest-TPH Dx), and conventional parameters including ammonia and pH. GMW MW-59 was installed north of the SSL lagoon to assess potential infiltration of chemicals from the lagoon. Groundwater samples from GMW MW-59 will be analyzed for the same constituents as GMW MW-57 and MW-58.

4.2.3 ENNIS CREEK SEDIMENTS

Previous investigations and remedial actions at the former Rayonier Mill Site have generated enough data to adequately characterize freshwater sediment quality conditions in Ennis Creek. As a result, the existing data set is sufficient to evaluate contaminant pathways and assess potential risks to human health and the environment. As discussed above in Section 3.1.3 and summarized below, the data for Ennis Creek freshwater sediments were collected from source locations targeted to evaluate worst-case conditions. The results show that levels of all COPCs in the sediment samples are well below levels that would be detrimental to the freshwater or marine environments.

Freshwater sediment samples were collected from Ennis Creek during the EPA ESI (E&E, 1998) and targeted the area around the finishing room as an area of potential concern. Eight co-located surface water and freshwater sediment samples were collected throughout Ennis Creek (see Figure 3-5). Three of the samples were collected upstream of the former Rayonier Mill Site and identified as background samples by EPA (E&E, 1998). Sample EC07 was located in White Creek above its confluence with Ennis Creek, and sample EC08 was located in Ennis Creek above the Ennis/White Creek confluence. Sample EC06 was located in Ennis Creek below the confluence of the two creeks, but upstream of any probable contamination points of entry from sources on the mill site. Five samples were collected along the creek within the facility boundaries. Sample EC05 was located in the creek near the parking lot area to characterize potential contaminant inputs from runoff from the secondary treatment area drainage ditch. Three sampling stations (i.e., EC02, EC03, and EC04) were located near the former finishing room area, and station EC01 was located just beyond the mouth of the creek.

Washington State has not adopted specific standards for freshwater sediments; however, Ecology (1997) evaluated a number of potential sediment quality criteria that could be applied to freshwater sediments. That study proposed FSQVs as guidance levels for Washington State. The Ecology (1997) study indicated that the sediment quality standards for metals were appropriate criteria to use in evaluating freshwater

sediments. The study also indicated that the probable apparent effects threshold (PAET) Microtox[®] criterion for organic compounds was somewhat more appropriate for freshwater sediments than the SQS. The FSQV guidance levels were based on a combination the SQS for metals and the PAET Microtox for organic compounds.

EPA (E&E, 1998) used the three background freshwater sediment samples collected from Ennis and White creeks for comparison to sediment samples collected from within the site area on Ennis Creek. Several metals were detected at levels above the CRDLs among the three background samples. None of these concentrations were above the FSQVs Washington State uses as guidance values. Sample EC07 was the only one of the three background samples analyzed for dioxin/furans. Three dioxin congeners (i.e., total TCDD, total HpCDD, and OCDD) were detected above the CRQL. The dioxin TEQ concentration for this sample was 0.05 ppt.

Concentrations of COPCs found in the five freshwater sediment samples located in Ennis Creek, within the Mill Site boundaries, compare well with the background samples. Total organic carbon (TOC) levels were low, generally less than 1 percent. In Sample EC01, collected just beyond the mouth of the creek, acetone was detected at 64 µg/kg and above the undetected quantity within the background samples. Sample EC03 was the only other sediment sample to contain a target analyte at a concentration that exceeded a background concentration, total TCDF at 1.6 ppt. Although two COPC were elevated relative to the background samples, concentration levels of all detected COPCs from each of the Ennis Creek sediment samples were well below the FSQVs used as guidance to screen freshwater sediments in Washington State. PCBs were not detected in any of the sediment samples, including those collected next to the finishing room. Dioxin TEQ was lower at the facility station (0.01 ppt) than at the background location (0.05 ppt). Although the data for Ennis Creek freshwater sediments are limited to five samples, they show that levels of all COPCs are well below levels that would be detrimental to the freshwater or marine environments.

An interim action was conducted at the Finishing Room in 1998 that removed contaminated soil extending eastward to the sheet pile wall on the western bank of Ennis Creek. A second interim action was conducted in 2002 to address potential contamination occurring in soils east of the sheet pile wall and/or potentially occurring in sediment in Ennis Creek. A total of 1248 tons of affected soil/sediment were removed from the area, as well as, the sheet pile wall, two concrete standpipes, shoreline riprap, and groundwater monitoring and extraction wells. The excavation was backfilled with clean graded fill material and the area was modified to improve the habitat. Table 4-3 describes the planned RI activities for the sediments of Ennis Creek.

Table 4-3. Summary of Potential Concerns for Freshwater Sediments Pathway and Planned RI Activities

Potential Concern	Remedial Investigation Activity
1. Determine the upstream extent of potential contaminants.	No additional background sampling is needed. Previous background sampling occurred upstream of the facility at three locations. Additional sampling occurred near the upstream boundary, along the creek, and at the creek mouth. Levels of COPCs either are not detected or are consistently lower than FSQV levels. Essentially, background levels exist along the entire length of the creek as it crosses the former Rayonier Mill Site.
2. Evaluate the extent of contamination in the freshwater sediments in Ennis Creek.	The levels of COPCs found during the EPA ESI (1998) are comparable to background levels and are well below Washington State FSQV guidance levels. During the recent interim action, petroleum hydrocarbon and PCB-affected sediments were removed from the former Finishing Room area. Sediments will be collected from a single location upstream from the Finishing Room interim action to confirm the acceptable nature of the sediment quality.
3. Evaluate exposure to the freshwater sediments as part of the revised site conceptual model.	Existing freshwater sediment data will be used as the revised site conceptual model is developed.

4.2.4 OFF-SITE SOIL

Previous investigations at the former Rayonier Mill Site conducted by EPA (E&E 1998) have generated a significant volume of data about the concentrations of dioxins in the city of Port Angeles. Unfortunately, these data were not interpreted thoroughly during the ESI reporting phase. EPA noted that dioxin levels were below the residential cleanup level of 1 ppb (EPA 1998b). ATSDR also reviewed the data and concluded there probably would not be any health effects based on the concentrations observed during EPA's study. Additionally, many sources of the chemical releases can occur in the city environment.

To ensure a common understanding and to identify the scope of any additional work, this Work Plan proposes a two-phased process for further investigation of off-site chemical levels: Phase 1 – analysis of existing data and Phase 2 – additional soil sampling and analysis. The first phase focuses on a thorough analyses and presentation of the existing data set for the Port Angeles area, as well as other communities within the northern Olympic Peninsula. This analysis will consist of three parts: (1) air modeling to delineate the areas of primary particulate deposition from the former Rayonier Mill Site, (2) an evaluation of dioxin congeners to determine if patterns from different sources are identifiable from the former Rayonier Mill Site, and (3) an evaluation of chemical data EPA collected as stratified by isopleths resulting from air modeling and congener distributional analyses. These are discussed further in the sections below.

The second phase would target soil collection and analyses. If warranted, samples could be collected to further define sources, evaluate ambient conditions, and further refine understanding of deposition isopleths.

4.2.4.1 Dioxin Pattern Analyses

Dioxin releases to the environment come from numerous sources. EPA has grouped sources of dioxin-like compounds into five broad categories: combustion sources (e.g., waste incineration, agricultural burning, forest fires, and volcanoes); metals smelting, refining and processing sources; chemical manufacturing (e.g., by-products from the manufacture of chlorine bleached wood pulp, biological and photochemical processes); reservoir sources (i.e., materials or places that contain previously formed dioxins/dibenzofurans); and biological and photochemical processes (e.g., microbial action and photolysis of chlorinated compounds). Environmental releases of dioxins/dibenzofurans in the United States come from a wide variety of sources, but are dominated by releases to the air from combustion sources.

Formation of dioxins/dibenzofurans may occur in combustion processes from the oxidation of carbon particulate catalyzed by a transition metal in the presence of chlorine.

Dioxins and dibenzofurans are persistent chemical classes that are found everywhere. Because there are numerous sources of non-site-related dioxins (both natural and man-made), it becomes important to identify, where possible, the potential sources of the dioxins that may be found in the Port Angeles area. In other words, where possible, it is important to understand whether dioxins found in areas surrounding the former Rayonier Mill Site result from operations at the facility, or whether they result from other sources of dioxin, either natural, or from some other, unrelated industrial emission source.

Dioxin-like compounds include the following chemical classes: polychlorinated dibenzo-p-dioxins (PCDDs or CDDs) and polychlorinated dibenzofurans (PCDFs or CDFs). The CDDs include 75 individual compounds, and the CDFs include 135 different compounds. These individual compounds are technically referred to as congeners. Seven of the 75 congeners of CDDs are thought to have dioxin-like toxicity; they have chlorine substitutions in, at least, the 2, 3, 7, and 8 positions. Also, 10 of the 135 possible congeners of CDFs are thought to have dioxin-like toxicity; these have substitutions in, at least, the 2, 3, 7, and 8 positions. All the PCDF or PCDD congeners that fall within a certain degree of chlorination (i.e., all the PCDDs that have five chlorines [called tetrachlorinated dibenzodioxins, or TCDD], or all PCDFs that have five chlorines [called tetrachlorinated dibenzofurans, or PeCDF]), are called homologues.

Many authors have approached the task of dioxin source identification. While some methods used are fairly straight forward, other authors have employed complex statistical techniques. However, no preferential methodology seems to have been

widely accepted in the open literature, and none has been adopted by any regulatory body to identify dioxin sources. Therefore, we propose using a tiered analytical approach based on methods presented in the scientific literature. The techniques that will be employed preferentially are described by Yamamoto and Fukushima (1993), and Bright et al. (1999).

The dioxin analytical results for each area of interest (residential, industrial) will be compiled. The first decision to be made is the treatment of analytical results that contain non-detect values for an individual congener or set of congeners. Bright et al. (1999) indicates past experiences with polychlorinated biphenyls have shown that the method of treatment of these sample results can result in drastically different outcomes. The problem with the use of common practices in treating such non-detect results, such as using the detection limit or half the detection limit, is the congener-specific detection limits tend to vary nonrandomly. Use of the detection limit or half the detection limit in profile analyses can create artificial correlations and can incorrectly influence the results of the analysis. The solution to this problem suggested by Bright et al. (1999) is to generate a random number from between zero and the detection limit based on a distribution appropriate to the data set, and then use the result in place of the "ND."

To compare the homologue profiles across samples, the homologue concentrations must be normalized. In normalizing homologue concentrations, the contribution of each homologue relative to the overall dioxin-like chemical concentration is established, and the homologue pattern at each location of interest can be compared to the patterns of suspected sources and background concentrations. For each sampling location, the homologue sums can be normalized to relative concentrations using the following equation:

$$\textit{Homologue normalized concentration} = \frac{\textit{Individual Homologue Concentration}}{\sum \textit{Individual Homologue Concentrations}}$$

such that the sum of all normalized homologue concentrations for a given sample location equals 1.0, or 100 percent. The use of normalized concentrations allows samples that may differ dramatically in concentration, but are indicative of the same source, to be compared to one another graphically (Figure 4-1). In the absence of normalization, the presence of a sample data with much higher overall concentrations could obscure the profile of a lower concentration sample when, in fact, the source of the dioxin could be the same.

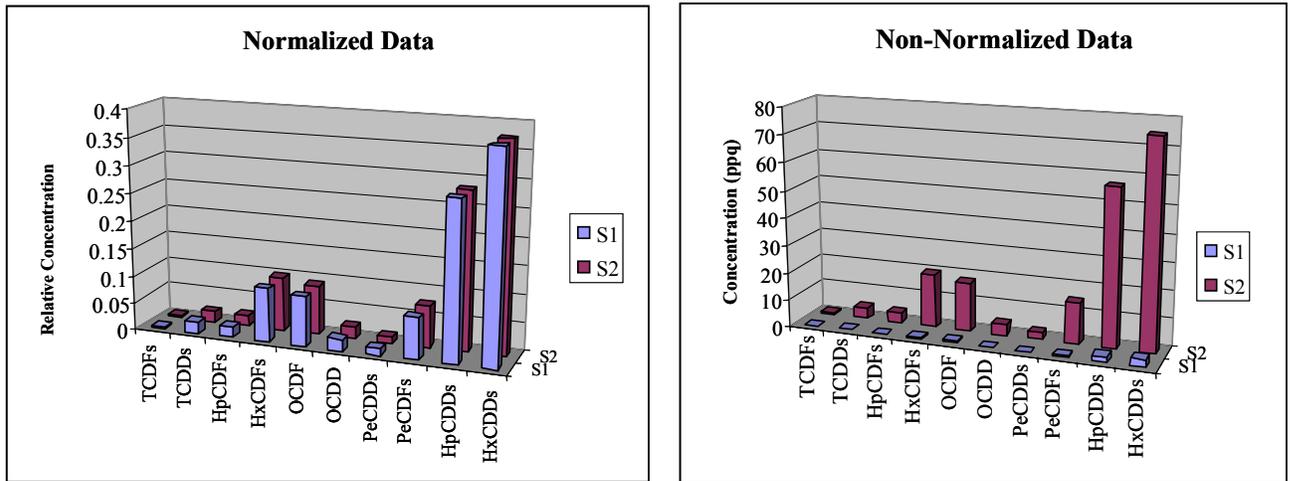
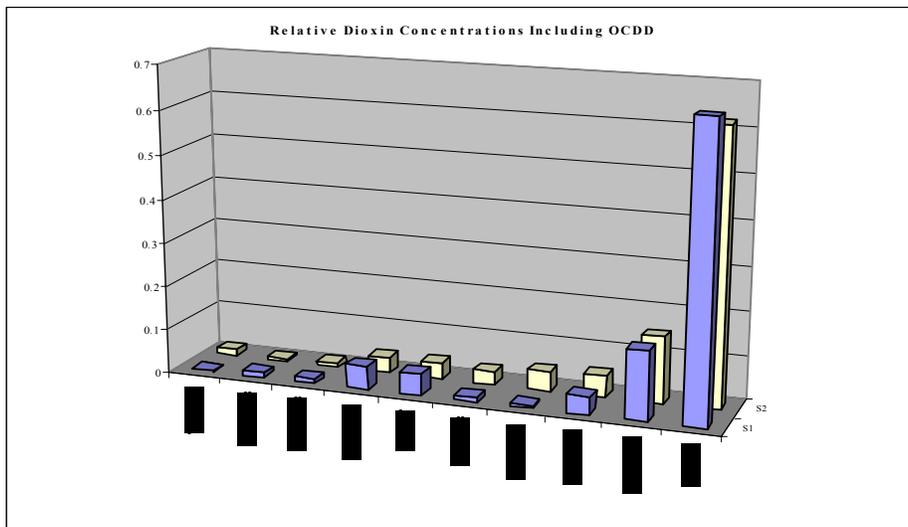


Figure 4-1. Examples of Normalized and Non-normalized Data

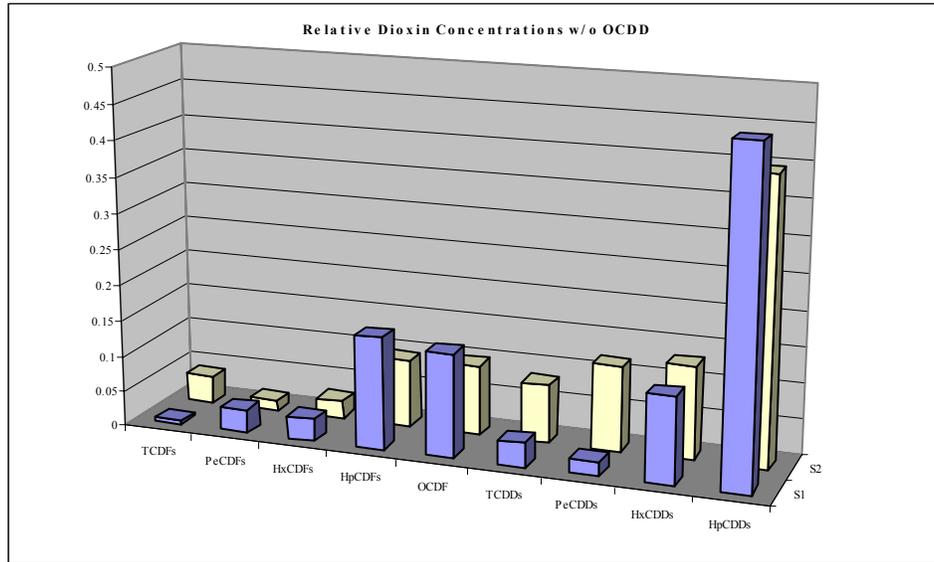
In some cases, there is a possible risk that a single or several dominant homologues (such as OCDD) could overwhelm the influence of other less dominant homologues during normalization, thereby diluting/hiding the underlying patterns of these less dominant homologues (Figure 4-2).

Figure 4-2. Relative Dioxin Concentrations, Including OCDD



In such cases, it may be useful to also develop homologue profiles for the samples without the influence of these highly dominant variables, thereby bringing out the underlying patterns (Figure 4-3).

Figure 4-3. Relative Dioxin Concentrations without OCDD



In source identification efforts by Bright et al. (1999), the authors indicated that, where a single dominant congener (e.g., OCDD) makes up less than 65 percent of the sum of all detected PCDD/PCDF congeners, the risk of this type of suppression is minimal. For a given sample where the concentration of a single congener exceeds 65 percent, therefore, homologue profiles will be generated that include and exclude the dominant homologues.

If, in creating the homologue profiles, it becomes clear that several of the homologues are routinely predominating the relative concentrations and are potentially muting the resolution of the resulting profile for less dominant congeners, similar to Bright et al. (1999) and Yamamoto and Fukushima (1993), different homologue groupings may be explored. Flexibility in developing site-specific homologue profiles is needed to provide greater detail and resolution.

The homologue profiles will be displayed graphically as shown above. Where possible, soil samples will be grouped based on their relative spatial relationship with the former Rayonier Mill Site. For example, the results of air dispersion modeling and meteorological data analysis will be used to identify those areas downwind that are most likely to have received mill emissions and deposition products, as well as those areas upwind that are not likely to be impacted by mill activities.

Homologue profiles for each sample area of interest will be compared to homologue profiles of possible source materials from the former Rayonier Mill Site (e.g., mill fly ash or stack emissions), possible industrial sources other than the former Rayonier Mill (e.g., other mills or municipal waste incinerators), as well as background concentration profiles from areas that were likely not affected by site operations. Where possible,

sources of dioxins from sample areas of interest will be identified based on visual analysis and comparison of site-related, background, and alternative source homologue patterns.

If the data exploration exercises outlined above fail to provide the clear resolution needed to identify dioxin sources, additional analyses may be undertaken to explore the data set using more advanced statistical techniques. Techniques that may be pursued include, but are not limited to, principal component and polytopic vector analyses.

4.2.4.2 Air Modeling

Evaluation of off-site chemical effects will assess the impacts of off-site transfer of stack emissions due to air dispersion. The primary focus of the investigation is CDDs and CDFs. These substances will primarily be associated with the particulate phase in ambient air emissions. Once emissions are dispersed into off-site air, particulate matter settles and deposits onto nearby surface soils. The off-site sampling will delineate areas with significant impacts from off-site transfer of CDDs and CDFs. At this time, however, further investigation is recommended before selection of off-site soil sampling points. Since the primary off-site transfer is air dispersion, an evaluation of on-site meteorology, combined with off-site dispersion and deposition, will provide information needed to focus the soil sampling investigation on areas with greater potential for impact from on-site stack emissions. The evaluation can be accomplished using air dispersion and deposition models that consider local meteorology. The dispersion and deposition air modeling approach to be used is described below. The results of the modeling will not replace soil measurements to estimate CDD and CDF concentrations in soil. Rather, the modeling evaluation will enable soil sampling to be focused at an early stage of the off-site investigation. The modeling process includes reviewing current, readily available information to determine what data are available to complete the modeling project, as well as the existing data gaps that must be filled to provide a useful model output. The modeling discussion below includes evaluations of data gaps and their influences on the modeling results.

4.2.4.2.1 Model Selection

In selecting an air dispersion model for use in this project, a number of air quality models approved by EPA (40 CFR Ch. 1 Pt. 51 App. W, Guidelines on Air Quality Models [7-1-99 Edition]) were considered. The factors considered were the ability to estimate particle deposition, the ability to simulate one to several point sources, and incorporation of local meteorological influences. Several models can meet these requirements; however, EPA recommends one model for situations with particulate emissions. Also, the settling and deposition issues are of greatest concern. The EPA-preferred model is the Industrial Source Complex Model (ISC3). Consequently, the ISC3 model will be used. No readily available model evaluated provided an estimated CDD and CDF concentration at the surface soil but, rather, an overall impact from particle deposition. Because the CDDs and CDFs are primarily associated with the particulate

phase, the particle deposition estimates can be used to identify those areas most impacted by particulates that would indicate greater potential impact from CDD and CDF deposition as well.

4.2.4.2.2 Model Settings

The ISC3 model can be run in either a short-term (ISCST3) or a long-term (ISCLT3) mode. The ISCLT3 model is designed to evaluate long-term average results from emissions sources. The ISCST3 can incorporate hourly climate data over very short-term release as well as long-term scenarios. The ISCLT3 model will estimate particle settling due to dry deposition, while the ISCST3 model will estimate particle settling due to wet and dry deposition, taking into account deposition due to precipitation. The ISCST3 model is the more up-to-date of the two models. Because ISCST3 evaluates dry and wet deposition and contains more updates, it is the model selected for use.

ISCST3 can be run according to a variety of settings that establish the manner in which the model will predict particle deposition. The settings used in this analysis are part of the regulatory default option.

This option uses several modeling options EPA preferred in the 1999 Guidelines on Air Quality Models. This option is the default operating mode for the ISC3 model. It directs ISC3 to assess a number of issues, including the following:

- Stack-tip downwash (except for Schulman-Scire downwash).
- Buoyancy-induced dispersion (except for Schulman-Scire downwash).
- Gradual plume rise (except for building downwash).
- Calm processing routines.
- Upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings.
- Default wind speed profile exponents.
- Default vertical potential temperature gradients.
- Urban/Rural (the model will be run in the urban mode).
- Averaging Time (this option will be set to calculate the total particle deposition at each receptor).
- Terrain (the model will be run using algorithms that account for complex terrain, allowing the model to consider terrain with varying elevations, including elevations above the source).

4.2.4.2.3 Source Data

The source and release inputs required included stack height, exit velocity, stack temperature, particle emission rate, and stack diameter. The ISC3 model is designed to handle multiple emissions sources with different parameters, if necessary. Four particulate sources have been identified on site: the recovery stack, oil-fired power boiler No. 4, oil-fired power boiler No. 5, and hog fuel boiler No. 6. The particulate emissions from these four sources were characterized and documented in two previous investigations. The emissions parameters from those two studies are summarized in Table 4-4. While all four are sources of particulates, it is unclear whether all four are sources of CDDs and CDFs. Only two have been tested for CDD and CDF emissions: the recovery stack and the hog fuel boiler No. 6. Of these two, hogged fuel boiler No. 6 was by far the dominant source of CDD and CDF releases into the atmosphere. Verification of which stacks were sources or potential sources of CDD and CDF emissions is a current data gap. In addition, the source information reviewed included only bulk particulate emissions. A detailed breakdown of particulate size emissions by size fractions from the emission sources at the mill is lacking. The ISC3 model allows for the characterization of the particle-size fractions of the emissions. Improper characterization of the particle-size distribution could cause the model output to under- or overestimate the impacts of particle deposition away from the former Rayonier Mill Site. Particle size fractions will be obtained from reports for boilers with similar operating parameters.

Table 4-4. ISC Source Input Parameters

Emission Source	Stack Height (m)	Gas Exit Temp (K)	Flow Rate (ACFM)	Stack Gas Exit Velocity (m/s)	Stack Diameter (m)	Particulate Concentration (gr/SDCF)
Source Emission Parameters – 1983						
Recovery Stack	91.4	300	110,000			0.006
Hog Fuel Boiler No. 6	45.7	491	150,000			0.05
Oil-Fired Power Boiler No. 5	35.1	478	77,000			0.16
Oil-Fired Power Boiler No. 4	33.5	478	67,000			0.14
Source Emission Parameters – 1976						
Recovery Stack	96.0	297.5	94,400	10.63	2.31	
Power Boiler No. 6	65.5	357	119,163	3.01	2.44	
Power Boiler No. 5	35	438	47,000	2.51	1.68	
Power Boiler No. 4	35.1	476	62,000	1.57	2.44	

4.2.4.2.4 Meteorological Data

The ISCST3 model uses hourly meteorological data as one of its model inputs. Hourly surface data from 1989 to 1998 and twice-daily mixing height data are available from nearby Fairchild Airport in Port Angeles. Precipitation data are also available for Port Angeles. These data were obtained from National Climatic Data Center (NCDC) weather stations. The data contain consistent temporal measurements for 10 years. In addition, an on-site meteorological station collected surface data from 1992 to 1999. Typically, the station collected data every 10 minutes. This on-site data will be compared with nearby data sets. Where data sets are comparable, they will be used to augment the existing data.

4.2.4.2.5 Receptor Network

The study area can be apportioned into cartesian networks to maximize coverage. The emission stacks will be the center of the coordinate system. In addition, elevation data will be linked to receptor locations to account for the complex terrain primarily to the south of the former Rayonier Mill Site.

4.2.4.2.6 Model Output

The model output will be used to generate an isopleth of particle deposition surrounding the former Rayonier Mill Site. While the ISC3 output will not quantitatively predict CDD and CDF concentrations, it is assumed that the relative particle deposition between locations will be indicative of CDD and CDF soil concentrations, due to emissions from the former Rayonier Mill Site. Identification of areas with relatively high levels of particle deposition will help maximize sampling in areas with the greatest potential for impacts.