Interim Action Report Volume I: Upland Data Summary Report For the Study Area

Port Angeles Rayonier Mill Site
Port Angeles, Washington
Final

for
Rayonier

September 1, 2021

GeoEngineers
Earth Science + Technology

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1.0 INTRODUCTION

This Interim Action Report Volume I: Upland Data Summary Report for the Study Area (Upland Data Summary Report) was prepared for upland property formerly occupied by the Port Angeles Rayonier Mill in Port Angeles, Washington. This report was prepared in accordance with Agreed Order DE 6815 (the "Agreed Order") negotiated between the Washington State Department of Ecology (Ecology) and Rayonier Properties LLC (Rayonier) and signed by Ecology on March 25, 2010 (Ecology, 2010a). It provides a cumulative summary of upland investigations and interim actions completed to date on the upland property, including the supplemental upland data collection effort conducted by Rayonier in 2010 and 2011 (hereafter referred to as the "Supplemental Upland Investigation") to address data gaps identified in Exhibit B of the Agreed Order. Review comments received from Ecology on the previously submitted Draft Supplemental Upland Data Collection Technical Memorandum (Supplemental Upland Technical Memorandum; GeoEngineers, 2011) have been incorporated in this report. Responses to these comments are included as Appendix A.

1.1 Background and Regulatory Framework

The Port Angeles Rayonier Mill property, located at 700 North Ennis Street in Port Angeles, Washington, comprises approximately 80 acres on the northern coast of Washington's Olympic Peninsula bordering on the Strait of Juan de Fuca (Figure 1). From 1930 until 1997, the mill operated as a dissolving sulfite pulp mill that produced acetate, specialty paper, fluff, and viscose-grade pulps for industrial use. In 1997, Rayonier closed the mill and began dismantling the mill facilities. The mill decommissioning was completed by October 1999.

The investigation and evaluation of cleanup action alternatives for the upland property are being conducted under the Washington State Model Toxics Control Act Cleanup Regulation (MTCA; Washington Administrative Code [WAC] Chapter 173-340). The specific requirements for this study are specified in the Agreed Order. The Agreed Order also identifies the geographic boundaries of the "Study Area" associated with the former Port Angeles Rayonier Mill. The Study Area includes both upland property and adjacent marine environment (Figure 1). This report focuses only on the upland portion of the Study Area (the "Upland Study Area"). The Upland Study Area includes parcels that are owned or leased by Rayonier, as well as parcels previously owned by Rayonier that were purchased by the City of Port Angeles (City) in 2011.

The boundaries of the "Site," as defined under MTCA, have not yet been defined. This Upland Data Summary Report summarizes the nature and extent of upland contamination associated with former mill activities, in accordance with WAC 173-340-350. Information in this report will subsequently be used to develop and evaluate interim action alternatives for the Upland Study Area as specified in the Agreed Order. The evaluation of interim action alternatives for the entire Study Area (upland and marine) will be presented in the Interim Action Report Volume III: Interim Action Alternatives Evaluation Report for the Study Area.

1.2 Purpose and Objectives

The purpose of this Upland Data Summary Report is to define the nature and extent of contaminants of potential concern (COPCs) in the Upland Study Area to support the development and evaluation of interim action alternatives (Ecology 2010a). Specific objectives of the report are as follows:

- Summarize the history of the Upland Study Area and surrounding area.
- Summarize the physical conditions of the Upland Study Area, including climate, topography, geology, hydrogeology, surface water resources, and ecological setting.
- Summarize previous investigations and interim actions completed in the Upland Study Area.
- Present a comprehensive summary of data from the Upland Study Area. This includes existing data collected during previous studies and supplemental data collected during the Supplemental Upland Investigation to address the data gaps identified in Exhibit B of the Agreed Order.
- Evaluate potential contaminant transport pathways and potential risks to human health and the environment by comparing the concentrations of COPCs to screening levels.
- Present the current understanding of conditions in the Upland Study Area in a conceptual site model (CSM). The CSM will subsequently be used to develop and evaluate interim actions for the Upland Study Area.
- Present a refined list of COPCs based on the data evaluation and CSM described above.

1.3 Report Organization

This report was developed in accordance with WAC 173-340-350; the remaining sections of the report are organized as follows:

- Section 2.0: Physical Setting and History – This section describes historical land use and physical features of the Upland Study Area and general vicinity.
- Section 3.0: Summary of Previous Upland Investigations and Interim Actions – This section summarizes the previous investigations and interim actions completed in the Upland Study Area.
- Section 4.0: Supplemental Upland Investigation (2010-2011) – This section summarizes field investigations completed between August 2010 and June 2011 to address the data gaps identified in Exhibit B of the Agreed Order.
- Section 5.0: Environmental Setting – This section summarizes the climate, topography, geology, hydrogeology, surface water resources, and ecological setting of the Upland Study Area.
- Section 6.0: Chemical Analytical Data Evaluation – This section presents the evaluation of the chemical analytical data for Upland Study Area soil, groundwater, and surface water samples.
- Section 7.0: Conceptual Site Model for the Upland Study Area – This section presents a description of the contaminant sources, release mechanisms, transport mechanisms, and exposure pathways of potential concern for the Upland Study Area.

- Section 8.0: Fate and Transport of Contaminants of Potential Concern – This section discusses factors that control the fate and transport of the COPCs identified in the Upland Study Area.
- Section 9.0: Conclusions – This section presents the major conclusions regarding the nature and extent of COPCs in the Upland Study Area.
- Section 10.0: References – This section presents references used in preparing this report.

In addition to the sections listed above, this report includes nine appendices. The appendices are listed in the Table of Contents.

2.0 PHYSICAL SETTING AND HISTORY

This section summarizes the physical setting and history of the Upland Study Area.

2.1 Upland Study Area Location and Description

The Upland Study Area is located in Port Angeles, Clallam County, Washington, on the southern shore of Port Angeles Harbor, in the Strait of Juan de Fuca (Figure 1). The Upland Study Area comprises approximately 80 acres and is located in Sections 2, 11, and 12, Township 30 North, Range 6 West.

The mill property is bounded on the south by high, tree-covered bluffs that rise to a plateau above the property. The mill property is mostly flat between the bluffs and Port Angeles Harbor to the north (Figure 2). Residential and commercial properties, including Olympic Memorial Hospital, are located on the plateau to the south of the mill property. Ennis Creek flows from the Olympic Mountains, through the Upland Study Area, and discharges into Port Angeles Harbor.

The majority of the Upland Study Area is vacant. The Olympic Discovery Trail, a pedestrian pathway constructed along the former Seattle and Northcoast Railroad right-of-way, is located at the foot of the bluff in the southern portion of the Upland Study Area (Figure 2). The pedestrian pathway is separated from the majority of the Upland Study Area by a fence; it includes a bridge that crosses Ennis Creek near the northeastern corner of the former mill parking lot.

A municipal wastewater treatment plant owned by the City is located east of, and adjacent to, the southern portion of the Upland Study Area (Figure 2). In 2011, the City purchased a portion of the Upland Study Area immediately northwest of the wastewater treatment plant from Rayonier. The parcels comprising the purchased property, referenced as the City Purchase Area (Figure 2), include a 5-million gallon aboveground storage tank that previously functioned as part of the wastewater treatment system for the mill. The City intends to use the purchased property and the aboveground storage tank to improve the combined sewer overflow (CSO) components of the City's Publicly Owned Treatment Works (POTW). An easement for a CSO pipeline that will connect to the City's wastewater treatment system was granted, and is referred to as the CSO Area (Figure 2). The CSO project will connect existing City infrastructure to the City's POTW, and will include installing new structures and underground piping, as well as using existing piping (Shannon & Wilson, 2010).

Structures in the Upland Study Area include a few small buildings for equipment storage, fire water pressurization equipment, and electrical switch equipment (Landau, 2010). Several empty

aboveground storage tanks are located in the north-central portion of the mill property, near the southwestern corner of a large concrete pad that was the foundation of the former pulp storage warehouse. Several additional aboveground storage tanks are located immediately northwest of the CSO storage tank, adjacent to the City Purchase Area.

Remnants of building foundations/slabs are present in the northern and western portions of the mill property. The mill's former shipping pier extends north into Port Angeles Harbor. A jetty constructed of rock, pilings, and timbers extends to the northwest into Port from the northwestern corner of the property. Three bridges, including the pedestrian bridge for the Olympic Discovery Trail, cross Ennis Creek.

The Upland Study Area is situated in an area of mixed industrial, commercial, recreational, and residential land uses. The majority of the Upland Study Area is zoned heavy industrial. The steep bluffs and ravine along the southern margin of the Upland Study Area is zoned for public buildings and parks. Two small areas along the bluff, on the eastern and western sides of Ennis Creek, are zoned low-density residential. A small area at the southern end of the Upland Study Area is zoned commercial arterial (Integral, 2007).

2.2 History of Upland Study Area and Surrounding Area

Information contained in the following sections was obtained primarily from the report *Remedial Investigation for the Uplands Environment of the Former Rayonier Mill Site, Port Angeles, Washington*, prepared by Integral Consulting, Inc. (Integral, 2007).

2.2.1 Property Use Before Mill Operations

Before pulp mill operations began in 1930, portions of the Upland Study Area supported a Klallam Native American Village, the Puget Sound Cooperative Colony, and a spruce mill.

2.2.1.1. KLALLAM NATIVE AMERICAN VILLAGE

Historically, a portion of the Upland Study Area was used by Native Americans of the Lower Elwha Klallam Tribe. A Klallam village, called I'e'nis, was located on the eastern bank of Ennis Creek (Figure 3), and supported a population of hunter-fisher-gatherers before Euro-American contact. I'e'nis was one of more than 30 known Klallam villages in the region. The total population of the tribe was as high as 10,000 in the early 1800s. After introduced diseases swept through the tribe in the 1850s, only a few residents of I'e'nis remained. Some of the survivors continued to live on the beaches of Port Angeles Harbor until the 1930s (Integral, 2007). In 1937, land was purchased at the mouth of the Elwha River for a tribal reservation, and tribal members were relocated.

Information on the historic Klallam village of I'e'nis (site 45CA235), suggests a moderate to high probability of prehistoric to historic period Native American cultural resources in some portions of the mill property (Cascadia, 2010). Because of the archaeological significance of these cultural resources, excavation and drilling activities on the mill property are monitored by an archaeologist.

2.2.1.2. PUGET SOUND COOPERATIVE COLONY

From 1887 to 1904, a portion of the mill property was used by the Puget Sound Cooperative Colony. This community included several buildings such as homes, a saw mill, a meeting house, a schoolhouse, and a hotel (Figure 3). The saw mill served as the economic base of the colony and

contributed to the development of Port Angeles. Klallam tribe members still lived in the village east of Ennis Creek during the colony period, but most of the mill property was occupied by colony members. The gradual assimilation of many colony members into the town and disputes over business profits led to abandonment of the colony by 1893. The legal matters of the colony were settled in 1904 (LAAS, 1997; Integral, 2007).

2.2.1.3. PORT ANGELES WATERFRONT DEVELOPMENT

Much of Port Angeles is built on historical tidal flats. Beginning in 1914, areas of the city were re-graded to eliminate coastal flooding of the central waterfront. Hydraulic mining and sluicing of nearby hills was used to raise street levels one full story above then-existing street levels (Wegmann et al., 2010).

In 1913, construction was completed on the Elwha Dam, located approximately 5 miles east-southeast of Port Angeles on the Elwha River. Inexpensive hydroelectric power generated by the dam spurred the economic development of Port Angeles. The hydroelectric power provided to the City supported the construction and operation of three thriving pulp mills along the shores ofthe Port Angeles Harbor: the Fibreboard mill, the Crown Zellerbach mill (now owned by Nippon Paper Industries), and the Rayonier mill (Figure 1).

The Port Angeles waterfront soon became dominated by the wood products and maritime industries. The availability of electricity, and a natural, deep, protected harbor formed by Ediz Hook supported industrial development along the waterfront. Inexpensive power and the availability of raw materials – primarily wood and water – necessary to produce pulp and paper, spurred the growth of pulp mills. The mills were instrumental in the development of Port Angeles as the cultural and economic hub for the region.

2.2.1.4. SPRUCE SAW MILL

In 1917, the United States Spruce Production Corporation constructed a new saw mill (Spruce Mill) on the property to mill spruce wood for the manufacture of aircraft (Figure 3). A large portion of the saw mill was constructed on pilings. The success of wooden aircraft proved to be very limited. The saw mill was never operated and sat idle until Olympic Forest Products purchased it in 1929 (Integral, 2007).

From 1929 to 1930, the Spruce Mill was renovated and a pulp mill constructed. The pulp mill was operated by Olympic Forest Products from 1930 to 1937. In 1937, Olympic Forest Products merged with two other independent Olympic Peninsula companies to form Rayonier Inc. Mill ownership shifted to ITT Rayonier, Inc. between 1968 and 1994, after which it returned to Rayonier Inc. Rayonier permanently ceased pulp production at the mill in 1997 and dismantled the mill facilities between 1997 and 1999.

2.2.2 Former Pulp Mill Operations

The Port Angeles Rayonier Mill produced dissolving-grade pulps from wood chips using an acid sulfite process. During the early years of operation, the mill configuration and operation remained relatively unchanged. However, during its later life, numerous alterations and improvements were made to the mill, many of which were instituted to reduce potential environmental impacts and improve mill efficiency (Integral, 2007). The former mill layout at the time of closure in 1997 is shown in Figure 4, and a process flow diagram of mill operations at that time is shown in Figure 5.

The former mill operations are described in detail in several previous reports and work plans (Foster Wheeler, 1997; E&E, 1998; Integral and Foster Wheeler, 2004; Integral, 2007). The pulp milling process at the Rayonier Mill is summarized below (Integral, 2007).

- Logs were delivered to the mill by raft or truck and staged in the log pond or log yard area before being processed in the wood mill (Figure 4). Approximately 50 percent of the mill's chip supply was purchased directly from saw mills and delivered by truck or chip barge that docked on the western side of the mill's shipping pier. The pier area was periodically inspected and dredged; the dredged material was hauled and deposited in Rayonier's off-property landfills in Port Angeles.
- Bark removed from the logs and rejected wood chips and debris were transported to the hog fuel pile to be burned in the hog fuel boilers. The hog fuel boilers and the recovery boiler generated process steam. When necessary, Bunker C fuel oil was used to supplement fuel demands.
- Water, ammonia, and sulfur dioxide were combined in the acid plant to produce fortified ammonium bisulfite cooking liquor, which was combined with the wood chips and treated at high pressure and temperature in nine large pressure vessels called digesters. This reduced the wood chips to cellulose fibers (pulp) and water-soluble, non-cellulose wood residuals. Once digestion was complete, pressure was reduced in the digesters by venting steam and gases into condensers. The condensed steam (condensate) was then fed back to the acid plant and recycled into the cooking liquor.
- Residual pressure in the digesters was used to blow the pulp into the blowpit tanks associated with each digester. Before the blow event, each blowpit was prepared to receive the pulp slurry by being partially filled with a cushioning liquor of digestion chemicals such as spent sulfite liquor (SSL). This reduced the release of gases during the transfer process. The mechanical agitation of the pulp slurry resulting from being blown against a metal plate in the blowpits separated the digested wood into individual fibers. Process gases released during the blow event were recovered, reprocessed, and reused. The pulp slurry was then transferred from the blowpits to the red stock washers, where the digestion chemicals were washed from the pulp. The pulp was screened to remove knots and other undigested wood residue and then transferred to the bleach plant.
- The SSL consisted of approximately 10 percent solids upon leaving the red stock washers. The SSL was filtered and stripped of sulfur dioxide, and the solids content was increased by vapor recompression and multi-effect evaporators. This allowed approximately 95 percent of the SSL to be burned in the recovery boiler to generate steam for the digestion process. The sulfur dioxide was recovered in the boiler flue gas using aqueous ammonia in a large absorber to produce the cooking liquor precursor.
- The SSL was temporarily stored in the SSL Lagoon, located in the easternmost portion of the mill property (Figure 4), before it was burned in the recovery boiler. The SSL Lagoon had a 1- to 2-foot-thick base layer of clay (10^{-5} centimeters per second permeability) and a 60 millimeter, high-density polypropylene (HDPE) floating cover over the SSL liquid.
- In the bleach plant, the bleaching process generally consisted of sequential treatments using chlorine, caustic soda, sodium hypochlorite, and chlorine dioxide, as well as multiple washing

stages. Both chlorine dioxide and sodium hypochlorite were produced at the mill. The bleached pulp was then transported to the drying machine where water was removed. The pulp was then pressed, dried, and formed into large rolls. These rolls were then processed into smaller rolls or bales before being transported from the mill to the customer.

An important component of operations at the Rayonier Mill was the management of process wastewater and stormwater. From the 1930s to 1972, process wastewater and stormwater generated at the mill were discharged into Port Angeles Harbor through five nearshore outfalls distributed along the shoreline between the former log pond area and Ennis Creek (Figure 4) (Shea et al., 1981). Before adoption of the Clean Water Act in 1972, wastewater, sewage, and stormwater were discharged to Port Angeles Harbor by many industrial and commercial entities, as well as the City. In 1972, an extensive wastewater and stormwater drainage system and primary wastewater treatment plant were constructed at the Rayonier Mill, and the five nearshore outfalls were removed from service. Treatment plant effluent and stormwater were routed to a new deep-water outfall, which extended 7,900 feet into the Strait of Juan de Fuca (Figure 4). A secondary wastewater treatment plant was constructed at the mill in 1979 to provide additional treatment of wastewater prior to discharge through the deep-water outfall.

2.2.3 Other Port Angeles Industrial Activities

Many other industrial, commercial and general urban activities have historically contributed sources of contamination to the Port Angeles environment, and therefore are pertinent to efforts to evaluate environmental impacts associated with the former Rayonier Mill. In addition to the former Crown Zellerbach and Fibreboard mills, bulk fuel facilities, marine terminals, marinas, boat yards, and a medical waste incinerator have been located in the Port Angeles area, some of which continue to operate. Before the City constructed its municipal wastewater treatment plant in 1969, urban sewage and stormwater were discharged into the harbor via 11 historical outfalls. Untreated sewage and stormwater have been discharged to the harbor via these outfalls, and via present-day CSO outfalls during overflow events. Common contaminants in urban runoff and sanitary sewer discharges include petroleum, cleaning products, pesticides, fertilizers, metals, and detergents; other contaminants may occur in these source streams as well. In addition to contributing contaminants to stormwater, sewage, and wastewater, the legacy of industrial and urban activities for more than a century in the Port Angeles area would have also impacted environmental media via discharge to (and fallout from) the air.

3.0 SUMMARY OF PREVIOUS UPLAND INVESTIGATIONS AND INTERIM ACTIONS

This section presents a summary of previous investigations and interim actions completed in the Upland Study Area prior to the 2010-2011 Supplemental Upland Investigation. Chemical analytical data from these investigations and interim actions have been included in the evaluation of the nature and extent of contamination presented in Section 6.0.

3.1 Previous Upland Investigations

A number of environmental investigations were completed in the Upland Study Area between 1989 and 2003. A summary of these investigations is presented in this section and in Table 1. The two largest previous investigations were the Expanded Site Inspection (ESI) conducted in 1997 by the

United States Environmental Protection Agency (USEPA) (E&E, 1998) and the Upland Remedial Investigation (RI) conducted in 2003 by Rayonier (Integral, 2007). Samples of soil, groundwater, surface water, freshwater sediment, earthworm tissue, and/or plant tissue were collected for chemical analysis from locations across the Upland Study Area during these investigations. In addition to the ESI and RI, several other investigations focusing on localized areas of the mill property have been completed. Most of these other investigations were initiated before 1997 (i.e., before the ESI) and were conducted primarily in conjunction with interim actions.

Figure 6 shows the ESI and Upland RI soil sampling locations. Figure 7 shows the locations of ESI soil samples and other soil samples collected prior to the completion of mill decommissioning in October 1999. Figure 8 shows the locations of Upland RI soil samples and other soil samples collected after the completion of mill decommissioning but before the 2010-2011 Supplemental Upland Investigation. In addition to previous soil sampling locations, Figures 6 through 8 also show previous interim action areas. The locations of characterization soil samples that were subsequently excavated during interim actions are not shown in Figures 6 through 8; however, verification soil samples collected at the limits of interim action remedial excavations are included in Figures 7 and 8.

3.1.1 Investigations Initiated Before 1997

The ESI conducted by USEPA in 1997 (E&E, 1998) was the first property-wide investigation of the Rayonier Pulp Mill. Before the 1997 ESI, several investigations were initiated at the mill property to assess soil and groundwater conditions, beginning with an investigation of a hydraulic oil release in the Finishing Room/Ennis Creek area in 1989-1990. The investigations initiated before 1997 are summarized below.

3.1.1.1 FINISHING ROOM/ENNIS CREEK HYDRAULIC OIL RELEASE INVESTIGATION (1989-1990)

During a USEPA chemical safety audit in May 1989, an oil sheen was discovered in Ennis Creek adjacent to the Finishing Room. The sheen appeared to originate from riprap on the west bank of Ennis Creek. A subsequent investigation conducted by ITT Rayonier in 1989 and 1990 (Landau, 1991) determined that the oil originated from past releases of hydraulic oil from pulp baling presses in the Finishing Room. A free-phase oil plume measuring approximately 160 by 65 feet was identified in shallow soil beneath the eastern portion of the Finishing Room and extending to Ennis Creek. Polychlorinated biphenyls (PCBs) also were detected in soil beneath the Finishing Room. ITT Rayonier initially installed absorbent pads/booms and containment structures to collect the oil; Rayonier later installed a free-product recovery system to intercept and collect oil migrating towards Ennis Creek (Foster Wheeler, 1997).

Interim actions completed in the Finishing Room/Ennis Creek area are summarized in Section 3.2.1.

3.1.1.2 INVESTIGATIONS AT FORMER FUEL OIL TANK 2 (1989-1997)

Subsurface investigations completed by ITT Rayonier near Fuel Oil Tank 2 before demolition of the tank in 1993 consisted of drilling 28 soil borings and installing 13 groundwater monitoring wells (Landau, 1990). The investigations identified petroleum hydrocarbons in soil and groundwater beneath the tank and in an adjacent sump area immediately east of the tank. Non-aqueous phase liquid (NAPL) had accumulated in monitoring wells MW-7 and MW-16 in the sump area.

During a groundwater sampling event in August and September 1997, NAPL was observed in monitoring well MW-11 in the sump area (Landau, 1998a). Groundwater samples were not collected from well MW-11, but a sample of the NAPL in the well was collected and analyzed for PCBs. PCBs were not detected in the NAPL. Groundwater samples collected from three other wells near Fuel Oil Tank 2 (MW-20, MW-23 and MW-29) in August/September 1997 were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), PCBs, total petroleum hydrocarbons (TPH), and dissolved priority pollutant metals. None of these constituents was detected above MTCA Method A cleanup levels (WAC 173-340-720).

Interim actions completed in the Fuel Oil Tank 2 area are summarized in Section 3.2.2.

3.1.1.3 QUANTITATIVE ENVIRONMENTAL SURVEY PROGRAM INVESTIGATION (1993)

The objective of this 1993 investigation performed by ITT Rayonier (HLA, 1993) was to assess stratigraphic and hydrogeologic conditions at the mill property. It included installing 12 monitoring wells (PZ-1 through PZ-7 and PZ-9 through PZ-13), measuring groundwater and surface water elevations, and assessing tidal influence on groundwater elevations/flow. Samples were not collected for chemical analysis during the study. Unconfined groundwater was encountered at depths of 5 to 15 feet below ground surface (bgs) during the study. The groundwater flow direction was determined to be generally northward towards Port Angeles Harbor.

3.1.1.4 HOG FUEL PILE INVESTIGATIONS (1993 AND 2001)

In 1993, ITT Rayonier conducted an investigation to evaluate an area of possible petroleum contamination in the Hog Fuel Pile area. The investigation included excavating test pits and collecting samples of soil/wood chip material and groundwater. The samples were analyzed for TPH. Analytical results indicated that TPH concentrations were only slightly above the MTCA cleanup level of 200 milligrams per kilogram (mg/kg). Due to the apparent limited extent and volume of the contamination (approximately 90 cubic yards, including soil and wood residue), ITT Rayonier chose a natural attenuation remedy for the impacted material.

Rayonier conducted a supplemental investigation of the Hog Fuel Pile area in 2001 to assess the suitability of the material for disposal at the Port Angeles Sanitary Landfill (Landau, 2001a and 2001b). The supplemental investigation consisted of collecting up to 25 samples from 0 to 6 feet bgs and analyzing them for diesel- and heavy oil-range TPH and Toxicity Characteristic Leaching Procedure (TCLP) constituents including VOCs, SVOCs, pesticides, herbicides, and metals.

Interim actions completed in the Hog Fuel Pile area are summarized in Section 3.2.3.

3.1.1.5 PROPERTY-WIDE GROUNDWATER MONITORING (1997-1998)

In 1997, Rayonier collected groundwater samples for chemical analysis from the monitoring wells installed during the 1993 quantitative environmental survey program investigation (Landau, 1997). Rayonier sampled these wells again in 1998 after the mill was closed (Landau, 1998a). Selected monitoring wells in the Fuel Oil Tank 2 area also were sampled in 1998. Rayonier installed two additional monitoring wells (MW-51 and MW-52) in 1998, between the shoreline and the former equipment maintenance facility (MW-51), and near former monitoring well PZ-1 (MW-52) (Landau, 1998a).

The groundwater samples were analyzed for VOCs, SVOCs, PCBs, diesel- and heavy oil-range TPH, priority pollutant metals, turbidity, asbestos, and indicator parameters identified in the Minimum Functional Standards for Solid Waste Handling (WAC 173-304-490). Arsenic and chromium were the only constituents that exceeded the regulatory screening criteria used in the study (MTCA Method A cleanup levels; WAC 173-340-720). Diesel-range TPH, acenaphthene, fluorene, carbazole, fluoranthene, and naphthalene were detected but did not exceed the screening criteria.

3.1.2 Expanded Site Inspection (1997)

The USEPA conducted the ESI field investigation in 1997 (E&E, 1998). The ESI included the collection of environmental samples from mill process areas and areas that were considered to be susceptible to impacts from contaminant migration (the Log Yard, Hog Fuel Pile, Equipment Storage Area, soil under facility buildings, Pre-Fab Area/Chlorine Dioxide Generator, Wastewater Collection System, Ennis Creek, Strait of Juan de Fuca, and nearby homes and businesses). Three hundred and one samples were collected from multiple upland and marine locations. Media sampled included soil, groundwater, sediment, and process wastes. The ESI marine sediment sampling activities and results are addressed in the Marine Data Summary report for the Study Area (Interim Action Report Volume II).

Thirty-four soil borings were completed during the ESI, and 146 soil samples were collected for analysis (90 surface soil samples and 56 subsurface soil samples). The samples were analyzed for the full suite of priority pollutants (167 chemicals), including VOCs, SVOCs, pesticides, PCBs, polycyclic aromatic hydrocarbons (PAHs), metals, and dioxins/furans. Based on the soil analytical results, USEPA identified 42 constituents that had elevated concentrations relative to the concentrations reported in a soil sample collected at an on-property background location.

Groundwater was sampled at 12 monitoring wells and 7 direct-push boring locations. The groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, diesel- and heavy oil-range TPH, and dissolved priority pollutant metals. Constituents detected at elevated concentrations in groundwater relative to an on-property background location included arsenic, barium, chromium, copper, lead, manganese, vanadium, zinc, Aroclor 1260, acenaphthene, and bis(2-ethylhexyl)-phthalate (BEHP).

3.1.3 Upland Remedial Investigation (2003)

Rayonier conducted the Upland RI field investigation in 2003 (Integral, 2007). Soil samples were collected in May 2003 from areas where mill operations occurred as well as surrounding areas. Groundwater samples were collected from on-property monitoring wells in June 2003.

A total of 85 soil samples (45 surface samples and 40 subsurface samples) were obtained from 43 locations using drill rigs, backhoes, and hand augers. Most of the surface soil samples were obtained from a depth of 0 to 0.25 feet bgs. The subsurface soil samples were obtained from depths of 0.25 to 16 feet bgs.

The following constituents were detected in soil at concentrations exceeding the RI screening criteria, which consisted of MTCA Method B cleanup levels protective of human health for unrestricted land uses (i.e., residential/direct contact exposure scenario):

- Arsenic and PAHs in the Equipment Storage area.
- Copper in the Chlorine Dioxide Generator and Pre-Fab areas.
- PAHs, PCBs, and dioxins/furans in the Wood Mill area.
- PAHs, diesel- and heavy oil-range TPH, arsenic, lead, and dioxins/furans in the Log Yard area.
- Arsenic, cadmium, total chromium, lead, thallium, vanadium, carcinogenic PAHs (cPAHs), pentachlorophenol (PCP), pyrene, and dioxins/furans in the Main Process area.
- Dioxins/furans in the eastern portion of the property (east of Ennis Creek).
- Arsenic, lead, heptachlor epoxide, cPAHs, and dioxins/furans in off-property residential soil.

Based on the detections exceeding RI screening criteria, the constituents listed above were identified in the Upland RI Report as COPCs in soil.

Groundwater samples were collected and analyzed from 20 monitoring wells in June 2003. The following constituents were detected in groundwater at concentrations exceeding the RI screening criteria, which consisted of MTCA Method B cleanup levels protective of marine surface water (aquatic organisms and human consumption of aquatic organisms):

- Conventional parameters: ammonia.
- Metals: arsenic, chromium, copper, nickel, lead, and mercury.
- SVOCs: 2,4,6-trichlorophenol and PCP.
- cPAHs: benzo(a)anthracene and chrysene.
- Pesticides: 4,4′-DDD, 4,4′-DDE, 4,4′-DDT, alpha-chlordane, dieldrin, endrin, and heptachlor.
- PCBs: Aroclor 1260 and total PCBs.

Based on the detections exceeding RI screening criteria, the constituents listed above were identified in the Upland RI Report as COPCs in groundwater. In addition, although aldrin, heptachlor epoxide, and toxaphene were not detected in groundwater samples, they were conservatively identified as groundwater COPCs because the analytical method reporting limits (MRLs) for these constituents exceeded the associated RI screening criteria. The distribution of COPCs in groundwater was described in the Upland RI Report as "patchy;" no clear COPC plumes (i.e., contiguous areas of elevated concentrations) were observed in groundwater. The areas with the highest concentrations of groundwater COPCs included the SSL Lagoon area and the area immediately east of the dock (Integral, 2007).

3.1.4 City of Port Angeles Geotechnical Investigations and Environmental Sampling (2006-2009)

The City recently initiated a project to upgrade the CSO components of its POTW. The CSO upgrade project, which will connect existing City infrastructure to the POTW, includes installation of new underground sewer piping and the use of existing City-owned sewer piping in the Upland Study Area. Because the proposed new CSO pipeline alignment crosses the Upland Study Area, the City performed geotechnical investigations in 2006 and 2009 as part of the City's CSO upgrade project (Shannon & Wilson, 2006; Shannon & Wilson, 2010). Fifteen borings (PA-1, PA-2, and PA-13

through PA-25) were drilled along the planned CSO pipeline alignment to a maximum depth of 80 feet bgs. Groundwater monitoring wells were installed in eight of the borings (PA-1, PA-2, PA-15, PA-17, PA-19, PA-21, PA-23, and PA-24); the locations of these wells are shown in Figure 8. Boring logs for the City's geotechnical explorations are presented in Appendix C.

Based on visual observations and field screening of soil samples collected during the 2009 investigation, one soil sample obtained from a depth of 7.5 to 9 feet bgs in boring PA-19, and one groundwater grab sample obtained from the same boring, were submitted for laboratory analysis. The groundwater grab sample was collected from the open borehole using a disposable bailer before a monitoring well was installed in the borehole. The soil sample was analyzed for VOCs and metals. The groundwater sample was analyzed for gasoline- and diesel-range TPH, PCBs, and metals. The soil analyses did not detect VOCs or metals at concentrations exceeding the screening levels used in this report. The groundwater analyses detected diesel-range TPH, cadmium, lead, mercury, selenium, and silver at concentrations exceeding the screening levels used in this report. PCBs were not detected in the groundwater sample, but the analytical MRLs for the PCB analysis exceeded the associated screening level for PCBs. Groundwater grab samples collected from open boreholes, such as the sample collected from boring PA-19, are useful only for screening purposes. Groundwater samples collected from this type of exploration often contain suspended solids that may contain adsorbed contaminants, thereby reflecting disturbed conditions that may not be representative of actual groundwater conditions. Groundwater in monitoring well PA-19 was sampled during the Supplemental Upland Investigation; the analytical results from this sampling are included in the evaluation of chemical analytical data presented in Section 6.0.

3.2 Interim Actions

Rayonier has completed interim actions in seven areas of the Upland Study Area to clean up contamination from past mill operations. The locations of the interim action areas are shown in Figure 6. This section provides a summary of the interim actions. Further details regarding the interim actions can be found in the Upland RI Report (Integral, 2007).

3.2.1 Finishing Room/Ennis Creek Interim Actions (1991 to 2002)

In 1991, ITT Rayonier began operating an oil recovery system in the Finishing Room/Ennis Creek area to address the hydraulic oil release discovered in this area in 1989 (Foster Wheeler, 1997). The system included three oil/water extraction wells, and oil/water separator, and an oil storage tank. Extracted groundwater containing dissolved petroleum constituents was conveyed to the mill's wastewater treatment plant for treatment. In 1992 and 1993, ITT Rayonier installed a sheet pile containment wall and interceptor trench to further mitigate impacts to Ennis Creek (Foster Wheeler, 1997). Extraction pumps in the interceptor trench pumped groundwater through an oil/water separator, and the water was then conveyed to the mill's wastewater treatment plant. The recovered hydraulic oil was transferred to a storage tank for subsequent disposal.

In 1998, Rayonier entered into an agreed order with Ecology to clean up petroleum-contaminated soil and groundwater in the Finishing Room area. The interim action work plan called for the removal of contaminated soil exceeding TPH and PCB cleanup levels of 1,000 mg/kg and 10 mg/kg, respectively. The work plan also called for the removal of PCB-contaminated soil in the Load Center Transformer Room area (at the southern end of the Finishing Room area) to meet the Toxic Substances Control Act cleanup level for PCBs (1 mg/kg). A total of approximately

8,300 tons of soil was removed from the Finishing Room and Load Center Transformer Room areas in 1998. Verification soil samples were collected from the excavation limits and analyzed by a mobile laboratory to confirm that cleanup levels were achieved (SECOR, 1999).

In 2002, Rayonier conducted an interim action to remove the sheet pile containment wall and petroleum- and PCB-contaminated soil and sediment immediately east of the containment wall (Integral and Foster Wheeler, 2003). A total of 1,248 tons of contaminated soil/sediment was removed from the western bank and streambed of Ennis Creek in 2002. In addition to removing contaminated soil/sediment, Rayonier removed the sheet pile wall, two existing concrete pipe supports, four monitoring wells, two extraction sumps, and riprap on the western bank of Ennis Creek. Verification samples were collected from the excavation limits, and the excavation was then backfilled with clean graded material.

Following the 2002 interim action, habitat enhancements were made to the portion of the Ennis Creek channel affected by the interim actions. Riprap was removed and a shallow inundation area was constructed to allow the creek to flow more naturally. Anchored root wads and vegetation were established in the inundation area as additional habitat enhancements.

3.2.2 Former Fuel Oil Tank 2 Interim Actions (1993 and 2002)

In 1993, after Fuel Oil Tank 2 was dismantled, Rayonier excavated approximately 1,500 cubic yards of petroleum-contaminated (Bunker C) soil from beneath the former tank. The soil was treated by thermal desorption, and the treated soil was used to backfill the remedial excavation. Following the soil treatment and backfilling activities, Rayonier installed a steam injection and groundwater extraction system to enhance petroleum recovery and continue remediation.

In 2002, Rayonier excavated an additional 5,137 tons of petroleum-contaminated soil from two large areas near the former Fuel Oil Tank 2 and Hog Fuel Pile (Integral and Foster Wheeler, 2003). The soil was removed to the depth of the groundwater table and transported off site for disposal. Following verification soil sampling at the excavation limits, the excavations were backfilled with concrete rubble and clean soil. The verification sampling confirmed that the interim action removed soils exceeding the action level (500 mg/kg TPH) except in a few small localized areas.

3.2.3 Hog Fuel Pile Interim Action (2001)

Rayonier excavated approximately 2,700 cubic yards of wood residue containing diesel and heavy oil from the Hog Fuel Pile area in 2001. The excavated material was transported to the Port Angeles Sanitary Landfill for disposal. The excavation was backfilled with concrete rubble and clean soil.

3.2.4 Spent Sulfite Liquor Lagoon Interim Action (2001)

During mill operation, SSL produced during the pulping process was recovered and recycled as boiler fuel to power the mill's operations. As part of the recovery process, SSL was temporarily stored in the SSL Lagoon in the eastern portion of the mill property before it was burned in the recovery boiler.

In 1997, 13 samples were collected from the lagoon's clay liner, residual material at the bottom of the lagoon, and the perimeter berm surrounding the lagoon (Landau, 1998b). The samples were

analyzed for SVOCs, metals, and dioxins/furans. Arsenic was detected above the MTCA Method A soil cleanup level (unrestricted land use) in the sample of residual material obtained from the bottom of the lagoon.

The SSL Lagoon was decommissioned in 2001. Approximately 4,800 tons of clay liner material and stained soil above the groundwater table was excavated from the lagoon and transported to Rayonier's Mt. Pleasant Landfill for use as subgrade fill below the synthetic membrane of the final landfill cover (Landau, 2003). The lagoon excavation was backfilled with clean soil from the perimeter berm; excess berm soil was transported to the Mt. Pleasant Landfill.

3.2.5 Former Machine Shop Interim Action (2002)

The machine shop was located inside the engineering building in the western portion of the mill property. When the engineering building was demolished in 1999, oil staining was noted both on the wooden floor of the machine shop and on soil beneath the shop. The wooden flooring was tested for diesel- and heavy oil-range TPH and PCBs in preparation for disposal.

Rayonier conducted an interim action in the Machine Shop area in 2002 (Integral and Foster Wheeler, 2003). The objectives of the interim action were to remove petroleum-contaminated soil above the groundwater table beneath the former machine shop and to clean residual petroleum from the surface of the concrete support piers. Approximately 970 tons of petroleum-contaminated soil was removed. Concrete support piers within the excavation footprint were either left in place and cleaned, or removed to a staging area for further characterization and disposal. The remedial excavation was backfilled with clean concrete rubble.

3.2.6 Former Fuel Oil Tank 1 and Wood Mill Interim Actions (2006)

Rayonier removed approximately 7,980 tons of petroleum- and PCB-contaminated soil from the Fuel Oil Tank 1 and Wood Mill areas in 2006 (GeoEngineers, 2006). The excavated soil was transported to the Port Angeles Sanitary Landfill for disposal. Approximately 0.5 cubic yards of contaminated soil was left in place adjacent to a utility pole near the southeastern edge of the Fuel Oil Tank 1 remedial excavation; this soil could not be removed without threatening the structural integrity of the utility pole and potentially exposing the remediation contractor to an electrical hazard. Contaminated soil also was left in place in the easternmost portion of the former wood mill remedial excavation, where the edge of a sheet pile wall was encountered. Other than these two locations, verification soil sampling at the limits of the remedial excavations confirmed that the targeted soil contamination exceeding actions levels was successfully removed.

4.0 SUPPLEMENTAL UPLAND INVESTIGATION (2010-2011)

The Supplemental Upland Investigation was completed in five phases between August 2010 and June 2011. The five phases are summarized below.

- Phase 1 – Property-wide baseline groundwater sampling, shoreline groundwater seep survey, and surface water sampling in Ennis Creek and White Creek (August 2010). Field activities performed during Phase 1 included measuring groundwater levels and checking for the presence of NAPL in existing groundwater monitoring wells; redeveloping and collecting baseline groundwater samples from the existing monitoring wells installed prior to 2010;

conducting a groundwater seep survey along the shoreline of the Upland Study Area; and collecting surface water samples from Ennis Creek and White Creek.

- Phase 2 – Subsurface soil sampling, monitoring well installation, and groundwater sampling (October–November 2010). Field activities performed during Phase 2 included a pre-construction site walk to inspect the planned sampling locations and locate utilities; collecting groundwater grab samples from nine locations (groundwater grab borings GWG-1 through GWG-9); collecting discrete-depth soil samples at ten locations (supplemental soil boringsSSB-1 through SSB-10); and collecting discrete-depth soil samples and installing groundwater monitoring wells at five locations (wells MW-60 through MW-64).
- Phase 3 – Test pit explorations and soil sampling in interim action areas and process piping contents sampling (January 2011). Field activities performed during Phase 3 included excavating 21 test pits (locations TP-1 through TP-21; includes 17 locations originally scoped in the Work Plan and 4 additional "step-out" locations); removing visibly impacted soil where encountered in the test pits; and digging an exploratory trench in an effort to locate and sample the contents of a buried pipe (assumed to be a former process wastewater pipe) that was encountered during the 2003 Upland RI (location PIPE-1-SR23).
- Phase 4 – Additional "infill' monitoring well installation and groundwater sampling (March–May 2011). The Phase 4 field activities were completed in two phases. Phase 4A was completed on March 9 and 10, 2011, and consisted of installing three "infill" groundwater monitoring wells (wells MW-65, MW-66, and MW-67) to fill spatial gaps in the monitoring well network. Phase 4B was completed between May 6 and May 18, 2011, and consisted of installing three groundwater monitoring wells: a deep well in the vicinity of former well MW-13 (well MW-68, completed in the glacial deposits beneath the surficial fill unit), and two wells completed in the surficial fill unit, approximately 100 feet east and 100 feet west of Ennis Creek along the CSO pipeline alignment (wells MW-69 and MW-70).
- Phase 5 – Property-wide quarterly groundwater sampling (November 2010–May/June 2011). In addition to the baseline groundwater sampling conducted in August 2010 (Phase 1), three additional quarterly monitoring events were completed in November 2010, February 2011, and May/June 2011.

Field exploration activities were performed in general accordance with the Supplemental Upland Data Collection Work Plan and Ecology's conditional Supplemental Upland Data Collection Work Plan approval letter dated August 10, 2010 (GeoEngineers, 2010; Ecology, 2010b). As detailed in the Supplemental Upland Data Collection Work Plan, results from each phase of the investigation were used to adjust the scope and locations of additional sampling and analyses performed during subsequent phases. The scope and schedule of each exploration phase were reviewed with Ecology before each phase was initiated, and the results and analytical data from each phase were submitted for Ecology review before performing the next phase of field activities.

The Supplemental Upland Investigation sampling locations are shown in Figure 9. Also shown in Figure 9 are a number of "functional use areas" that collectively make up the Upland Study Area. These functional use areas are discussed further in Section 6.4. Soil, groundwater, and surface water samples collected during the Supplemental Upland Investigation are listed in Tables 2A, 3, and 4, along with the analyses performed on each sample. All chemical analyses, except

dioxins/furans, were performed by Analytical Resources, Inc. in Tukwila, Washington (ARI). Dioxin/furan analyses were performed by Frontier Analytical Laboratory in El Dorado Hills, California. ARI also performed most of the geotechnical testing (grain size, bulk density, and hydraulic conductivity). GeoEngineers' soils laboratory in Tacoma, Washington, performed grain size analyses on select soil samples. An archaeological monitor was present during field explorations completed in native soil below fill (Cascadia, 2010). A detailed discussion of field investigation activities is presented in the Draft Supplemental Upland Data Collection Technical Memorandum (Supplemental Upland Technical Memorandum; GeoEngineers, 2011).

5.0 ENVIRONMENTAL SETTING

This section summarizes the climate, topography, surface water resources, geology, hydrogeology, and ecological setting of the Upland Study Area.

5.1 Climate

The climate of the northern coastline of the Olympic Peninsula is influenced by winds from the Pacific Ocean. Based on data gathered for Port Angeles between 1971 and 2010, average temperatures in the area range from approximately 35°F in January to 69°F in August (WRCC, 2011). Average annual precipitation (mostly occurring as rain in the lower elevations) is approximately 26 inches, ranging from approximately 0.6 inches in July to 4.5 inches in November (WRCC, 2011).

Winds in the area vary seasonally and are influenced by weather patterns approaching the coast. During mill dismantling activities between October 1997 and October 1999, on-property winds were monitored as part of the air quality monitoring program (Foster Wheeler, 1998). Winds during this period were predominantly light to moderate, blowing mainly from the west-northwest.

5.2 Topography and Surface Water

The Upland Study Area is bordered to the north by Port Angeles Harbor and to the south by steep bluffs. The shoreline converges with the bluffs east and west of the Upland Study Area. The ground surface topography is shown in Figure 10. Ground surface elevations range from 3 feet above mean sea level at the shoreline to more than 130 feet above the 1929 National Geodetic Vertical Datum at the top of the Ennis Creek ravine in the southernmost portion of the Upland Study Area (NTI, 2000). With the exception of the bluff areas, the Upland Study Area is generally flat. The upland property on which the former mill was located extends farther into Port Angeles Harbor than the surrounding shoreline as a result of historical tideland filling.

The closest surface water bodies are Port Angeles Harbor, Ennis Creek, and White Creek (Figure 2). A steep ravine is present where Ennis Creek flows through the bluff in the southern portion of the Upland Study Area; White Creek converges with Ennis Creek in this area. A portion of the Ennis Creek bank was modified to improve habitat following the interim action in the Finishing Room Area in 2002. A shallow inundation area was constructed to allow the creek to flow more naturally, and anchored root wads and vegetation were established as additional habitat enhancements. A detailed discussion of the interim action and associated Ennis Creek restoration

is presented in the Interim Action Report prepared by Integral Consulting, Inc. and Foster Wheeler Environmental Corporation (Integral and Foster Wheeler, 2003).

Stormwater from the Upland Study Area is managed under a Stormwater Pollution Prevention Plan (Landau, 2010). Stormwater in the Upland Study Area generally follows surface topography, flowing from south to north (see Figure 11). In the majority of the Upland Study Area, stormwater infiltrates into the ground. On paved portions of the property adjacent to the shoreline, stormwater runoff flows into Port Angeles Harbor. On paved portions of the property not adjacent to the shoreline, stormwater runoff is conveyed through ditches or subsurface piping to outfalls along Ennis Creek (Landau, 2010).

5.3 Surface and Subsurface Structures

The ground surface of the mill property west of Ennis Creek consists of a mixture of pavement and barren to semi-vegetated areas of concrete rubble generally devoid of topsoil. The ground surface east of Ennis Creek is generally a combination of paved asphalt roadways and large areas of grassy fields.

Most of the former mill structures have been demolished, and were either removed or used as a source of the concrete rubble used to stabilize surface soils. The surface structures that remain on the property include (see Figure 2):

- A large, rectangular, pile-supported concrete pad where the former pulp storage building existed (west of the mouth of Ennis Creek).
- Two small vehicle bridges, an elevated concrete pad from the former roll storage building, and one pedestrian bridge for the Olympic Discovery Trail, all crossing Ennis Creek.
- Three aboveground storage tanks near the southwest corner of the former pulp storage building pad.
- A block building immediately south of the former shipping pier.
- Security fencing and a guard shack with a security gate (the former mill entrance).
- A steel water supply standpipe near the western corner of the property.
- A building and an aboveground storage tank adjacent to the former primary clarifier structure east of Ennis Creek.
- Three buildings and four aboveground storage tanks (one approximately 5 million gallons) in the area of the former mill secondary wastewater treatment system.
- Shoreline structures including the former shipping pier, the jetty west of the pier, a bulkhead constructed of pilings and timbers between the former shipping pier and the mouth of Ennis Creek, and riprap armoring.

In addition to the surface structures that remain, there are a number of subsurface structures present on the mill property, including concrete footers and foundations, wood pilings, sheet piles, and wood timbers. The most prominent subsurface structures observed during the Supplemental Upland Investigation included foundations and footers in the areas of the former wood mill,

recovery boiler, power house, digesters, and maintenance shop/engineering building. As shown in Figure 4, these structures were relatively close to the present-day shoreline.

5.4 Geology

The local geology beneath the Upland Study Area and nearby areas consists of Tertiary-age bedrock overlain by Pleistocene-age glacial deposits and Holocene-age marine sediment, alluvium, and fill. The depth to bedrock in the Upland Study Area is unknown, but is likely variable in the Port Angeles area based on local isolated outcrops of the Tertiary-age Twin River Formation (Tabor and Cady, 1978; HLA, 1993). Most of the glacial deposits resulted from continental glaciers that advanced from the north, with fewer glacial deposits that resulted from alpine glaciation in the Olympic Mountains to the south.

Near-surface soil within the Upland Study Area consists of fill, alluvium deposited by Ennis Creek, beach deposits, and glacial deposits including till and outwash. The occurrence of these units beneath the Upland Study Area is illustrated in eight cross sections (Figures 12 through 19); the locations of the cross section lines are shown in Figure 10.

5.4.1 Fill

Based on an evaluation of historical information, the majority of the fill material beneath the mill property was likely placed before construction of the pulp mill began in the 1930s, with smaller amounts placed before 1917 for construction of the Spruce Saw Mill. The location of the shoreline and the Ennis Creek channel changed over the development history of the property (Figure 3). Before construction of the pulp mill, the shoreline was located farther south, and the majority of the Upland Study Area was below the mean higher high water elevation.

Fill material beneath the mill property consists of sand and gravel with varying amounts of concrete rubble and other construction debris from the mill demolition. The thickness of fill ranges from 3 feet in the southern portion of the Upland Study Area to 25 feet in the northwestern portion. In some locations, the fill consists primarily of concrete rubble, gravel, and rock. During mill decommissioning from 1997 to 1999, crushed concrete rubble was distributed across some areas of the mill property (Figure 2). In 1999, fill material consisting of gravel, rock, and riprap was imported to reconstruct and prevent further erosion of the shoreline adjacent to the former Log Yard. Materials in many areas of the mill property have been modified through grading, dredging, filling, or former mill operations (HLA, 1993), and thus can vary considerably across the Upland Study Area. As a result, the physical characteristics of the fill material likely vary considerably across the Upland Study Area as well.

During pulp mill dismantling, crushed concrete rubble from mill facilities was distributed across the western portion of the property; some of the rubble was placed in stockpiles. The stockpiled concrete rubble was subsequently distributed throughout the central portion of the mill property (Figure 2). In addition, boiler ash and slag (clinker) were identified in a few explorations in the western portion of the mill property. Based on boring logs from previous investigations and explorations completed during the Supplemental Upland Investigation, boiler ash and/or slag were encountered in the vicinity of test pit locations TP-04, TP-05, and TP-07, monitoring well locations MW-28 and MW-28, and former monitoring well location MW-11 (Figure 9).

In general, the fill unit is thinner, and native beach sand deposits (consisting of poorly graded sand with varying amounts of gravel, cobbles, silt and shell fragments) occur more frequently, in explorations completed closer to the bluffs bordering the mill property to the south. Similarly, the thickness of fill generally decreases in the vicinity of Ennis Creek, where apparent alluvium consisting of native sand and silt is present at relatively shallow depths of approximately 5 feet bgs. Explorations completed in the eastern portion of the property exhibited similar conditions, with 3 to 7 feet of gravelly sand fill overlying native beach sands. Soil encountered in the Equipment Storage Area, located in the southeastern portion of the property near the mill's former secondary wastewater treatment facility (Figure 4), generally consists of approximately 4 feet of gravelly fill overlying glacial deposits.

In the northwestern portion of the Upland Study Area, fill materials consisting of gravel, sand, and silt with fragments of shells, wood, brick, metal, and other debris are present up to 25 feet bgs. Relic concrete footers, foundations, and wood pilings were observed in test pits TP-01, TP-02, TP-03, and TP-20 (Figure 9).

5.4.2 Beach Deposits

Beach deposits consisting of poorly graded sand with varying amounts of gravel, cobbles, silt, and shell fragments are present beneath the fill unit in portions of the Upland Study Area. These deposits become thinner and terminate in a landward (southerly) direction, representing the southern extent of marine (beach) deposition in the Port Angeles area.

Gravelly beach deposits are present immediately west of the mouth of Ennis Creek. These deposits are consistent with an east-west trending gravelly sand spit that existed before filling activities occurred in the Upland Study Area. South and west of this gravelly sand spit, the beach deposits encountered in explorations contain more silt, suggesting a lower energy depositional environment that was possibly an intertidal mudflat area.

5.4.3 Alluvial Deposits

Alluvium consisting of gravel, sand, and silt was observed in the Upland Study Area. The alluvium was deposited primarily by fluvial processes associated with Ennis Creek and White Creek. For the purposes of this report, alluvium also includes natural deposits associated with erosion of the bluffs south of the Upland Study Area. The alluvium appears to be thickest along the western side of Ennis Creek in the vicinity of Supplemental Upland Investigation locations SSB-5, GWG-5, GWG-5A, MW-62, and MW-65 (Figure 9).

5.4.4 Glacial Deposits

Glacial deposits underlie the fill, beach deposits, and alluvium beneath the mill property. These deposits consist of Vashon till, Vashon outwash, and older glacial drift. The glacial deposits were encountered at depths ranging from approximately 7 to 33 feet bgs. The Vashon till beneath the property consists of a well graded, highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders. The results of past investigations indicate that the Vashon till and outwash deposits are at least 10 to 25 feet thick beneath the mill property (CH2M Hill, 1977; Landau, 1991), and past and recent investigations indicate that the till is laterally continuous across the majority of the property. Till was not observed within the expected depth range in the

borings completed adjacent to Ennis Creek during the Supplemental Upland Investigation; however, mixtures of sand, gravel, and silt interpreted as glacial outwash/drift were encountered in these borings.

5.4.5 Soil Physical Properties

During the Supplemental Upland Investigation, representative samples of the fill, native alluvium/beach deposits, and glacial deposits were collected and analyzed for grain size (sieve analysis), bulk density, and/or hydraulic conductivity. The results of these analyses are included in Appendix D.

The results of the sieve analyses (ASTM Method D422) for select samples were generally consistent with the soil descriptions recorded by the field geologist on boring logs and test pit logs. General descriptions of soils encountered in Upland Study Area explorations are provided in Sections 5.4.1 through 5.4.4 above.

Samples of the fill unit were collected from three test pits (TP-02, TP-07, and TP-11) in the western portion of the mill property to characterize the bulk density of the fill (ASTM Method C29). The bulk density results ranged from 59.9 to 120.4 pounds per cubic foot, averaging 92.2 pounds per cubic foot.

Hydraulic conductivity analyses were performed using ASTM Method D5084 (flexwall analysis for cohesive soils) and ASTM Method D2434 (rigidwall analysis for sandy/non-cohesive soils). The results of the hydraulic conductivity analyses indicate that the hydraulic conductivity of the uppermost portion of the glacial deposits (Vashon till/outwash) ranges from approximately 10^{-7} to 10^{-2} centimeters per second (cm/s), with the majority of the reported values falling in the range of 10^{-7} to 10^{-5} cm/s. These values correspond to published hydraulic conductivity values for glacial till and very fine sand, silt, and clay. The hydraulic conductivity of the shallow water-bearing zone above the glacial deposits is discussed in Section 5.5.

5.5 Hydrogeology

Regionally, groundwater in the Port Angeles area is present in shallow water-bearing zones and deeper aquifers. Shallow groundwater in the Port Angeles area is recharged by precipitation and is part of a larger groundwater recharge basin (WRIA 18, 2005). Most water supply wells in the area obtain groundwater from water-bearing zones greater than 60 feet deep, either beneath the Vashon till, or deeper, within interbedded basalt and sedimentary bedrock. Groundwater is the primary source of drinking water in the Port Angeles area. The City obtains its municipal water supply from a well adjacent to the Elwha River, approximately 8 miles west of the Upland Study Area. Groundwater beneath the Upland Study Area is not a drinking water source, and is not upgradient of any drinking water sources (Integral, 2007).

In 1941, Rayonier installed a 434-feet deep well to extract groundwater for the pulp milling process. This process water well yielded 100 to 250 gallons of water per minute. The well was abandoned in 1947 after rising chloride concentrations made the water unusable (Foster Wheeler, 1997).

The locations of existing monitoring wells in the Upland Study Area are shown in Figure 9. Monitoring well construction details are presented in Table 5 and on the boring/monitoring well logs included in Appendix B. The majority of the monitoring wells are screened in the shallow water-bearing zone above the glacial deposits. Monitoring well MW-68 is screened within the glacial deposits, from approximately 53 to 58 feet bgs. Monitoring wells PA-1 and PA-2 also are screened within the glacial deposits, from approximately 20 to 30 feet bgs and 70 to 80 feet bgs, respectively. The existing network of monitoring wells enables groundwater quality to be evaluated upgradient, beneath, and downgradient of former mill operations.

The depth to groundwater beneath the Upland Study Area ranges from approximately 2 to 15 feet bgs based on groundwater level measurements obtained between August 2010 and June 2011. Groundwater elevation data are presented in Table 6. In general, groundwater is shallower in monitoring wells located near the shoreline, and deeper in monitoring wells located further inland. Groundwater surface contour (potentiometric) maps, shown in Figures 20 through 23, show the estimated elevation of groundwater beneath the Upland Study Area during the four most recent groundwater monitoring events in August 2010, November 2010, February 2011, and May 2011. The inferred groundwater flow direction beneath the Upland Study Area is generally to the north towards Port Angeles Harbor, with flow components toward Ennis Creek in the vicinity of the creek. Shallow groundwater flow is likely influenced locally by subsurface structures remaining from the past mill operations, such as building foundations.

The groundwater flow direction does not appear to vary substantially on a seasonal basis. Groundwater elevations in monitoring wells in the Upland Study Area were generally 1 to 2 feet higher during the February 2011 monitoring event than the event completed in August 2010. This is consistent with seasonal rainfall patterns (i.e., more rainfall/infiltration occurs in February than in August).

The 2010-2011 groundwater elevation data indicate that horizontal groundwater gradients generally range from 0.02 to 0.04 beneath the southern portion of the Upland Study Area, and from 0.004 to 0.01 beneath the northern portion of the Upland Study Area. Estimates of vertical groundwater gradients were derived using groundwater elevation data from four well pairs consisting of a shallow monitoring well and a deeper monitoring well located near each other (MW-63/MW-68, MW-52/PA-1, PZ-6/PA-2, and MW-69/PA-17). The vertical gradients estimated for the western portion of the Upland Study Area ranged from 0.04 to 0.18 downward (based on well pairs MW-63/MW-68 and MW-52/PA-1). Vertical gradients estimated for the southern/central portion of the Upland Study Area near Ennis Creek ranged from 0.03 to 0.05 upward (based on well pairs PZ-6/PA-2 and MW-69/PA-17). The estimate of an upward vertical gradient in the Ennis Creek ravine is consistent with previous studies that suggest deeper groundwater in the Ennis Creek ravine is potentially under confined conditions (HLA, 1993).

The hydraulic conductivity of the shallow water-bearing zone above the glacial deposits was estimated in 2001 by performing slug tests in eight monitoring wells. The slug test results are summarized in Table 7. The slug tests yielded hydraulic conductivity estimates of the order of 10^{-4} to 10^{-2} cm/s (Integral, 2007). This range of estimated hydraulic conductivity values is consistent with the silty sand and gravel fill observed in the Upland Study Area. The significant contrast between the relatively low hydraulic conductivities of the glacial deposits (generally in the range of

10^{-7} to 10^{-5} cm/s; see Section 5.4.5) and the relatively high hydraulic conductivities of the overlying shallow water-bearing zone (roughly three orders of magnitude difference, on average) suggests that the glacial deposits act as a low-permeability barrier to downward groundwater migration below the shallow water-bearing zone.

Estimates of groundwater flow (seepage) velocity and volumetric discharge to Port Angeles Harbor were derived for the shallow water-bearing zone during the Upland RI (Integral, 2007) using the following inputs/estimated parameter values: horizontal groundwater gradient estimates from groundwater elevation measurements in monitoring wells; hydraulic conductivity estimates from the slug tests performed in 2001; an effective porosity of 0.3; and a flow front area of 27,000 square feet (10 feet thick by 2,700 feet wide). Groundwater flow velocity estimates ranged from 0.003 to 0.8 cm/s, with an average of 0.15 cm/s. Discharge estimates ranged from 0.1 to 34 gallons per minute, with an average of 6.5 gallons per minute (9,360 gallons per day).

A groundwater seep survey was performed during the Supplemental Upland Investigation, with the intention of collecting seep water samples along the shoreline if visible seeps were identified. It was anticipated that groundwater seeps may be found in the intertidal zone during low tide. Seeps were not observed during the field reconnaissance; consequently, groundwater seep samples were not collected. Seep survey methods and observations are presented in Appendix A of the Supplemental Upland Technical Memorandum (GeoEngineers, 2011).

The effect of marine tidal fluctuations on groundwater elevations beneath the Upland Study Area was evaluated during three tidal monitoring studies performed in 1993, 1997, and 2003 (HLA, 1993; ESI, 1998; Integral, 2007). Groundwater fluctuation data obtained during the three studies were generally consistent. Results from the 2003 tidal study are summarized here because this was the most comprehensive of the three studies. The 2003 tidal monitoring study was performed from July 7 to 21, 2003 and included 12 monitoring wells; the maximum tidal fluctuation during the study was approximately 12 feet. Details of the 2003 tidal study are presented in the Upland RI Report (Integral, 2007). In general, monitoring wells near the shoreline (MW-51, MW-55, MW-56, and MW-59) exhibited the greatest groundwater level fluctuations in response to tidal fluctuations – on the order of 2 to 5 feet for a tidal fluctuation of 12 feet. Monitoring wells located farther inland from the shoreline (PZ-2, PZ-4, PZ-5, PZ-10, MW-23, MW-52, and MW-58) exhibited less than 1 foot of groundwater fluctuation in response to a 12-foot tidal fluctuation. Groundwater elevations in two monitoring wells (MW-57 and PZ-9) did not conform to this general pattern of decreasing tidal response with distance inland from the shoreline. The measured tidal responses in inland well MW-57, located in the central portion of the mill property, were more consistent with the responses in shoreline wells. By comparison, well PZ-9, located near the shoreline in the eastern portion of the property, exhibited less tidal influence than other shoreline wells.

5.6 Ecological Setting

The majority of this section is reproduced from the Upland RI Report (Integral, 2007).

The mill property is primarily zoned heavy industrial. The Ennis Creek riparian area and the bluffs bordering the southern property boundary contain disturbed forest habitat that provide corridors of upland wildlife habitat. Information regarding species listed as threatened, endangered, proposed,

candidate, sensitive, and/or monitored under the Federal Endangered Species Act (ESA) or under Washington State regulations was acquired from the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Washington Department of Natural Resources Natural Heritage Program, and the Washington Department of Fish and Wildlife (WDFW) Priority Habitat Species List data.

No Federally listed endangered or threatened species were identified in the Upland Study Area. Bald eagles were removed from the Federal Endangered Species list in 2007, but they continue to be protected by the Federal Bald and Golden Eagle Protection Act (16 U.S.C. 668(a); 50 CFR 22). No nesting bald eagles are located on or near the Upland Study Area; however, they are known to forage along this stretch of shoreline. The closest nesting territory (Morse Creek #258) is located approximately 1 mile east of the Upland Study Area. There is also a nesting territory (Angels Point #649) west of the Upland Study Area. Wintering bald eagles require perch trees for day use and mature/old-growth forest stands for night roosts. Perch trees are typically dominant live or dead trees situated near a shoreline where a nest or defendable territory is evident or a prey source is abundant. Prey items are primarily fish and waterfowl. Bald eagles do forage along this stretch of shoreline and in the Port Angeles Harbor area during the winter months; however, there are no major concentrations or winter night roosts located near the Upland Study Area.

The marbled murrelet is listed as threatened on both Federal and State lists and may forage within the harbor area, but their numbers documented during the Puget Sound Avian Monitoring Project flights are low. Marbled murrelets forage primarily for small fish and invertebrates in the nearshore environment and may forage near the Upland Study Area on occasion. In western Washington, marbled murrelets nest in large conifer trees and may travel up to 50 miles or more inland to nest (Nelson and Hamer, 1995). The closest known occupied nesting stands are in the Olympic National Forest, located approximately 6 miles south of the Upland Study Area. No suitable nesting habitat occurs within the Upland Study Area or its surroundings.

Other avifauna that may forage within the Port Angeles Harbor include various shorebirds, waterfowl, and sea birds. No species listed as endangered, either by USFWS or WDFW, occur near the Upland Study Area. The common murre is a State of Washington candidate species. Small groups of murres may forage within the harbor. Other sea birds that may be found near the Upland Study Area, primarily during the winter months, include pigeon guillemots and surf scoters as well as various waterfowl and shorebird species.

Information regarding listed and candidate ESA fish species in the vicinity of the Upland Study Area was acquired from USFWS, NMFS, WDFW, and the Lower Elwha Klallam Tribe. There are no Federally listed endangered fish species identified in the vicinity of the Upland Study Area. Federally listed threatened species (also noted as State candidate species) that may be found in the Puget Sound evolutionary significant unit within the nearshore environment of the Upland Study Area include Puget Sound Chinook salmon (Oncorhynchus tshawytcha), Puget Sound Steelhead (O. mykiss), and Hood Canal summer-run chum salmon (O. keta), which may migrate through the area during certain periods of the year. Puget Sound/Strait of Georgia coho salmon (O. kisutch) is considered a species of concern by NMFS. In addition, Coastal-Puget Sound bull trout (Salvelinus confluentus), which may be found in the general area of the Upland Study Area, are listed under the ESA as threatened.

Certain marine mammals may also be expected to use the marine area adjacent to the Upland Study Area. Harbor seals have been seen actively swimming and apparently foraging in the marine environment near the former mill, but no haul-out locations are currently available. River otters are also commonly observed near the Upland Study Area. Sea otters have not been documented east of Pilar Point, located about 30 miles west of Port Angeles Harbor (Jameson and Jefferies, 2001).

ESA-listed marine mammals that may occur in offshore environments adjacent to the Upland Study Area include Southern Resident killer whale (Orcinus orca), including critical habitat, and humpback whales (Megaptera novaeangliae), both of which are endangered, as well as Stellar sea lion (Eumetopias jubatus), which is listed as threatened under the ESA.

6.0 CHEMICAL ANALYTICAL DATA EVALUATION

This section presents an evaluation of the existing chemical analytical data for the Upland Study Area. Included are a summary of the data used in the evaluation and information regarding data quality; a description of the regulatory screening levels used to evaluate the data; a general overview of the nature and extent of contamination in the Upland Study Area; and detailed summaries of the distribution and concentrations of COPCs relative to screening levels in each of the functional use areas that collectively make up the Upland Study Area.

6.1 Data Used in Evaluation/Data Quality Assessment

The analytical data/data sources used in the chemical analytical data evaluation presented in this report are identified below. Summary data tables containing the soil, groundwater, and surface water data used in the evaluation are presented in Appendix E.

- Previous Investigation Data
  - Includes soil data collected during previous upland investigations, as listed in Table 1 and summarized below.
    - 1997 ESI. The quality of the ESI chemical analytical data was assessed by USEPA chemists. The data quality objectives established for the ESI were met (E&E, 1998).
    - 2003 Upland RI. The quality of the Upland RI chemical analytical data was assessed by Integral chemists. The data quality objectives established for the Upland RI were met (Integral, 2007).
    - 2009 City of Port Angeles Environmental Sampling. The report published for the City's 2009 limited sampling at location PA-19 (Brown and Caldwell, 2009) did not discuss data quality. For the purposes of the evaluation presented herein, the data are assumed to be of sufficient quality for general site characterization.
  - Verification soil sampling data from interim actions and soil data collected during investigations associated with interim actions, as listed below. Data used to characterize soil or other media that were later removed during interim actions were not included in the evaluation.
    - Fuel Oil Tank 2 Interim Actions (1990-1991 and 2002)

- Finishing Room Area/Ennis Creek Interim Actions (1993, 1998, and 2002)
- Hog Fuel Pile Interim Action (2001)
- Spent Sulfite Liquor Lagoon Interim Action (2001)
- Machine Shop Interim Action (2002)
- Fuel Oil Tank 1 and Wood Mill Interim Actions (2006)

Table 2B lists the previous investigation soil samples and analyses that were used to evaluate the nature and extent of contamination as presented in Sections 6.3 and 6.4. It is important to note that although analytical data from shallow soil samples collected in areas where mill facilities previously existed are included in the data evaluation, these data may not be representative of current conditions because significant disturbance and reworking of shallow soil occurred during mill dismantling activities in 1997-1999.

- Supplemental Upland Investigation Data (2010-2011)
  - Laboratory analytical data generated during the Supplemental Upland Investigation were reviewed and verified in general conformance with USEPA functional guidelines for data validation (USEPA, 2008 and 2010a) to ensure that the data are valid and usable. The data quality assessment reports are provided in Appendix F. With limited exceptions, the results of the data quality assessment indicated no unusual problems or significant out-of-control conditions. For the minor deviations that were identified, qualifiers were applied to the data where necessary in accordance with the Quality Assurance Project Plan (QAPP; GeoEngineers, 2010). A few soil results were rejected due to out-of-control surrogate and matrix spike recoveries; these data were not used in the evaluation. Overall, the quality of the data meets the objectives defined in the QAPP and the data are considered to be usable for the intended purposes.

The following data were excluded from the evaluation presented in Sections 6.3 and 6.4:

- Analytical data from samples representing soil and other media removed during interim actions. These data are representative of material that has been removed from the mill property, and thus are not representative of current conditions.
- Groundwater analytical data collected prior to 2010. This includes data from groundwater sampling performed during the 2003 Upland RI and earlier studies. These data were collected more than eight years ago, and thus are not considered representative of current groundwater conditions due to groundwater flow and recharge that occurs over time. The August 2010 baseline groundwater sampling data and data from subsequent sampling events conducted in November 2010, February-March 2011, and May-June 2011 are used to evaluate current Upland Study Area groundwater conditions.
- Surface water (Ennis Creek) analytical data collected prior to 2010. These historical surface water data are not considered representative of current conditions in Ennis Creek because of the temporal nature of surface water flow in the creek. The August 2010 surface water (Ennis Creek and White Creek) sampling data are used to evaluate current Upland Study Area surface water conditions.

- Soil samples collected from the bluff areas along the southern boundary of the Upland Study Area. This includes samples EC020, EC021, EC022, EC030, EC031, EC032, and EC035. Because these samples were obtained from locations outside of the functional use areas defined for the Upland Study Area, they will be addressed as part of the off-property report.
- Analytical data from field duplicate samples. Analytical results from field duplicate samples provide a means of assessing homogeneity of the sample matrix; they do not supplement or replace primary sample data.

Although groundwater and surface water analytical data collected prior to 2010 were not used to characterize current conditions in the Upland Study Area as presented in Sections 6.3 and 6.4, historical groundwater and surface water data are included in the Appendix E data tables for completeness. The historical groundwater data were used to evaluate longer-term trends in groundwater COPC concentrations; observed trends for selected COPCs are discussed in Section 8.0.

Soil and groundwater data from the City's 2011 baseline assessment of the City Purchase Area (Farallon, 2011) have not been incorporated in this report. However, the City's report summarizing the results of their 2011 assessment (Farallon, 2011) is included in Appendix G. The City's findings for the City Purchase Area are consistent with the findings presented in Section 6.4. For example, concentrations of PCBs in several soil samples collected by the City in the northern portion of the City Purchase Area exceeded screening levels. The sampling conducted in the Equipment Storage area during the ESI and Upland RI also detected PCBs at concentrations exceeding screening levels. Isolated detections of other COPCs in soil reported by the City (Farallon, 2011) are also consistent with previous sampling results for the City Purchase Area.

6.2 Screening Levels

Risk-based screening levels were developed for the constituents analyzed in soil, groundwater, and surface water that have numeric regulatory criteria (or toxicity data that can be used to calculate protective criteria) listed in Ecology's on-line Cleanup Levels and Risk Calculations (CLARC) database (Ecology, 2010c). The regulatory criteria that were used to derive the screening levels are described in this section. The screening levels used in this evaluation represent threshold concentrations above which the COPCs may present a risk to human health or the environment if a complete exposure pathway exists. Screening levels are not the same as cleanup levels or remediation levels, which are regulatory criteria that dictate the need for, and scope of, cleanup actions and interim actions. COPC detections that exceed screening levels do not imply that cleanup actions or interim actions are necessary to address the exceedances. Cleanup levels and/or remediation levels for future interim actions in the Study Area will be developed during preparation of Interim Action Report Volume III: Interim Action Alternatives Evaluation Report for the Study Area. Screening levels for soil and groundwater are presented in Tables 8 and 9, respectively.

6.2.1 Soil

The regulatory criteria used to derive the soil screening levels presented in Table 8 include the following:

- MTCA Method B soil cleanup levels (standard formula values for carcinogens and non-carcinogens) protective of human health for unrestricted land use (WAC 173-340-740[3]), obtained from Ecology's CLARC database (Ecology 2010c).
- Soil criteria protective of groundwater as marine surface water were calculated using the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747[3][a]). For each constituent, the protective groundwater concentration used in the calculations was selected as the lowest of the respective marine surface water regulatory criteria used to derive groundwater screening levels. Default assumptions provided in WAC 173-340-747(4) for unsaturated zone soil were used in the calculations, and model input parameter values were taken directly from Ecology's CLARC database. Where input parameter values were not available in CLARC, they were obtained from Oak Ridge National Laboratory's Risk Assessment Information System (Oak Ridge National Laboratory, 2010).
- As discussed in the RI Work Plan (Integral and Foster Wheeler, 2004), a site-specific terrestrial ecological evaluation is required for the Uplands Study Area because there are at least 10 acres of native vegetation within 500 feet of the mill property (WAC 173-340-7491[2][a][iii]). Consistent with WAC 173-340-7493(3), the MTCA Ecological Indicator Soil Concentrations for protection of terrestrial plants and animals (WAC 173-340-900, Table 749-3) were used in developing screening levels. Since the future use of the mill property has not been determined, and may include unrestricted use including habitat for terrestrial plants and animals, the lowest of the indicator soil concentrations for protection of plants, soil biota, and wildlife was selected as the terrestrial ecological criterion for use in deriving soil screening levels.
- The MTCA Cleanup Regulation (WAC 173-340-705[6]) specifies that the cleanup level (or screening level) for a given constituent determined using Method B shall not be set at a level below the natural background concentration or analytical practical quantitation limit (PQL), whichever is higher. Preliminary soil screening levels were selected as the lowest of the applicable numeric regulatory criteria. The preliminary screening levels were then adjusted as necessary based on Washington state natural background soil metals concentrations (Ecology, 1994) and PQLs to derive the final soil screening levels used in this evaluation.
- The analytical PQLs were obtained from Analytical Resources Incorporated of Tukwila, Washington (ARI), and Frontier Analytical Laboratory of El Dorado Hills, California, both of which are Washington-certified laboratories. Discussions with these laboratories regarding the analytical requirements for this project indicate that the soil PQLs are the lowest practicably attainable values using conventional/accepted (although not necessarily the most commonly used) analytical methods, without performing extensive custom calibration studies (which may or may not result in lower PQLs) or increasing the probability of unacceptably high matrix interferences. For those analytes with PQLs that exceed the lowest applicable numeric regulatory criteria, the laboratories have determined that PQLs below the regulatory criteria cannot be practicably achieved.

6.2.2 Groundwater

As discussed in Section 5.5, groundwater beneath the property or potentially affected by the property is not a current or reasonable future source of drinking water. Consequently, human

ingestion of groundwater is not a potential exposure pathway. Potential risks associated with groundwater beneath the Upland Study Area include:

- Acute and chronic effects to aquatic organisms resulting from exposure to contaminants in groundwater that discharges to Port Angeles Harbor. Groundwater discharge to Port Angeles Harbor can occur either directly, via mixing with seawater in soil and/or sediment near the upland/marine interface and subsequent flow into the harbor, or indirectly, via groundwater discharge to Ennis Creek and subsequent flow of Ennis Creek into the harbor.
- Human consumption of aquatic organisms exposed to contaminants in groundwater that discharges to, and mixes with, marine surface water in Port Angeles Harbor.

The groundwater screening levels presented in Table 9 were developed to be protective of these potential exposure pathways. Regulatory criteria used to derive the groundwater screening levels include the following:

- MTCA Method B marine surface water cleanup levels protective of aquatic organisms and human health (WAC 173-340-730[3]), including:
    - Water quality criteria published in the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A).
    - Water quality criteria based on the protection of aquatic organisms (acute and chronic criteria) and human health published under Section 304 of the Federal Clean Water Act.
    - Concentrations established under the National Toxics Rule (Code of Federal Regulations [CFR] Title 40, Part 131).
    - MTCA standard formula values (for carcinogens and non-carcinogens) protective of human health (consumption of aquatic organisms), obtained from Ecology's CLARC database.

The MTCA Cleanup Regulation (WAC 173-340-705[6]) specifies that the cleanup level (or screening level) for a given constituent determined using Method B shall not be set at a level below the natural background concentration or analytical PQL, whichever is higher. Preliminary groundwater screening levels were selected as the lowest of the applicable numeric regulatory criteria. The preliminary screening levels were then adjusted as necessary based on PQLs to derive the final groundwater screening levels used in this evaluation. (Note: Washington state natural background concentrations for the groundwater COPCs in the Upland Study Area have not been established.)

The analytical PQLs in the Work Plan were obtained from ARI and Frontier Analytical Laboratory. Discussions with these laboratories regarding the analytical requirements for this project indicate that the groundwater PQLs are the lowest practicably attainable values using conventional/accepted (although not necessarily the most commonly used) analytical methods, without performing extensive custom calibration studies (which may or may not result in lower PQLs), collecting unreasonably large sample volumes in the field (e.g., four times the normal volume), or increasing the probability of unacceptably high matrix interferences. For those analytes with PQLs that exceed the lowest applicable numeric regulatory criteria, the laboratories have determined that PQLs below the regulatory criteria cannot be practicably achieved.

Based on review of a previous draft of this report, Ecology requested that the report be amended to consider not only the potential impacts to marine surface water from the discharge of upland

groundwater to Port Angeles Harbor, but also the potential impacts to marine sediments offshore of the mill property. Accordingly, an empirical evaluation of the groundwater-to-sediment exposure pathway has been added to this report. The empirical evaluation compares available groundwater analytical data for constituents detected in surface sediments offshore of the mill property at concentrations exceeding Washington State sediment quality standards (SQS; WAC 173-204-320) to preliminary groundwater screening levels developed by Ecology for the protection of marine sediments (Ecology, 2011). This evaluation was performed for the functional use areas bordering Port Angeles Harbor, as groundwater in the shoreline/nearshore monitoring wells in these areas is assumed to be representative of the groundwater that may mix with seawater in the nearshore environment before discharging to the harbor. The evaluation of the groundwater-to-sediment pathway is included in Appendix H; the results of the evaluation for each functional use area bordering Port Angeles Harbor are summarized in Section 6.4.

Ecology's draft vapor intrusion screening levels for groundwater (and soil vapor) contained in the document *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology, 2009) are relevant regulatory criteria to be considered for areas of the mill property where buildings may be constructed in the future. Appropriate vapor intrusion assessment and design evaluations will be performed in the future as necessary, once site development plans and the locations of future buildings are better known. As requested by Ecology, the Supplemental Upland Data Collection Work Plan (GeoEngineers, 2010) included a preliminary comparison of groundwater data from the 2003 Upland RI and earlier studies to Ecology's draft vapor intrusion screening levels for groundwater.

6.2.3 Surface Water

The potential risks associated with surface water are the same as the risks associated with groundwater as described above in Section 6.2.2. Consequently, the regulatory criteria used to derive surface water screening levels are the same as those used to derive groundwater screening levels (Section 6.2.2), and the screening levels for surface water are the same as the groundwater screening levels.

6.3 Overview of Upland Study Area Nature and Extent of COPCs

This section presents an overview of the nature and extent of COPCs in the Upland Study Area. Section 6.4 presents a more detailed evaluation of the COPCs in each of the functional use areas.

COPCs detected in soil and/or groundwater in the Upland Study Area at concentrations exceeding screening levels include metals, dioxins/furans, TPH, cPAHs, PCBs, SVOCs, and ammonia. Pesticides were detected in select historical soil samples at concentrations exceeding screening levels protective of groundwater. However, pesticides were not detected in any groundwater samples analyzed during the Supplemental Upland Investigation, and the pesticide concentrations detected in the historical soil samples were below human health and ecological-based screening levels. Consequently, because the analytical data indicate that the low pesticide concentrations detected in soil are protective of human health, terrestrial ecological receptors, and groundwater, pesticides are not considered a COPC in the Upland Study Area. Analytical results for pesticides are discussed further in Section 6.3.3.

VOCs have generally not been detected in historical soil samples or groundwater samples. VOCs were analyzed in groundwater during the Supplemental Upland Investigation but were not detected in most monitoring wells, and the few detections reported by the laboratory were less than screening levels. As discussed in the Supplemental Upland Data Collection Technical Memorandum (GeoEngineers, 2011), trace concentrations of chlorinated VOCs were detected in monitoring well MW-63, which is in the vicinity of a former monitoring well (MW-13) that had a small number of low-level chlorinated VOC detections in 1991. The VOC concentrations detected in well MW-63 are not indicative of the potential presence of dense non-aqueous phase liquid (DNAPL) in the vicinity of the well, and no field screening evidence of DNAPL was encountered in any of the explorations completed during the Supplemental Upland Investigation. Due to the general lack of VOC detections in soil and groundwater, VOCs are not considered a COPC in the Upland Study Area.

Concentrations of metals and dioxins/furans exceeding screening levels were found in shallow and deep soil at many locations across the mill property, and also are present in many groundwater monitoring wells. These COPCs do not appear to be associated with distinct source areas. Soil and groundwater impacts from other COPCs (e.g., TPH, cPAHs, and/or PCBs) are more localized; these COPCs are limited in their extent and appear to be associated with distinct source areas such as the Fuel Oil Tanks 1 and 2 areas, Wood Mill Area, Machine Shop Area, and Finishing Room Area. General findings regarding the occurrence of metals and dioxins/furans in the Upland Study Area are discussed below. Details concerning the distribution of these and other COPCs are discussed in the individual functional use area summaries in Section 6.4.

6.3.1 Metals

With limited exceptions, the concentrations of barium, chromium, cobalt, copper, nickel, and vanadium detected in soil in the Upland Study Area appear to be naturally occurring. This conclusion is based on the similarity of the concentrations of these metals detected in soil in former mill operations areas to the concentrations detected at upgradient location MW-64 in the southernmost portion of the Upland Study Area. Concentrations of arsenic, manganese, mercury, and zinc that exceed soil screening levels protective of groundwater were detected in shallow soil at a number of locations in the former mill operations areas, and the detected concentrations in these areas appear to be elevated relative to concentrations at upgradient location MW-64. Shallow soil concentrations of copper and nickel that exceed screening levels protective of groundwater, and that appear to be elevated relative to upgradient concentrations, are more localized.

Similar to the nearly ubiquitous presence of metals in soil at concentrations exceeding screening levels, several metals – manganese, copper, and nickel – have been widely detected in groundwater beneath the mill property at concentrations exceeding screening levels.

The cumulative soil and groundwater sampling results indicate that several metals that may be related to former mill operations – arsenic, copper, manganese, mercury, nickel, and zinc – are present in soil in several functional use areas at concentrations that may represent a source of contamination to groundwater. The possible mill-related arsenic, copper, manganese, and nickel concentrations that may represent a source of contamination to groundwater are limited to the upper 5 feet of soil. The mercury and zinc concentrations that may represent a source of

contamination to groundwater are limited to the upper 10 feet of soil. Concentrations of metals in soil relative to screening levels based on protection of human health (direct contact) and terrestrial plants and animals are discussed in the individual functional use area summaries in Section 6.4.

6.3.2 Dioxins/Furans

The soil analytical data indicate that the highest dioxin/furan concentrations generally occur in shallow soil, and that dioxin/furan concentrations generally decrease with depth in deeper soil. Dioxin/furan concentrations exceeding screening levels are generally limited to the upper 10 feet of soil.

Dioxins/furans have been detected in groundwater beneath every functional use area. All of the reported detections exceed the conservative screening level protective of marine surface water (0.0051 picograms per liter total toxic equivalent concentration [TEC]). However, the majority of the dioxin/furan concentrations reported in the groundwater samples collected in 2010-2011 strongly correlate with field-measurements of sample turbidity. This is illustrated in Figures 24A through 24D, which show dioxin/furan concentrations and turbidity data for the 15 monitoring wells that were analyzed for dioxins/furans during at least two quarters, and had at least one positive detection of dioxins/furans, in 2010-2011. The data for 11 of the 15 wells show a strong correlation between dioxin/furan concentrations and sample turbidity (i.e., higher dioxin/furan concentrations are associated with higher turbidities), which suggests that most of the dioxins/furans detected in groundwater samples are associated with suspended solids present in the unfiltered samples. This conclusion is consistent with the USEPA's *Technical Factsheet on Dioxin (2,3,7,8-TCDD)* (USEPA, 2010b), which states: "Due to its very low water solubility, most of the 2,3,7,8-TCDD occurring in water is expected to be associated with sediments or suspended material."

6.3.3 Pesticides

Low concentrations of pesticides were detected in approximately two thirds (115 out of 174) of the primary soil samples analyzed for these constituents during the 1997 ESI, 2003 Upland RI, and 2010-2011 Supplemental Upland Investigation. The detections occurred in all functional use areas analyzed for pesticides (only soil in the East Shoreline Area was not analyzed for pesticides). The highest pesticide concentrations were detected in select surface soil samples collected in the Main Former Mill Area during the ESI. Pesticide concentrations exceeding the most stringent regulatory criteria (i.e., the screening levels protective of groundwater) were detected in the Main Former Mill Area, Northwest Shoreline Area, Estuary Area, and City Purchase Area. Most of the exceedances occurred in surface soil samples collected in the Main Former Mill Area during the ESI. Only two soil samples analyzed during the 2003 Upland RI and one sample analyzed during the 2010-2011 Supplemental Upland Investigation had concentrations of pesticides exceeding screening levels protective of groundwater. Seven pesticides were detected in ten or more soil samples at concentrations exceeding screening levels protective of groundwater; the most common constituent detected above screening levels was beta-BHC (25 samples). None of the detected pesticide concentrations in soil exceeded screening levels protective of human health (direct-contact) or terrestrial ecological receptors.

The majority of the non-detect pesticide results for soil samples collected during the 1997 ESI and 2003 Upland RI had analytical MRLs that exceeded the screening levels protective of groundwater

used in this report. By contrast, only a few soil samples collected during the 2010-2011 Supplemental Upland Investigation had MRLs that exceeded the screening levels protective of groundwater. The MRLs in all soil samples analyzed for pesticides were less than the respective screening levels protective of human health and terrestrial ecological receptors.

Isolated detections of pesticides were reported at low concentrations in groundwater samples collected in June 2003 during the Upland RI. Eight pesticides were detected above the conservative groundwater screening levels protective of marine surface water in 11 monitoring wells. The reported concentrations of these exceedances were generally only slightly greater than the respective screening levels. The majority of the non-detect pesticide results for groundwater samples analyzed prior to 2010 had analytical MRLs that exceeded the screening levels protective of marine surface water used in this report. In contrast to the June 2003 groundwater sampling results, pesticides were not detected in any of the baseline (sitewide) or subsequent groundwater samples collected during the 2010-2011 Supplemental Upland Investigation. The pesticide MRLs for the 2010-2011 groundwater samples were lower than the respective screening levels with few exceptions; the most notable exception was the MRL for gamma-chlordane, which exceeded the screening level in approximately half of the samples.

Because the low levels of pesticides detected in historical and recent soil samples did not exceed human health or ecological-based screening levels, and the 2010-2011 groundwater monitoring results indicate that the detected pesticide concentrations in soil are protective of groundwater (i.e., pesticides were not detected in any groundwater samples in 2010-2011), pesticides are not considered a COPC for the Upland Study Area.

6.4 Functional Use Areas

The Upland Study Area is divided into eleven “functional use areas” to facilitate discussion of past property use and presentation of the large amount of chemical analytical data that exists. These functional use areas are shown in Figures 9 and 10. The mill operations that occurred in each functional use area are summarized in Table 10. The functional use areas were established with consideration given to the locations of former mill operations, the location of known, distinct contamination sources (e.g., former Wood Mill interim action area, fuel oil tanks, Finishing Room, etc.), the Ennis Creek corridor, the property purchased by the City for its CSO project, and potential future property restoration opportunities.

To facilitate evaluation of the cumulative body of soil, groundwater, and surface water chemical analytical data relative to the screening levels for potential human health, terrestrial ecological, soil-to-groundwater, groundwater-to-surface water, and surface water exposure pathways, graphical symbols and maps were developed to show relative concentrations of COPCs compared to screening levels in the functional use areas. A color-coded circular “pie” symbol is used to depict soil results relative to screening levels. The outer ring of the pie symbol displays results for shallow soil samples (i.e., samples obtained from 0 to 2 feet bgs). The inner circle displays results for deep soil samples (i.e., samples obtained from greater than 2 feet bgs). A color-coded “stacked-block” symbol is used to depict groundwater and surface water results relative to screening levels. The symbols are defined further on the data summary maps depicting chemical analytical data for each functional use area (Plates 1 through 7). Data summary maps were not prepared for the CSO Area

(Figure 9) because there were relatively few samples collected in this area and the long, narrow shape of this area is not easily displayed at an appropriate scale.

In the subsections that follow, chemical analytical results for soil, groundwater, and surface water are compared to screening levels for the following potential exposure/risk pathways:

Human Health (Direct Contact) Exposure Pathway

Soil chemical analytical data were compared to screening levels protective of human health (MTCA Method B standard formula values for unrestricted land use) to evaluate potential risks associated with direct human contact (through ingestion and/or dermal contact) with soil containing COPCs. Under MTCA, for soil cleanup actions that address potential human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the pathway, the standard point of compliance is throughout site soils from the ground surface to a depth of 15 feet bgs.

Terrestrial Ecological Exposure Pathway

Soil chemical analytical data were compared to screening levels protective of terrestrial ecological receptors (MTCA Ecological Indicator Soil Concentrations) to evaluate potential risks associated with direct or food-chain exposures of wildlife, plants, and soil biota to soil containing COPCs. Under MTCA, for soil cleanup actions that address potential terrestrial ecological exposures, the standard point of compliance is throughout site soils from the ground surface to a depth of 15 feet bgs. However, for sites with institutional controls to address potential future excavation of soil deeper than 6 feet bgs, a conditional point of compliance may be set throughout soil from the ground surface to a depth of 6 feet bgs; MTCA defines this depth interval as the biologically active soil zone.

Soil-to-Groundwater Exposure Pathway

Soil chemical analytical data were compared to screening levels protective of groundwater as marine surface water (calculated using the MTCA fixed parameter three-phase partitioning model as described in Section 6.2) to evaluate risks associated with potential leaching of COPCs from soil to groundwater and subsequent discharge of groundwater to the offshore marine environment. Under MTCA, for soil cleanup actions that address the soil-to-groundwater pathway, the standard point of compliance is throughout site soils.

Groundwater-to-Surface Water Exposure Pathway

Groundwater chemical analytical data were compared to screening levels protective of marine surface water (MTCA Method B marine surface water criteria, derived as described in Section 6.2) to evaluate risks associated with discharge of groundwater beneath the Upland Study Area to the offshore marine environment. Under MTCA, the standard point of compliance for groundwater cleanup actions is throughout the site from the uppermost level of the saturated zone extending vertically to the lowest depth that could potentially be affected by the site.

Groundwater-to-Sediment Exposure Pathway

Groundwater analytical data for constituents detected in surface sediments offshore of the mill property at concentrations exceeding Washington State SQS (as reported in the Interim Action

Report Volume II: Marine Data Summary Report; Windward, in preparation) were compared to preliminary groundwater screening levels developed by Ecology for the protection of marine sediments (Ecology, 2011). This evaluation was performed using 2010-2011 groundwater data for shoreline monitoring wells in the functional use areas bordering Port Angeles Harbor, to assess whether there is evidence for a complete groundwater-to-sediment exposure pathway (i.e., whether the observed exceedances in marine sediments could have been caused – at least in part – by the discharge of contaminated upland groundwater to the harbor through the sediments). Some constituents that exceeded SQS in marine sediments were not analyzed in the groundwater samples collected in 2010-2011. For these constituents, historical data from previous groundwater sampling events were used, if available. Details of the groundwater-to-sediment pathway evaluation are provided in Appendix H; the results of the evaluation for each functional use area bordering Port Angeles Harbor are summarized in the subsections below.

Surface Water Exposure Pathway

Surface water chemical analytical data were compared to screening levels protective of marine surface water (MTCA Method B marine surface water criteria, derived as described in Section 6.2) to evaluate risks associated with the surface water exposure pathway. Under MTCA, the standard point of compliance for surface water cleanup actions is the point or points where COPCs are released to surface waters.

As discussed in Section 6.1, historical analytical data that are not considered representative of current conditions in the Upland Study Area were excluded from the evaluation presented herein. Historical and recent data deemed representative of current conditions have been incorporated into the following discussions and serve as the basis for the evaluation of the nature and extent of contamination in each functional use area. Sampling and analytical testing summaries for the Supplemental Upland Investigation are presented in Tables 2A, 3, and 4. Comprehensive chemical analytical data tables for historical and recent data are contained in Appendix E.

6.4.1 Northwest (NW) Shoreline Area

The Northwest Shoreline Area chemical analytical data evaluation summary is presented on Plate 1; analytical data tables are included in Appendix E. The Northwest Shoreline Area is located in the western portion of the Upland Study Area, and is bounded by Port Angeles Harbor to the northwest, the West Former Mill functional use area to the southeast, east, and north, and the CSO functional use area to the south. The shoreline of the Northwest Shoreline Area is armored by riprap. Part of the Northwest Shoreline Area is paved. During mill operations, the Northwest Shoreline Area was used for temporary log storage and boiler ash storage. Temporary boiler ash storage was confined to a paved area adjacent to a concrete retaining wall near ESI exploration location PA01. The ash was transported off-property via trucks for disposal (E&E, 1998). The Northwest Shoreline Area is underlain by approximately 10 to 15 feet of fill material.

Surface and subsurface soil samples were collected and analyzed during the ESI (locations with "GB" and "PA" identifiers and locations LY15 and LY16), the Upland RI (locations LY-20 and LY-22 through LY-25), and the Supplemental Upland Investigation (locations MW-61 and MW-67). With the exception of soil samples collected below 15 feet bgs from soil borings MW-61 and MW-67, surface and subsurface soil samples were generally collected from fill material. Groundwater

chemical analytical data summarized on Plate 1 were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation.

6.4.1.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

The primary COPCs that exceed human health (direct contact) screening levels in shallow soil are cPAHs (eight locations). The cPAH exceedances are distributed across much of the sampled area and most are less than 10 times the screening level; one exceedance is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in deep soil include cPAHs (one location) and lead (two locations). The cPAH exceedance was detected in soil between 2 and 4 feet bgs and is less than 10 times the screening level. Both lead exceedances were detected in soil between 2 and 4 feet bgs. One lead exceedance (location MW-67) is less than 10 times the screening level; the other lead exceedance (location GB08) is greater than 10 times (but less than 100 times) the screening level.

Comparison of COPCs in Shallow and Deep Soil

cPAHs are the primary COPCs that exceed human health (direct contact) screening levels in shallow soil. cPAHs exceed the human health screening level at eight shallow soil locations and one deep soil location. Lead exceeds the human health screening level at two deep soil locations but no shallow soil locations.

6.4.1.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include metals and dioxins/furans.

One or more metals (barium, copper, lead, manganese, mercury, nickel, selenium, thallium, and/or zinc) exceed ecological screening levels at 11 shallow soil locations. Copper exceeds screening levels most frequently (six exceedances); each of the other metals has four or fewer exceedances. The metals exceedances in shallow soil are distributed throughout the sampled area and all are less than 10 times the respective screening levels.

Dioxins/furans exceed the ecological screening level at five shallow soil locations. The dioxin/furan exceedances are limited to the southwestern two-thirds of the Northwest Shoreline Area and all are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

Metals (copper, lead, mercury, nickel, silver, and/or thallium) are the only COPCs that exceed terrestrial ecological screening levels in deep soil (seven locations). Lead exceeds screening levels most frequently (five exceedances); each of the other metals has two or fewer exceedances. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 10 feet bgs, and most are less than 10 times the respective screening levels. One

exceedance (lead at location MW-67, 2-3.5 feet bgs) is greater than 10 times (but less than 100 times) the screening level, and one exceedance (lead at location GB08, 2-4 feet bgs) is greater than 100 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

Metals exceed terrestrial ecological screening levels at 11 shallow soil locations and 7 deep soil locations. Copper and lead exceed the ecological screening level most frequently. Dioxins/furans exceed the ecological screening level at five shallow soil locations but no deep soil locations.

6.4.1.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

The primary COPCs that exceed soil-to-groundwater screening levels in shallow soil include cPAHs, metals, and dioxins/furans.

cPAHs exceed the soil-to-groundwater screening level at four shallow soil locations. The cPAH exceedances in shallow soil are limited to the southwestern two-thirds of the Northwest Shoreline Area and most are less than 10 times the screening level; one exceedance is greater than 10 times (but less than 100 times) the screening level.

One or more metals (copper, manganese, mercury, nickel, silver, thallium, and/or zinc) exceed soil-to-groundwater screening levels at 11 shallow soil locations. Copper exceeds the screening level most frequently (six exceedances); each of the other metals has four or fewer exceedances. The metals exceedances in shallow soil are distributed throughout the sampled area and all are less than 10 times the respective screening levels. The majority of the copper exceedances and one of the two nickel exceedances are within the range of the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxins/furans exceed the soil-to-groundwater screening level at five shallow soil locations. The dioxin/furan exceedances are limited to the southwestern two-thirds of the Northwest Shoreline Area and all are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

The primary COPCs that exceed soil-to-groundwater screening levels in deep soil are metals.

One or more metals (copper, lead, mercury, nickel, silver, and/or thallium) exceed soil-to-groundwater screening levels at six deep soil locations; each of the metals has three or fewer exceedances. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 10 feet bgs, and all are less than 10 times the respective screening levels. The copper and nickel exceedances are within the range of the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Comparison of COPCs in Shallow and Deep Soil

cPAHs exceed the soil-to-groundwater screening level at four shallow soil locations but no deep soil locations. Metals exceed soil-to-groundwater screening levels at 11 shallow soil locations and 6 deep soil locations. Copper exceeds the soil-to-groundwater screening level most frequently; however, the majority of the copper exceedances in shallow soil, and all of the copper exceedances in deep soil, are within the range of the copper concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxins/furans exceed the soil-to-groundwater screening level at five shallow soil locations but no deep soil locations.

6.4.1.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are six existing groundwater monitoring wells in the Northwest Shoreline Area (MW-28, MW-52, MW-53, MW-61, MW-67, and PZ-2). Monitoring wells MW-53, MW-61, and MW-67 are considered shoreline monitoring wells. Dioxins/furans and the metal manganese were the COPCs that were most often detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. Well MW-28 had the greatest number of COPCs detected at concentrations exceeding screening levels (dioxins/furans, cPAHs, ammonia, PCBs, and metals). Manganese exceedances in wells MW-52 and MW-61 appear to correlate with manganese exceedances of soil-to-groundwater screening levels in shallow soil in the vicinity of these wells (locations GB01, GB04, and GB08). There does not appear to be a correlation between the COPCs detected at concentrations exceeding groundwater screening levels in well MW-28 and the concentrations of COPCs in shallow soil at this location (PA01).

6.4.1.5 GROUNDWATER-TO-SEDIMENT EXPOSURE PATHWAY

The following constituents have been detected in marine surface sediments offshore of the Northwest Shoreline Area at concentrations exceeding SQS: 2-methylphenol, 2,4-dimethylphenol, 4-methylphenol, acenaphthene, BEHP, dibenzofuran, fluoranthene, mercury, phenol, and total PCBs (Appendix H, Figure H-1; Windward, in preparation).

BEHP was detected in a groundwater sample obtained from shoreline monitoring well MW-61 in February 2011 at a concentration (1.4 micrograms per liter [ug/L]) that exceeds Ecology's preliminary groundwater screening level protective of sediments. Well MW-61 is upgradient of Marine RI sediment sample LP-03, which is the only sediment sample in the entire offshore area adjacent to the mill property that exceeded the SQS for BEHP (Appendix H, Figures H-1 and H-2). BEHP is a common laboratory contaminant; there are no known mill-related sources of BEHP. Analytical results presented in the Marine RI Report (Malcolm Pirnie, 2007b) indicate that BEHP was detected in one or more laboratory method blanks associated with all of the sediment samples collected during the 2002 Marine RI, including the samples collected offshore of the Northwest Shoreline Area. This indicates that all of the reported BEHP detections in the Marine RI sediment samples are suspect. Furthermore, the concentration of BEHP detected in the February 2011 groundwater sample from well MW-61 (1.4 ug/L) was only slightly greater than the analytical MRL of 1 ug/L, and BEHP was detected in a method blank associated with many of the groundwater samples collected during the February 2011 monitoring event (although not the sample from MW-61).

The detections of BEHP in laboratory method blanks associated with the Marine RI sediment samples and many of the February 2011 groundwater samples, and the fact that there are no known mill-related sources of BEHP, suggest that the reported BEHP detections in sediment and groundwater are likely the result of laboratory contamination. None of the other constituents detected above SQS in sediments was detected in recent (2010-2011) groundwater samples or historical groundwater samples (where recent data do not exist) at concentrations exceeding Ecology's preliminary screening levels protective of sediment. Consequently, the groundwater-to-sediment pathway does not appear to be a significant pathway of concern in the Northwest Shoreline Area, and will not be further considered in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.1.6 NORTHWEST SHORELINE AREA SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are cPAHs. The primary COPCs that exceed terrestrial ecological screening levels in soil are metals (primarily copper and lead) and dioxins/furans. The primary COPCs that exceed soil-to-groundwater screening levels in soil are cPAHs, metals (primarily copper), and dioxins/furans.

In general, there are more screening level exceedances in shallow soil (0-2 feet bgs) than in deep soil (>2 feet bgs), and in most, but not all sampling locations, COPC concentrations are higher in shallow soil than in deep soil. COPC exceedances for all three exposure pathways (human health, ecological, and soil-to-groundwater) are present in soil throughout much of the area; the footprint of COPC exceedances for each of these pathways is similar.

The concentrations of the copper screening level exceedances in soil are similar to the concentrations of copper that were detected in soil at upgradient location MW-64.

Dioxins/furans and the metal manganese are the two primary COPCs detected in groundwater at concentrations exceeding screening levels protective of marine surface water. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. There does appear to be a possible correlation between manganese exceedances in some groundwater monitoring wells and manganese concentrations in nearby shallow soil. For example, manganese exceedances in well MW-52 may be related to elevated manganese concentrations detected in soil at location GB08, and manganese exceedances in well MW-61 may be related to elevated manganese concentrations detected in soil at locations GB01 and GB04 (see soil and groundwater data tables in Appendix E). The manganese exceedances in groundwater in the Northwest Shoreline Area also may be related to elevated manganese concentrations reported in soil in the adjacent West Former Mill Area to the east, where manganese concentrations as high as 14,100 mg/kg were detected (see for example samples TP-05-6', TP-07-6', and SSB-2-5-6.5 in the soil data table in Appendix E). There are no obvious correlations between isolated exceedances of other COPCs in groundwater and concentrations of the same COPCs in nearby soils.

Based on the results of the groundwater-to-sediment evaluation presented in Appendix H and summarized above in Section 6.4.1.5, the groundwater-to-sediment pathway will not be further considered for the Northwest Shoreline Area in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.2 West Former Mill Area

The West Former Mill Area chemical analytical data evaluation summary is presented on Plates 2A through 2C. Analytical data tables are included in Appendix E. The West Former Mill Area is located in the western portion of the Upland Study Area, and is bounded by Port Angeles Harbor to the north, the Main Former Mill Area to the east, the CSO Area to the south, and the Northwest Shoreline Area and Port Angeles Harbor to the west. The shoreline portion of the West Former Mill Area is armored by riprap. The following former mill facilities were located in the West Former Mill Area:

- Fuel Oil Tanks 1 and 2 (Bunker C storage).
- Maintenance Shop.
- Wood Mill.
- Power House.
- Hog Fuel Pile.
- Paint Shop.
- Auto Shop.
- Sludge Building.
- Recovery Boiler.

The West Former Mill Area is underlain by approximately 5 to 22 feet of fill material. Surface and subsurface soil analytical data summarized on Plates 2A through 2C were collected and analyzed during the following investigations and interim actions:

- 1991 Fuel Oil Tank 2 Soil Investigation (locations with "B" identifiers) (Landau, 1991).
- 1997 ESI (locations with "HF" identifiers, LY21, RB01 through RB04, SMT01, and SMT02) (E&E, 1998).
- 2001 Hogged Fuel Material TPH Supplemental Testing (locations WWHF-9 and WWHF-10) (Landau, 2001).
- 2002 Fuel Oil Tank 2 Interim Action (locations with "FOT" identifiers) (Integral and Foster Wheeler, 2003).
- 2006 Fuel Oil Tank 1 Interim Action (locations with "FOT-EX" identifiers) (GeoEngineers, 2006).
- 2006 Wood Mill Interim Action (locations with "WM-EX" identifiers) (GeoEngineers, 2006).
- 2003 Upland RI (locations BP20, PS20, RB01, RB20 through RB22, and WM21) (Integral, 2007).
- 2010-2011 Supplemental Upland Investigation (locations with "SSB" and "TP" identifiers,MW-60, and MW-68).

Approximately 13,380 tons of soil and 2,700 cubic yards of wood residue were removed from the West Former Mill Area during interim actions completed between 1993 and 2006. The interim

actions were performed in the Fuel Oil Tank 1, Fuel Oil Tank 2, Wood Mill, and Hog Fuel Pile areas (Figure 6).

Groundwater chemical analytical data summarized on Plates 2A through 2C were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation. One groundwater grab sample was collected from boring GWG-9 during the Supplemental Upland Investigation. The remaining groundwater samples were collected from monitoring wells.

6.4.2.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include dioxins/furans (five locations), cPAHs (seven locations), PCBs (one location), and metals (two locations).

The dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area and all are less than 100 times the screening level.

The cPAH exceedances are limited to the eastern half of the West Former Mill Area and are less than 10 times the screening level, with one exception (location RB01), which has a concentration less than 100 times the screening level.

The PCB exceedance is limited to one location (TP-12) and is less than 10 times the screening level.

Metals exceedances are limited to two locations and include antimony, arsenic, lead, and thallium. Arsenic was the only metal that was detected at a concentration greater than 10 times the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in deep soil include cPAHs (15 locations), TPH (8 locations), PCBs (2 locations), metals (5 locations), and dioxins/furans (2 locations).

The cPAH exceedances are distributed throughout the sampled area and were detected in soil between 2 and 16 feet bgs; all are less than 10 times the screening level, with one exception (location MW-60, 10-11.5 feet bgs), which has a concentration less than 100 times the screening level.

The TPH exceedances are limited to the southern half of the West Former Mill Area with one exception (location TP-02). All TPH exceedances are less than 10 times the screening level, with one exception (location FOT-0086).

The PCB exceedances are both in the central portion of the West Former Mill Area, and both are less than 10 times the screening level.

The metals exceedances are limited to the southern half of the West Former Mill Area and all are less than 10 times the screening levels. Lead, manganese, and vanadium are the only metals that exceed screening levels in deep soil.

The dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area and all are less than 10 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the West Former Mill Area generally decrease with depth, with the exception of metals, PCBs, and TPH at some locations. Concentrations of metals generally decrease with depth, but several locations have higher concentrations of metals at depth than at the surface (locations HF-04, HF-05, HF09, RB20, RB21, TP-03, TP-05, and TP-11). PCB exceedances are limited to two locations in the central portion of the West Former Mill Area. Several locations have higher concentrations of PCBs at depth than at the surface (locations TP-01, TP-03, TP-05, TP-11, TP-12, and WM21). TPH exceeds screening levels in no shallow locations and eight deep locations. Three locations have higher concentrations of TPH at depth than near the surface (locations TP-02, TP-03, and TP-11). No clear difference of cPAH concentrations between shallow and deep soil is discernible. Dioxin/furan concentrations decrease with depth and are limited to the northeastern quadrant of the West Former Mill Area.

6.4.2.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include metals (17 locations), dioxins/furans (5 locations), and TPH (4 locations).

One or more metals (antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, thallium, and/or zinc) exceed ecological screening levels at 17 shallow soil locations. Lead and copper exceed screening levels most frequently. The metals exceedances in shallow soil are distributed throughout the sampled area and all are less than 100 times the respective screening levels. The majority of the lead exceedances are within the range of the lead concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area and are less than 100 times the screening level, with one exception (location BP-20).

TPH exceeds ecological screening levels at four shallow soil locations. The TPH exceedances are limited to the eastern half of the West Former Mill Area and all are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in deep soil include metals (20 locations), dioxins/furans (3 locations), TPH (28 locations), and PCBs (2 locations).

One or more metals (barium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and/or zinc) exceed terrestrial ecological screening levels in deep soil. Copper exceeds screening levels most frequently. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 30.75 feet bgs; most are less than 10 times the respective screening levels, and all are less than 100 times the screening levels. Half of the copper exceedances are within the range of the copper concentrations detected in soil at upgradient location MW-64.

The dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area at depths ranging from 2 to 11.5 feet bgs. Two of the exceedances are less than 10 times the screening level, and one is less than 100 times the screening level.

The TPH exceedances are distributed throughout the sampled area at depths ranging from 2 to 16.5 feet bgs, and the majority of the exceedances are less than 10 times the screening level. One of the exceedances is greater than 100 times the screening level (location FOT-0086, 7 feet bgs).

The PCB exceedances are both in the central portion of the West Former Mill Area, and both are less than 10 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the West Former Mill Area generally decrease with depth, with the exception of metals, PCBs, and TPH at some locations. Concentrations of metals generally decrease with depth, but several locations have higher concentrations of metals at depth than near the surface. The metal that exceeds screening levels most frequently is copper. PCB exceedances are limited to deep soil in the central portion of the West Former Mill Area. TPH exceeds screening levels at 4 shallow locations and 28 deep locations. Dioxin/furan concentrations decrease with depth and are limited to the northeastern quadrant of the West Former Mill Area.

6.4.2.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include metals (ten locations), dioxins/furans (five locations), PCBs (ten locations), SVOCs (two locations), and cPAHs (two locations).

One or more metals (arsenic, copper, manganese, mercury, nickel, silver, thallium, and/or zinc) exceed soil-to-groundwater screening levels at ten shallow soil locations. Copper exceeds the screening level most frequently, followed by silver and nickel. The metals exceedances in shallow soil are distributed throughout the sampled area and are less than 10 times the respective screening levels, with one exception (location RB01), which has concentrations greater than 10 times but less than 100 times the screening levels for arsenic, copper, thallium, and zinc. The majority of the copper exceedances and two of the five nickel exceedances are within the range of the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area and are less than 100 times the screening level, with one exception (location BP20), which has a concentration slightly greater than 100 times the screening level.

The PCB exceedances are distributed throughout the sampled area and are less than 100 times the screening level, with one exception (location TP-12).

The SVOC exceedances are less than 10 times the screening level and both are located in the northeastern quadrant of the West Former Mill Area.

The cPAH exceedances are less than 10 times the screening level and both are located in the central portion of the West Former Mill Area.

Deep Soil (>2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in deep soil include metals (16 locations), dioxins/furans (3 locations), PCBs (13 locations), TPH (8 locations), cPAHs (5 locations) and SVOCs (2 locations).

One or more metals (copper, manganese, mercury, nickel, silver, and/or zinc) exceed soil-to-groundwater screening levels at 16 deep soil locations. Copper exceeds the screening level most frequently. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 30.75 feet bgs; all are less than 10 times the respective screening levels, with three exceptions that have concentrations less than 100 times the respective screening levels. The majority of copper exceedances and one of the four nickel exceedances are within the range of the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxin/furan exceedances are limited to the northeastern quadrant of the West Former Mill Area at depths ranging from 2 to 11.5 feet bgs, and are less than 10 times the screening level, with one exception (location BP20), which has a concentration slightly greater than 10 times the screening level.

PCB exceedances are distributed throughout the sampled area at depths ranging from 2 to 16 feet bgs. The PCB exceedances are less than 100 times the screening level, with three exceptions (locations TP-03 at 4 feet bgs, TP-11 at 5 feet bgs, and TP-12 at 4 feet bgs).

TPH exceedances are less than 10 times the screening level with one exception (location FOT-0086). All but one of the TPH exceedances (TP-02) are located in the southern half of the West Former Mill Area.

cPAH exceedances are distributed throughout the sampled area and all are less than 10 times the screening level.

SVOCs exceedances are in the southern half of the West Former Mill Area and all are less than 10 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the West Former Mill Area generally decrease with depth, with the exception of metals, PCBs, and TPH at some locations. Concentrations of metals generally decrease with depth, but several locations have higher concentrations of metals at depth than near the surface. The metal that exceeds screening levels most frequently is copper. The majority of the copper exceedances and one third of the nickel exceedances are within the range of copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area. PCB exceedances are distributed across much of the West Former Mill Area, in both shallow and deep soil. TPH exceeds screening levels in deep soil only, and most of these exceedances are in the southern half of the West Former Mill Area. No clear difference in cPAH or SVOC concentrations between shallow and deep soil is discernible. Dioxin/furan concentrations decrease with depth and are limited to the northeastern quadrant of the West Former Mill Area.

6.4.2.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are nine existing groundwater monitoring wells (MW-23, MW-29, MW-54, MW-55, MW-57, MW-60, MW-63, MW-68, and PZ-3) and one groundwater grab sample location (GWG-9) in the West Former Mill Area. Monitoring wells MW-54 and MW-55 are considered shoreline monitoring wells. Dioxins/furans and the metals manganese, copper, and nickel are the COPCs that were most often detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. Well MW-29 had the greatest number of COPCs detected at concentrations exceeding screening levels (dioxins/furans, cPAHs, SVOCs, ammonia, and metals). Manganese exceedances in well MW-23 appear to correlate with manganese exceedances of soil-to-groundwater screening levels in soil (2 to 6.5 feet bgs) in the vicinity of this well (location SSB-2). Other than cPAHs in well MW-60, there does not appear to be a correlation between the COPCs detected at concentrations exceeding groundwater screening levels in wells MW-60 and MW-68 and the concentrations of COPCs in soil at these locations.

Well MW-68, the only deep well sampled in the Upland Study Area, had exceedances of BEHP, copper, and manganese. VOCs were not detected in this well. The BEHP exceedance was only slightly above the screening level and is likely attributable to laboratory contamination of the sample. The copper and manganese exceedances were less than 100 and 10 times the screening levels, respectively.

6.4.2.5 GROUNDWATER-TO-SEDIMENT EXPOSURE PATHWAY

The following constituents have been detected in marine surface sediments offshore of the West Former Mill Area at concentrations exceeding SQS: 4-methylphenol, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenol, total high molecular weight PAHs (HPAHs), and total PCBs (Appendix H, Figure H-1; Windward, in preparation).

Indeno(1,2,3-cd)pyrene was detected in a groundwater sample obtained from shoreline monitoring well MW-54 in August 2010 at a concentration (0.024 ug/L) that exceeds Ecology's preliminary groundwater screening level protective of sediments. In addition, benzo(g,h,i)perylene was detected in two groundwater samples, obtained from well MW-55 in June 2003 and well PZ-3 in August 2001, at concentrations (0.017 and 0.82 ug/L, respectively) that exceed Ecology's preliminary groundwater screening level protective of sediments. Wells MW-54, MW-55, and PZ-3

are upgradient of marine sediment sample SD36, which is the only sediment sample in the entire offshore area adjacent to the mill property that exceeded the SQS for indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene (Appendix H, Figures H-1 and H-2). Sample SD36 was collected from sediments just off the north end of the mill dock. Numerous sediment samples have been collected between sample SD36 and shoreline wells MW-54, MW-55, and PZ-3, and none of these other sediment samples exceeded the SQS for indeno(1,2,3-cd)pyrene or benzo(g,h,i)perylene. Furthermore, indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene were not detected in the majority of the groundwater samples obtained from wells MW-54, MW-55, and PZ-3. These findings suggest that the indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene detected in sediment sample SD36 are not directly related to the isolated detections of these constituents in nearshore groundwater in the West Former Mill Area.

None of the other constituents detected above SQS in sediments was detected in recent (2010-2011) groundwater samples or historical groundwater samples (where recent data do not exist) at concentrations exceeding Ecology's preliminary screening levels protective of sediment. Consequently, the groundwater-to-sediment pathway does not appear to be a significant pathway of concern in the West Former Mill Area, and will not be further considered in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.2.6 WEST FORMER MILL AREA SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are cPAHs and dioxins/furans. The primary COPCs that exceed terrestrial ecological screening levels in soil are metals, dioxins/furans, and TPH. The primary COPCs that exceed soil-to-groundwater screening levels in soil are PCBs, metals, and dioxins/furans.

In general, there are more screening level exceedances in shallow soil (0-2 feet bgs) than in deep soil (>2 feet bgs), and in most, but not all sampling locations, COPC concentrations are higher in shallow soil than in deep soil. COPC exceedances for all three exposure pathways (human health, ecological, and soil-to-groundwater) are present in soil throughout much of the area; the footprint of COPC exceedances for each of these pathways is similar.

Dioxins/furans and the metals manganese, copper, and nickel are the primary COPCs detected in groundwater at concentrations exceeding screening levels protective of marine surface water. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. There appears to be a correlation between manganese and cPAH exceedances in wells MW-23 and MW-60, respectively, and the concentrations of these COPCs in nearby shallow soil. However, there are no obvious correlations between isolated exceedances of other COPCs in groundwater and concentrations of the same COPCs in nearby soil.

Based on the results of the groundwater-to-sediment evaluation presented in Appendix H and summarized above in Section 6.4.2.5, the groundwater-to-sediment pathway will not be further considered for the West Former Mill Area in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.3 Estuary Area

The Estuary Area chemical analytical data evaluation summary is presented on Plates 3A through 3C. Analytical data tables are included in Appendix E.

The Estuary Area is located in the eastern-central portion of the Upland Study Area and includes the mouth of Ennis Creek. It is bounded by Port Angeles Harbor to the north, the East Shoreline and East Former Mill Areas to the east, the CSO Area to the south, and the Main Former Mill and North Shoreline Areas to the west. The shoreline of the Estuary Area is armored by riprap. The western portion of the Estuary Area shoreline also contains a bulkhead (Plates 3A through 3C). Ennis Creek flows south to north through the center of the Estuary Area and discharges to Port Angeles Harbor. Two bridges span the creek in the northern and southern portions of the Estuary Area. Former mill facility foundations remain on the Estuary Area including a concrete pad that spans Ennis Creek and a cluster of wood pilings and smaller concrete pads located east of Ennis Creek. Some of the area east of Ennis Creek is paved with asphalt.

The Estuary Area generally is underlain by approximately 5 feet of fill material that overlies alluvial and beach deposits.

During the period of mill operations, the Finishing Room, Transformer Building, West Roll Storage, and East Roll Storage facilities were located in the Estuary Area.

Soil analytical data summarized on Plates 3A through 3C were collected and analyzed during the following investigations and interim actions:

- 1997 ESI (locations CD01 and FR05) (E&E, 1998).
- 1998 Finishing Room Interim Action (locations with "WEC" and "LC" identifiers) (SECOR, 1999).
- 2002 Ennis Creek/Finishing Room Interim Action (locations with "EC" and "FW00" identifiers) (Integral and Foster Wheeler, 2003).
- 2003 Upland RI (locations EC033, RS20, and RS21) (Integral, 2007).
- 2010-2011 Supplemental Upland Investigation (locations SSB-5 and MW-62).

The majority of the soil analytical data for the Estuary Area are from verification samples collected following interim actions. Approximately 10,150 tons of soil containing TPH and PCBs was removed from the Estuary Area during interim actions completed in 1998 and 2002. Habitat enhancements were constructed as part of the 2002 interim action. As discussed in Section 6.1, analytical data representing soil removed during interim actions are not included in the evaluation presented herein.

Surface water samples SW-1, SW-2, and SW-3 were collected in 2010 during the Supplemental Upland Investigation.

Groundwater chemical analytical data summarized on Plate 3A through 3C were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation.

6.4.3.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include TPH (two locations), cPAHs (two locations), and dioxins/furans (one location).

The TPH exceedances are limited to two locations (FW0067 and FW0070) in the northern portion of the sampled area and are greater than 10 times (but less than 100 times) the screening level.

The cPAH exceedances are limited to two locations (FR05 and RS21) in the southern portion of the sampled area and are less than 10 times the screening level.

Dioxins/furans exceed the screening level at one shallow soil location. The dioxin/furan exceedance (location EC033, 0-0.5 feet bgs) is in the southern portion of the sampled area and is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in deep soil include cPAHs (one location), PCBs (five locations), and metals (one location).

The cPAH exceedance is limited to one location (CD01) in the southern portion of the sampled area and is less than 10 times the screening level.

The PCB exceedances are distributed across the northern portion of the sampled area and are less than 10 times the screening level.

The metals exceedance is limited to one location (CD01) in the southern portion of the sampled area and is less than 10 times the screening level. Lead is the only metal that exceeds a screening level in deep soil.

Comparison of COPCs in Shallow and Deep Soil

Shallow and deep soil samples obtained from the Estuary Area are primarily verification samples associated with interim actions completed in 1998 and 2002. Most soil samples in the Estuary Area were collected between the ground surface and a depth of 3 feet bgs.

The only two locations where samples were collected at multiple depths are MW-62 and SSB-5, both of which are located in the northern portion of the Estuary Area. PCB concentrations at locations MW-62 and SSB-5 decrease with depth, with the highest concentrations occurring at a depth of 2 to 3.5 feet bgs. Shallow soil samples (0-2 feet bgs) were not collected at these two locations.

6.4.3.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include TPH (nine locations), metals (five locations), and dioxins/furans (one location).

The TPH exceedances are distributed throughout the northern portion of the sampled area and most are less than 10 times the screening level; two exceedances (locations FW0067 and FW0070, 1 foot bgs) are greater than 10 times (but less than 100 times) the screening level.

One or more metals (barium, chromium, cobalt, copper, lead, mercury, nickel, selenium, and/or zinc) exceed ecological screening levels at five shallow soil locations. Copper exceeds screening levels most frequently. The metals exceedances in shallow soil are distributed throughout the southern portion of the sampled area and are less than 10 times the respective screening levels. The cobalt and nickel exceedances are within or very close to the range of the concentrations of these metals detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxins/furans exceed the ecological screening level at one shallow soil location. The dioxin/furan exceedance (location EC033, 0-0.5 feet bgs) is in the southern portion of the sampled area and is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in deep soil include TPH (18 locations), PCBs (2 locations), and metals (1 location).

TPH exceedances are distributed throughout the northern portion of the sampled area and are less than 10 times the screening level.

PCB exceedances are limited to two locations (LC-2 and LCS-18) in the northern portion of the sampled area and are less than 10 times the screening level.

Copper and lead are the only metals that exceed ecological screening levels in deep soil (location CD01), and the exceedances are less than 10 times the screening levels. The copper exceedances are within the range of the copper concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Comparison of COPCs in Shallow and Deep Soil

The shallow and deep soil samples obtained from the Estuary Area were primarily verification samples associated with interim actions completed in 1998 and 2002. Most soil samples in the Estuary Area were collected between the ground surface and a depth of 3 feet bgs.

The only two locations where samples were collected at multiple depths are MW-62 and SSB-5, both of which are located in the northern portion of the Estuary Area. PCB concentrations at locations MW-62 and SSB-5 decrease with depth, with the highest concentrations occurring at a depth of 2 to 3.5 feet bgs. Shallow soil samples (0-2 feet bgs) were not collected at these two locations.

6.4.3.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include TPH (2 locations), cPAHs (1 location), SVOCs (1 location), PCBs (12 locations), metals (5 locations), and

dioxins/furans (1 location). TPH exceedances are limited to two locations (FW0067 and FW0070) in the northern portion of the Estuary Area and are greater than 10 times (but less than 100 times) the screening level.

The cPAH and SVOC exceedances are limited to one location (FR05) in the southern portion of the Estuary Area and are less than 10 times the screening levels. The only SVOC that exceeds the screening level is PCP.

PCB exceedances are distributed throughout the northern and southern portions of the Estuary Area. Most exceedances are greater than 10 times (but less than 100 times) the screening level. At two locations (LC12A in the northern portion and FR05 in the southern portion of the Estuary Area), the exceedance equals or exceeds 100 times the screening level.

Metals exceedances are distributed across the southern portion of the Estuary Area and are less than 10 times the screening levels. Copper, mercury, nickel, silver, and zinc are the only metals that exceed soil-to-groundwater screening levels in shallow soils. The nickel exceedance is within the range of the nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxins/furans exceed the soil-to-groundwater screening level at one shallow soil location. The dioxin/furan exceedance (location EC033, 0-0.5 feet bgs) is in the southern portion of the sampled area and is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in deep soil include PCBs (21 locations) and metals (1 location).

PCB exceedances are distributed throughout the northern portion of the Estuary Area and one location in the southern portion of the Estuary Area (location RS21). The exceedances range from less than 10 times the screening level to greater than 100 times the screening level.

Copper is the only metal that exceeds the soil-to-groundwater screening level in deep soil (location CD01), and the exceedance is less than 10 times the screening level. The copper exceedance is within the range of the copper concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Comparison of COPCs in Shallow and Deep Soil

The shallow and deep soil samples obtained from the Estuary Area were primarily verification samples associated with interim actions completed in 1998 and 2002. Most soil samples in the Estuary Area were collected between the ground surface and a depth of 3 feet bgs.

The only two locations where samples were collected at multiple depths are MW-62 and SSB-5, both of which are located in the northern portion of the Estuary Area. PCB concentrations at locations MW-62 and SSB-5 decrease with depth, with the highest concentrations occurring at a depth of 2 to 3.5 feet bgs. Shallow soil samples (0-2 feet bgs) were not collected at these two locations.

6.4.3.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There is one existing groundwater monitoring well in the Estuary Area (MW-62). Well MW-62 is considered a shoreline monitoring well. Dioxins/furans and the metal manganese were the COPCs that were most often detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. Ammonia was detected at concentrations exceeding screening levels during one monitoring event. There does not appear to be a correlation between the COPCs detected at concentrations exceeding groundwater screening levels in well MW-62 and the concentrations of COPCs in shallow soil in the northern portion of the Estuary Area.

6.4.3.5 GROUNDWATER-TO-SEDIMENT EXPOSURE PATHWAY

The only constituent that has been detected in marine surface sediments offshore of the Estuary Area at a concentration exceeding SQS is total PCBs (Appendix H, Figure H-1; Windward, in preparation). PCBs were not detected in shoreline monitoring well MW-62 in the Estuary Area at concentrations exceeding Ecology's preliminary groundwater screening level protective of sediment (see Appendix H). Consequently, the groundwater-to-sediment pathway does not appear to be a significant pathway of concern in the Estuary Area, and will not be further considered in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.3.6 SURFACE WATER EXPOSURE PATHWAY

Three surface water samples were collected near the mouth of Ennis Creek in the Estuary functional use area in 2010 as part of the Supplemental Upland Investigation. Two additional surface water samples were collected from White Creek and Ennis Creek in the Ennis Creek functional use area (see Section 6.4.5). Dioxins/furans are the only COPCs that were detected at concentrations exceeding surface water screening levels. The only dioxin/furan congener detected was 1,2,3,4,6,7,8,9-octachloro dibenzo-p-dioxin (OCDD), and the detected concentrations in two of the three samples (SW-2 and SW-3) were estimated concentrations below the laboratory MRLs for this constituent. The detected concentration of OCDD in the third sample (SW-1) was only slightly above the laboratory MRL.

6.4.3.7 ESTUARY AREA SUMMARY

COPCs that exceed human health (direct contact), terrestrial ecological, and soil-to-groundwater screening levels in soil include TPH, metals (primarily copper, lead, mercury, and zinc), dioxins/furans, and PCBs. In addition, some cPAHs exceed human health (direct contact) screening levels, and SVOCs (PCP) and cPAHs exceed soil-to-groundwater screening levels at one location.

The distribution of COPC exceedances for the three soil exposure pathways (human health, ecological, and soil-to-groundwater) are divided between the northern and southern portions of the Estuary Area. Dioxins/furans, metals, and cPAHs are distributed across the southern portion, while PCBs and TPH are distributed across two different areas in the northern portion of the area. The PCB exceedance footprint for the soil-to-groundwater pathway is the largest for this pathway, and is primarily in an area approximately 50 feet by 50 feet immediately north of the concrete slab that spans Ennis Creek in the middle of the Estuary Area. The TPH exceedance footprint for the terrestrial ecological pathway is the largest for this pathway, and is primarily in an area approximately 150 feet by 150 feet just north of the PCB exceedance footprint for the soil-to-groundwater pathway.

Dioxins/furans and the metal manganese are the two COPCs most frequently detected in groundwater at concentrations exceeding screening levels protective of marine surface water. Ammonia was detected at concentrations exceeding screening levels during one monitoring event. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. There does not appear to be a correlation between manganese exceedances in monitoring well MW-62 and manganese concentrations in nearby shallow soil.

Based on the results of the groundwater-to-sediment evaluation presented in Appendix H and summarized above in Section 6.4.3.5, the groundwater-to-sediment pathway will not be further considered for the Estuary Area in the interim action alternatives evaluation (Interim Action Report Volume III).

Dioxins/furans are the only COPCs that were detected above screening levels in the three surface water samples collected in the Estuary Area during the Supplemental Upland Investigation. Only one dioxin/furan congener (OCDD) was detected in these samples, and the reported concentrations in two of the three samples were estimated concentrations below the laboratory MRLs. The detected concentration of OCDD in the third sample (SW-1) was only slightly above the laboratory MRL.

6.4.4 North Shoreline and Main Former Mill Areas

The North Shoreline and Main Former Mill Areas are located in the central portion of the Upland Study Area, and are bounded by Port Angeles Harbor to the north, the Estuary Area to the east, the CSO Area to the south, and the West Former Mill Area to the west. The shoreline of the North Shoreline Area is armored by riprap and a bulkhead (Plates 4A through 4C). The majority of the North Shoreline and Main Former Mill Areas are covered with concrete rubble. A concrete pad that formerly housed the Pulp Storage Warehouse, and three aboveground storage tanks are present in the northern portion of the area.

The North Shoreline and Main Former Mill Areas generally are underlain by approximately 3 to 30 feet of fill material that overlies alluvial and beach deposits. Glacial till was encountered in deep borings in the western and southern portions of the Main Former Mill Area. In general, fill material appears to be thickest beneath the northern portion of the North Shoreline Area, and becomes thinner to the south beneath the Main Former Mill Area.

During the period of mill operations, the following facilities were located in the North Shoreline and Main Former Mill Areas:

- Main Process Area.
- Pulp Storage Warehouse.
- Chip Storage.
- Chip Screening.
- Acid Plant.
- Digesters.
- Screen Room.

- Bleach Plant.
- Machine Room.
- Engineering Building.
- Machine Shop.
- Administration Building.
- Garage.

Soil analytical data summarized on Plates 4A through 4C were collected and analyzed during the following investigations and interim actions:

- 1997 ESI (locations AP01 through AP04, BL01 through BL03, BP01 through BP04, BS01, BS02, DB02, FR02, FR04, LB01, LB02, MR01 through MR12, PC01, PC02, SR01 through SR04, TB01, and TB02) (E&E, 1998).
- 1998 Finishing Room Interim Action (location WEC-37) (SECOR, 1999).
- 2002 Machine Shop Interim Action (locations with "MCH" identifiers) (Integral and Foster Wheeler, 2003).
- 2003 Upland RI (locations EC034, AP03, AP20, BL20, CS20, DB02, DB21, DK20, FR02, FR20, MR03, MR20, MS20, PC20, PW20, SR03, and SR20 through SR24) (Integral, 2007).
- 2010-2011 Supplemental Upland Investigation (locations with "SSB," "GWG," "TP," and "MW" identifiers).

During the Upland RI, ESI soil sampling locations AP03, DB02, FR02, MR03, and SR03 were resampled to confirm and/or further characterize the COPC concentrations detected in soil at these locations during the ESI.

Approximately 970 tons of soil containing TPH was removed from the Main Former Mill Area during the Machine Shop interim action completed in 2002. As discussed in Section 6.1, analytical data representing soil removed during interim actions are not included in the evaluation presented herein.

Most of the groundwater chemical analytical data summarized on Plates 4A through 4C were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation. One groundwater grab sample (PIPE-1-SR23) was collected from groundwater just below a ductile iron pipe encountered at a depth of 6 feet bgs in a test pit. Groundwater grab samples GWG-1 through GWG-5 were collected from temporary well points. The remaining groundwater samples were collected from monitoring wells.

6.4.4.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include cPAHs (27 locations), SVOCs (2 locations), PCBs (9 locations), metals (15 locations), and dioxins/furans (20 locations).

cPAH exceedances are distributed across much of the Main Former Mill Area, with only one exceedance in the North Shoreline Area. Most exceedances are less than 10 times the screening level; four exceedances are greater than 10 times (but less than 100 times) the screening level.

SVOC exceedances are limited to two locations in the Main Former Mill Area and are less than 10 times the screening level.

PCB exceedances are located in the northeast portion of the Main Former Mill Area and are less than 10 times the screening level.

Metals exceedances are distributed across much of the Main Former Mill Area; there are no metals exceedances in the North Shoreline Area. Lead and arsenic exceed screening levels most frequently; antimony and cadmium exceed screening levels at a few locations. Exceedances are less than 10 times the screening level in most locations; two exceedances are greater than 10 times (but less than 100 times) the screening level.

Dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances are less than 10 times the screening level in nine locations; nine exceedances are greater than 10 times (but less than 100 times) the screening level; and two exceedances are greater than 100 times the screening level (both in the Main Former Mill Area).

Deep Soil (>2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in deep soil include cPAHs (eight locations), SVOCs (one location), metals (four locations), and dioxins/furans (ten locations).

CPAH exceedances are distributed across the Main Former Mill Area; there are two exceedances in the North Shoreline Area. The exceedances are less than 10 times the screening level.

The SVOC exceedance is limited to one location (MS20) in the Main Former Mill Area and is greater than 10 times (but less than 100 times) the screening level.

Metals exceedances are distributed across much of the Main Former Mill Area; there are no metals exceedances in the North Shoreline Area. Lead and arsenic are the only metals that exceed screening levels in deep soils. The exceedances are less than 10 times the screening level in all locations.

Dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances are less than 10 times the screening level in nine locations; one exceedance is greater than 10 times (but less than 100 times) the screening level.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the North Shoreline and Main Former Mill Areas generally decrease with depth, with the exception of cPAHs at some locations. cPAH exceedances are distributed across much of the Main Former Mill Area. No clear difference in cPAH concentrations between shallow and deep soil is discernible. SVOCs (BEHP, PCP, and/or pyrene) exceed screening levels at two shallow soil locations and one deep soil location. Because these exceedances are at different

locations, a comparison of shallow and deep SVOC concentrations cannot be made. The metals that exceed screening levels most frequently are lead and arsenic. Concentrations of metals decrease with depth. PCB exceedances are limited to shallow soil. Dioxin/furan concentrations decrease with depth.

6.4.4.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include TPH (2 locations), PCBs (8 locations), metals (42 locations), and dioxins/furans (20 locations).

TPH exceedances are limited to one location (DK20) in the North Shoreline Area and one location (MR20) in the Main Former Mill Area; both are less than 10 times the screening level.

PCB exceedances are located in the northeastern portion of the Main Former Mill Area and are less than 10 times the screening level.

Metals exceedances are distributed across much of the Main Former Mill Area; there are no metals exceedances in the North Shoreline Area. Antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, selenium, and zinc exceed screening levels most frequently; cobalt, manganese, thallium, and silver exceed screening levels at a few locations. Several chromium, cobalt, copper, and nickel exceedances are within the range of concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area. The metals exceedances are less than 10 times the screening level in most locations, greater than 10 times (but less than 100 times) the screening level in several locations, and greater than 100 times the screening level in one location (in the Main Former Mill Area).

The dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances range from less than 10 times the screening level to greater than 100 times the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in deep soil include TPH (5 locations), metals (28 locations), and dioxins/furans (11 locations).

TPH exceedances are in the southeastern portion of the North Shoreline Area. Most of the exceedances are less than 10 times the screening level; one exceedance is greater than 10 times (but less than 100 times the screening level.

Metals exceedances are distributed across much of the Main Former Mill Area. There are only two metals exceedances (mercury and zinc) in the North Shoreline Area, each in a different location. Chromium, copper, lead, mercury, nickel, selenium, and zinc exceed screening levels most frequently in the Main Former Mill Area; antimony, arsenic, barium, cobalt, manganese, silver, and/or vanadium exceed screening levels at only a few locations. Several chromium, cobalt, copper, and nickel exceedances are within the range of concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area. Metals exceedances are less than 10 times the screening level in most locations, and greater than

10 times (but less than 100 times) the screening level in a few locations (in the Main Former Mill Area).

The dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances are less than 10 times the screening level in several locations and greater than 10 times (but less than 100 times) the screening level in other locations (in the Main Former Mill Area).

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the North Shoreline and Main Former Mill Areas generally decrease with depth. Metals exceed screening levels in shallow and deep soil throughout much of the Main Former Mill Area. However, there are no metals exceedances in shallow soil in the North Shoreline Area, and only a few metals exceedances in deep soil in this area. PCB exceedances are limited to shallow soil in the northeastern portion of the Main Former Mill Area.

6.4.4.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include cPAHs (19 locations), SVOCs (14 locations), PCBs (18 locations), metals (38 locations), and dioxins/furans (20 locations).

cPAH exceedances in shallow soil are distributed across the Main Former Mill Area and most are less than 10 times the screening level; one exceedance is greater than 10 times (but less than 100 times) the screening level. There are no cPAH exceedances in shallow soil in the North Shoreline Area.

SVOC exceedances in shallow soil are distributed across the Main Former Mill Area. The exceedances range from less than 10 times the screening level to greater than 100 times the screening level. There are no SVOC exceedances in shallow soil in the North Shoreline Area.

PCB exceedances in shallow soil are distributed across the Main Former Mill Area. The exceedances range from less than 10 times the screening level to greater than 100 times the screening level. There are no PCB exceedances in shallow soil in the North Shoreline Area.

One or more metals (arsenic, cadmium, lead, copper, mercury, nickel, silver, thallium, and/or zinc) exceed soil-to-groundwater screening levels at 38 shallow soil locations in the Main Former Mill Area. No metals exceed soil-to-groundwater screening levels in the North Shoreline Area. Arsenic, copper, mercury, nickel, silver, and zinc exceed the screening level most frequently in the Main Former Mill Area. The metals exceedances in shallow soil are distributed throughout the sampled area. Most metal exceedances are less than 10 times the respective screening levels; several exceedances are greater than 10 times (but less than 100 times) the screening level. Some of the copper exceedances are within the range of the copper concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances range from less than 10 times the screening level to greater than 100 times the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in deep soil include cPAHs (2 locations), SVOCs (6 locations), PCBs (14 locations), metals (28 locations), and dioxins/furans (11 locations).

cPAH exceedances in deep soil are limited to the southeast portion of the Main Former Mill Area and are less than 10 times the screening level. There are no cPAH exceedances in the North Shoreline Area.

SVOC exceedances in deep soil are sparsely distributed across the Main Former Mill Area. A few exceedances are less than 10 times the screening level; one exceedance is greater than 100 times the screening level. There are no SVOC exceedances in deep soil in the North Shoreline Area.

PCB exceedances in deep soil are distributed across the Main Former Mill Area. A few exceedances are less than 10 times the screening level; several exceedances are greater than 10 times (but less than 100 times) the screening level; and one exceedance is greater than 100 times the screening level. There are no PCB exceedances in deep soil in the North Shoreline Area.

One or more metals (arsenic, copper, mercury, nickel, silver, and/or zinc) exceed soil-to-groundwater screening levels at 26 deep soil locations in the Main Former Mill Area. Only mercury and zinc exceed soil-to-groundwater screening levels in the North Shoreline Area, at two separate locations. Arsenic, copper, mercury, nickel, and zinc exceed the screening level most frequently in the Main Former Mill Area. Metals exceedances in shallow soil are distributed throughout the sampled area. Most exceedances are less than 10 times the respective screening levels, and a few exceedances are greater than 10 times (but less than 100 times) the screening level. Some of the copper exceedances are within the range of the copper concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The dioxin/furan exceedances are distributed across much of the North Shoreline and Main Former Mill Areas. The exceedances are less than 10 times the screening level in some locations and greater than 10 times (but less than 100 times) the screening level in others.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the North Shoreline and Main Former Mill Areas generally decrease with depth. cPAH exceedances in deep soil are limited to a few locations. Fewer metals exceed screening levels in deep soil than in shallow soil – there are no deep soil exceedances of cadmium, lead, or thallium. There are no cPAH, SVOC, or PCB exceedances in shallow or deep soil in the North Shoreline Area.

6.4.4.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are six existing groundwater monitoring wells (MW-58, MW-65, MW-66, MW-69, PA-17, and PZ-4) and six groundwater grab sample locations (GWG-1, GWG-2, GWG-3, GWG-4, GWG-5, and

PIPE-1-SR23) in the Main Former Mill Area. There are two monitoring wells in the North Shoreline Area (MW-51 and MW-56). Dioxins/furans, the metals copper and manganese, ammonia, PCBs, and cPAHs were the COPCs that were most often detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. Monitoring wells MW-51 and MW-56 are considered shoreline monitoring wells. Dioxins/furans, metals, cPAHs, and ammonia exceeded groundwater screening levels in these wells. Monitoring wells PA-17 and MW-69, which are the wells farthest from the Main Former Mill process areas, contained only dioxins/furans and metals (arsenic, copper, and/or manganese) at concentrations exceeding groundwater screening levels. Copper exceeded soil-to-groundwater screening levels in deep soil at MW-69, but the detected concentrations are within the range of the copper concentrations detected in soil at upgradient location MW-64. With few exceptions, there does not appear to be a correlation between the COPCs detected in groundwater at concentrations exceeding screening levels and the concentrations of COPCs in soil at the monitoring well locations.

6.4.4.5 GROUNDWATER-TO-SEDIMENT EXPOSURE PATHWAY

The following constituents have been detected in marine surface sediments offshore of the North Shoreline Area at concentrations exceeding SQS: 4-methylphenol, acenaphthene, benzo(g,h,i)-perylene, chrysene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, phenol, pyrene, total HPAHs, total low molecular weight PAHs (LPAHs), and total PCBs (Appendix H, Figure H-1; Windward, in preparation).

Acenaphthene was detected in five groundwater samples obtained from shoreline monitoring well MW-51 between 1998 and 2003 at concentrations that slightly exceed Ecology's preliminary groundwater screening level protective of sediments. Well MW-51 is the nearest monitoring well to marine sediment sample SD82, which is one of only two sediment samples in the entire offshore area adjacent to the mill property that exceeded the SQS for acenaphthene (Appendix H, Figures H-1 and H-2). In addition, phenol was detected in a groundwater sample obtained from shoreline monitoring well MW-56 in August 2001 at a concentration (80 ug/L) that slightly exceeds Ecology's preliminary groundwater screening level protective of sediments. Well MW-56 is upgradient of marine sediment sample MD04A, which is one of only two sediment samples in the entire offshore area adjacent to the mill property that exceeded the SQS for phenol (Appendix H, Figures H-1 and H-2). Sample MD04A was collected from sediments off the northwest corner of the mill dock. Numerous sediment samples have been collected between sample MD04A and shoreline well MW-56, and none of these other sediment samples exceeded the SQS for phenol. Three other groundwater samples obtained from well MW-56 between 2001 and 2003 had concentrations of phenol that were below Ecology's preliminary groundwater screening level protective of sediments. These findings suggest that the phenol detected in sediment sample MD04A is not directly related to the detections of phenol in nearshore groundwater in the North Shoreline Area.

None of the other constituents detected above SQS in sediments was detected in recent (2010-2011) groundwater samples or historical groundwater samples (where recent data do not exist) at concentrations exceeding Ecology's preliminary screening levels protective of sediment. The groundwater-to-sediment pathway appears to be a potential pathway of concern for acenaphthene in the North Shoreline Area, and this pathway will be further considered for acenaphthene in the interim action alternatives evaluation (Interim Action Report Volume III). The groundwater-to-

sediment pathway does not appear to be a significant pathway of concern for other constituents in the North Shoreline Area, and thus will not be further considered for other constituents.

6.4.4.6 NORTH SHORELINE AND MAIN FORMER MILL AREAS SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are cPAHs, SVOCs, PCBs, metals (primarily lead and arsenic), and dioxins/furans.

The primary COPCs that exceed terrestrial ecological screening levels in soil are PCBs, metals (primarily antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, selenium, and zinc), and dioxins/furans.

The primary COPCs that exceed soil-to-groundwater screening levels in soil are cPAHs, metals (primarily arsenic, copper, and manganese), and dioxins/furans.

In general, there are more screening level exceedances in shallow soil than in deep soil. COPC exceedances for all three exposure pathways (human health, ecological, and soil-to-groundwater) are present in soil throughout much of the area; the footprint of COPC exceedances for each of these pathways is similar. There are fewer locations and COPCs that exceed soil screening levels in the North Shoreline Area than in the Main Former Mill Area.

Dioxins/furans, PCBs, copper, and manganese are the primary COPCs detected in groundwater at concentrations exceeding screening levels; cPAHs and ammonia do not exceed groundwater screening levels as frequently. PCBs exceeded groundwater screening levels in one shoreline well (MW-56) during one monitoring event. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. The detections of metals in groundwater may in part reflect the presence of naturally occurring metals in soil, particularly copper, manganese, and nickel. There are no obvious correlations between isolated exceedances of other COPCs in groundwater and concentrations of the same COPCs in nearby soil.

Based on the results of the groundwater-to-sediment evaluation presented in Appendix H and summarized above in Section 6.4.4.5, the groundwater-to-sediment pathway will be further considered for acenaphthene in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.5 Ennis Creek

The Ennis Creek Area chemical analytical data evaluation summary is presented on Plate 5. Analytical data tables are included in Appendix E. The Ennis Creek Area is located in the southern portion of the Upland Study Area, and is bounded by the CSO Area to the north, the Prefab Area, City Purchase Area, and City POTW to the east, and the Upland Study Area boundary to the south and west. Ennis Creek flows from south to north through the area. With the exception of the paved parking lot in the northern portion, the Ennis Creek Area is forested (Plate 5). No specific mill operations are known to have occurred on the area. The Ennis Creek Area generally is underlain by native alluvial deposits. Glacial deposits were encountered in borings at approximately 12 to 20 feet bgs.

Surface and subsurface soil samples were collected and analyzed during the 1997 ESI (location DD02), the 2003 Upland RI (locations ECO23 and ECO25 through ECO29), and the 2010-2011

Supplemental Upland Investigation (upgradient location MW-64). Surface water samples SW-4 and SW-5 were collected from Ennis Creek and White Creek during the Supplemental Upland Investigation. Groundwater chemical analytical data summarized on Plate 5 were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation.

6.4.5.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include cPAHs (one location) and dioxins/furans (two locations).

The cPAH exceedance is limited to one location (DD02) in the northern portion of the Ennis Creek area and is less than 10 times the screening level.

Dioxins/furans exceed the screening level at two shallow soil locations (ECO27 and ECO28). The dioxin/furan exceedances are in the southern portion of the sampled area and are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

No COPCs exceeded human health (direct contact) screening levels in deep soil.

Comparison of COPCs in Shallow and Deep Soil

Most soil samples collected in the Ennis Creek Area were obtained from shallow soil. Only three deep soil samples were obtained in this area, all from upgradient location MW-64. These deep samples were analyzed for dioxins/furans and metals. Shallow soil samples were not obtained from location MW-64.

6.4.5.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include metals (four locations) and dioxins/furans (two locations).

One or more metals (barium, chromium, cobalt, copper, nickel, and/or zinc) exceed ecological screening levels at four shallow soil locations. Chromium, copper, and nickel exceed screening levels most frequently. The metals exceedances in shallow soil are distributed throughout the southern two-thirds of the Ennis Creek Area and are less than 10 times the respective screening levels. The chromium, cobalt, copper, and nickel exceedances are within or close to the range of the metal concentrations detected in soil at upgradient location MW-64.

Dioxins/furans exceed the screening level at two shallow soil locations (ECO27 and ECO28). The dioxin/furan exceedances are in the southern portion of the sampled area and are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

The only COPCs that exceed terrestrial ecological screening levels in deep soil are metals (barium, chromium, cobalt, copper, and nickel). The metals exceedances are limited to one upgradient location (MW-64) in the southern portion of the sampled area, and occur at depths ranging from 2 to 11.5 feet bgs. All of the metals exceedances are less than 10 times the respective screening levels. Because upgradient location MW-64 is far from the historical mill operations, metals concentrations in soil at this location likely reflect naturally occurring metals concentrations in soil.

Comparison of COPCs in Shallow and Deep Soil

Most soil samples collected in the Ennis Creek Area were obtained from shallow soil. Only three deep soil samples were obtained in this area, all from upgradient location MW-64. These deep samples were analyzed for dioxins/furans and metals. Shallow soil samples were not obtained from location MW-64.

6.4.5.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include cPAHs (one location), metals (four locations), and dioxins/furans (two locations).

The cPAH exceedance is in the northern portion of the Ennis Creek area (location DD02) and is less than 10 times the screening level.

One or more metals (copper, mercury, nickel, and/or zinc) exceed soil-to-groundwater screening levels at four shallow soil locations. Nickel exceeds screening levels most frequently. The metals exceedances in shallow soil are distributed throughout the southern two-thirds of the Ennis Creek Area and are less than 10 times the respective screening levels. The copper, mercury, and nickel exceedances are within or close to the range of the metal concentrations detected in soil at upgradient location MW-64.

Dioxins/furans exceed the screening level at two shallow soil locations (EC027 and EC028). The dioxin/furan exceedances are in the southern portion of the sampled area and are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

The only COPCs that exceed soil-to-groundwater screening levels in deep soil are copper and nickel (one location). These exceedances are in the southern portion of the sampled area (upgradient location MW-64) and are only slightly above the screening levels. Because upgradient location MW-64 is far from the historical mill operations, metals concentrations detected in soil at this location likely reflect naturally occurring metals concentrations in soil.

Comparison of COPCs in Shallow and Deep Soil

Most soil samples collected in the Ennis Creek Area were obtained from shallow soil. Only three deep soil samples were obtained in this area, all from upgradient location MW-64. These deep samples were analyzed for dioxins/furans and metals. Shallow soil samples were not obtained from location MW-64.

6.4.5.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are four existing groundwater monitoring wells in the Ennis Creek Area (PA-2, PZ-5, PZ-6, and MW-64). Wells PA-2, PZ-5, and PZ-6 are located in the northern portion of the Ennis Creek Area, while upgradient well MW-64 is in the southernmost portion of the Ennis Creek Area. Well PA-2 was not sampled during the 2010-2011 quarterly monitoring program. Dioxins/furans and metals (copper, manganese, and nickel) in wells PZ-5 and PZ-6 were the only COPCs detected in groundwater at concentrations exceeding screening levels in 2010-2011. The copper, manganese, and nickel exceedances in these wells are less than 10 times the screening levels. There does not appear to be a correlation between the COPCs detected at concentrations exceeding groundwater screening levels in wells PZ-5 and PZ-6 and the concentrations of COPCs in shallow soil in the northern portion of the Ennis Creek Area.

6.4.5.5 SURFACE WATER EXPOSURE PATHWAY

Two surface water samples were collected from Ennis Creek and White Creek in the Ennis Creek functional use area. Three additional surface water samples were collected in the Estuary functional use area (see Section 6.4.3). Dioxins/furans are the only COPCs that were detected at concentrations exceeding surface water screening levels. The only dioxin/furan congener detected was OCDD, and the detected concentrations in both of the samples were estimated concentrations below the laboratory MRLs.

6.4.5.6 ENNIS CREEK AREA SUMMARY

COPCs that exceed human health (direct contact), terrestrial ecological, and soil-to-groundwater screening levels in soil include metals (primarily chromium, copper, and nickel) and dioxins/furans. In addition, cPAHs exceed soil-to-groundwater screening levels at one shallow soil location.

The COPC exceedances for the three soil exposure pathways (human health, ecological, and soil-to-groundwater) are generally distributed throughout the Ennis Creek Area. Dioxins/furans and metals are distributed across the southern two-thirds of the area, while the single cPAH exceedance is in the northern portion of the area.

Dioxins/furans and metals (copper, manganese, and nickel) are the two COPCs most frequently detected in groundwater at concentrations exceeding screening levels. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. There does not appear to be a correlation between metal exceedances in monitoring wells and metal concentrations detected in nearby soil, with the possible exception of copper in well PZ-6.

Dioxins/furans are the only COPCs that were detected at concentrations above screening levels in the two surface water samples collected in the Ennis Creek Area. Only one dioxin/furan congener (OCDD) was detected in these samples, and the reported concentrations in both samples were estimated concentrations below the laboratory MRLs.

6.4.6 City Purchase Area and Prefab Area

The City Purchase Area and Prefab Area chemical analytical data evaluation summary is presented on Plate 6. Analytical data tables are included in Appendix E.

The City Purchase Area and Prefab Area are located in the southern portion of the Upland Study Area, and are bounded by the CSO Area to the north, the Upland Study Area boundary and City POTW to the east, and the Ennis Creek Area to the south and west. The majority of the City Purchase Area is paved (Plate 6). Several concrete pads, an existing building, and several aboveground storage tanks are present in these areas. Rayonier sold the City Purchase Area and a 5 million gallon tank on the property to the City for the City's CSO project. During the period of mill operations, the City Purchase Area housed the mill's secondary wastewater treatment system beginning in 1979, the contractor's parking lot, and the Equipment Storage Area. A mechanic's prefabrication area was housed in the Prefab area. The ground surface elevations in the City Purchase and Prefab Areas are higher than in most other functional use areas. The City Purchase and Prefab Areas are underlain by fill material (generally 1 to 5 feet thick), alluvium, and glacial deposits.

Surface and subsurface soil samples were collected and analyzed during the 1997 ESI (locations with "BY" and "PF" identifiers), the 2003 Upland RI (locations BY02, BY20, and PF02), and the 2010-2011 Supplemental Upland Investigation (locations GWG-8, SSB-9, and SSB-10). Soil samples were collected from boring PA-19 as part of the City's 2009 exploration activities. Groundwater chemical analytical data summarized on Plate 6 were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation. A groundwater grab sample was collected from one temporary well point (GWG-8). The remaining groundwater samples were collected from monitoring wells.

Additional soil and groundwater analytical data were obtained and evaluated by the City as part of the property ownership transfer. Soil samples were obtained from 23 locations and groundwater samples were obtained from 6 locations in the City Purchase Area (Farallon, 2011). The City's data report for this sampling effort is contained in Appendix G; the analytical data from the City's sampling effort are not included in the following data evaluation.

6.4.6.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include cPAHs (two locations) and metals (two locations). The cPAH exceedances are limited to the southeastern half of the sampled City Purchase Area and are less than 10 times the screening level. The metals exceedances are arsenic (location BY02) and copper (location PF02). Both of the metals exceedances were less than 10 times the screening levels.

Deep Soil (>2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in deep soil include cPAHs (one location) and dioxins/furans (one location). The cPAH exceedance is located in the eastern portion (former Equipment Storage Area) of the City Purchase Area (location BY03, 2-4 feet bgs), and is less than 10 times the screening level. The dioxin/furan exceedance is also located in the eastern portion of the City Purchase Area (location SSB-10, 2-3.5 feet bgs), and is less than 10 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the City Purchase and Prefab Areas generally decrease with depth. cPAH exceedances (three locations) are limited to the eastern portion of the City Purchase Area (former Equipment Storage Area) and occur in both shallow and deep soil. The shallow and deep cPAH exceedances are not collocated. The only dioxin/furan exceedance is in deep soil in the eastern portion of the City Purchase Area; shallow soil was not analyzed for dioxins/furans. Metals exceedances are limited to shallow soil at two locations in the City Purchase and Prefab Areas.

6.4.6.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

Metals (arsenic, chromium, copper, lead, manganese, mercury, nickel, and/or zinc) are the only COPCs that exceed terrestrial ecological screening levels in shallow soil (seven locations). Copper exceeds screening levels most frequently. The metals exceedances in shallow soil are distributed throughout the sampled areas and are less than 10 times the respective screening levels, with the exception of copper and silver at location PF02 in the Prefab Area. The copper concentration at this location exceeds the screening level by more than 100 times, and the silver concentration exceeds the screening level by more than 10 times but less than 100 times. The chromium and nickel exceedances are within the range of the chromium and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Deep Soil (>2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in deep soil include metals (11 locations) and dioxins/furans (1 location).

One or more metals (barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, thallium, and/or zinc) exceed terrestrial ecological screening levels in deep soil. Copper exceeds screening levels most frequently. The metals exceedances in deep soil are distributed throughout the sampled areas in the City Purchase and Prefab Areas at depths ranging from 2 to 31.5 feet bgs, and all are less than 10 times the respective screening levels. All of the cobalt exceedances are within the range of the cobalt concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The dioxin/furan exceedances are less than 10 times the screening level, and are limited to the former Equipment Storage area in the City Purchase Area, at depths ranging from 2 to 6.5 feet bgs.

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the City Purchase and Prefab Areas generally decrease with depth. The only dioxin/furan exceedance location is in deeper soil in the eastern portion of the City Purchase Area; shallow soil was not analyzed for dioxins/furans. Metals exceedances are distributed throughout the sampled areas in the City Purchase and Prefab Areas in both shallow and deep soil. All deep soil exceedances and all but two shallow soil exceedances are less than 10 times the respective screening levels. All of the cobalt exceedances are within the range of the cobalt concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

6.4.6.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include metals (seven locations) and PCBs (five locations).

Several metals (arsenic, copper, manganese, mercury, nickel, silver, and/or zinc) exceed soil-to-groundwater screening levels. Copper exceeds the screening level most frequently. The metals exceedances in shallow soil are distributed throughout the sampled areas of the City Purchase and Prefab Areas and are less than 10 times the respective screening levels, with the exception of location PF02 in the Prefab Area, which had a copper concentration greater than 100 times the screening level and a silver concentration greater than 10 times the screening level. The nickel exceedances are within the range of the nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

The PCB exceedances are distributed throughout the eastern sampled area of the City Purchase Area, and all are less than 100 times the screening level.

Deep Soil (>2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in deep soil include metals (11 locations), dioxins/furans (1 location), and PCBs (5 locations).

Several metals (copper, manganese, mercury, nickel, silver, and/or zinc) exceed soil-to-groundwater screening levels. Copper exceeds the screening level most frequently. The metals exceedances in deep soil are distributed throughout the sampled areas of the City Purchase and Prefab Areas at depths ranging from 2 to 31.5 feet bgs and are less than 10 times the respective screening levels, with one exception (silver at location BY05 in the City Purchase Area).

The dioxin/furan exceedance is limited to the former Equipment Storage Area in the City Purchase Area (location SSB-10) at depths ranging from 2 to 6.5 feet bgs, and is less than 10 times the screening level.

PCB exceedances are distributed throughout the eastern sampled portion of the City Purchase Area at depths ranging from 2 to 4 feet bgs. The PCB exceedances are less than 10 times the screening level, with one exception (location BY02, 2-4 feet bgs).

Comparison of COPCs in Shallow and Deep Soil

COPC concentrations in soil in the City Purchase and Prefab Areas generally decrease with depth. The only dioxin/furan exceedance location is in deeper soil in the eastern portion of the City Purchase Area; shallow soil was not analyzed for dioxins/furans. Metals exceedances are distributed throughout the sampled areas of the City Purchase and Prefab Areas in both shallow and deep soil. All but one deep soil exceedance and one shallow soil exceedance are less than 10 times the screening levels. PCB exceedances occur in both shallow and deep soil in the eastern sampled portion of the City Purchase Area; the PCB concentrations decrease with depth.

6.4.6.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are five existing groundwater monitoring wells (PZ-7, PA-19, PA-23, PZ-11, and PZ-12) and one groundwater grab sample location (GWG-8) in the City Purchase and Prefab Areas. PCBs, dioxins/furans, SVOCs (BEHP), and the metals arsenic, copper, lead, manganese, mercury, nickel, and zinc were detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. The northernmost wells, PA-19 and PZ-7, had the greatest number of COPCs detected at concentrations exceeding screening levels (dioxins/furans, PCBs, SVOCs, and/or metals). There does not appear to be a correlation between the COPCs detected at concentrations exceeding groundwater screening levels and the concentrations of COPCs in soil at the well locations.

6.4.6.5 CITY PURCHASE AND PREFAB AREAS SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are cPAHs and metals. The primary COPCs that exceed terrestrial ecological screening levels in soil are metals. The primary COPCs that exceed soil-to-groundwater screening levels in soil are PCBs and metals.

In general, there are more screening level exceedances in shallow soil than in deep soil, and in most, but not all sampling locations, COPC concentrations are higher in shallow soil than in deep soil. COPC exceedances for two of the exposure pathways (ecological and soil-to-groundwater) are present in soil throughout the sampled areas in the Prefab and City Purchase Areas; the footprint of COPC exceedances for each of these pathways is similar. The human health exposure pathway exceedance footprint is smaller than the footprint of exceedances for the ecological and soil-to-groundwater pathways.

Dioxins/furans and the metals manganese and copper are the primary COPCs detected in groundwater at concentrations exceeding screening levels. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. There are no obvious correlations between the exceedances of COPCs in groundwater and concentrations of the same COPCs in nearby soil.

6.4.7 East Shoreline and East Former Mill Areas

The East Shoreline and East Former Mill Areas chemical analytical data evaluation summary is presented on Plate 7. Analytical data tables are included in Appendix E.

The East Shoreline and East Former Mill Areas are located in the eastern portion of the Upland Study Area, and are bounded by Port Angeles Harbor to the north, the Upland Study Area boundary to the east and south, small portions of the CSO and City Purchase Areas to the southwest, and the Estuary Area to the west. A portion of the East Shoreline Area shoreline is armored by riprap. Most of the western portion of the East Former Mill Area is asphalt paved. Two small buildings, and concrete pads that formerly housed the Primary Wastewater Clarifier and two warehouses, are present in the western portion of the area.

The East Shoreline and East Former Mill Areas generally are underlain by approximately 5 to 12 feet of fill material that overlies alluvial and beach deposits. Glacial till is present below these deposits.

During the period of mill operations, the following facilities were located in the East Shoreline and East Former Mill Areas:

- Primary Wastewater Clarifier (beginning in 1972).
- Warehouses.
- SSL Lagoon.
- Chlorine Dioxide Generator.

Soil analytical data summarized on Plate 7 were collected and analyzed during the following investigations and interim actions:

- 1997 ESI (locations CD02 and CD03) (E&E, 1998).
- 2003 Upland RI (locations SL20, SL21, and SL22) (Integral, 2007).
- 2010-2011 Supplemental Upland Investigation (location GWG-7).

Approximately 4,800 tons of soil was removed from the East Shoreline and East Former Mill Areas during the SSL Lagoon interim action completed in 2001. As discussed in Section 6.1, analytical data representing soil removed during interim actions are not included in the evaluation presented herein.

Groundwater chemical analytical data summarized on Plate 7 were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation. Groundwater grab sample GWG-7 was collected from a temporary well point. The remaining groundwater samples were collected from monitoring wells.

6.4.7.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed human health (direct contact) screening levels in shallow soil include cPAHs (one location) and dioxins/furans (two locations).

The cPAH exceedance is in the western portion of the East Former Mill Area (near the former Chlorine Dioxide Generator) and is less than 10 times the screening level. cPAHs were not detected in two other shallow soil samples collected in these areas.

The dioxin/furan exceedances are in two locations in the East Shoreline Area and are less than 10 times the screening level.

Deep Soil (>2 feet bgs)

The only COPC that exceeds human health (direct contact) screening levels in deep soil is cPAHs (one location).

The cPAH exceedance is in the western portion of the East Former Mill Area (near the former chlorine dioxide generator) and is less than 10 times the screening level. cPAHs were not detected above screening levels in five other deep soil samples collected in these areas.

Comparison of COPCs in Shallow and Deep Soil

No clear difference of cPAH concentrations between shallow and deep soil is discernible. cPAHs exceed screening levels at only one shallow and one deep soil location. These exceedances are not at the same location. Where dioxins/furans concentrations exceeded screening levels in shallow soil, no deep soil sample was submitted for analysis. Dioxins/furans were analyzed in shallow and deep soil samples at one location in the East Former Mill Area; the reported concentrations in these samples were less than the screening level.

6.4.7.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include metals (two locations) and dioxins/furans (two locations).

Metals exceedances are limited to the East Former Mill Area; soil in the East Shoreline Area was not analyzed for metals. Copper, lead, and mercury exceed screening levels in one or two locations in the East Former Mill Area. All of the metals exceedances are less than 10 times the screening level.

Dioxin/furan concentrations exceeded screening levels in two samples from the East Shoreline Area. One exceedance is less than 10 times the screening level and the other is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

One or more metals (barium, chromium, cobalt, copper, lead, mercury, nickel, selenium, and/or zinc) were detected above terrestrial ecological screening levels in deep soil at five locations. All of the metals exceedances are less than 10 times the screening level. No other COPCs were detected above ecological screening levels in deep soil.

Comparison of COPCs in Shallow and Deep Soil

Shallow and deep soil samples collected at three locations in the East Former Mill Area were analyzed for metals. The concentration ranges of detected metals were similar between shallow and deep samples. In general, concentrations of lead and mercury were higher in shallow samples, whereas concentrations of copper and zinc were higher in deeper samples.

6.4.7.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include metals (two locations) and dioxins/furans (two locations).

Copper and/or mercury exceed soil-to-groundwater screening levels at two shallow soil locations in the East Former Mill Area. These exceedances are less than 10 times the screening levels.

Dioxin/furan concentrations exceeded screening levels in two samples from the East Shoreline Area. One exceedance is less than 10 times the screening level and the other is greater than 10 times (but less than 100 times) the screening level.

Deep Soil (>2 feet bgs)

Only metals (copper, mercury, nickel, and/or zinc) exceed soil-to-groundwater screening levels in deep soil (four locations). Copper exceeds the screening level at all four locations; zinc, mercury, and nickel exceed screening levels less frequently (two locations, one location, and one location, respectively). All of the metals exceedances are less than 10 times the respective screening levels.

Comparison of COPCs in Shallow and Deep Soil

Shallow and deep soil samples were submitted for metals analyses from three locations in the East Former Mill Area. The concentration ranges for detected metals were similar between shallow and deep samples. In general, concentrations of lead and mercury were higher in shallow samples, whereas copper, nickel, and zinc concentrations were higher in deep samples.

6.4.7.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are five existing groundwater monitoring wells (MW-59, PA-24, PZ-9, PZ-10, and PZ-13) and one groundwater grab sample location (GWG-7) in the East Shoreline and East Former Mill Areas. Well PZ-13 was found to be damaged during the August 2010 baseline groundwater monitoring event (the well was dry, and much of the well casing appeared to be filled with filter pack sand); consequently, well PZ-13 was not sampled in 2010-2011. COPCs detected in groundwater samples at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program include dioxins/furans, metals (arsenic, copper, manganese, and/or mercury), and ammonia. Arsenic, copper, and manganese were the metals detected most frequently in groundwater. Monitoring well MW-59 is considered a shoreline monitoring well. Dioxins/furans and arsenic, copper, manganese, and mercury exceeded groundwater screening levels in groundwater samples from this monitoring well.

6.4.7.5 GROUNDWATER-TO-SEDIMENT EXPOSURE PATHWAY

No constituents have been detected in marine surface sediments offshore of the East Shoreline Area at concentrations exceeding SQS (Appendix H, Figure H-1; Windward, in preparation). Consequently, the groundwater-to-sediment pathway will not be further considered for the East Shoreline Area in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.7.6 EAST SHORELINE AND EAST FORMER MILL AREAS SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are cPAHs and dioxins/furans.

The primary COPCs that exceed terrestrial ecological screening levels in soil are metals and dioxins/furans.

The primary COPCs that exceed soil-to-groundwater screening levels in soil are metals (copper, mercury, nickel, and zinc) and dioxins/furans.

Dioxins/furans are the primary COPCs detected in groundwater at concentrations exceeding screening levels. The metals arsenic, copper, manganese, and mercury also have been detected above groundwater screening levels. Ammonia exceeds the screening level at one location (PZ-9). The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. The detections of metals in groundwater may in part reflect the

presence of naturally occurring metals in soil, particularly copper, manganese, and nickel. There are no obvious correlations between isolated exceedances of other COPCs in groundwater and concentrations of the same COPCs in nearby soils.

Based on the results of the groundwater-to-sediment evaluation presented in Appendix H and summarized above in Section 6.4.7.5, the groundwater-to-sediment pathway will not be further considered for the East Shoreline Area in the interim action alternatives evaluation (Interim Action Report Volume III).

6.4.8 Combined Sewer Overflow (CSO) Area

The CSO Area is a narrow corridor that is generally located along the southern border of the mill property and terminates at the western boundary of the City Purchase Area (Figure 9). It is bounded by the Northwest Shoreline, West Former Mill, Main Former Mill, Estuary, and East Former Mill Areas to the North; the City Purchase Area to the East, the bluffs, Ennis Creek, and Prefab Areas to the south, and the Upland Study Area boundary to the west. No known significant mill operations occurred in the CSO Area. A portion of the excavation for the Fuel Oil Tank 1 interim action extended into the CSO Area. In November 2010, Rayonier granted an easement to the City for the CSO Area, for construction of CSO upgrades to the City's POTW.

The eastern portion of the CSO Area is underlain by less than 5 feet of fill material, which overlies alluvial and glacial deposits. The western portion of the CSO Area, closer to Port Angeles Harbor, is underlain by approximately 15 feet of fill material, alluvial/beach deposits, and glacial deposits.

Surface and subsurface soil samples were collected and analyzed during the 1997 ESI (locations GB02 and GB03), the 2006 Fuel Oil Tank 1 interim action (locations FOT-EX-8 and FOT-EX-13), and the 2010-2011 Supplemental Upland Investigation (locations GWG-6, MW-70, and SSB-8). Groundwater chemical analytical data were collected during quarterly groundwater monitoring performed in 2010 and 2011 as part of the Supplemental Upland Investigation.

6.4.8.1 HUMAN HEALTH (DIRECT CONTACT) EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

Dioxins/furans detected in the shallow soil sample at location GB03 are the only COPCs that exceed human health (direct contact) screening levels in shallow soil. The concentration of dioxins/furans in this sample is less than 10 times the screening level.

Deep Soil (>2 feet bgs)

cPAHs detected in the deep soil sample obtained from 2 to 4 feet bgs at location GB03 are the only COPCs that exceed human health (direct contact) screening levels in deep soil. The concentration of cPAHs in this sample is less than 10 times the screening level.

Comparison of COPCs in Shallow and Deep Soil

Location GB03 is the only location in the CSO Area where concentrations of COPCs exceed screening levels in soil. Dioxins/furans exceed screening levels in shallow soil and cPAHs exceed screening levels in deep soil.

6.4.8.2 TERRESTRIAL ECOLOGICAL EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed terrestrial ecological screening levels in shallow soil include metals and dioxins/furans.

Cobalt, copper, and dioxins/furans exceed ecological screening levels at one shallow soil location (GB03); the exceedances are less than 10 times the respective screening levels.

Deep Soil (>2 feet bgs)

Metals (chromium, copper, lead, manganese, mercury, nickel, and zinc) are the only COPCs that exceed terrestrial ecological screening levels in deep soil (four locations). Copper exceeds screening levels most frequently (three locations); nickel exceeds at two locations, and each of the other metals exceeds at one location. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 26.5 feet bgs, and are less than 10 times the respective screening levels.

Comparison of COPCs in Shallow and Deep Soil

Metals exceed terrestrial ecological screening levels at one shallow soil location and four deep soil locations. Copper exceeds the ecological screening level most frequently. Dioxins/furans exceed the ecological screening level at one shallow soil location but no deep soil locations.

6.4.8.3 SOIL-TO-GROUNDWATER EXPOSURE PATHWAY

Shallow Soil (0-2 feet bgs)

COPCs that exceed soil-to-groundwater screening levels in shallow soil include metals and dioxins/furans.

Copper, cadmium, and dioxins/furans exceed soil-to-groundwater screening levels at one shallow soil location (GB03); the exceedances are less than 10 times the respective screening levels.

Deep Soil (>2 feet bgs)

Metals are the only COPCs that exceed soil-to-groundwater screening levels in deep soil.

One or more metals (cadmium, copper, manganese, mercury, nickel, and/or zinc) exceed soil-to-groundwater screening levels at four deep soil locations. Copper exceeds the screening level most frequently (three locations). Each of the other metals exceeds at two or fewer locations. The metals exceedances in deep soil are distributed throughout the sampled area at depths ranging from 2 to 26.5 feet bgs, and all are less than 10 times the respective screening levels. The copper and nickel exceedances are within, or only slightly greater than, the range of the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Comparison of COPCs in Shallow and Deep Soil

Metals exceed soil-to-groundwater screening levels at one shallow soil locations and four deep soil locations. Copper exceeds the soil-to-groundwater screening level most frequently. All of the copper exceedances and the majority of the nickel exceedances in deep soil are within the range of

the copper and nickel concentrations detected in soil at upgradient location MW-64 in the southernmost portion of the Upland Study Area.

Dioxins/furans exceed the soil-to-groundwater screening level at one shallow soil location but no deep soil locations.

6.4.8.4 GROUNDWATER-TO-SURFACE WATER EXPOSURE PATHWAY

There are two existing groundwater monitoring wells (MW-70 and PA-15) and one groundwater grab sample location (GWG-6) in the CSO Area. Dioxins/furans and the metals copper, manganese, and nickel were the only COPCs detected in groundwater at concentrations exceeding screening levels during the 2010-2011 quarterly monitoring program. Nickel exceeded the screening level only in the groundwater grab sample collected at location GWG-6. The copper exceedance detected in well MW-70 appears to correlate with copper detections exceeding the soil-to-groundwater screening level in soil at this location. However, the copper exceedances in deep soil at location MW-70 are within the range of the copper concentrations detected in soil at upgradient location MW-64.

6.4.8.5 CSO AREA SUMMARY

The primary COPCs that exceed human health (direct contact) screening levels in soil are dioxins/furans and cPAHs. The primary COPCs that exceed terrestrial ecological screening levels in soil are metals (primarily copper) and dioxins/furans. The primary COPCs that exceed soil-to-groundwater screening levels in soil are copper and dioxins/furans. The footprints of COPC exceedances for the human health, ecological, and soil-to-groundwater pathways are similar. COPCs detected in groundwater at concentrations exceeding screening levels include dioxins/furans, copper, manganese, and nickel. Nickel exceeded the screening level only in a groundwater grab sample (location GWG-6); there were no nickel exceedances in monitoring wells. The detections of dioxins/furans in groundwater likely reflect the presence of suspended solids in unfiltered groundwater samples. The copper exceedance detected in well MW-70 appears to correlate with copper detections exceeding the soil-to-groundwater screening level in soil at this location. However, the copper exceedances in deep soil at location MW-70 are within the range of the copper concentrations detected in soil at upgradient location MW-64.

7.0 CONCEPTUAL SITE MODEL FOR THE UPLAND STUDY AREA

Based on the known history of the former pulp mill and the results of investigations completed to date, a conceptual site model (CSM) for the Upland Study Area was developed. The CSM is a general qualitative description of the contaminant sources, release mechanisms, transport mechanisms, and exposure pathways of potential concern for the Upland Study Area. The types and spatial distribution of COPCs that have been identified in the Upland Study Area are described in Sections 6.3 and 6.4. A detailed discussion of the fate and transport of the COPCs is presented in Section 8.0.

7.1 Contaminant Sources, Release Mechanisms, and Transport Mechanisms

7.1.1 Potential Contaminant Sources

The industrial processes and support activities associated with the historical pulp manufacturing operations utilized or produced petroleum and other chemical products that may have been sources for some of the COPCs identified in the Upland Study Area. Various byproducts associated with the mill operations also may have been sources of COPCs. The three major categories of historical mill operations were as follows:

- Power and Steam Generation: Electrical power and steam generating facilities at the pulp mill included a recovery boiler, hog fuel boiler, and two auxiliary power boilers that used wood residue, combustible solid process residues, and Bunker C fuel oil as fuel sources (Integral and Foster Wheeler, 2004). A byproduct of fuel combustion in the boilers was boiler ash, which may have contained metals and dioxins/furans. The boiler ash was collected and periodically transported off site for disposal; however, small quantities of ash were sometimes used as fill on the mill property.
- Pulp Production: Specialty pulps were produced at the mill using an ammonia-based acid sulfite process. Chemicals used in the pulp production process included ammonium bisulfate cooking liquor, chlorine, sodium hydroxide, hydrogen peroxide, sodium hypochlorite, and chlorine dioxide (Integral and Foster Wheeler, 2004). Byproducts of the pulp production process included wood residue, which may undergo chemical reactions in the environment to produce phenolic compounds; SSL that contained ammonia and wood-derived organic residues; and industrial wastewater that contained mainly dissolved sugars and organic acids, but may have also contained ammonia and low concentrations of metals and/or dioxins/furans. Significant improvements to the mill's wastewater treatment facilities were made beginning in 1972, and from 1972 until the mill's closure in 1997, the mill's wastewater was treated prior to discharge to Port Angeles Harbor.
- Support Operations: Various petroleum and chemical products were used in support of mill operations, such as diesel fuel, solvents, paints, and lubricating, hydraulic, and transformer oils. Classes of COPCs that may be associated with these products include petroleum hydrocarbons, VOCs, SVOCs, cPAHs, PCBs, and some metals.

In addition to these operations, many of the mill structures such as buildings, piping, tanks, piping/tank supports, and utility raceways were constructed of various metals/metal alloys such as iron and steel. Many of the metal structures were exposed to corrosive/reactive environments due to the use of steam and caustic materials such as acids, bases, and oxidizers in the manufacturing processes, and thus may have been an historical source of metals contamination.

Another potential source of COPCs is naturally occurring metals present in soil beneath the mill property. Under certain subsurface geochemical conditions such as reducing and/or low pH conditions (which the former mill may have created or influenced due to the nature of the chemical products and residues associated with the pulp manufacturing process), naturally occurring metals in the soil matrix may have mobilized and leached to groundwater. This concept is discussed further in Section 8.0.

Pulp production ended in 1997 when the pulp mill ceased operations. The potential primary sources of contaminants associated with the historical mill operations were removed with the dismantling and decommissioning of the mill in 1997-1999.

7.1.2 Release Mechanisms

During pulp mill operations, the following mechanisms may have released COPCs from the sources identified in Section 7.1.1 to environmental media in the Upland Study Area:

- Stack emissions from power and steam generation may have resulted in releases of COPCs such as dioxins/furans to air. Fallout and settling of airborne particulates from the stack emissions may have resulted in deposition to surface soil and surface water bodies.
- Wastewater discharge through outfalls to Port Angeles Harbor may have resulted in releases of COPCs such as ammonia, dioxins/furans, and metals to the harbor.
- Leaks, spills, and drips from process machinery, equipment, and petroleum/chemical product storage and conveyance facilities may have resulted in releases of COPCs such as petroleum products, SVOCs, cPAHs, and PCBs to surface and subsurface soil and surface water bodies.
- Direct deposition of residues and byproducts such as boiler ash and wood/pulp residue may have resulted in releases of COPCs such as metals and dioxins/furans to surface and subsurface soil.
- Corrosion and flaking of aboveground metal process or support structures may have resulted in releases of metals to surface soil and surface water bodies.

These release mechanisms would have acted only during the time of active mill operations; the primary contaminant sources and release mechanisms associated with mill operations were eliminated with the mill's decommissioning in 1997-1999.

7.1.3 Transport Mechanisms

Under current conditions, physical and chemical transport mechanisms that may contribute to the migration of COPCs in the environment within the Upland Study Area include the following:

- Erosion of soil containing COPCs via stormwater runoff or wind, with subsequent deposition to soil in other areas of the Upland Study Area or in surface water bodies.
- Leaching of COPCs in soil to nearby (e.g., deeper) soil and/or groundwater via stormwater infiltration and percolation.
- Migration of COPCs in groundwater via advection and diffusion, including possible discharge of groundwater containing COPCs to surface water bodies.

A detailed discussion of contaminant transport mechanisms and physical/chemical conditions in the Upland Study Area that may affect the mobility of COPCs in the environment is presented in Section 8.0.

7.2 Exposure Pathways of Potential Concern

Cross sections depicting subsurface geologic conditions at the mill property are presented in Figures 12 through 19. The subsurface conditions illustrated in these cross sections are discussed below in the context of potential exposure pathways for the COPCs identified in soil, groundwater, and surface water.

7.2.1 Soil

In general, subsurface geology at the mill property consists of fill material underlain by native beach and alluvial deposits, which are in turn underlain by native glacial deposits. The fill material consists primarily of sand and gravel with varying amounts of silt. In many areas, construction debris is present in the fill horizon; this debris includes concrete, bricks, scrap wood and metal, electrical wire, sections of broken pipe, and wood residue.

Mill-related COPCs detected in soil in the Upland Study Area are generally assumed to be associated with historical releases to the ground surface or shallow subsurface from the potential sources described above in Section 7.1.1, via one or more of the release mechanisms identified in Section 7.1.2. Several interim cleanup actions have been completed in areas of the mill property where past releases occurred and contaminants such as hydraulic oil, PCBs, Bunker C, hog fuel waste, and residual SSL were present in soil and/or shallow groundwater. The last of these interim actions was completed in 2006. The interim actions removed approximately 34,000 tons of hog fuel and contaminated soil, and limited quantities of affected groundwater, from known areas of concentrated past releases. The COPC residuals that remain in soil are generally present at lower concentrations and are more widely distributed across the mill property.

Exposure pathways of potential concern for the residual COPCs that remain in soil in the Upland Study Area include:

- Direct contact with affected soil by visitors, workers, future residents, and other property users, primarily via incidental ingestion of soil and/or dermal contact (human health exposure pathway).
- Exposure of soil biota, terrestrial plants, and wildlife to affected soil (terrestrial ecological exposure pathway). Wildlife may be exposed via ingestion of soil biota or terrestrial plants that contain COPCs, or incidental ingestion and/or dermal contact with affected soil.
- Exposure of aquatic organisms and humans (via consumption of aquatic organisms) to marine surface water affected by leaching of COPCs from soil to groundwater and subsequent discharge of groundwater to surface water (soil-to-groundwater exposure pathway).

7.2.2 Groundwater

Unconfined, shallow groundwater occurs in the fill and native beach and alluvial deposits beneath the mill property. The shallow water-bearing zone is variable in thickness; the base of this zone (defined by the top of the glacial deposits) occurs at depths ranging from 12 feet bgs to greater than 30 feet bgs. The majority of the monitoring wells at the property are screened in the shallow water-bearing zone. The depth to groundwater in monitoring wells ranges from approximately 2 to 17 feet bgs. The inferred groundwater flow direction is generally to the north toward Port Angeles Harbor. The glacial till that underlies the fill and beach/alluvial deposits in most areas of the mill

property impedes downward vertical migration of COPCs in groundwater due to the low permeability of the till deposits.

Similar to the distribution of COPCs in soil, COPCs have been detected at relatively low concentrations in groundwater in many areas of the mill property. There are no well-defined contaminant plumes with spatially distinct areas of relatively higher (i.e., source area) and lower (i.e., downgradient) concentrations. In accordance with WAC 173-340-720(2)(d), due to the availability of municipal water and the proximity of the mill property to marine surface water that is not suitable as a domestic water supply, groundwater beneath the property or potentially affected by the property is not a current or reasonable future source of drinking water. Consequently, human ingestion of groundwater containing COPCs is not an exposure pathway of potential concern at the mill property. However, based on the inferred northerly groundwater flow direction in the Upland Study Area, groundwater likely discharges to the offshore marine environment of Port Angeles Harbor. Accordingly, exposure pathways of potential concern for COPCs in groundwater beneath the Upland Study Area include exposure of aquatic organisms and humans (via consumption of aquatic organisms) to marine surface water and/or sediments affected by discharge of groundwater to surface water (groundwater-to-surface water and groundwater-to-sediment exposure pathways). As discussed in Section 6.4, based on the evaluation presented in Appendix H, the groundwater-to-sediment pathway is being considered further only for select constituents in the Northwest Shoreline and North Shoreline functional use areas.

7.2.3 Fresh Surface Water

In the southern portion of the Upland Study Area, Ennis Creek and White Creek converge. The resulting stream, Ennis Creek, flows through the mill property and discharges to Port Angeles Harbor in the north-central portion of the property. There have been only isolated detections of COPCs in surface water samples collected from Ennis Creek (metals and dioxins/furans). Only the dioxin/furan detections exceeded the conservative surface water screening levels used in this report; none of the detected metals exceeded screening levels. The dioxin/furan detections only slightly exceeded the parts-per-quadrillion laboratory reporting limits for these COPCs.

The primary exposure pathway of potential concern for the COPCs detected in surface water samples obtained from Ennis Creek is exposure of aquatic organisms and humans (via consumption of aquatic organisms) to marine surface water affected by the flow of Ennis Creek into Port Angeles Harbor. However, due to the low concentrations of COPCs reported in the surface water samples (most COPCs either were not detected or were detected at concentrations less than surface water screening levels), this exposure pathway is considered insignificant compared to the groundwater-to-surface water pathway described above in Section 7.2.2.

7.3 Upland Study Area CSM Summary

Chemicals and byproducts from the approximately 60-year history of pulp mill operations have left behind residual concentrations of certain COPCs in soil and shallow groundwater that exceed conservative, risk-based screening levels. Table 11 summarizes the primary COPCs identified for each functional use area. Approximately 34,000 tons of impacted soil and wood residue was removed from the Upland Study Area for off-property treatment or disposal during interim cleanup actions completed between the late 1980s and 2006. In addition, liquid-phase hydraulic oil and

Bunker C associated with historical releases in the Finishing Room and Fuel Oil Tank 2 areas were removed for off-property disposal during the interim actions completed in these areas.

Potential receptors that may be exposed to residual COPCs remaining in soil at the mill property include visitors, trespassers, construction workers, future workers, future residents, and terrestrial plants and animals. COPCs in soil also may be transported to the off-shore marine environment through soil erosion or leaching of COPCs from soil to groundwater, and subsequent discharge of affected groundwater to Port Angeles Harbor or Ennis Creek. Potential receptors that may be exposed to COPCs in the marine environment include aquatic organisms and humans (through consumption of aquatic organisms).

Groundwater in many areas of the mill property is affected by low concentrations of COPCs that may have leached from soil. The glacial till underlying the fill material and native beach and alluvial deposits acts as a low-permeability barrier to downward vertical migration of COPCs in groundwater. Groundwater beneath the mill property or potentially affected by the property is not a current or reasonable future source of drinking water because of the proximity to marine surface water. Consequently, human ingestion of groundwater containing COPCs is not an exposure pathway of potential concern. The only exposure pathway of potential concern for COPCs in groundwater is discharge of affected groundwater to Port Angeles Harbor.

Ennis Creek and White Creek drain an urban watershed. The analytical testing results for surface water samples obtained from these creeks in the upgradient (southernmost) portion of the Upland Study Area were similar to the analytical results for surface water samples obtained from the mouth of Ennis Creek. Most COPCs either were not detected or were detected at concentrations less than surface water screening levels; dioxins/furans were detected at concentrations slightly greater than laboratory reporting limits. Due to the limited number and low concentrations of COPCs detected in surface water samples, the exposure pathway associated with discharge of Ennis Creek to Port Angeles Harbor is considered insignificant compared to the exposure pathway associated with groundwater discharge to the harbor.

8.0 FATE AND TRANSPORT OF CONTAMINANTS OF POTENTIAL CONCERN

The CSM for the Upland Study Area presented in Section 7.0 describes contaminant sources, release mechanisms, transport mechanisms, and exposure pathways of potential concern. Some of the contaminant transport mechanisms discussed in Section 7.0 are potentially applicable under present-day conditions, whereas others are historical transport mechanisms that are no longer active/applicable. The release of airborne particulates from stack emissions is an example of an historical transport mechanism that is no longer active.

The contaminant fate and transport evaluation presented in this section focuses on potential present-day contaminant transport mechanisms. Soil erosion is one example of a potential present-day transport mechanism. Soil erosion may be caused by stormwater runoff or wind, and eroded soil may be transported and deposited to the ground surface in adjacent areas of the property or to surface water. However, due to the overall flat topography of the property and general lack of exposed soil in sloped areas, and the fact that most of the property is covered by vegetation, pavement, former building pads, and/or concrete rubble, current property conditions

are not conducive to soil erosion. Additionally, stormwater runoff on the property is managed under a stormwater pollution prevention plan (Landau, 2010), which calls for engineered drainage controls to minimize erosion of soil. For these reasons, soil erosion is not a significant contaminant transport mechanism under current conditions and is not considered further in this section. Soil erosion will be further evaluated during the interim action alternatives evaluation (Interim Action Report Volume III). The remainder of this section discusses transport mechanisms that may affect contaminant mobility and migration under current conditions in the Upland Study Area.

The only potentially active *primary* contaminant transport mechanism under current conditions is leaching of COPCs from soil to groundwater. Potential present-day *secondary* transport mechanisms include:

- Groundwater advection and adsorption of dissolved COPCs to soil particles.
- Groundwater advection and mixing with seawater in nearshore soil/sediment and subsequent discharge of dissolved COPCs to Port Angeles Harbor.
- Groundwater advection and discharge of dissolved COPCs to Ennis Creek and subsequent flow of Ennis Creek into Port Angeles Harbor.

The subsections below present a focused discussion of these potential transport mechanisms and their effect on the fate of the COPCs identified in the Upland Study Area. The subsections are organized according to the following COPCs/COPC groups:

- Heavy organics (including heavy oil-range TPH, cPAHs, PCBs, and dioxins/furans).
- Ammonia.
- Metals.

As discussed in Section 6.3, VOCs and pesticides are not considered COPCs, and thus are not addressed in the subsections below.

Non-cPAH SVOCs also are not addressed in the subsections below. There were limited detections of these constituents in soil and groundwater, and of these detections, only a fraction exceeded screening levels. The two primary non-cPAH SVOCs that have been detected above screening levels are BEHP and PCP. Although there were a few isolated detections of BEHP in groundwater in 2010-2011 that slightly exceeded the screening level, none of the detections was confirmed during subsequent monitoring events. Due to their very low concentrations and transient nature, the BEHP detections in groundwater are suspected to be the result of laboratory contamination. There have also been isolated detections of BEHP in soil at concentrations exceeding screening levels, but all of these detections were qualified as either estimated ("J" qualifier) or suspect due to the detection of BEHP in an associated method blank ("B" qualifier). Additionally, analytical results for some field duplicate samples indicate that BEHP concentrations in the primary and duplicate samples differed by several orders of magnitude, suggesting that the BEHP results are highly variable and dependent on laboratory analytical procedures. Furthermore, many of the BEHP detections reported in soil had a corresponding detection in an associated method blank. For these reasons, and because there are no known mill-related sources of BEHP, the BEHP detections in soil also are suspected to be the result of laboratory contamination.

PCP also has been detected in soil at concentrations exceeding screening levels, but PCP was not detected above the groundwater screening level in any monitoring wells in 2010-2011. This demonstrates that the existing PCP concentrations in soil are protective of groundwater, and thus the PCP detected in soil is unlikely to leach to, or be transported in, groundwater.

8.1 Fate and Transport of Heavy Organic COPCs

The heavy organic COPCs include heavy oil-range TPH, cPAHs, PCBs, and dioxins/furans. Each of these heavy organic COPCs consists of multiple individual compounds. The potential for these individual compounds to migrate via groundwater advection to exposure media is controlled by their tendency to adsorb to soil particles. The tendency of a chemical to be adsorbed is typically quantified by the chemical's distribution coefficient (Kd), which is a measure of the ratio of the chemical mass that partitions to the solid and liquid phases under equilibrium conditions. The ability of organic contaminants to adsorb to soil is a function of the organic carbon content of the soil – in general, the higher the organic carbon content, the greater the ability of the soil to adsorb organics. Contaminant solubility is another factor controlling the potential for COPCs to partition into groundwater and migrate via groundwater advection. Contaminants with low solubilities undergo limited mass transfer from soil to groundwater.

In general, the heavy organic COPCs identified in soil and groundwater in the Upland Study Area have high Kd values and low solubilities, and therefore are expected to have a strong affinity for soils, with very little dissolution into groundwater. Consequently, migration of heavy organic COPCs in groundwater is expected to be limited. This is consistent with the observed limited detections and/or low concentrations of heavy organic COPCs in groundwater beneath the Upland Study Area (GeoEngineers, 2011). The presence of dissolved heavy organic COPCs in groundwater monitoring wells suggests a localized source in soil in the immediate vicinity of the wells in which they are detected. Given their relative lack of mobility, the heavy organic COPCs in groundwater are expected to remain in the near vicinity of these localized sources, and over time they are expected to attenuate as a result of natural processes.

8.2 Fate and Transport of Ammonia

Ammonia is a reduced form of nitrogen and is typically found in waters that are depleted of oxygen, nitrate, and sulfate. Reduction of nitrite and nitrogen gas can form ammonia under favorable conditions. Although the reverse process – oxidation of ammonia to nitrite and nitrogen gas – also can occur under favorable conditions (i.e., abundance of oxygen), ammonia is not expected to be oxidized under reducing conditions. Unlike the other COPCs (heavy organics and metals), ammonia is very soluble and is readily transported by groundwater advection. Thus, once present in groundwater, ammonia can potentially migrate significant distances in the subsurface under reducing conditions.

Ammonia was used in the mill's pulp manufacturing process. Another potential source of ammonia is organic matter such as buried wood residue present in fill. Regardless of whether the source of ammonia is historical releases associated with mill operations, buried wood residue, or a combination thereof, ammonia is readily oxidized under favorable (i.e., oxygen-rich) conditions. The groundwater monitoring data for the Upland Study Area suggest an inverse relationship between dissolved oxygen (DO) and ammonia – monitoring wells with low DO concentrations (indicative of reducing conditions) tend to have higher ammonia concentrations than wells with relatively higher

DO concentrations. This can be seen, for example, in the temporal behavior of ammonia in monitoring well MW-57, which has decreased from 4.6 milligrams per liter (mg/L) in 2003 to 0.76 mg/L in 2011, while DO has increased to greater than 1 mg/L over the same time period.

Ammonia concentration trend plots for monitoring wells with historical ammonia exceedances are included in Appendix I. In the majority of the wells, ammonia concentrations are trending downward. Most of the remaining wells show fluctuating ammonia concentrations over time or relatively stable concentrations. These trends indicate that groundwater quality is generally stable or improving with respect to ammonia, and suggest that ammonia concentrations may continue to attenuate over time as a result of natural processes.

8.3 Fate and Transport of Metal COPCs

This section discusses the fate and transport of metals. Subsection 8.3.1 summarizes the fate and transport characteristics of individual metals. Subsection 8.3.2 describes potential sources and historical release mechanisms for metals, as well as potential present-day and future transport mechanisms. In Subsection 8.3.3, subsurface conditions that may control the distribution of dissolved metals are reviewed. In Subsection 8.3.4, geochemical conditions are considered, and in Subsection 8.3.5, aqueous concentration trends are reviewed to evaluate the potential for future migration of metals. Finally, in Subsection 8.3.6, the potential for metals dissolved in upland groundwater to migrate to surface water is discussed.

8.3.1 Physiochemical Characteristics of Metal COPCs

Physiochemical characteristics of the primary metal COPCs that affect their fate and transport in the subsurface are summarized below.

Arsenic speciation determines the behavior of arsenic under varying oxidation-reduction (redox) and pH conditions. As(V) is the prevalent species under oxidizing conditions and conditions where high concentrations of iron or iron oxides are present, whereas As(III) is the prevalent species under reducing conditions. As(V) is less soluble and more likely to adsorb to soils under low and high pH conditions than under more neutral pH conditions. Monitoring data indicate that reducing conditions exist in the shallow water-bearing zone in many areas beneath the mill property, suggesting that As(III) is likely the dominant arsenic species. Unlike As(V), the solubility of As(III) increases at low and high pH, especially in soils with high organic content.

Cadmium is a cationic metal, and its chemistry in soil is controlled by pH more than any other factor. Cadmium solubility increases with decreasing pH (i.e., acidic conditions). Cadmium solubility typically decreases with increasing pH. However, in the presence of chlorine ions, which would be present at the groundwater/seawater interface, cadmium solubility increases with increasing pH.

Copper, in contrast to cadmium, is not affected by extreme pH values, and tends to adsorb to soil surfaces readily (more so than any of the other identified metal COPCs), thus greatly reducing its mobility. However, a notable exception is when copper is collocated with soluble organic matter in a reducing environment. Under these conditions, organo-copper complexes can form, which are more soluble than the mineral complexes that copper ions typically form.

Lead exhibits similar adsorptive behaviors as copper, and has only limited mobility under very acidic (pH <3) conditions. However, in the presence of organic matter under reducing conditions, organo-lead complexes can form that are comparatively soluble in groundwater.

Manganese typically occurs naturally at comparatively high concentrations relative to the other metal COPCs in soil. In soil, manganese is usually found in its natural state as manganese dioxide (MnO_2). In water, dissolved manganese is normally present as Mn(II), and dissolved manganese is favored by conditions that are reducing and mildly to strongly acidic. In waters with neutral pH and oxidizing conditions, such as typical seawater, Mn(II) will oxidize rapidly to Mn(III) and Mn(IV), which form insoluble manganese oxides and oxide-hydroxide minerals. Thus, the risk of manganese impact to marine surface water in Port Angeles Harbor by groundwater discharge from the Upland Study Area is low. When manganese oxide-hydroxide minerals precipitate, they also entrain other metals such as nickel, iron, chromium, and arsenic, thereby reducing the leaching, mobility, and bioavailability of those metals. On the other hand, manganese oxide-hydroxide minerals will dissolve under reducing and acidic conditions, which can result on a synergistic increase in dissolved metal concentrations in groundwater.

Mercury solubility is highly dependent on both pH and redox conditions. Mercury solubility generally decreases with increasing pH, leading to either adsorption in the soil matrix, or precipitation, often as a stable mercuric hydroxide complex. Under reducing conditions, mercury and mercury compounds can be converted to methyl or ethyl mercury, which are highly soluble.

Nickel has a strong affinity for adsorbing to iron and manganese oxides. Nickel also complexes with organic matter, and thereby becomes more soluble, under reducing conditions.

Selenium occurs in four oxidation states in soil, including Se(-II), elemental selenium, Se(IV), and Se(VI). The form selenium takes in soil is governed by pH, redox potential, and the composition of the soil, making its transport mechanisms among the most complex of any of the metal COPCs. In general, selenium solubility increases in high pH environments. However, under reducing conditions at neutral pH, selenium tends to revert to its elemental state and precipitate out of solution. Thus, selenium solubility generally decreases under reducing conditions at neutral pH.

8.3.2 Historical Sources and Release Mechanisms for Metal COPCs

All of the metal COPCs are naturally occurring and present in soils, sediments, and groundwater throughout Washington State. Ecology has established natural background concentrations of metals in soil in the report *Natural Background Soil Metals Concentrations in Washington State* (Ecology, 1994). The background concentrations of the metal COPCs range from 0.07 mg/kg for mercury to 1,100 mg/kg for manganese.

It is unlikely that large quantities of metal COPCs were released to the environment by historical mill operations, as the main process chemicals that were used did not contain the metal COPCs that have been detected in the Upland Study Area. Among the chemicals used in the pulp manufacturing process were sodium hydroxide, chlorine dioxide, hydrogen peroxide, sodium hypochlorite, and other caustic chemicals; ammonia; and various acids including sulfuric, nitric, and phosphoric acids. As discussed in Section 7.0, some of the metal structures and equipment used at the mill were exposed to corrosive conditions due to the use of these chemicals, and small

quantities of metals may have been released to the environment as a result. Although corrosion of the mill's metal infrastructure may account for some of the metal COPCs that have been detected, there is no evidence that this was a major source of metals contamination. Consequently, the elevated metals concentrations detected on the mill property likely resulted primarily from other processes/release mechanisms.

A potentially important source of metals contamination at the mill property is the dissolution and mobilization of naturally occurring metals in the soil matrix caused by historical releases of acids and/or caustics. The acids and caustic substances that were used in various processes at the mill may have spilled or leaked to the ground surface or shallow soil and infiltrated the subsurface over the course of the mill's history. This could have changed the geochemical conditions in the subsurface (e.g., increased/decreased pH or redox potential) and caused leaching and mobilization of naturally occurring metals in soil. The movement of acids and caustic substances into groundwater beneath the mill property would have been facilitated by the shallow groundwater table and infiltration/percolation of stormwater. Because spills would have been sporadic, occurring at different times and locations with varying degrees of severity, the extent of the impacts on the subsurface geochemistry was likely variable, resulting in heterogeneous pH and redox conditions in soil and groundwater during the period of active mill operations.

Another historical activity that may have affected soil and groundwater geochemistry, and possibly the distribution of metal COPCs on the mill property, was the use of wood waste and boiler ash as fill. While much of the wood waste was used as hog fuel, and boiler ash was placed in off-property landfills beginning in 1971, for a period of approximately 40 years, some wood waste and ash was used as fill during periods of mill expansion.

Other potential sources of metal COPCs include deposition of airborne particulates from the mill's stack, and metal fragments/flakes from scrap metal generated during demolition of the mill.

8.3.3 Subsurface Conditions Affecting Fate and Transport of Metal COPCs

As postulated in the 2007 Upland RI Report (Integral, 2007), the concentrations of metals in groundwater are believed to primarily reflect localized geochemical conditions rather than dissolved plumes emanating from specific source areas. The presumed sporadic distribution of acid and caustic substance spills and leaks, in combination with historical filling, mill demolition, and regrading activities, collectively resulted in a heterogeneous distribution of metals in soil and heterogeneous geochemical conditions. This heterogeneity is likely the dominant factor that controls present-day dissolved metals concentrations in groundwater.

The nature and extent of metal COPCs in soil is discussed in Section 6.4. The data indicate that there are localized occurrences of elevated metal concentrations in soil throughout the mill property. In addition to the variable soil metals concentrations, geochemical conditions also are variable beneath the mill property, likely a result of the sporadic distribution of historical acid and caustic substance spills and leaks and the heterogeneous distribution of debris such as wood waste, concrete, and boiler ash. The presence of lime in concrete can raise the pH, while degradation of wood waste can lower the pH and generate reducing conditions. Thus, the presence of debris in the subsurface can locally raise or lower pH, or may buffer pH in areas where historical releases of acids/caustics occurred. Representative values of groundwater pH (field

measurements from the May 2011 monitoring event) are shown in Figure 25. Tabulated data for pH and other field parameters measured in groundwater during the 2010-2011 monitoring events are contained in Appendix E.

In general, the primary geochemical conditions that influence dissolved metals concentrations in groundwater include pH, DO, and redox potential. The initial groundwater sampling event after the mill's closure in 1997 was performed in 2003 (Integral, 2007); the results indicated that areas of both high and low pH were present in groundwater beneath the property. Similar results were obtained during the quarterly groundwater monitoring performed in 2010-2011; i.e., select monitoring wells exhibited groundwater pH values of less than 6 or greater than 9 (Figure 25). Because no known pH-altering chemicals have been introduced to mill property soil or groundwater since the mill's closure in 1997, these anomalous pH conditions likely reflect conditions that existed in the past during the period of active mill operations.

Groundwater field parameter data from the 2010-2011 groundwater monitoring effort (contained in Appendix E) also indicate variable DO and redox conditions. Although DO concentrations are generally low (i.e., less than 2 mg/L) and redox data are generally indicative of reducing conditions (i.e., negative redox potential), there are a number of wells with higher DO and positive redox potential. Additionally, DO and redox potential show temporal variations in individual wells. These spatial and temporal variations in DO and redox conditions can affect the solubility and mobility of metals as discussed further in the next section.

8.3.4 Specific Geochemical Factors Influencing Leaching and Transport of Metal COPCs

Precipitation/dissolution and adsorption/desorption of metals in soil are complex processes that affect the ability of metals to be leached and transported in groundwater. Geochemical factors that influence these processes, and thus the resulting dissolved metal concentrations in groundwater, include:

- pH.
- DO content and redox state.
- Groundwater composition and metals speciation.
- Behavior of hydrous metal oxides.
- Presence and nature of particulate and dissolved organics.

Metals can be removed from aqueous solutions by precipitation (inorganic reaction) and adsorption (organic reaction), and added to aqueous solutions by dissolution (inorganic reaction) and desorption (organic reaction). In the remainder of this section, for simplicity, the terms adsorption and desorption (or collectively, sorption) are generally used to describe metals being removed from or added to solution, as organic reactions are likely the more important processes controlling metals concentrations in groundwater.

The primary geochemical factors that influence metals sorption and leaching are pH, DO content, and redox state. These factors are discussed in the following section (Section 8.3.4.1). The other factors (groundwater composition and metals speciation, behavior of hydrous metal oxides, and

the presence and nature of particulate and dissolved organics) also play a role, but are likely less important; these factors are discussed in Section 8.3.4.2.

8.3.4.1 PRIMARY GEOCHEMICAL FACTORS AFFECTING METALS SORPTION AND MOBILITY

pH

As discussed above in Section 8.3.1 for individual metal COPCs, pH is an important controlling factor affecting metals adsorption/desorption and the resulting dissolved metal concentrations. There are extensive data indicating that pH directly and indirectly affects the mechanisms by which metals in soil are dissolved or bound to the soil matrix. The effects of pH vary in intensity depending on the metals speciation, the presence of other metals (e.g., iron and manganese oxides), and the redox state. pH can be buffered by soil particles, and the effects of pH can vary in different soil types.

When groundwater pH falls below 5.8 or rises above 8.5, the solubility of most of the metal COPCs increases, and solubilities can increase significantly at lower and higher pH extremes as discussed in Section 8.3.1 for individual metal COPCs.

In addition to being a controlling factor for present-day metals sorption and mobility, pH changes in soil and groundwater were likely instrumental in leaching naturally occurring metals from the soil matrix during the period of active mill operations. As noted previously, areas of high and low pH likely would have been localized from historical spills and leaks of acids or caustic materials, which may have been redistributed by stormwater runoff. As a result, a wide range of conditions affecting metals sorption likely existed in the past at various locations on the mill property.

While the present-day groundwater pH in most of the monitoring wells is in the neutral range, there are areas of lower and higher pH (Figure 25). Relatively low pH (less than 6) groundwater is present at wells MW-64 and MW-70, and pH is somewhat depressed at other wells (e.g., PA-19, PZ-6, and PZ-7). Relatively high pH (greater than 9) groundwater is present at wells MW-28, MW-29, and MW-56. Concrete debris from the mill demolition may have buffered more acidic groundwater over time in some locations.

DO Content and Redox State

DO content is a transient property that reflects the balance between recharge of oxygenated water (e.g., from infiltration of rainwater) and the biochemical conditions of groundwater. The presence of oxygen-rich and oxygen-poor (anoxic) groundwater, as well as fluctuations in DO content, can drive reactions that control metals sorption/leaching and dissolved metal concentrations. DO content also influences redox potential, which can also control metals sorption/leaching and dissolved metal concentrations.

Temporal and spatial changes in the redox state of the saturated zone can strongly influence dissolved metal concentrations. Metals present or mobilized under reducing conditions (i.e., negative redox potential) can be deposited in downgradient areas where metals-rich anoxic groundwater mixes with groundwater having a higher DO content. Transport rates may be affected by heterogeneity of aquifers. Gradients in redox potential can occur both laterally and vertically in the saturated zone. Vertical redox gradients can be caused by infiltration of oxygen-rich rainwater, vertical groundwater gradients, and water table fluctuations.

If organic materials (e.g., wood waste, ammonia process waste) were introduced locally to the saturated zone in the past, localized areas of low DO content may have resulted, which could have enhanced the desorption of metals from soil and increased dissolved metals concentrations in groundwater. Field investigations have identified varying concentrations of total organic carbon in soil and wood residues beneath the mill property, ranging from less than 1 percent to a few percent in most areas, to greater than 90 percent in some locations.

Present-day DO concentrations in groundwater are relatively low at most monitoring well locations, with the exception of wells in the vicinity of Ennis Creek and in the upgradient portion of the property; the higher DO content of groundwater in these areas may reflect interaction with relatively oxygen-rich surface water. Redox potential, like DO content, is relatively low (negative) beneath much of the mill property indicating reducing conditions. However, positive values of redox potential occur sporadically throughout the property, including at some wells close to the shoreline (MW-62 and PA-24) and in historical operations areas (MW-68, PZ-4, and PZ-7). Although DO content and redox potential are generally low across much of the mill property, making the subsurface environment favorable for dissolution of metal COPCs, the observed presence of local oxidizing conditions (positive redox potential) supports the existence of heterogeneous geochemical conditions beneath the property.

8.3.4.2 SECONDARY GEOCHEMICAL FACTORS AFFECTING METALS SORPTION AND MOBILITY

Groundwater Composition and Metals Speciation

In addition to pH, DO content, and redox state, groundwater composition and metals speciation can also influence metals sorption and mobility in groundwater. The chemical composition of natural groundwater (i.e., groundwater that has not been altered by human activity) generally reflects the composition of the host soil or rock formation, and can affect the equilibrium concentrations of metals introduced as a result of human activity. The primary factor controlling this effect is the relative abundance of competitor species (e.g., other metals) in natural groundwater. The importance of this effect in influencing dissolved metals concentrations beneath the mill property is difficult to assess due to the relative abundance and variable concentrations of the metal COPCs, which likely reflect the altered/anomalous geochemical conditions resulting from the former mill operations. Nonetheless, this effect is believed to be of minor importance compared to the effects of pH, DO content, and redox state.

The fate and transport of metals in the subsurface also are dependent on the chemical form and speciation of the metals. However, similar to natural groundwater composition, these factors are believed to be of minor importance compared to the effects of pH, DO content, and redox state. Measurement of the total concentration of metals in groundwater (i.e., all forms/species) is the most useful analytical tool for characterizing the spatial distribution and concentration trends of the metal COPCs over time.

Behavior of Hydrous Metal Oxides

The dissolved concentrations of metals in groundwater are controlled by adsorption/desorption reactions. Hydrous metal oxides and organic matter in soil are the dominant adsorbents. The most common hydrous metal oxides are aluminum, iron, and manganese oxides, which provide adsorptive sites in soil for positively charged species such as cadmium, zinc, lead, and copper, and negatively charged species such as arsenate and selenite. Adsorption of these species on oxides

is strongly dependent on pH; therefore, pH changes can lead to changes in dissolved metals concentrations through their effect on oxide adsorption. Precipitation and dissolution of hydrous metal oxides are in turn dependent on redox state. If, for example, groundwater migrates into an oxidizing zone (i.e., positive redox potential), hydrous metal oxides will precipitate and adsorption of metal COPCs will occur, thus reducing their concentrations in groundwater. This may explain why the concentrations of manganese and other metal COPCs in groundwater beneath the mill property generally follow the same trends (i.e., fluctuate together; see COPC trend plots in Appendix I). Nonetheless, the effect of hydrous metal oxides on metals sorption and mobility is believed to be of minor importance compared to the effects of pH, DO content, and redox state.

Presence and Nature of Particulate and Dissolved Organics

Particulate and dissolved organic materials such as humic acids can be important sorbents for metals in soil and groundwater. They are commonly present as ligands, which can bind to metals in solution and/or bind metals to soil particles. In general, organic matter does not appear to be present in significant quantities in soil and groundwater beneath the mill property. Consequently, the presence and nature of organics in the subsurface are considered to be of minor importance in controlling the sorption and mobility of metal COPCs.

8.3.5 Effect of Changing Subsurface Conditions on Leaching and Advective Transport

As described in the preceding sections, pH extremes and reducing conditions (due to the presence of organic matter, for example) can increase leaching (desorption) of metals from soil and increase dissolved metals concentrations in groundwater. Dissolved metals can migrate to other media such as soil and surface water via advection (i.e., groundwater flow) and diffusion. Conditions favorable for leaching of metal COPCs from soil (e.g., low or high pH, low DO content, reducing conditions) also could allow dissolved metals to remain in a more mobile, soluble state, which would facilitate advective transport. In addition, metals mobility can be enhanced by the presence of competing chemical cations or metal complexes in groundwater that limit metals adsorption to soil.

Conversely, metals mobility can be inhibited by geochemical reactions that cause metals to adsorb to soil, and by pH and/or redox conditions that tend to keep metals in the solid phase and prevent them from leaching. Neutral pH and a neutral or oxidizing redox state favor the adsorption of most metal COPCs, thereby decreasing dissolved metals concentrations and limiting their potential migration in groundwater.

Subsurface geochemical conditions can vary both spatially and temporally. This is especially true when the organic content of soil is variable. Spatial variations in geochemical conditions are discussed in Section 8.3.4; the remainder of this section discusses temporal variations.

Groundwater Level Fluctuations

Groundwater in the shallow water-bearing zone beneath the Upland Study Area is unconfined and flows in a northerly direction toward Port Angeles Harbor, with localized influence from Ennis Creek and relic building foundations. Seasonally, groundwater levels fluctuate 2 to 5 feet in most monitoring wells as a function of seasonal rainfall patterns. In addition, groundwater levels in some areas fluctuate in response to daily tidal fluctuations. Tidal responses of 0.5 to 5 feet were

measured in a number of monitoring wells during a 14-day tidal survey conducted in July 2003, with the greatest response generally occurring in wells nearest the shoreline.

Groundwater level fluctuations can cause geochemical changes. For example, at high water levels, groundwater may contact more organic material (driving reducing conditions) or more concrete debris (raising pH). Also at high water levels, infiltrating rainwater will have a shorter distance to travel and less contact time in the vadose zone, where reactions affecting dissolved metals concentrations can occur. In addition, tidally-driven groundwater fluctuations can increase the DO content of shallow groundwater, as the water table alternately rises and falls through the air-filled porosity of the vadose zone above the water table.

Rainwater Infiltration

Infiltration of rainwater to groundwater is expected to cause changes in DO content and thus redox conditions. Rainwater is typically rich in DO and is likely to increase DO concentrations and redox potential in shallow groundwater, which can lead to reductions in dissolved metals concentrations. Rainwater infiltration may also lead to longer-term geochemical changes (i.e., increased DO content and redox potential) as well as spatial changes. Spatial changes in geochemistry would be expected in areas where rainwater infiltration is enhanced, such as areas of coarser/more permeable surface soil relative to paved areas that do not directly receive infiltrating rainwater.

Dissipation of Non-Equilibrium Geochemical Conditions

The original effects of mill-related, subsurface pH anomalies on the solubility and mobility of metals are expected to dissipate over time. Historical mill activities that may have caused pH changes in the past ceased when the mill was decommissioned in 1997-1999. As a result, subsurface conditions beneath the mill property are expected to equilibrate over time to a more neutral pH. This should lead to a corresponding reduction in the concentrations and mobility of the metal COPCs in groundwater over time.

The expected temporal trends in DO concentrations and redox conditions are less certain. Oxygen demand in the subsurface is expected to decrease over time, as there have been no releases of petroleum or other chemical products (which can increase oxygen demand) since the mill stopped operating. Additionally, the interim actions completed to date have removed significant quantities of petroleum contamination from the subsurface. A reduction in oxygen demand would be expected to lead to increased DO content and redox potential, with a corresponding reduction in metals concentrations and mobility. On the other hand, wood residue, which contributes to reducing conditions through natural degradation processes, is still present in the subsurface and may be counteracting the expected trend toward higher DO content and neutral or oxidizing redox conditions.

In summary, the geochemical conditions in the shallow water-bearing zone beneath the Upland Study Area (pH, DO content, and redox state) likely were favorable for enhancing the solubility and mobility of metals during the period of active mill operations. These conditions have likely attenuated in most areas since the mill was closed in 1997; that is, pH has likely normalized and redox has likely trended toward a more neutral or oxidizing state. Consequently, dissolved concentrations of metal COPCs in groundwater should stabilize or decrease with time.

Observed Concentration Trends

The preceding section suggests that dissipation of anomalous geochemical conditions in groundwater beneath the mill property should result in reduced dissolved metals concentrations over time. Probably due to spatial and temporal complexities in the subsurface (for example, groundwater level fluctuations, variable rainwater infiltration, and the presence of wood residue), many of the monitoring wells show fluctuating metals concentrations. Trend plots for selected metals and wells are presented in Appendix I. Despite the observed fluctuations, the existing groundwater monitoring data indicate that the general long-term trend at the majority of the wells is one of stable or decreasing metals concentrations. This general trend is expected to continue, resulting in further reductions in the extent and concentrations of metal COPCs exceeding screening levels.

8.3.6 Advective Transport of Metal COPCs to Exposure Media

The CSM for the Upland Study Area described in Section 7.0 identifies surface water as the primary potential receptor/exposure medium for the COPCs in groundwater. Surface water samples collected from Ennis Creek in August 2010 were found to contain low concentrations of arsenic, copper, manganese, and/or nickel, but none of these metals exceeded screening levels. Field measurements of pH and DO indicated that the surface water samples had neutral pH and that DO concentrations in surface water were, on average, more than five times higher than DO concentrations measured in groundwater samples. Furthermore, measurements of surface water redox potential indicated an oxidizing environment.

Groundwater field parameter data indicate that groundwater in monitoring wells near Ennis Creek tends to have higher DO concentrations and redox potential than groundwater in wells farther away from the creek. These conditions would be expected to drive dissolved metals out of solution via adsorption. Accordingly, it is likely that dissolved metals concentrations in groundwater migrating toward Ennis Creek are attenuated by adsorption in a “transition zone” (i.e., a zone where groundwater transitions from relatively oxygen-depleted conditions to more oxygen-rich conditions) before the groundwater discharges to surface water in the creek.

Adsorption of dissolved metals is similarly expected to occur at the groundwater/seawater interface near the shoreline. In the case of the groundwater/seawater transition zone, both physical mixing (through advection, diffusion, and tidal fluctuation) and geochemical reactions can attenuate dissolved metals concentrations. The potential magnitude of attenuation caused by these processes is discussed in Section 8.4.

8.3.7 Metals Fate and Transport Conclusions

Inferred historical releases of high and/or low pH solutions from pulp mill operations likely created conditions favorable for mobilizing naturally occurring metals that were present in soils beneath the mill. Metals also may have been released from metal structures and equipment at the mill through exposure to corrosive environments. The changes in subsurface geochemical conditions caused by the pulp manufacturing process are thought to be responsible for the elevated metals concentrations detected in groundwater beneath the mill property. The conclusions regarding present-day sources and advective transport of dissolved metals, and migration of dissolved metals to surface water, are summarized below.

Present-day sources of dissolved metals:

- There are no clear ongoing sources of dissolved metals in the Upland Study Area.
- Inferred historical releases of high and/or low pH solutions – believed to have been initially responsible for mobilizing naturally occurring metals in soil – have dissipated in the 15 years since mill closure, suggesting a decreased potential for present-day leaching of metals from soils to groundwater.
- Groundwater monitoring indicates that elevated metals concentrations are generally associated with reducing conditions, whereas metals concentrations are generally lower where oxidizing conditions exist; this suggests that leaching of metals is associated with reducing conditions.

Transport of dissolved metals by groundwater advection:

- Groundwater monitoring indicates that dissolved metals concentrations are generally stable or decreasing.
- Elevated metals concentrations in groundwater likely reflect localized geochemical (e.g., reducing) conditions rather than migrating plumes.
- Heterogeneous subsurface geochemical conditions limit the migration distance of dissolved metals.
- Reducing conditions associated with elevated metals concentrations are expected to diminish with time due to inflow of upgradient oxygenated groundwater and infiltration of oxygen-rich rainwater. This should result in decreased potential for dissolved metals transport.

Migration of dissolved metals to surface water:

- Groundwater monitoring suggests that a groundwater "transition zone" characterized by relatively high DO concentrations likely exists near Ennis Creek, and that dissolved metals concentrations are attenuated in this zone before groundwater discharges to the creek.
- Attenuation of dissolved metals concentrations also is expected to occur before groundwater discharges to Port Angeles Harbor, as a result of physical mixing and geochemical reactions in a groundwater/seawater transition zone near the mill property shoreline.

8.4 Attenuation of Dissolved COPCs in Groundwater Due to Tidal Mixing

For waterfront sites where groundwater cleanup levels are based on the protection of surface water, MTCA allows Ecology to approve a conditional point of compliance for groundwater that is located within the surface water, subject to certain conditions (WAC 173-340-720[8][d][i]). Rayonier will assess these conditions during the evaluation of interim action alternatives for the Upland Study Area, and will consider whether a conditional point of compliance is appropriate based on the procedures outlined in MTCA. For the purposes of this discussion, it is assumed that cleanup levels developed during the evaluation of interim action alternatives will include a conditional point of compliance for groundwater. This point of compliance would be located where groundwater beneath the Upland Study Area discharges to surface water, in accordance with

MTCA. In concept, this point would coincide with the sediment/surface water interface offshore of the Upland Study Area.

MTCA allows the use of monitoring wells to evaluate groundwater compliance at waterfront sites where a conditional point of compliance has been established (WAC 173-340-720[8][e][i]). These wells should be located between the surface water body and the source of upland groundwater contamination. MTCA also states that Ecology "*should consider an estimate of natural attenuation between the monitoring wells and the point or points where groundwater flows into the surface water in evaluating whether compliance has been achieved*." Consistent with these MTCA provisions, cleanup actions at waterfront sites in the Puget Sound area often incorporate an attenuation factor to account for the attenuation of contaminant concentrations between upland compliance wells and the point of groundwater discharge to surface water.

An attenuation factor was recently used to develop shoreline compliance levels for groundwater at the Terminal 117 (T-117) property within the Lower Duwamish Waterway Superfund Site (AECOM et al., 2010). The attenuation factor reflects contaminant attenuation that occurs as a result of tidal mixing beneath the margin of the T-117 upland. The attenuation factor for the T-117 site was developed by reviewing empirical data from 13 tidally influenced sites. The estimated attenuation factors for the 13 sites ranged from 1.3 to 135. One of the 13 sites (Boeing site) was also located within the Lower Duwamish Waterway Superfund Site; modeling was used to derive an attenuation factor of 50 for this site (CALIBRE, 2008). Based on the physical attributes of the T-117 site relative to the other 13 sites, an attenuation factor of 25 was selected for the T-117 site (AECOM et al., 2010).

The tidal mixing and attenuation of groundwater contaminants reported at the waterfront sites noted above likely also occurs beneath the margin of the Rayonier Mill Upland Study Area. The contaminant attenuation at tidally influenced sites results from surface water infiltration beneath the margin of the upland during high tide. The mixing of surface water and groundwater beneath the upland margin attenuates contaminant concentrations before the mixed waters discharge to surface water. Certain physical attributes of a site can enhance surface water infiltration and tidal mixing, leading to greater attenuation. In general, enhanced tidal mixing occurs at sites with lower (flatter) beach slopes, greater tidal ranges, greater hydraulic conductivity of shoreline soils, and lower groundwater flux from the upland due to lower hydraulic gradients and/or smaller saturated thicknesses.

The physical attributes that influence tidal mixing are generally similar for the Rayonier Mill Upland Study Area and the two Lower Duwamish Waterway sites (T-117 and Boeing) described above. Consequently, dissolved COPCs in groundwater beneath the Upland Study Area are expected to be similarly attenuated before the groundwater discharges to Port Angeles Harbor. Although shallow groundwater flow beneath the mill property is likely influenced locally by the heterogeneous nature of the subsurface in many areas, the majority of the heterogeneities (fill, concrete rubble, relic building foundations, etc.) are inland and upgradient of the nearshore/offshore zone where most of the tidal mixing and attenuation is expected to occur. Based on the locations of historical filling, construction, and demolition activities on the mill property, the subsurface conditions between shoreline monitoring wells and offshore groundwater discharge points are likely to be more homogeneous and uniform than in the upland areas where mill facilities existed. Accordingly, the

attenuation of groundwater COPCs beneath the Upland Study Area margin is not likely to be significantly affected by the heterogeneous nature of the subsurface farther inland.

9.0 CONCLUSIONS

The major conclusions of the investigations completed to date in the Upland Study Area are summarized below.

- The nature and extent of contamination within the Upland Study Area has been sufficiently defined to complete an evaluation of interim action alternatives for the Study Area.
- Metals and dioxins/furans are nearly ubiquitous in soil within the various functional use areas comprising the Upland Study Area, and do not appear to be associated with distinct source areas. Soil impacts from other COPCs such as TPH, cPAHs, and PCBs are more localized and appear to be associated with distinct source areas such as the Fuel Oil Tanks 1 and 2 areas, the Wood Mill Area, and the Machine Shop Area. The more localized distribution of these latter COPCs is likely in part a function of the heterogeneous nature of the shallow subsurface, which consists of fill material (sand, gravel, and silt) and locally contains construction debris such as concrete rubble, brick, and scrap metal, as well as relic structures such as building foundations and wood pilings.
- Groundwater monitoring conducted from August 2010 through June 2011 did not detect TPH, VOCs, pesticides, or SVOCs (except cPAHs and a few isolated detections of BEHP) in groundwater at concentrations exceeding screening levels protective of marine surface water. The monitoring data indicate that groundwater impacts are generally limited in both spatial extent and the number of COPCs exceeding screening levels. Select metals, cPAHs, PCBs, and ammonia were detected at concentrations exceeding groundwater screening levels protective of surface water in five or more monitoring wells. Dioxins/furans also were detected in many monitoring wells. However, the dioxin/furan detections in groundwater appear to be associated with suspended solids in the unfiltered groundwater samples analyzed for these constituents.
- Groundwater seeps were not observed in the intertidal zone offshore of the Upland Study Area during field reconnaissance surveys performed in 2010. Consequently, groundwater monitoring wells located along the upland shoreline were used to evaluate the potential transport of COPCs to marine surface water in Port Angeles Harbor via groundwater flow and discharge to the harbor. cPAHs were detected at concentrations exceeding the screening level protective of surface water in two shoreline wells (MW-51 and MW-54). One or more of the metals arsenic, copper, mercury, and nickel were detected at concentrations exceeding screening levels in seven shoreline wells (MW-51, MW-54, MW-55, MW-56, MW-59, MW-62, and PZ-9). Manganese was detected at concentrations exceeding the screening level in all of the shoreline wells except MW-56, and dioxins/furans were detected at concentrations exceeding the screening level in all of the shoreline wells except MW-61. The dioxin/furan detections appear to be associated with suspended solids in the unfiltered groundwater samples analyzed for these constituents.

- Attenuation of COPCs in nearshore groundwater likely occurs between the upland shoreline and the offshore point of groundwater discharge to Port Angeles Harbor (i.e., the sediment/surface water interface) due to tidal mixing beneath the upland margin.
- Based on a comparison of marine sediment analytical data from areas offshore of the mill property (Windward, in preparation) to groundwater data from adjacent upland areas, exceedances of Washington State sediment quality standards (WAC 173-204-320) in surface sediments of Port Angeles Harbor do not appear to be associated with elevated COPC concentrations in nearshore groundwater, with the possible exception of acenaphthene in the North Shoreline functional use area. In most areas of the mill property, COPC concentrations in shoreline groundwater monitoring wells are below preliminary screening levels developed by Ecology for the protection of marine sediments. The available data indicate that in general, the exceedances in marine surface sediments are not the result of groundwater flow and discharge from the mill property to Port Angeles Harbor. Furthermore, the data indicate that future discharge of groundwater from the mill property to the harbor is unlikely to result in marine sediment contamination exceeding SQS. Although the groundwater-to-sediment exposure pathway does not appear to be a significant pathway of concern in most areas of the mill property, it is a potential pathway of concern for acenaphthene in the North Shoreline functional use area. Consequently, the groundwater-to-sediment pathway will be further considered for acenaphthene in the interim action alternatives evaluation (Interim Action Report Volume III).
- Metals (arsenic, copper, manganese, and/or nickel), dioxins/furans, and ammonia were detected in one or more of the surface water samples collected from Ennis Creek and White Creek in 2010; other COPCs were not detected in the surface water samples. Of the COPCs detected, only dioxins/furans exceeded the associated screening level. The only dioxin/furan congener detected was OCDD, and the detected concentrations of OCDD in all samples were either less than, or slightly greater than, the laboratory MRLs for this constituent. The concentrations of metals, dioxins/furans, and ammonia detected in the surface water samples collected downstream of the areas of the former mill where pulp processing and support activities took place were similar to the concentrations detected upstream of these areas. This indicates that present-day surface water quality in Ennis Creek and White Creek is not impaired by the historical mill operations.
- The results of soil sampling conducted in the Upland Study Area indicate that concentrations of COPCs are generally highest in shallow soil, and that concentrations decrease with depth. The soil and groundwater analytical data suggest that PCBs and select metals may have leached from soil to groundwater in some localized areas at concentrations that could present a risk via the groundwater-to-surface water pathway. However, in general, the concentrations of PCBs and metals detected in soil beneath the mill property are relatively low, and the areas where PCBs and metals may have leached to groundwater appear to be limited in spatial extent. No significant areas of other potential COPC leaching to groundwater (i.e., TPH, VOCs, SVOCs, dioxins/furans, or pesticides) were identified in soil.
- Historical leaks in the mill's former underground network of wastewater drain piping that existed in the areas of the Acid Plant, Bleach Plant, and Machine Room are a potential source of the ammonia detected in groundwater in the vicinity of the former drain piping. However, concentrations of other COPCs detected in soil and groundwater in the vicinity of the

wastewater drain piping are generally consistent with, or less than, concentrations that have been detected in other former mill operations areas, suggesting that the wastewater piping was likely not a source of these other COPCs.

- The results of soil sampling conducted in previous interim action areas during the 2010-2011 Supplemental Upland Investigation indicate that the interim actions were successful in removing a substantial volume of contaminated soil from the Upland Study Area. The sampling results also indicate that residual soil contamination remains beyond the limits of previous soil excavation in some interim action areas, as follows:

  - Wood Mill: Residual contamination consisting of TPH, cPAHs, and PCBs was detected in soil at concentrations exceeding the respective screening levels to the east of the Wood Mill interim action area. Based on the results of groundwater monitoring conducted downgradient of the Wood Mill interim action area, the residual soil contamination in this area does not appear to be a significant source of COPCs to groundwater. Select metals also are present in soil in the Wood Mill area at concentrations exceeding screening levels. However, because metals are nearly ubiquitous within the former mill operations areas, the metals detected in the Wood Mill interim action area are not necessarily associated with the former Wood Mill. With the possible exception of copper, the metals detected in the Wood Mill area soil do not appear to be a significant source of metals to groundwater.

  - Machine Shop: Residual contamination consisting of TPH and PCBs was detected in soil at concentrations exceeding the respective screening levels to the southeast and west of the Machine Shop interim action area. Based on the results of groundwater monitoring conducted downgradient of the Machine Shop interim action area, the residual soil contamination in this area does not appear to be a significant source of COPCs to groundwater. Select metals also are present in soil in the Machine Shop area at concentrations exceeding screening levels. However, because metals are nearly ubiquitous within the former mill operations areas, the metals detected in the Machine Shop interim action area are not necessarily associated with the former Machine Shop. The metals detected in the Machine Shop area soil do not appear to be a significant source of metals to groundwater.

  - Fuel Oil Tank No. 2 and Hog Fuel Pile: Residual contamination consisting of TPH, cPAHs, PCP, and PCBs was detected in soil at concentrations exceeding the respective screening levels near the Fuel Oil Tank No. 2 and Hog Fuel Pile interim action areas. Based on the results of groundwater monitoring conducted downgradient of the Fuel Oil Tank No. 2 and Hog Fuel Pile interim action areas, the residual soil contamination in these areas does not appear to be a significant source of TPH, PCP, or PCBs to groundwater. The residual soil contamination may be a source of cPAHs to groundwater at some locations. Select metals also are present in soil in the Fuel Oil Tank No. 2 and Hog Fuel Pile areas at concentrations exceeding screening levels. However, because metals are nearly ubiquitous within the former mill operations areas, the metals detected in the Fuel Oil Tank No. 2 and Hog Fuel Pile interim action areas are not necessarily associated with the former Fuel Oil Tank No. 2 and Hog Fuel Pile. The metals detected in the Fuel Oil Tank No. 2 and Hog Fuel Pile area soil (manganese, copper, lead, mercury, and nickel) may be a source of metals to groundwater at some locations.

- Finishing Room: Residual contamination consisting of PCBs was detected in soil at concentrations exceeding the associated screening level to the north of the Finishing Room interim action area (location MW-62). Based on the results of groundwater monitoring conducted at well MW-62, this residual soil contamination does not appear to be a significant source of PCBs to groundwater.
- Fuel Oil Tank No. 1: Residual contamination consisting of TPH, cPAHs, PCP, and PCBs was detected in soil at concentrations exceeding the respective screening levels in the vicinity of the Fuel Oil Tank No. 1 interim action area. Based on the results of groundwater monitoring conducted downgradient of the Fuel Oil Tank No. 1 interim action area, the residual soil contamination in this area does not appear to be a significant source of COPCs to groundwater. Lead also is present in soil in the Fuel Oil Tank No. 1 area at concentrations exceeding screening levels. However, because lead and other metals are nearly ubiquitous within the former mill operations areas, the lead detected in the Fuel Oil Tank No. 1 interim action area is not necessarily associated with the former Fuel Oil Tank No. 1. The lead detected in the Fuel Oil Tank No. 1 area soil does not appear to be a significant source of lead to groundwater.

- The soil and groundwater sampling conducted during the 2010-2011 Supplemental Upland Investigation to evaluate the potential presence of chlorinated DNAPL in the vicinity of former monitoring well MW-13 found no evidence of DNAPL.
- Inferred historical releases of high and/or low pH solutions from pulp mill operations likely created conditions favorable for mobilizing naturally occurring metals present in soil beneath the mill. Small quantities of metals also may have been released by the corrosion of metal infrastructure at the mill. Changes in subsurface geochemical conditions caused by the pulp manufacturing process are thought to be the primary mechanism responsible for the elevated metals concentrations detected in groundwater beneath the mill property.
- Reducing conditions associated with elevated metals concentrations in groundwater are expected to diminish with time due to inflow of upgradient oxygenated groundwater and infiltration of oxygen-rich rainwater. This should decrease the potential for transport of dissolved metals in groundwater over time.

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TABLES

GeoEngineers

Table 1

Previous Investigation Reports for Upland Study Area

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Author and Date	Title
Landau 1990	Soil and Ground Water Investigation Fuel Tank No. 2 Project Port Angeles Pulp Mill. ITT Rayonier Inc., Port Angeles, WA, October 1990. Landau Associates, Edmonds, WA.
Landau 1991	Review Draft Report, Oil Contamination Characterization, Pulp Mill Finishing Room Area, ITT Rayonier Inc., Port Angeles, Washington, February 26, 1991.
HLA 1993	Draft Field Investigation Report, Quantitative Environmental Survey Program, ITT Rayonier Pulp Division, Port Angeles, Washington, October 28, 1993.
Landau 1993	Hog Fuel Pile Contamination Investigation, ITT Rayonier, Port Angeles, Washington, August 5, 1993.
Foster Wheeler 1997	Current Situation/Site Conceptual Model Report for Rayonier, Port Angeles Mill Site, Mt. Pleasant Road Landfill and 13th and M Street Landfill. Prepared for Rayonier, Port Angeles, Washington, Foster Wheeler Environmental Corporation, Bellevue, WA.
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Landau 1998a	Rayonier Port Angeles Mill Groundwater Monitoring Project. Prepared for Rayonier Inc., October 19, 1998. Landau Associates, Inc., Edmonds, WA.
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Landau 2001b	Hogged Fuel Pile Supplemental Volatile Organic Compound and TPH Analysis, Rayonier Port Angeles Mill, Port Angeles, Washington. Letter Report submitted to Mr. Jack Anderson, Rayonier Inc., June 1, 2001.
Landau 2001c	Groundwater Monitoring Report, Rayonier Inc., Port Angeles Mill Site, Port Angeles, Washington. Prepared for Rayonier Inc. Landau Associates, Edmonds, WA.
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Landau 2002	August 2001 Groundwater Monitoring Report, Former Rayonier Mill Site, Port Angeles, Washington. Prepared for Rayonier Inc., February 19 2002. Landau Associates, Edmonds, WA.
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Landau 2003a	December 2002 Groundwater Monitoring Report, Former Rayonier Mill Site, Port Angeles, Washington. Prepared for Rayonier Inc. February 5, 2003. Landau Associates, Edmonds, WA.
Landau 2003b	Summary of Construction Observations Spent Sulfite Liquor Lagoon (SSL) Excavation, Rayonier Inc., Former Pulp Mill Site, Port Angeles, Washington. Letter Report submitted to Mr. Jack Anderson, Rayonier Inc., January 16, 2003. Landau Associates, Edmonds, WA.
Integral 2004	Management Plans for the Remedial Investigation – Feasibility Study of the Uplands Environment at the Former Rayonier Pulp Mill Site, Port Angeles, Washington. Prepared for Rayonier, Jacksonville, FL. Integral Consulting, Inc., Mercer Island, WA.
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Malcolm Pirnie 2005b	Evaluation of the Sources of Dioxins and Furans in Soils Near the Former Rayonier Mill Site, Port Angeles, Washington. Prepared for Rayonier, Jacksonville, FL. Malcolm Pirnie, Inc., Seattle, WA.
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Table 2A

Supplemental Upland Investigation Sampling and Analytical Testing Summary – Soil

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	SVOCs (not including PAHs & Chlorophenols)	VOCs	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Diesel Extended	Total Petroleum Hydrocarbons - Gasoline Range	Select Metals	Select Metals	Mercury	Selenium	Select Toxicity Characteristic Leaching Procedure Metals	PCB Aroclors	Grain Size (Sieve Analysis)	Bulk Density	Hydraulic Conductivity	Total Organic Carbon
					EPA 1613	SW8270	SW8260	SW8270DSIM	SW8041	NWTPH-DX	NWTPH-GX	EPA 200.8	SW6010B	SW7471A	AA, Furnace Technique	6010B-TCLP	SW8082	ASTM D422	ASTM C39	ASTM D-5084/D-2434	SW9060M
Phase 2 (October-November 2010)	GWG-1	GWG-1-2-3.5	2 to 3.5	11/03/10	X			X				X	X	X			X				X
		GWG-1-5-6.5	5 to 6.5	11/03/10	X			X				X	X	X			X				X
		GWG-1-7.5-9	7.5 to 9	11/03/10	X			X				X	X	X			X				X
		GWG-1-10-11.5	10 to 11.5	11/04/10	X			X				X	X	X			X				
		GWG-1-15-16.5	15 to 16.5	11/04/10	X			X				X	X	X			X				
		GWG-1-20-21.5	20 to 21.5	11/04/10	X			X				X	X	X			X				
		GWG-1-20.75-21	20.75 to 21	11/04/10																X	
	GWG-4	GWG-4-8-9.5	8 to 9.5	11/01/10						X							X				X
		GWG-4-10-11.5	10 to 11.5	11/02/10						X							X	X			
		GWG-4-15-16.5	15 to 16.5	11/02/10						X							X				
		GWG-4-20-21.5	20 to 21.5	11/02/10						X							X				
		GWG-4-26-27.5	26 to 27.5	11/02/10						X							X				
		GWG-4-30-31.5	30 to 31.5	11/02/10						X							X				
		GWG-4-31-31.25	31 to 31.25	11/02/10																X	
	GWG-5	GWG-5-2-3.5	2 to 3.5	11/03/10		X		X	X			X	X	X	X		X				X
		GWG-5-5-6.5	5 to 6.5	11/03/10		X		X	X			X	X	X	X		X				X
	GWG-5A	GWG-5A-5-6.5	5 to 6.5	11/04/10		X		X	X			X	X	X	X		X				X
		GWG-5A-10-11.5	10 to 11.5	11/04/10		X		X	X			X	X	X	X		X				X
		GWG-5A-15-16.5	15 to 16.5	11/05/10		X		X	X			X	X	X	X		X				
		GWG-5A-20-21.5	20 to 21.5	11/05/10		X		X	X			X	X	X	X		X				
		GWG-5A-24-25.5	24 to 25.5	11/05/10		X		X	X			X	X	X	X		X				
	GWG-6	GWG-6-2-3.5	2 to 3.5	11/02/10		X		X	X	X		X	X	X	X		X				X
		GWG-6-5-6.5	5 to 6.5	11/02/10		X		X	X	X		X	X	X	X		X				X
		GWG-6-10-11.5	10 to 11.5	11/02/10		X		X	X	X		X	X	X	X		X				X
	GWG-7	GWG-7-2-3.5	2 to 3.5	11/02/10		X		X	X	X		X	X	X	X		X				X
		GWG-7-5-6.5	5 to 6.5	11/02/10		X		X	X	X		X	X	X	X		X				X
		GWG-7-7-8.5	7 to 8.5	11/02/10		X		X	X	X		X	X	X	X		X				X
	GWG-8	GWG-8-2-3.5	2 to 3.5	10/28/10		X		X	X	X		X	X	X	X		X				X
		GWG-8-10-11.5	10 to 11.5	10/28/10		X		X	X	X		X	X	X	X		X	X			X
		GWG-8-15-16.5	15 to 16.5	10/28/10		X		X	X	X		X	X	X	X		X	X			X
	MW-60	MW-60-2-3.5	2 to 3.5	10/19/10		X		X	X	X		X					X				
		MW-60-10-11.5	10 to 11.5	10/19/10		X		X	X	X		X					X				
		MW-60-15-16.5	15 to 16.5	10/19/10		X		X	X	X		X					X				
		MW-60-20-20.75	20 to 20.75	10/19/10		X		X	X	X		X					X				
		MW-60-23-24.4	23 to 24.4	10/19/10		X		X	X	X		X					X				
		MW-60-24-24.25	24 to 24.25	10/19/10																X	

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	SVOCs (not including PAHs & Chlorophenols)	VOCs	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Diesel Extended	Total Petroleum Hydrocarbons - Gasoline Range	Select Metals	Select Metals	Mercury	Selenium	Select Toxicity Characteristic Leaching Procedure Metals	PCB Aroclors	Grain Size (Sieve Analysis)	Bulk Density	Hydraulic Conductivity	Total Organic Carbon
					EPA 1613	SW8270	SW8260	SW8270DSIM	SW8041	NWTPH-DX	NWTPH-GX	EPA 200.8	SW6010B	SW7471A	AA, Furnace Technique	6010B-TCLP	SW8082	ASTM D422	ASTM C39	ASTM D-5084/D-2434	SW9060M
Phase 2 (October-November 2010) (Continued)	MW-61	MW-61-5-6.5	5 to 6.5	10/19/10		X		X	X	X		X					X				
		MW-61-10-11.5	10 to 11.5	10/19/10		X		X	X	X		X					X				
		MW-61-15-16.5	15 to 16.5	10/19/10		X		X	X	X		X					X				
		MW-61-20.21.25	20 to 21.25	10/19/10		X		X	X	X		X					X				
	MW-62	MW-62-2-3.5	2 to 3.5	10/20/10		X		X	X	X							X	X			X
		MW-62-5-6.5	5 to 6.5	10/20/10		X		X	X	X							X				X
		MW-62-10-11.5	10 to 11.5	10/20/10		X		X	X	X							X				X
		MW-62-15-16.5	15 to 16.5	10/20/10		X		X	X	X							X	X			
		MW-62-20-21.5	20 to 21.25	10/20/10		X		X	X	X							X				
		MW-62-25-26.5	25 to 26.5	10/20/10		X		X	X	X							X				
		MW-62-30-31.5	30 to 31.5	10/20/10													X				
		MW-62-35-36.5	35 to 36.5	10/20/10													X				
	MW-63	MW-63-23-24.5	23 to 24.5	10/21/10			X														
		MW-63-26-27.5	26 to 27.5	10/21/10			X														
		MW-63-27.25-28	27.25 to 28	10/21/10																X	
	MW-64	MW-64-2-3.5	2 to 3.5	10/18/10	X							X	X	X	X						
		MW-64-10-11.5	10 to 11.5	10/18/10	X							X	X	X	X						
		MW-64-20-20.66	20 to 20.66	10/18/10								X	X	X	X						
		MW-64-21.25-21.5	21.25 to 21.5	10/18/10																X	
	SSB-1	SSB-1-7-8.5	7 to 8.5	10/25/10	X	X		X	X			X	X	X	X		X				
		SSB-1-10-11.5	10 to 11.5	10/25/10	X	X		X	X	X		X	X	X	X		X				
		SSB-1-15-16.5	15 to 16.5	10/25/10	X	X		X	X	X		X	X	X	X		X				
		SSB-1-20-21.5	20 to 21.5	10/25/10	X																
		SSB-1-25-26.5	25 to 26.5	10/25/10	X	X		X	X	X		X	X	X	X		X				
		SSB-1-26.25-26.5	26.25 to 26.5	10/25/10																X	
	SSB-2	SSB-2-2-3.5	2 to 3.5	10/21/10		X		X	X	X		X	X	X	X		X				
		SSB-2-5-6.5	5 to 6.5	10/21/10		X		X	X	X		X	X	X	X		X				
		SSB-2-10-11.5	10 to 11.5	10/21/10		X		X	X	X		X	X	X	X		X				
		SSB-2-15-16.5	15 to 16.5	10/21/10		X		X	X	X		X	X	X	X		X				
		SSB-2-20-20.5	20 to 20.5	10/21/10		X		X	X	X		X	X	X	X		X				
	SSB-3	SSB-3-2-3.5	2 to 3.5	10/22/10		X		X	X												
		SSB-3-10-11.5	10 to 11.5	10/22/10		X		X	X												
		SSB-3-15-16.5	15 to 16.5	10/22/10		X		X	X												
		SSB-3-20-21.5	20 to 21.5	10/22/10		X		X	X												
		SSB-3-25-26.5	25 to 26.5	10/22/10		X		X	X												
		SSB-3-27-28.5	27 to 28.5	10/22/10		X		X	X												
		SSB-3-30.5-30.75	30.5 to 30.75	10/22/10																X	

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	SVOCs (not including PAHs & Chlorophenols)	VOCs	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Diesel Extended	Total Petroleum Hydrocarbons - Gasoline Range	Select Metals	Select Metals	Mercury	Selenium	Select Toxicity Characteristic Leaching Procedure Metals	PCB Aroclors	Grain Size (Sieve Analysis)	Bulk Density	Hydraulic Conductivity	Total Organic Carbon
					EPA 1613	SW8270	SW8260	SW8270DSIM	SW8041	NWTPH-DX	NWTPH-GX	EPA 200.8	SW6010B	SW7471A	AA, Furnace Technique	6010B-TCLP	SW8082	ASTM D422	ASTM C39	ASTM D-5084/D-2434	SW9060M
Phase 2 (October-November 2010) (Continued)	SSB-4	SSB-4-5-6.5	5 to 6.5	10/22/10								X	X	X	X		X				
		SSB-4-10-11.5	10 to 11.5	10/22/10								X	X	X	X		X				
		SSB-4-15-16.5	15 to 16.5	10/22/10								X	X	X	X		X				
		SSB-4-21-22.33	21 to 22.33	10/22/10								X	X	X	X		X				
		SSB-4-22-22.25	22 to 22.25	10/22/10																X	
	SSB-5	SSB-5-2-3.5	2 to 3.5	10/26/10													X				X
		SSB-5-5-6.5	5 to 6.5	10/26/10													X	X			X
		SSB-5-10-11.5	10 to 11.5	10/26/10													X	X			
		SSB-5-15-16.5	15 to 16.5	10/26/10													X				
		SSB-5-20-21.5	20 to 21.5	10/26/10													X				X
		SSB-5-30-31.5	30 to 31.5	10/26/10														X			
	SSB-6	SSB-6-5-6.5	5 to 6.5	10/26/10													X				X
		SSB-6-10-11.5	10 to 11.5	10/26/10													X				X
		SSB-6-15-16.5	15 to 16.5	11/01/10													X				X
		SSB-6-20-21.5	20 to 21.5	11/01/10													X	X			
		SSB-6-25-26.5	25 to 26.5	11/01/10													X				
		SSB-6-28-28.75	28 to 28.75	11/01/10													X				
		SSB-6-28-29	28 to 29	11/01/10													X	X			
		SSB-6-28.5-28.75	28.5 to 28.75	11/01/10																X	
	SSB-7	SSB-7-2-3.5	2 to 3.5	10/26/10	X	X		X	X	X		X	X	X	X		X				
		SSB-7-10-11.5	10 to 11.5	10/26/10	X	X		X	X	X		X	X	X	X		X				
		SSB-7-20-21.5	20 to 21.5	10/26/10	X	X		X	X	X		X	X	X	X		X				
		SSB-7-25-26.5	25 to 26.5	10/26/10	X	X		X	X	X		X	X	X	X		X				
		SSB-7-30-30.75	30 to 31.75	10/26/10	X	X		X	X	X		X	X	X	X		X				
		SSB-7-30.5-30.75	30.5 to 30.75	10/26/10																X	
	SSB-8	SSB-8-2-3.5	2 to 3.5	10/25/10								X	X	X	X			X			X
		SSB-8-5-6.5	5 to 6.5	10/25/10								X	X	X	X						X
		SSB-8-10-11.5	10 to 11.5	10/25/10								X	X	X	X			X			
		SSB-8-15-16.5	15 to 16.5	10/25/10								X	X	X	X						X
		SSB-8-20-21.5	20 to 21.25	10/25/10								X	X	X	X						
		SSB-8-25-26.33	25 to 26.33	10/25/10								X	X	X	X						
		SSB-8-30.5-30.75	30.5 to 30.75	10/25/10																X	
		SSB-8-30-31	30 to 31	10/25/10														X			
	SSB-9	SSB-9-2-3.5	2 to 3.5	10/27/10								X	X	X	X						X
		SSB-9-5-6.5	5 to 6.5	10/27/10								X	X	X	X			X			X
		SSB-9-10-11.5	10 to 11.5	10/27/10								X	X	X	X						
		SSB-9-15-16.5	15 to 16.5	10/27/10								X	X	X	X						
		SSB-9-20-21.5	20 to 21.25	10/27/10								X	X	X	X			X			X
		SSB-9-25-26	25 to 26	10/27/10								X	X								
		SSB-9-30-31.5	30 to 31.5	10/27/10								X	X					X			
	SSB-10	SSB-10-2-3.5	2 to 3.5	10/28/10	X	X		X	X			X	X	X	X		X				X
		SSB-10-5-6.5	5 to 6.5	10/28/10	X	X		X	X			X	X	X	X		X	X			X
		SSB-10-10-11.5	10 to 11.5	10/28/10	X	X		X	X			X	X	X	X		X				
		SSB-10-15-16.5	15 to 16.5	10/28/10	X	X		X	X			X	X	X	X		X	X			X
		SSB-10-20-21.5	20 to 21.5	10/28/10	X	X		X	X			X	X	X	X		X				
		SSB-10-25-26.5	25 to 26.5	10/28/10														X			
		SSB-10-26.25-26.5	26.25 to 26.5	10/28/10																X	

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	SVOCs (not including PAHs & Chlorophenols)	VOCs	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Diesel Extended	Total Petroleum Hydrocarbons - Gasoline Range	Select Metals	Select Metals	Mercury	Selenium	Select Toxicity Characteristic Leaching Procedure Metals	PCB Aroclors	Grain Size (Sieve Analysis)	Bulk Density	Hydraulic Conductivity	Total Organic Carbon
					EPA 1613	SW8270	SW8260	SW8270DSIM	SW8041	NWTPH-DX	NWTPH-GX	EPA 200.8	SW6010B	SW7471A	AA, Furnace Technique	6010B-TCLP	SW8082	ASTM D422	ASTM C39	ASTM D-5084/D-2434	SW9060M
Phase 3 (January 2011)	TP-01	TP-01-2'	2	1/04/11		X		X	X	X		X					X				X
		TP-01-8'	8	1/04/11		X		X	X	X		X					X	X			X
		TP-01-10'	10	1/04/11														X			X
	TP-02	TP-02-2'	2	1/04/11		X		X	X	X		X	X	X	X		X				X
		TP-02-8'	8	1/04/11		X		X	X	X		X	X	X	X		X	X	X		X
		TP-02-9'	9	1/04/11														X	X		X
	TP-03	TP-03-2'	2	1/04/11		X		X	X	X		X					X				
		TP-03-4'	4	1/04/11		X		X	X	X		X					X				
		TP-03-7'	7	1/04/11		X		X	X	X		X					X				
	TP-04	TP-04-2'	2	1/05/11		X		X	X	X		X					X				
		TP-04-7'	7	1/05/11		X		X	X	X		X					X				
	TP-05	TP-05-2'	2	1/05/11		X		X	X	X		X	X	X	X		X				X
		TP-05-6'	6	1/05/11		X		X	X	X		X	X	X	X	X	X	X			X
		TP-05-8'	8	1/05/11														X			X
	TP-06	TP-06-3'	3	1/05/11		X		X	X	X		X					X				
		TP-06-7'	7	1/05/11		X		X	X	X		X					X				
	TP-07	TP-07-2'	2	1/05/11		X		X	X	X		X	X	X	X		X				X
		TP-07-6'	6	1/05/11		X		X	X	X		X	X	X	X	X	X	X	X		X
		TP-07-8'	8	1/05/11														X	X		X
	TP-08	TP-08-2'	2	1/05/11		X		X	X	X		X				X	X				
		TP-08-5'	5	1/05/11		X		X	X	X		X					X				
	TP-09	TP-09-2'	2	1/06/11		X		X	X	X											X
		TP-09-3'	3	1/06/11		X		X	X	X								X			X
		TP-09-5'	5	1/06/11														X			X
	TP-10	TP-10-2'	2	1/06/11		X		X	X	X		X				X	X				
		TP-10-3'	3	1/06/11		X		X	X	X		X					X				
	TP-11	TP-11-2'	2	1/07/11		X		X	X	X		X					X				X
		TP-11-5'	5	1/07/11		X		X	X	X		X				X	X	X	X		X
		TP-11-7'	7	1/07/11														X	X		X
	TP-12	TP-12-2'	2	1/04/11		X		X	X	X		X				X	X				
		TP-12-4'	4	1/04/11		X		X	X	X		X					X				
	TP-14	TP-14-2'	2	1/06/11		X		X	X	X		X				X	X				
		TP-14-3'	3	1/06/11		X		X	X	X		X				X	X				
		TP-14-5'	5	1/06/11		X		X	X	X		X					X				
	TP-15	TP-15-2'	2	1/06/11		X		X	X	X		X				X	X				X
		TP-15-4'	4	1/06/11		X		X	X	X		X				X	X	X			X
		TP-15-5'	5	1/06/11														X			X
	TP-16	TP-16-2'	2	1/06/11		X		X	X	X		X					X				
		TP-16-5'	5	1/06/11		X		X	X	X		X					X				
	TP-21	TP-21-3'	3	1/07/11		X		X	X	X		X					X				

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	SVOCs (not including PAHs & Chlorophenols)	VOCs	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Diesel Extended	Total Petroleum Hydrocarbons - Gasoline Range	Select Metals	Select Metals	Mercury	Selenium	Select Toxicity Characteristic Leaching Procedure Metals	PCB Aroclors	Grain Size (Sieve Analysis)	Bulk Density	Hydraulic Conductivity	Total Organic Carbon
					EPA 1613	SW8270	SW8260	SW8270DSIM	SW8041	NWTPH-DX	NWTPH-GX	EPA 200.8	SW6010B	SW7471A	AA, Furnace Technique	6010B-TCLP	SW8082	ASTM D422	ASTM C39	ASTM D-5084/D-2434	SW9060M
Phase 4 (March - May 2011)	MW-65	MW-65-5-6.5	5 to 6.5	3/10/11	X			X	X	X		X	X	X	X		X				
		MW-65-15-16.5	15 to 16.5	3/10/11	X			X	X	X		X	X	X	X		X				
	MW-66	MW-66-2.5-4	2.5 to 4	3/09/11	X			X	X			X	X	X	X		X				
		MW-66-15-16.5	15 to 16.5	3/09/11	X			X	X			X	X	X	X		X				
		MW-66-30-30.5	30 to 30.5	3/09/11								X	X	X	X						
	MW-67	MW-67-2-3.5	2 to 3.5	3/09/11	X			X	X	X		X	X	X	X						
		MW-67-15-16.5	15 to 16.5	3/09/11	X			X	X	X		X	X	X	X						
		MW-67-25-25.5	25 to 25.5	3/09/11								X	X	X	X						
	MW-68	MW68-5.5-6	5.5 to 6	5/4/11		X	X	X		X		X									
		MW68-13-14	13 to 14	5/4/11		X	X	X		X		X									
		MW-68-37	37	5/4/11								X						X			
		MW-68-39	39	5/4/11								X						X			
		MW-68-43	43	5/4/11								X						X			
		MW-68-45	45	5/4/11								X						X			
		MW-68-50	50	5/4/11								X						X			
		MW-68-55	55	5/4/11		X	X	X	X			X		X							
		MW-68-60	60	5/4/11														X			
	MW-69	MW69-2-3.5	2 to 3.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-5-6.5	5 to 6.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-10-11.5	10 to 11.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-15-16.5	15 to 16.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-20-21.5	20 to 21.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-25-26.5	25 to 26.5	5/6/11		X		X	X	X	X	X	X	X			X				
		MW69-29-30	29 to 30	5/6/11		X		X	X	X	X	X	X	X			X				
	MW-70	MW70-2-3.5	2 to 3.5	5/6/11		X		X	X	X	X	X	X	X							
		MW70-5-6.5	5 to 6.5	5/6/11		X		X	X	X	X	X	X	X							
		MW70-10-11.5	10 to 11.5	5/6/11		X		X	X	X	X	X	X	X							
		MW70-15-16.5	15 to 16.5	5/6/11		X		X	X	X	X	X	X	X							
		MW70-20-21.5	20 to 21.5	5/6/11		X		X	X	X	X	X	X	X							
		MW70-25-26.5	25 to 26.5	5/6/11								X	X	X							

Notes:

SVOCs = Semivolatile organic compounds

PAHs = Polycyclic aromatic hydrocarbons

VOCs = Volatile organic compounds

PCB = Polychlorinated biphenyl

Table 2B

Previous Investigations Sampling and Analytical Testing Summary – Soil

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	Metals	PAHs	Organochlorinated Pesticides	PCB Aroclors	SVOCs	Total Petroleum Hydrocarbons	VOCs
AP01	AP01SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
AP02	AP02SS	0 to 0.25	11/13/1997	X	X	X	X	X	X		X
AP03	AP03SS	0 to 0.25	11/13/1997	X	X	X	X	X	X		X
AP03	E2300325-001	0 to 0.25	5/16/2003	X							
AP03	E2300325-001RE	0 to 0.25	5/16/2003	X							
AP03	K2303762-003	0 to 0.25	5/16/2003		X						
AP03	E2300325-002	0.25 to 6	5/16/2003	X							
AP03	K2303762-004	0.25 to 6	5/16/2003		X						
AP04	AP04SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
AP20	K2303762-001	0 to 0.25	5/16/2003		X						
AP20	K2303762-014	0 to 0.25	5/16/2003		X						
AP20	K2303762-002	0.25 to 9	5/16/2003		X						
B-11	LANDAUB-11-2.5	2.5 to 2.5	9/25/1990							X	
B-11	LANDAUB-11-7.5	7.5 to 7.5	9/25/1990							X	
B-12	LANDAUB-12-7.5	7.5 to 7.5	9/25/1990							X	
B-13	LANDAUB-13-7.5	7.5 to 7.5	9/24/1990							X	
B-14	LANDAUB-14-7.5	7.5 to 7.5	9/25/1990							X	
B-15	LANDAUB-15-7.5	7.5 to 7.5	9/25/1990							X	
B-17	LANDAUB-17-5.0	5 to 5	2/20/1991							X	
B-17	LANDAUB-17-7.5	7.5 to 7.5	2/20/1991							X	
B-21	LANDAUB-21-2.5	2.5 to 2.5	2/21/1991							X	X
B-21	LANDAUB-21-5.0	5 to 5	2/21/1991							X	X
B-23	LANDAUB-23-5.0	5 to 5	2/21/1991							X	X
B-23	LANDAUB-23	7.5 to 7.5	2/21/1991							X	
B-9	LANDAUB-9	10 to 10	9/24/1990							X	
BL01	BL01SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
BL02	BL02SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
BL03	BL03SS	0 to 0.25	11/14/1997	X	X	X	X	X	X		X
BL20	E2300322-001	0 to 0.25	5/15/2003	X							
BL20	E2300322-002	0.25 to 3.5	5/15/2003	X							
BL20	K2303678-002	0.25 to 3.5	5/15/2003		X	X	X		X		X
BP01	BP01SS	0 to 0.25	11/11/1997		X	X	X	X	X		X
BP02	BP02SS	0 to 0.25	11/11/1997		X	X	X	X	X		X
BP03	BP03SS	0 to 0.25	11/11/1997		X	X	X	X	X		X
BP04	BP04SS	0 to 0.25	11/11/1997	X	X	X	X	X	X		X
BP20	E2300298-011	0 to 0.25	5/13/2003	X							
BP20	E2300298-011RE	0 to 0.25	5/13/2003	X							
BP20	E2300298-012	0.25 to 8	5/13/2003	X							
BP20	K2303593-014	0.25 to 8	5/13/2003		X	X	X		X		X
BR01	BR01-1SS	1 to 2	11/20/1997		X	X	X	X	X		X
BR01	BR01-2SB	2 to 3	11/20/1997		X						
BR01	BR01-3SB	3 to 4	11/21/1997	X	X	X	X	X	X		X
BS01	BS01-SS	0 to 0.25	11/21/1997		X	X	X	X	X		X
BS02	BS02-SS	0 to 0.25	11/21/1997		X	X	X	X	X		X
BY01	BY01-0SS	0 to 2	11/17/1997		X	X	X	X	X		X
BY01	BY01-2SB	2 to 4	11/17/1997		X	X	X	X	X		X
BY02	K2303687-001	0 to 0.25	5/14/2003		X						
BY02	K2303687-001D	0 to 0.25	5/14/2003		X						
BY02	BY02-0SS	0 to 2	11/17/1997		X	X	X	X	X		X
BY02	K2303687-002	0.25 to 8.5	5/14/2003		X						
BY02	BY02-2SB	2 to 4	11/17/1997		X	X	X	X	X		X
BY03	BY03-0SS	0 to 2	11/17/1997		X	X	X	X	X		X
BY03	BY03-2SB	2 to 4	11/17/1997		X	X	X	X	X		X
BY04	BY04-0SS	0 to 2	11/17/1997		X	X	X	X	X		X
BY04	BY04-2SB	2 to 4	11/17/1997		X	X	X	X	X		X
BY05	BY05-0SS	0 to 2	11/17/1997		X	X	X	X	X		X
BY05	BY05-2SB	2 to 4	11/17/1997		X	X	X	X	X		X
BY05	BY05-4SB	4 to 6	11/17/1997		X	X	X	X	X		X
BY05	BY05-6SB	6 to 8	11/17/1997		X	X	X	X	X		X
BY05	BY05-8SB	8 to 10	11/17/1997		X	X	X	X	X		X
BY20	K2303678-003	0 to 0.25	5/15/2003		X						
BY20	K2303678-004	0.25 to 8.5	5/15/2003		X						
CD01	CD01-0SS	0 to 2	11/19/1997		X	X	X	X	X		X
CD01	CD01-2SB	2 to 4	11/19/1997		X	X	X	X	X		X
CD02	CD02-0SS	0 to 2	11/19/1997		X	X	X	X	X		X

Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	Metals	PAHs	Organochlorinated Pesticides	PCB Aroclors	SVOCs	Total Petroleum Hydrocarbons	VOCs
CD02	CD02-2SB	2 to 4	11/19/1997		X	X	X	X	X		X
CD02	CD02-4SB	4 to 6	11/19/1997		X	X	X	X	X		X
CD02	CD02-6SB	6 to 8	11/19/1997		X	X	X	X	X		X
CD03	CD03-0SS	0 to 2	11/19/1997		X	X	X	X	X		X
CD03	CD03-3SB	2 to 4	11/19/1997		X	X	X	X	X		X
CS20	E2300325-007	0 to 0.25	5/19/2003	X							
CS20	E2300325-008	0.25 to 9	5/19/2003	X							
CS20	K2303762-017	0.25 to 9	5/19/2003		X	X	X		X		X
DB01	DB01SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
DB02	DB02SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
DB02	K2303762-005	0 to 0.25	5/16/2003		X						
DB21	E2300325-009	0 to 0.25	5/19/2003	X							
DB21	E2300325-009RE	0 to 0.25	5/19/2003	X							
DB21	E2300325-010	0.25 to 11	5/19/2003	X							
DB21	K2303762-019	0.25 to 11	5/19/2003		X	X	X		X		X
DD02	97474373	0 to 0.25	11/17/1997	X		X	X		X		
DD02	97474373-1	0 to 0.25	11/17/1997	X							
DD02	97474373-2	0 to 0.25	11/17/1997	X							
DD02	97474373-3	0 to 0.25	11/17/1997	X							
DK20	E2300322-005	0 to 0.25	5/15/2003	X							
DK20	K2303678-007	0 to 0.25	5/15/2003							X	
DK20	K2303687-020	0 to 0.25	5/15/2003							X	
DK20	E2300322-006	0.25 to 7	5/15/2003	X							
DK20	K2303678-008	0.25 to 7	5/15/2003		X	X	X		X	X	X
EC030	RY03-0209	0 to 0.33	5/7/2003	X	X						
EC030	K2303509-008	0 to 0.5	5/7/2003		X						
EC-3	K2204294-003	0 to 1	6/25/2002					X		X	
EC-3	KWG0204679-1	0 to 1	6/25/2002							X	
EC-5	K2204294-007	0 to 1	6/25/2002					X		X	
EC-5	K2204294-008	0 to 1	6/25/2002					X		X	
EC-7	K2204294-012	0 to 1	6/25/2002					X		X	
EC-11	K2204294-020	0 to 1	6/25/2002					X		X	
EC-11	KWG0204679-2	0 to 1	6/25/2002							X	
EC-15	K2204294-030	0 to 1	6/25/2002					X		X	
EC-15	K2205252-001	0 to 1	6/25/2002					X		X	
EC-15	K2204294-031	1 to 2	6/25/2002					X		X	
EC-15	K2205252-002	1 to 2	6/25/2002					X		X	
EC-17	K2204294-035	0 to 1	6/25/2002					X		X	
EC-18	K2204294-036	1 to 2	6/25/2002					X		X	
EC-18	K2204294-039	2 to 3	6/25/2002					X		X	
EC-19	K2204294-040	0 to 1	6/25/2002					X		X	
EC-21	K2204294-045	0 to 1	6/25/2002					X		X	
EC-22	K2204294-046	0 to 0.5	6/25/2002					X		X	
EC-22	KWG0204724-3	0 to 0.5	6/25/2002							X	
EC-22	K2204294-051	2 to 3	6/25/2002					X		X	
EC023	E2300324-001	0 to 0.49	5/15/2003	X							
EC023	K2303719-001	0 to 0.49	5/15/2003		X						
EC025	E2300324-002	0 to 0.49	5/16/2003	X							
EC025	K2303719-002	0 to 0.49	5/16/2003		X						
EC026	E2300284-004	0 to 0.33	5/7/2003	X							
EC026	K2303509-004	0 to 0.33	5/7/2003		X						
EC026	K2303509-004D	0 to 0.33	5/7/2003		X						
EC027	E2300284-005	0 to 0.49	5/6/2003	X							
EC027	K2303509-005	0 to 0.49	5/6/2003		X						
EC028	E2300284-006	0 to 0.49	5/6/2003	X							
EC028	K2303509-006	0 to 0.49	5/6/2003		X						
EC029	E2300284-007	0 to 0.49	5/6/2003	X							
EC029	K2303509-007	0 to 0.49	5/6/2003		X						
EC033	E2300324-005	0 to 0.49	5/15/2003	X							
EC033	K2303719-005	0 to 0.49	5/15/2003		X			X			
EC034	E2300284-009	0 to 0.49	5/7/2003	X							
EC034	K2303509-009	0 to 0.49	5/7/2003		X			X			
EC035	E2300324-006	0 to 0.49	5/15/2003	X							
EC035	K2303719-006	0 to 0.49	5/15/2003		X			X			
ECY20	E2300326-007	0 to 0.33	5/19/2003	X							
ECY20	K2303763-007	0 to 0.33	5/19/2003		X	X			X		
ECY20	E2300326-008	0.33 to 0.98	5/19/2003	X							
ECY20	K2303763-008	0.33 to 0.98	5/19/2003		X	X			X		
FOT-0001	K2205162-001	10 to 10	7/29/2002							X	
FOT-0002	K2205162-002	10 to 10	7/30/2002							X	

Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	Metals	PAHs	Organochlorinated Pesticides	PCB Aroclors	SVOCs	Total Petroleum Hydrocarbons	VOCs
F0T-0002	KWG0205625-1	10 to 10	7/30/2002							X	
F0T-0003	K2205162-003	10 to 10	7/30/2002							X	
F0T-0004	K2205162-004	6 to 6	7/30/2002							X	
F0T-0005	K2205162-005	6 to 6	7/30/2002							X	
F0T-0006	K2205162-006	10 to 10	7/30/2002							X	
F0T-0008	K2205162-007	10 to 10	7/31/2002							X	
F0T-0009	K2205162-008	10 to 10	7/31/2002							X	
F0T-0010	K2205162-009	10 to 10	7/31/2002							X	
F0T-0012	K2205235-001	10 to 10	8/1/2002							X	
F0T-0013	K2205235-002	10 to 10	8/1/2002							X	
F0T-0014	K2205235-003	10 to 10	8/1/2002							X	
F0T-0014	KWG0205679-1	10 to 10	8/1/2002							X	
F0T-0015	K2205235-004	10 to 10	8/1/2002							X	
F0T-0015	F0T-EX-15-[080706]-11.0-FD	11 to 11	8/7/2006					X			
F0T-0016	K2205235-005	10 to 10	8/1/2002							X	
F0T-0017	K2205235-006	10 to 10	8/1/2002							X	
F0T-0023	K2205235-012	6 to 6	8/2/2002							X	
F0T-0026	K2205235-015	6 to 6	8/2/2002							X	
F0T-0027	K2205299-001	6 to 6	8/6/2002							X	X
F0T-0027	K2205299-001DUP	6 to 6	8/6/2002								
F0T-0028	K2205299-002	6 to 6	8/6/2002							X	X
F0T-0028	KWG0205846-1	6 to 6	8/6/2002							X	
F0T-0030	K2205301-001	10 to 10	8/6/2002							X	
F0T-0030	KWG0205728-1	10 to 10	8/6/2002							X	
F0T-0031	K2205415-001	6 to 6	8/8/2002							X	
F0T-0031	KWG0206099-1	6 to 6	8/8/2002							X	
F0T-0032	K2205415-002	6 to 6	8/8/2002							X	
F0T-0033	K2205415-003	6 to 6	8/8/2002							X	
F0T-0034	K2205415-004	6 to 6	8/8/2002							X	
F0T-0035	K2205415-005	6 to 6	8/8/2002							X	
F0T-0071	K2206190-001	10 to 10	8/29/2002							X	
F0T-0072	K2206190-002	10 to 10	8/29/2002							X	
F0T-0072	KWG0206855-1	10 to 10	8/29/2002							X	
F0T-0073	K2206190-003	10 to 10	8/29/2002							X	
F0T-0074	K2206190-004	10 to 10	8/29/2002							X	
F0T-0075	K2206190-005	10 to 10	8/29/2002							X	
F0T-0076	K2206190-006	10 to 10	8/29/2002							X	
F0T-0081	K2206190-011	6 to 6	8/30/2002							X	
F0T-0081	KWG0206855-2	6 to 6	8/30/2002							X	
F0T-0082	K2206190-012	6 to 6	8/30/2002							X	
F0T-0083	K2206190-013	6 to 6	8/30/2002							X	
F0T-0085	K2206278-001	10 to 10	9/6/2002							X	
F0T-0086	K2206278-002	7 to 7	9/6/2002							X	
F0T-0087	K2206278-003	10 to 10	9/6/2002							X	
F0T-0088	K2206278-004	10 to 10	9/6/2002							X	
F0T-0089	K2206278-005	10 to 10	9/6/2002							X	
F0T-0090	K2206278-006	10 to 10	9/6/2002							X	
F0T-0091	K2206278-007	10 to 10	9/6/2002							X	
F0T-0091	KWG0207178-4	10 to 10	9/6/2002							X	
F0T-EX-1	F0T-EX-1-[080106]-9.5	9.5 to 9.5	8/1/2006			X		X	X	X	
F0T-EX-10	F0T-EX-10-[080306]-10.5	10.5 to 10.5	8/3/2006							X	
F0T-EX-10	F0T-DUP-1-[080306]	10.5 to 10.5	8/4/2006							X	
F0T-EX-10	F0T-EX-10-[080706]-11.5	11.5 to 11.5	8/7/2006		X	X		X	X	X	
F0T-EX-11	F0T-EX-11-[080306]-8.0	8 to 8	8/3/2006							X	
F0T-EX-11	F0T-EX-19-[080806]-4.0	9 to 9	8/8/2006			X		X	X	X	
F0T-EX-12	F0T-EX-12-[080306]-6.0	6 to 6	8/3/2006			X		X	X	X	
F0T-EX-13	F0T-EX-13-[080306]-13.0	13 to 13	8/3/2006			X		X	X	X	
F0T-EX-14	F0T-EX-14-[080306]-9.0	9 to 9	8/3/2006			X		X	X	X	
F0T-EX-15	F0T-EX-15-[080706]-11.0	11 to 11	8/7/2006			X		X	X	X	
F0T-EX-16	F0T-EX-16-[080706]-8.0	8 to 8	8/7/2006			X			X	X	
F0T-EX-17	F0T-EX-17-[080806]-3.0	3 to 3	8/8/2006			X		X	X	X	
F0T-EX-18	F0T-EX-18-[080806]-7.0	7 to 7	8/8/2006			X		X	X	X	
F0T-EX-19	F0T-EX-19-[080806]-9.0	9 to 9	8/8/2006			X		X	X	X	
F0T-EX-2	F0T-EX-2-[080206]-9.0	9 to 9	8/2/2006			X		X	X	X	
F0T-EX-20	F0T-EX-20-[080806]-7.0	7 to 7	8/8/2006			X		X	X	X	
F0T-EX-21	F0T-EX-21-[080806]-7.0	7 to 7	8/8/2006			X		X	X	X	
F0T-EX-22	F0T-DUP-2-080806	5 to 5	8/8/2006			X		X	X		
F0T-EX-22	F0T-EX-22-[080806]-5.0	5 to 5	8/8/2006			X		X	X	X	
F0T-EX-23	F0T-EX-23-[080806]-5.0	5 to 5	8/8/2006			X		X	X	X	
F0T-EX-24	F0T-EX-24-[080806]-5.0	5 to 5	8/8/2006			X		X	X	X	
F0T-EX-25	WM-EX-25-[080906]-5.0	5 to 5	8/9/2006			X		X	X	X	

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FOT-EX-26	WM-EX-26-[080906]-5.0	5 to 5	8/9/2006			X		X	X	X	
FOT-EX-27	WM-EX-27-[080906]-8.0	8 to 8	8/9/2006			X		X	X	X	
FOT-EX-28	WM-EX-28-[080906]-8.0	8 to 8	8/9/2006			X		X	X	X	
FOT-EX-3	FOT-EX-3-[080206]-11.0	11 to 11	8/2/2006			X		X	X	X	
FOT-EX-4	FOT-EX-4-[080206]-8.0	8 to 8	8/2/2006			X		X	X	X	
FOT-EX-5	FOT-EX-5-[080206]-15.0	15 to 15	8/2/2006			X		X	X	X	
FOT-EX-6	FOT-EX-6-[080206]-3.0	3 to 3	8/2/2006			X		X	X	X	
FOT-EX-7	FOT-EX-7-[080206]-3.0	3 to 3	8/2/2006			X		X	X	X	
FOT-EX-8	FOT-EX-8-[080206]-8.0	8 to 8	8/2/2006			X		X	X	X	
FOT-EX-9	FOT-EX-9-[080206]-6.0	6 to 6	8/2/2006			X		X	X	X	
FOT-PCS-1	FOT-PCS-1-[080206]-11	11 to 11	8/2/2006							X	
FR01	FR01SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
FR02	FR02SS	0 to 0.25	11/12/1997	X	X	X	X	X	X		X
FR02	E2300325-003	0 to 0.25	5/16/2003	X							
FR02	E2300325-003RE	0 to 0.25	5/16/2003	X							
FR02	E2300325-004	0.25 to 5.5	5/16/2003	X							
FR02	E2300325-004RE	0.25 to 5.5	5/16/2003	X							
FR02	K2303762-007	0.25 to 5.5	5/16/2003		X	X	X		X		X
FR03	FR03SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
FR04	FR04SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
FR05	FR05SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
FR06	FR06SS	0 to 0.25	11/13/1997	X	X	X	X	X	X		X
FR07	FR07SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
FR08	FR08SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
FR09	FR09SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
FR10	FR10SS	0 to 0.25	11/14/1997	X	X	X	X	X	X		X
FR11	FR11SS	0 to 0.25	11/15/1997	X	X	X	X	X	X		X
FR20	E2300325-005	0 to 0.25	5/19/2003	X							
FR20	E2300325-005RE	0 to 0.25	5/19/2003	X							
FR20	K2303762-009	0.25 to 4.5	5/16/2003		X	X	X		X		X
FR20	E2300325-006	0.25 to 4.5	5/19/2003	X							
FW0054	K2205480-003	4.5 to 4.5	8/9/2002					X		X	
FW0055	K2205480-004	1 to 1	8/9/2002					X		X	
FW0056	K2205480-005	1 to 1	8/10/2002					X		X	
FW0057	K2205480-006	4.5 to 4.5	8/10/2002					X		X	
FW0058	K2205480-007	1 to 1	8/10/2002					X		X	
FW0059	K2205480-008	4.5 to 4.5	8/10/2002					X		X	
FW0061	K2205480-010	1 to 1	8/10/2002					X		X	
FW0062	K2205480-011	1 to 1	8/12/2002					X		X	
FW0063	K2205480-012	4.5 to 4.5	8/12/2002					X		X	
FW0064	K2205480-013	1 to 1	8/12/2002					X		X	
FW0065	K2205480-014	4.5 to 4.5	8/12/2002					X		X	
FW0067	K2205480-016	1 to 1	8/12/2002					X		X	
FW0067	KWG0206007-2	1 to 1	8/12/2002							X	
FW0068	K2205480-017	4.5 to 4.5	8/12/2002					X		X	
FW0069	K2205480-018	1 to 1	8/12/2002					X		X	
FW0070	FW0070	1 to 1	8/12/2002					X		X	
GB01	LY07SS-GB01	0 to 2	11/4/1997		X	X	X	X	X		X
GB01	LY08SB-GB01	2 to 4	11/11/1997		X	X	X	X	X		X
GB01	LY25SB-GB01	4 to 6	11/11/1997		X	X	X	X	X		X
GB02	LY17SS-GB02	0 to 2	11/4/1997		X	X	X	X	X		X
GB02	LY18SB-GB02	2 to 4	11/10/1997		X	X	X	X	X		X
GB03	LY19SS-GB03	0 to 2	11/4/1997	X	X	X	X	X	X		X
GB03	LY20SB-GB03	2 to 4	11/10/1997		X	X	X	X	X		X
GB04	LY01SS-GB04	0 to 2	11/4/1997		X	X	X	X	X		X
GB04	LY02SB-GB04	2 to 4	11/11/1997		X	X	X	X	X		X
GB05	LY05SS-GB05	0 to 2	11/4/1997		X	X	X	X	X		X
GB05	LY06SB-GB05	2 to 4	11/10/1997		X	X	X	X	X		X
GB06	LY09SS-GB06	0 to 2	11/4/1997		X	X	X	X	X		X
GB07	LY11SS-GB07	0 to 2	11/4/1997	X	X	X	X	X	X		X
GB07	LY12SB-GB07	2 to 4	11/12/1997	X	X	X	X	X	X		X
GB07	LY14SB-GB07	4 to 6	11/12/1997		X	X	X	X	X		X
GB07	LY27SB-GB07	6 to 8	11/12/1997		X	X	X	X	X		X
GB08	K2303593-010	0 to 0.25	5/12/2003		X						
GB08	LY13SS-GB08	0 to 2	11/4/1997		X	X	X	X	X		X
GB08	K2303593-009	0.25 to 7	5/12/2003		X						
GB08	LY29SB-GB08	2 to 4	11/12/1997		X	X	X	X	X		X
GB09	LY02SS-GB09	0 to 2	11/4/1997			X	X	X	X		X
GB09	LY03SS-GB09	0 to 2	11/4/1997		X						
GB09	LY04SB-GB09	2 to 4	11/10/1997	X	X	X	X	X	X		X

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GB10	LY10SB-GB10	10 to 10	11/11/1997		X	X	X	X	X		X
HF01	HF01-0SS	0 to 2	11/13/1997		X	X	X	X	X		X
HF01	HF01-2SB	2 to 4	11/13/1997		X	X	X	X	X		X
HF02	HF02-0SS	0 to 2	11/13/1997		X	X	X	X	X		X
HF02	HF02-2SB	2 to 4	11/13/1997		X	X	X	X	X		X
HF03	HF03-0SS	0 to 2	11/14/1997	X		X	X	X	X		X
HF03	HF03-2SB	2 to 4	11/14/1997		X	X	X	X	X		X
HF04	HF04-0SS	0 to 2	11/14/1997		X	X	X	X	X		X
HF04	HF04-2SB	2 to 4	11/14/1997		X	X	X	X	X		X
HF05	HF05-0SS	0 to 2	11/14/1997		X	X	X	X	X		X
HF05	HF05-2SB	2 to 4	11/14/1997		X	X	X	X	X		X
HF06	HF06-0SS	0 to 2	11/14/1997		X	X	X	X	X		X
HF06	HF06-2SB	2 to 4	11/14/1997		X	X	X	X	X		X
HF07	HF07-0SS	0 to 2	11/20/1997		X	X	X	X	X		X
HF07	HF07-2SB	2 to 4	11/20/1997	X	X	X	X	X	X		X
HF08	HF08-0SS	0 to 2	11/20/1997	X	X	X	X	X	X		X
HF08	HF08-2SB	2 to 4	11/20/1997		X	X	X	X	X		X
HF09	HF09-0SS	0 to 2	11/19/1997		X	X	X	X	X		X
HF09	HF09-2SB	2 to 4	11/19/1997		X	X	X	X	X		X
HF10	HF10-SS	0 to 0.25	11/21/1997			X	X	X	X		X
HF10	HF10SS	0 to 0.25	11/21/1997	X	X						
LB01	LB01-0SS	0 to 2	11/22/1997		X	X	X	X	X		X
LB02	LB02-0SS	0 to 2	11/22/1997		X	X	X	X	X		X
LC-1	LC 1	2.5 to 2.5	10/14/1998					X			
LC12A	LC 12A	1.5 to 1.5	10/14/1998					X			
LC12D	LC 12D	1.5 to 1.5	10/14/1998					X			
LC-2	LC 2	2.5 to 2.5	10/14/1998					X			
LC23A	LC 23A	1.5 to 1.5	10/14/1998					X			
LC23D	LC 23D	1.5 to 1.5	10/14/1998					X			
LC-3	LC 3	2.5 to 2.5	10/14/1998					X			
LC34G	LC 34G	1.5 to 1.5	10/15/1998					X			
LC34Z	LC 34Z	1.5 to 1.5	10/15/1998					X			
LC-4	LC 4	2.5 to 2.5	10/14/1998					X			
LC45A	LC 45A	1.5 to 1.5	10/14/1998					X			
LC45G	LC 45G	1.5 to 1.5	10/15/1998					X			
LC-5	LC 5	4.5 to 4.5	10/14/1998					X			
LC56A	LC 56A	1.5 to 1.5	10/14/1998					X			
LC56G	LC 56G	1.5 to 1.5	10/15/1998					X			
LC67A	LC 67A	1.5 to 1.5	10/14/1998					X			
LC67D	LC 67D	1.5 to 1.5	10/15/1998					X			
LC78A	LC 78A	1.5 to 1.5	10/14/1998					X			
LC78D	LC 78D	1.5 to 1.5	10/15/1998					X			
LC89C	LC 89C	1.5 to 1.5	10/15/1998					X			
LC89D	LC 89D	1.5 to 1.5	10/15/1998					X			
LCAB1	LC AB1	1.5 to 1.5	10/14/1998					X			
LCAB8	LC AB8	1.5 to 1.5	10/14/1998					X			
LCAZ2.5	LC AZ2.5	1.5 to 1.5	10/15/1998					X			
LCBC1	LC BC1	1.5 to 1.5	10/14/1998					X			
LCBC8	LC BC8	1.5 to 1.5	10/14/1998					X			
LCCD1	LC CD1	1.5 to 1.5	10/14/1998					X			
LCCD9	LC CD9	1.5 to 1.5	10/15/1998					X			
LCED2	LC ED2	1.5 to 1.5	10/15/1998					X			
LCED7	LC ED7	1.5 to 1.5	10/15/1998					X			
LCEF3	LC EF3	1.5 to 1.5	10/15/1998					X			
LCEF6	LC EF6	1.5 to 1.5	10/15/1998					X			
LCFG3	LC FG3	1.5 to 1.5	10/15/1998					X			
LCFG6	LC FG6	1.5 to 1.5	10/15/1998					X			
LCS-1	LC S-I	2.5 to 2.5	10/14/1998					X			
LCS-10	LC S-10	2.5 to 2.5	10/14/1998					X			
LCS-16	LC S-16	2.5 to 2.5	10/14/1998					X			
LCS-17	LC S-17	2.5 to 2.5	10/14/1998					X			
LCS-18	LC S-18	2.5 to 2.5	10/14/1998					X			
LCS-19	LC S-19	2.5 to 2.5	10/14/1998					X			
LCS-2	LC S-2	2.5 to 2.5	10/14/1998					X			
LCS-20	LC S-20	2.5 to 2.5	10/14/1998					X			
LCS-21	LC S-21	2.5 to 2.5	10/14/1998					X			
LCS-22	LC S-22	2.5 to 2.5	10/15/1998					X			
LCS-23	LC S-23	2.5 to 2.5	10/15/1998					X			
LCS-24	LC S-24	2.5 to 2.5	10/15/1998					X			
LCS-25	LC S-25	2.5 to 2.5	10/15/1998					X			

Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	Metals	PAHs	Organochlorinated Pesticides	PCB Aroclors	SVOCs	Total Petroleum Hydrocarbons	VOCs
LCS-26	LC S-26	2.5 to 2.5	10/15/1998					X			
LCS-27	LC S-27	2.5 to 2.5	10/15/1998					X			
LCS-28	LC S-28	2.5 to 2.5	10/15/1998					X			
LCS-29	LC S-29	2.5 to 2.5	10/15/1998					X			
LCS-3	LC S-3	2.5 to 2.5	10/14/1998					X			
LCS-30	LCS S-30	2.5 to 2.5	10/15/1998					X			
LCS-31	LCS S-31	2.5 to 2.5	10/15/1998					X			
LCS-32	LCS S-32	2.5 to 2.5	10/15/1998					X			
LCS-4	LC S-4	2.5 to 2.5	10/14/1998					X			
LCS-5	LC S-5	2.5 to 2.5	10/14/1998					X			
LCS-6	LC S-6	2.5 to 2.5	10/14/1998					X			
LCS-7	LC S-7	2.5 to 2.5	10/14/1998					X			
LCS-8	LC S-8	2.5 to 2.5	10/14/1998					X			
LCS-9	LC S-9	2.5 to 2.5	10/14/1998					X			
LY15	LY15SS	0 to 2	11/4/1997	X	X	X	X	X	X		X
LY16	LY16SS	0 to 2	11/4/1997		X	X	X	X	X		X
LY20	E2300326-009	0 to 0.25	5/19/2003	X							
LY20	E2300326-010	0.25 to 11.5	5/19/2003	X							
LY21	0305-175-01	0 to 0.25	5/15/2003							X	
LY21	E2300322-003	0 to 0.25	5/15/2003	X							
LY21	E2300322-003RE	0 to 0.25	5/15/2003	X							
LY21	K2303678-005	0 to 0.25	5/15/2003		X	X			X	X	
LY21	0305-175-02	0.25 to 5	5/15/2003							X	X
LY21	E2300322-004	0.25 to 5	5/15/2003	X							
LY21	K2303678-006	0.25 to 5	5/15/2003		X	X			X	X	
LY21	K2303678-006DL	0.25 to 5	5/15/2003			X			X		
LY21	KWG0307234-3	0.25 to 5	5/15/2003							X	
LY22	E2300298-001	0 to 0.25	5/12/2003	X							
LY22	E2300298-002	0.25 to 7	5/12/2003	X							
LY23	E2300298-003	0 to 0.25	5/12/2003	X							
LY23	E2300298-004	0.25 to 4.5	5/12/2003	X							
LY24	E2300298-005	0 to 0.25	5/12/2003	X							
LY24	K2303593-005	0 to 0.25	5/12/2003		X	X			X		
LY24	E2300298-006	0.25 to 6.5	5/12/2003	X							
LY24	K2303593-006	0.25 to 6.5	5/12/2003		X	X			X		
LY25	E2300298-007	0 to 0.25	5/12/2003	X							
LY25	K2303593-007	0 to 0.25	5/12/2003		X	X			X		
LY25	E2300298-008	0.25 to 8	5/12/2003	X							
LY25	K2303593-008	0.25 to 8	5/12/2003		X	X			X		
LYT01	LYT01SS	0 to 0.25	11/20/1997				X				
LYT02	LYT02SS	0 to 0.25	11/20/1997				X				
MCH0001	K2206204-001	9 to 9	9/3/2002		X			X		X	X
MCH0002	K2206204-002	9 to 9	9/3/2002		X			X		X	X
MCH0003	K2206204-003	9 to 9	9/3/2002		X			X		X	X
MCH0004	K2206204-004	9 to 9	9/3/2002		X			X		X	X
MCH0005	K2206204-005	9 to 9	9/3/2002		X			X		X	X
MCH0006	K2206204-006	9 to 9	9/3/2002		X			X		X	X
MCH0007	K2206204-007	9 to 9	9/3/2002		X			X		X	X
MCH0008	K2206204-008	9 to 9	9/3/2002		X			X		X	X
MCH0008	KWG0207078-1	9 to 9	9/3/2002							X	
MCH0009	K2206250-001	9 to 9	9/4/2002		X			X		X	X
MCH0010	K2206250-002	9 to 9	9/4/2002		X			X		X	X
MCH0011	K2206250-003	9 to 9	9/4/2002		X			X		X	X
MCH0012	K2206250-004	9 to 9	9/4/2002		X			X		X	X
MCH0013	K2206250-005	9 to 9	9/4/2002		X			X		X	X
MCH0014	K2206250-006	9 to 9	9/4/2002		X			X		X	X
MCH0015	K2206250-007	9 to 9	9/4/2002		X			X		X	X
MCH0015	KWG0207094-1	9 to 9	9/4/2002							X	
MCH0016	K2206250-008	9 to 9	9/4/2002		X			X		X	X
MR01	MR01SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR02	MR02SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR03	MR03SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR03	K2303763-011	0 to 0.25	5/20/2003		X						
MR03	K2303763-012	0.25 to 3.5	5/20/2003		X						
MR04	MR04SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR05	MR05SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR06	MR06SS	0 to 0.25	11/12/1997	X	X	X	X	X	X		X
MR07	MR07SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
MR08	MR08SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
MR09	MR09SS	0 to 0.25	11/15/1997	X	X	X	X	X	X		X

Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Dioxins/Furans	Metals	PAHs	Organochlorinated Pesticides	PCB Aroclors	SVOCs	Total Petroleum Hydrocarbons	VOCs
MR10	MR10SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
MR11	MR11SS	0 to 0.25	11/14/1997	X	X	X	X	X	X		X
MR12	MR12SS	0 to 0.25	11/14/1997		X	X	X	X	X		X
MR20	E2300323-001	0 to 0.25	5/14/2003	X							
MR20	K2303687-003	0 to 0.25	5/14/2003							X	
MR20	E2300322-011	0 to 0.25	5/15/2003	X							
MR20	K2303678-015	0 to 0.25	5/15/2003		X	X	X		X		X
MS20	E2300323-002	0.25 to 5	5/14/2003	X							
MS20	K2303687-004	0.25 to 5	5/14/2003		X	X	X		X	X	X
PA01	PA01-0SS	0 to 2	11/15/1997	X	X	X	X	X	X		X
PA02	PA02-0SS	0 to 2	11/15/1997	X	X	X	X	X	X		X
PA03	PA03-0SS	0 to 2	11/15/1997		X	X	X	X	X		X
PA04	PA04-0SS	0 to 2	11/15/1997		X	X	X	X	X		X
PA04	PA04-2SB	2 to 4	11/15/1997	X	X	X	X	X	X		X
PA04	PA04-4SB	4 to 6	11/15/1997		X	X	X	X	X		X
PA-19	PA-19	7.5 to 9	8/21/2009		X	X			X	X	X
PC01	PC01SS	0 to 0.25	11/10/1997		X	X	X	X	X		X
PC02	PC02SS	0 to 0.25	11/10/1997		X	X	X	X	X		X
PC20	E2300325-011	0 to 0.25	5/19/2003	X							
PC20	E2300326-006	0 to 0.25	5/19/2003	X							
PC20	E2300326-006RE	0 to 0.25	5/19/2003	X							
PC20	E2300326-001	0.25 to 11	5/19/2003	X							
PC20	K2303763-001	0.25 to 11	5/19/2003		X	X	X		X		X
PC20	K2303763-001D	0.25 to 11	5/19/2003		X						
PF01	PF01-0SS	0 to 2	11/18/1997		X	X	X	X	X		X
PF01	PF01-2SB	2 to 4	11/18/1997		X	X	X	X	X		X
PF02	K2303762-010	0 to 0.25	5/16/2003		X						
PF02	K2303762-011	0 to 0.25	5/16/2003		X						
PF02	PF02-0SS	0 to 2	11/18/1997		X	X	X	X	X		X
PF02	PF02-2SB	2 to 4	11/18/1997		X	X	X	X	X		X
PF03	PF03-0SS	0 to 2	11/18/1997		X	X	X	X	X		X
PF03	PF03-16SB	16 to 18	11/18/1997		X	X	X	X	X		X
PF03	PF03-2SB	2 to 4	11/18/1997	X	X	X	X	X	X		X
PF03	PF03-4SB	4 to 6	11/18/1997		X	X	X	X	X		X
PF03	PF03-6SB	6 to 8	11/18/1997		X	X	X	X	X		X
PF03	PF03-8SB	8 to 10	11/18/1997		X	X	X	X	X		X
PS20	E2300322-007	0 to 0.25	5/15/2003	X							
PS20	E2300322-008	0.25 to 6.5	5/15/2003	X							
PS20	K2303678-010	0.25 to 6.5	5/15/2003		X	X	X		X		X
PW20	K2303678-012	0.25 to 8.5	5/15/2003		X	X	X		X		X
RB01	RB01SS	0 to 0.25	11/10/1997	X	X	X	X	X	X		X
RB01	K2303600-001	0 to 0.25	5/13/2003		X					X	
RB01	K2303593-015	0.25 to 7	5/13/2003		X	X	X		X	X	X
RB02	RB02SS	0 to 0.25	11/10/1997	X	X	X	X	X	X		X
RB03	RB03-0SS	0 to 2	11/21/1997		X	X	X	X	X		X
RB03	RB03-8SB	8 to 10	11/21/1997		X	X	X	X	X		X
RB04	RB04-0SS	0 to 2	11/21/1997	X	X	X	X	X	X		X
RB04	RB04-4SB	4 to 6	11/21/1997	X	X	X	X	X	X		X
RB04	RB04-8SB	8 to 10	11/21/1997	X	X	X	X	X	X		X
RB20	K2303593-016	0 to 0.25	5/13/2003		X					X	
RB20	K2303593-017	0.25 to 8	5/13/2003		X	X	X		X	X	X
RB21	E2300298-013	0 to 0.25	5/13/2003	X							
RB21	E2300298-013RE	0 to 0.25	5/13/2003	X							
RB21	K2303593-018	0 to 0.25	5/13/2003		X						
RB21	E2300298-014	0.25 to 8	5/13/2003	X							
RB21	K2303593-019	0.25 to 8	5/13/2003		X	X	X		X		X
RB22	K2303600-005	0 to 0.25	5/13/2003							X	
RB22	KWG0306962-1	0 to 0.25	5/13/2003							X	
RB22	K2303600-002	0.25 to 7.5	5/13/2003							X	
RS20	E2300322-009	0 to 0.25	5/15/2003	X							
RS20	K2303678-013	0 to 0.25	5/15/2003		X	X	X	X	X		X
RS20	K2303687-019	0 to 0.25	5/15/2003		X	X	X	X	X		X
RS20	E2300322-010	0.25 to 2	5/15/2003	X							
RS20	K2303678-014	0.25 to 2	5/15/2003		X	X	X	X	X		X
RS21	K2303762-012	0 to 0.25	5/16/2003		X	X	X	X	X		X
RS21	K2303762-015	0 to 0.25	5/16/2003		X	X	X	X	X		X
RS21	K2303762-013	0.25 to 9.5	5/16/2003		X	X	X	X	X		X
RY03-0215	E2300284-010	0 to 0.67	5/5/2003	X							
RY03-0215	K2303509-010	0 to 0.67	5/5/2003		X						
SL20	E2300323-007	0 to 0.25	5/14/2003	X							

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SL20	E2300323-011	0 to 0.25	5/14/2003	X							
SL20	K2303687-010	0.25 to 7	5/14/2003		X	X			X		
SL21	E2300323-008	0 to 0.25	5/14/2003	X							
SL21	K2303687-012	0.25 to 6.5	5/14/2003		X	X			X		
SL21	K2303687-016	0.25 to 6.5	5/14/2003		X	X			X		
SL22	E2300323-009	0 to 0.25	5/14/2003	X							
SL22	K2303687-013	0 to 0.25	5/14/2003		X	X			X		
SL22	E2300323-010	0.25 to 7.5	5/14/2003	X							
SL22	K2303687-014	0.25 to 7.5	5/14/2003		X	X			X		
SMT01	97474412	0 to 0.25	11/20/1997				X	X			
SMT02	97474413	0 to 0.25	11/20/1997				X	X			
SR01	SR01-SS	0 to 0.25	11/21/1997		X	X	X	X	X		X
SR02	SR02-SS	0 to 0.25	11/21/1997		X	X	X	X	X		X
SR03	SR03-SS	0 to 0.25	11/21/1997	X	X	X	X	X	X		X
SR03	E2300326-002	0 to 0.25	5/19/2003	X							
SR03	E2300326-002RE	0 to 0.25	5/19/2003	X							
SR03	E2300326-003	0.25 to 11	5/19/2003	X							
SR03	E2300326-003RE	0.25 to 11	5/19/2003	X							
SR03	K2303763-003	0.25 to 11	5/19/2003		X	X	X		X		X
SR04	SR04-SS	0 to 0.25	11/21/1997		X	X	X	X	X		X
SR20	E2300326-004	0 to 0.25	5/19/2003	X							
SR20	E2300326-004RE	0 to 0.25	5/19/2003	X							
SR20	E2300326-005	0.25 to 7	5/19/2003	X							
SR20	K2303763-005	0.25 to 7	5/19/2003		X	X	X		X		X
SR21	E2300323-012	0 to 0.25	5/14/2003	X							
SR21	E2300323-013	0.25 to 3	5/15/2003	X							
SR21	K2303687-018	0.25 to 3	5/15/2003		X	X	X		X		X
SR22	E2300323-003	0 to 0.25	5/14/2003	X							
SR22	E2300323-004	0.25 to 5	5/14/2003	X							
SR22	K2303687-006	0.25 to 5	5/14/2003		X	X	X		X		X
SR23	E2300323-005	0 to 0.25	5/14/2003	X							
SR23	E2300323-005RE	0 to 0.25	5/14/2003	X							
SR23	K2303687-007	0 to 0.25	5/14/2003		X						
SR23	E2300323-006	0.25 to 13	5/14/2003	X							
SR23	K2303687-008	0.25 to 13	5/14/2003		X	X	X		X		X
SR23	E2300326-013	0.25 to 13	5/20/2003	X							
SR23	K2303763-015	0.25 to 13	5/20/2003		X	X	X		X		X
SR24	E2300326-011	0 to 0.25	5/19/2003	X							
SR24	E2300326-011RE	0 to 0.25	5/20/2003	X							
SR24	E2300326-012	0.25 to 16	5/20/2003	X							
SR24	K2303763-014	0.25 to 16	5/20/2003		X	X	X		X		X
TB01	TB01SS	0 to 0.25	11/12/1997		X	X	X	X	X		X
TB02	TB02SS	0 to 0.25	11/13/1997		X	X	X	X	X		X
WEC-1	NORTH WALL-3	1.5 to 1.5	10/13/1998					X		X	
WEC-10	COMP 2-3-(2)	3 to 3	10/13/1998					X		X	
WEC-11	COMP 2-2-(2)	3 to 3	10/13/1998					X		X	
WEC-12	COMP 1-3-(2)	3 to 3	10/13/1998					X		X	
WEC-13	WEST WALL-8	1.5 to 1.5	10/13/1998					X		X	
WEC-14	COMP 4-4-(1)	3 to 3	10/13/1998					X		X	
WEC-15	COMP 4-1-(3)	3 to 3	10/13/1998					X		X	
WEC-16	COMP 3-4-(3)	3 to 3	10/13/1998					X		X	
WEC-17	COMP 3-1-(3)	3 to 3	10/13/1998					X		X	
WEC-18	WEST WALL-9	1.5 to 1.5	10/13/1998					X		X	
WEC-19	COMP 4-5-(1)	3 to 3	10/13/1998					X		X	
WEC-2	NORTH WALL-2	1.5 to 1.5	10/13/1998					X		X	
WEC-20	COMP 3-5-(3)	3 to 3	10/13/1998					X		X	
WEC-21	COMP 4-3-(1)	3 to 3	10/13/1998					X		X	
WEC-22	COMP 4-2-(3)	3 to 3	10/13/1998					X		X	
WEC-23	COMP 3-3-(2)	3 to 3	10/13/1998					X		X	
WEC-24	COMP 3-2-(2)	6 to 6	10/13/1998					X		X	
WEC-25	WEST WALL-10	1.5 to 1.5	10/13/1998					X		X	
WEC-26	COMP 6-4-(1)	3 to 3	10/13/1998					X		X	
WEC-27	COMP 6-1-(2)	3 to 3	10/13/1998					X		X	
WEC-28	COMP 5-4-(1)	3 to 3	10/13/1998					X		X	
WEC-29	COMP 5-1-(3)	6 to 6	10/13/1998					X		X	
WEC-3	NORTH WALL-1	1.5 to 1.5	10/13/1998					X		X	
WEC-30	WEST WALL-11	1.5 to 1.5	10/13/1998					X		X	
WEC-31	COMP 6-5-(1)	3 to 3	10/13/1998					X		X	
WEC-32	COMP 5-5-(2)	3 to 3	10/13/1998							X	
WEC-33	COMP 6-3-(3)	3 to 3	10/13/1998					X		X	

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WEC-34	COMP 6-2-(3)	3 to 3	10/13/1998					X		X	
WEC-35	COMP 5-3-(2)	6 to 6	10/13/1998					X		X	
WEC-36	COMP 5-2-(2)	1.5 to 1.5	10/13/1998					X		X	
WEC-37	S-WALL-7	3 to 3	10/13/1998					X		X	
WEC-38	COMP 8-4-(1)	3 to 3	10/13/1998					X		X	
WEC-39	COMP 8-1-(1)	3 to 3	10/13/1998					X		X	
WEC-4	COMP 2-4	3 to 3	10/13/1998					X		X	
WEC-40	COMP 7-4-2	3 to 3	10/13/1998					X		X	
WEC-41	COMP 7-1-(2)	6 to 6	10/13/1998					X		X	
WEC-42	S-WALL-11	1.5 to 1.5	10/13/1998					X		X	
WEC-43	S-WALL-10	1.5 to 1.5	10/13/1998					X		X	
WEC-44	S-WALL-12	1.5 to 1.5	10/13/1998					X		X	
WEC-45	COMP 7-3-(A)	3 to 3	10/13/1998					X		X	
WEC-46	S-WALL-8	1.5 to 1.5	10/13/1998					X		X	
WEC-47	COMP 7-5-(2)	3 to 3	10/13/1998					X		X	
WEC-5	COMP 2-1-(2)	3 to 3	10/13/1998					X		X	
WEC-6	COMP 1-4-(2)	3 to 3	10/13/1998					X		X	
WEC-7	WEST WALL -1	1.5 to 1.5	10/13/1998							X	
WEC-8	COMP 2-5	3 to 3	10/13/1998					X		X	
WEC-9	COMP 1-5-(3)	3 to 3	10/13/1998					X		X	
WM20	E2300298-009	0 to 0.25	5/12/2003	X							
WM20	E2300298-009RE	0 to 0.25	5/12/2003	X							
WM20	K2303593-011	0 to 0.25	5/12/2003		X	X		X	X	X	
WM20	E2300298-010	0.25 to 8	5/12/2003	X							
WM20	K2303593-012	0.25 to 8	5/12/2003		X	X	X	X	X	X	X
WM21	E2300301-001	0 to 0.25	5/13/2003	X							
WM21	K2303600-003	0 to 0.25	5/13/2003		X	X		X	X	X	
WM21	E2300301-002	0.25 to 9.5	5/13/2003	X							
WM21	K2303600-004	0.25 to 9.5	5/13/2003		X	X	X	X	X	X	X
WM-EX-1	WM-EX-1-[080306]-8.0	8 to 8	8/3/2006			X		X	X	X	
WM-EX-10	WM-DUP-1-[080806]	16 to 16	8/8/2006							X	
WM-EX-10	WM-DUP-1-080806	16 to 16	8/8/2006			X		X	X		
WM-EX-10	WM-EX-10-[080806]-16.0	16 to 16	8/8/2006			X		X	X	X	
WM-EX-11	WM-EX-11-[080806]-12.0	12 to 12	8/8/2006							X	
WM-EX-11	WM-EX-11-[080806]-17.0	17 to 17	8/8/2006			X		X	X	X	
WM-EX-12	WM-EX-12-[080806]-8.0	8 to 8	8/8/2006			X		X	X	X	
WM-EX-13	WM-EX-13-[080806]-9.0	9 to 9	8/8/2006			X		X	X	X	
WM-EX-14	WM-EX-14-[080806]-14.0	14 to 14	8/8/2006			X		X	X	X	
WM-EX-15	WM-EX-15-[080806]-14.0	14 to 14	8/8/2006			X		X	X	X	
WM-EX-16	WM-EX-16-[080806]-14.0	14 to 14	8/8/2006			X		X	X	X	
WM-EX-17	WM-EX-17-[080806]-14.0	14 to 14	8/8/2006			X		X	X	X	
WM-EX-18	WM-EX-18-[080906]-9.0	9 to 9	8/9/2006					X			
WM-EX-18	WM-EX-18-[080906]-9.0	9 to 9	8/9/2006			X			X	X	
WM-EX-2	WM-EX-2-[080306]-11.0	11 to 11	8/3/2006			X		X	X	X	
WM-EX-3	WM-EX-3-[080306]-10.0	10 to 10	8/3/2006			X		X	X	X	
WM-EX-4	WM-EX-4-[080406]-13.0	13 to 13	8/4/2006			X		X	X	X	
WM-EX-5	WM-EX-5-[080406]-16.0	16 to 16	8/4/2006			X		X	X	X	
WM-EX-6	WM-EX-6-[080706]-9.0	9 to 9	8/7/2006			X		X	X	X	
WM-EX-7	WM-EX-7-[080706]-8.5	8.5 to 8.5	8/7/2006			X		X	X	X	
WM-EX-8	WM-EX-8-[080706]-15.0	15 to 15	8/7/2006			X		X	X	X	
WM-EX-9	WM-EX-9-[080706]-10.0	10 to 10	8/7/2006			X		X	X	X	
WWHF-10	WWHF-10D	2 to 4	10/4/2000							X	
WWHF-9	WWHF-9D	0 to 2	10/4/2000							X	

Notes:

SVOCs = Semivolatile organic compounds
PAHs = Polycyclic aromatic hydrocarbons
VOCs = Volatile organic compounds
PCB = Polychlorinated biphenyl

Table 3

Supplemental Upland Investigation Sampling and Analytical Testing Summary – Groundwater

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Ammonia EPA 350.1/350.3	Dioxins/ Furans EPA 1613	SVOCs (not including PAHs & Chlorophenols) SW8270	VOCs SW8260	PAHs SW8270D SIM	Chlorophenols SW8041	Total Petroleum Hydrocarbons - Gasoline Extended NWTPH-Gx	Total Petroleum Hydrocarbons - Diesel Extended NWTPH-Dx	Select Metals EPA 200.8	Hexavalent Chromium EPA A3500	Mercury SW7470A	Organo-chlorinated Pesticides SW8081	PCB Aroclors SW8082
Phase 1 Baseline Groundwater Sampling - August 2010	MW-23	MW-23_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-28	MW-28_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-29	MW-29_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-51	MW-51_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-52	MW-52_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-53	MW-53_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-54	MW-54_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-55	MW-55_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-56	MW-56_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-57	MW-57_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-58	MW-58_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	MW-59	MW-59_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-2	PZ-2_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-3	PZ-3_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-4	PZ-4_100825	--	8/25/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-5	PZ-5_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-6	PZ-6_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-7	PZ-7_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-9	PZ-9_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-10	PZ-10_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-11	PZ-11_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PZ-12	PZ-12_100827	--	8/27/10	X	X	X	X	X	X	X	X	X		X	X	X
	PA-19	PA-19_100826	--	8/26/10	X	X	X	X	X	X	X	X	X		X	X	X
Phase 2 (October-November 2010)	GWG-1	GWG-1-W	4 to 7.5	11/04/10	X	X	X	X	X	X		X	X		X	X	X
	GWG-2	GWG-2-W	7.5 to 10	11/01/10	X	X							X		X		X
	GWG-3	GWG-3-W	8.5 to 12	11/01/10	X	X							X		X		X
	GWG-4	GWG-4-W	8.5 to 11	11/02/10	X	X							X		X		X
	GWG-5	GWG-5-W	3.5 to 7	11/03/10	X	X							X		X		X
	GWG-6	GWG-6-W	10 to 13	11/02/10			X		X			X	X		X		X
	GWG-7	GWG-7-W	6 to 8.5	11/03/10			X		X			X	X		X		X
	GWG-8	GWG-8-W	13 to 16.5	10/28/10			X		X	X		X	X		X		X
	GWG-9	GWG-9-W	21.5 to 25	11/05/10				X									
Phase 3 (January 2011)	PIPE-1-SR23	PIPE-1-SR23	--	1/07/11	X	X	X	X	X	X		X	X		X		X
Phase 4 (March 2011)	MW-65	MW-65-110311-W	--	3/11/11	X				X	X		X	X		X		X
	MW-66	MW-66-110311-W	--	3/11/11	X				X	X			X		X		X
	MW-67	MW-67-110311-W	--	3/11/11	X				X	X		X	X		X		

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Ammonia EPA 350.1/350.3	Dioxins/ Furans EPA 1613	SVOCs (not including PAHs & Chlorophenols) SW8270	VOCs SW8260	PAHs SW8270D SIM	Chlorophenols SW8041	Total Petroleum Hydrocarbons - Gasoline Extended NWTPH-Gx	Total Petroleum Hydrocarbons - Diesel Extended NWTPH-Dx	Select Metals EPA 200.8	Hexavalent Chromium EPA A3500	Mercury SW7470A	Organo-chlorinated Pesticides SW8081	PCB Aroclors SW8082
Phase 5 Quarterly Groundwater Monitoring - November 2010	MW-23	MW-23_101110	--	11/10/10	X					X			X		X	X	X
	MW-28	MW-28_101110	--	11/10/10	X		X	X	X	X		X	X		X		X
	MW-29	MW-29_101111	--	11/11/10	X	X	X	X	X			X	X		X		X
	MW-51	MW-51_101110	--	11/10/10	X		X		X				X	X	X		
	MW-52	MW-52_101108	--	11/08/10			X						X		X		
	MW-54	MW-54_101111	--	11/11/10		X			X				X		X	X	
	MW-55	MW-55_101108	--	11/08/10			X						X		X		
	MW-56	MW-56_101109	--	11/09/10	X					X			X		X	X	X
	MW-57	MW-57_101108	--	11/08/10	X								X		X	X	
	MW-58	MW-58_101111	--	11/11/10									X		X	X	X
	MW-59	MW-59_101110	--	11/10/10			X						X	X	X	X	X
	MW-60	MW-60_101111	--	11/11/10	X	X	X	X	X	X	X	X	X		X		X
	MW-61	MW-61_101111	--	11/11/10	X	X	X	X	X	X	X		X		X		X
	MW-62	MW-62_101109	--	11/09/10	X	X	X		X	X	X	X	X		X		X
	MW-63	MW-63_101110	--	11/10/10				X									
	MW-64	MW-64_101108	--	11/08/10		X							X		X	X	
	PZ-2	PZ-2_101111	--	11/11/10	X	X	X						X		X		X
	PZ-3	PZ-3_101109	--	11/09/10	X		X						X		X	X	
	PZ-4	PZ-4_101109	--	11/09/10									X		X	X	
	PZ-6	PZ-6_101109	--	11/09/10									X		X	X	
	PZ-7	PZ-7_101110	--	11/10/10			X						X	X	X		
	PZ-9	PZ-9_101110	--	11/10/10	X		X	X					X	X	X		
	PZ-11	PZ-11_101109	--	11/09/10			X						X		X	X	
	PZ-12	PZ-12_101109	--	11/09/10			X						X		X	X	
	PA-15	PA-15_101109	--	11/09/10	X	X	X		X	X		X	X		X		X
	PA-19	PA-19_101111	--	11/11/10	X	X	X		X	X		X	X		X		X
	PA-23	PA-23_101108	--	11/08/10	X	X							X		X	X	
	PA-24	PA-24_101109	--	11/09/10	X	X	X		X	X		X	X		X		X

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Ammonia EPA 350.1/350.3	Dioxins/ Furans EPA 1613	SVOCs (not including PAHs & Chlorophenols) SW8270	VOCs SW8260	PAHs SW8270D SIM	Chlorophenols SW8041	Total Petroleum Hydrocarbons - Gasoline Extended NWTPH-Gx	Total Petroleum Hydrocarbons - Diesel Extended NWTPH-Dx	Select Metals EPA 200.8	Hexavalent Chromium EPA A3500	Mercury SW7470A	Organo-chlorinated Pesticides SW8081	PCB Aroclors SW8082
Phase 5 Quarterly Groundwater Monitoring - February 2011	MW-23	MW-23_110209	--	2/09/11	X					X			X		X	X	X
	MW-28	MW-28_110208	--	2/08/11	X	X	X	X	X	X		X	X		X		X
	MW-29	MW-29_110208	--	2/08/11	X	X	X	X	X	X		X	X		X	X	X
	MW-51	MW-51_110211	--	2/11/11	X	X	X		X	X			X		X		X
	MW-52	MW-52_110209	--	2/09/11			X		X	X			X		X	X	
	MW-53	MW-53_110211	--	2/11/11		X	X		X	X			X		X	X	X
	MW-54	MW-54_110210	--	2/10/11		X	X		X	X			X		X	X	X
	MW-55	MW-55_110210	--	2/10/11		X	X		X	X			X		X		X
	MW-56	MW-56_110211	--	2/11/11	X		X		X	X			X		X	X	X
	MW-57	MW-57_110211	--	2/11/11	X								X		X	X	
	MW-58	MW-58_110211	--	2/11/11	X	X	X		X	X			X		X	X	X
	MW-59	MW-59_110210	--	2/10/11	X		X		X	X			X		X	X	X
	MW-60	MW-60_110209	--	2/09/11		X	X		X	X		X	X		X		X
	MW-61	MW-61_110211	--	2/11/11	X	X	X		X	X		X	X		X		X
	MW-62	MW-62_110210	--	2/10/11	X	X	X		X	X		X	X		X		X
	MW-63	MW-63_110208	--	2/08/11				X					X		X		
	MW-64	MW-64_110207	--	2/07/11		X							X		X	X	
	PZ-2	PZ-2_110207	--	2/07/11	X	X	X		X	X							X
	PZ-3	PZ-3_110210	--	2/10/11	X		X		X	X			X		X	X	X
	PZ-4	PZ-4_110208	--	2/08/11									X		X	X	X
	PZ-5	PZ-5_110208	--	2/08/11		X											
	PZ-6	PZ-6_110208	--	2/08/11									X		X	X	
	PZ-7	PZ-7_110208	--	2/08/11		X	X						X		X		
	PZ-9	PZ-9_110208	--	2/08/11	X		X	X	X	X			X		X		
	PZ-11	PZ-11_110208	--	2/08/11									X		X	X	X
	PZ-12	PZ-12_110207	--	2/07/11									X		X	X	
	PA-15	PA-15_110208	--	2/08/11									X		X	X	
	PA-17	PA-17_110211	--	2/11/11		X	X		X	X		X	X		X	X	X
	PA-19	PA-19_110209	--	2/09/11		X	X		X	X		X	X		X	X	X
	PA-23	PA-23_110207	--	2/07/11									X		X	X	
	PA-24	PA-24_110210	--	2/10/11	X	X	X		X	X			X		X	X	X

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Depth (feet bgs)	Sample Date	Ammonia EPA 350.1/350.3	Dioxins/ Furans EPA 1613	SVOCs (not including PAHs & Chlorophenols) SW8270	VOCs SW8260	PAHs SW8270D SIM	Chlorophenols SW8041	Total Petroleum Hydrocarbons - Gasoline Extended NWTPH-Gx	Total Petroleum Hydrocarbons - Diesel Extended NWTPH-Dx	Select Metals EPA 200.8	Hexavalent Chromium EPA A3500	Mercury SW7470A	Organo-chlorinated Pesticides SW8081	PCB Aroclors SW8082
Phase 5 Quarterly Groundwater Monitoring - May/June 2011	MW-23	MW-23-110519	--	5/19/11	X					X			X				
	MW-28	MW-28-110520	--	5/20/11	X			X	X			X	X		X		X
	MW-29	MW-29-110520	--	5/20/11	X		X	X	X	X		X	X		X		
	MW-51	MW-51-110519	--	5/19/11	X				X				X				
	MW-52	MW-52-110517	--	5/17/11		X							X				
	MW-53	MW-53-110518	--	5/18/11									X				
	MW-54	MW-54-110518	--	5/18/11					X				X		X		
	MW-55	MW-55-110519	--	5/19/11									X		X		
	MW-56	MW-56-110518	--	5/18/11	X								X		X		
	MW-57	MW-57-110520	--	5/20/11	X								X		X		
	MW-58	MW-58-110519	--	5/19/11	X								X		X		X
	MW-59	MW-59-110518	--	5/18/11	X								X		X		
	MW-60	MW-60-110519	--	5/19/11					X			X	X		X		
	MW-61	MW-61-110518	--	5/18/11	X							X	X				
	MW-62	MW-62-110518	--	5/18/11	X							X	X				
	MW-63	MW-63-110520	--	5/20/11				X					X		X		
	MW-64	MW-64-110517	--	5/17/11									X		X		
	MW-65	MW-65-110518	--	5/18/11	X	X	X		X	X		X	X		X		X
	MW-66	MW-66-110518	--	5/18/11	X		X		X	X			X		X		X
	MW-67	MW-67-110518	--	5/18/11	X		X		X	X		X	X		X		X
	MW-68	MW-68-110607	--	6/7/2011			X	X	X				X		X		
	MW-69	MW-69-110518	--	5/18/11		X	X		X	X	X	X	X		X		X
	MW-70	MW-70-110518	--	5/18/11		X	X		X	X	X	X	X		X		X
	PA-15	PA-15-110518	--	5/18/11									X				
	PA-17	PA-17-110517	--	5/17/11									X		X		
	PA-19	PA-19-110518	--	5/18/11								X	X		X		X
	PA-23	PA-23-110517	--	5/17/11									X				
	PA-24	PA-24-110518	--	5/18/11	X	X							X				
	PZ-2	PZ-02-110517	--	5/17/11	X												X
	PZ-3	PZ-03-110519	--	5/19/11	X		X		X	X			X		X		
	PZ-4	PZ-04-110517	--	5/17/11									X		X		X
	PZ-6	PZ-06-110517	--	5/17/11									X		X		
	PZ-7	PZ-07-110517	--	5/17/11			X						X		X		
	PZ-9	PZ-09-110520	--	5/20/11	X			X					X		X		
	PZ-11	PZ-11-110517	--	5/17/11									X		X		
	PZ-12	PZ-12-110517	--	5/17/11									X		X		

Notes:

SVOCs = Semivolatile organic compounds

PAHs = Polycyclic aromatic hydrocarbons

VOCs = Volatile organic compounds

PCB = Polychlorinated biphenyl

Table 4

Supplemental Upland Investigation Sampling and Analytical Testing Summary – Surface Water

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Supplemental Upland Investigation Phase	Sample Location	Sample ID	Sample Date	Dioxins/ Furans	Ammonia	SVOCs (not including PAHs & Chlorophenols)	PAHs	Chlorophenols	Total Petroleum Hydrocarbons - Gasoline Extended	Total Petroleum Hydrocarbons - Diesel Extended	Select Metals	Mercury	Organo-chlorinated Pesticides	PCB Aroclors
				EPA 1613	EPA 350.1	SW8270	SW8270D SIM	SW8041	NWTPH-Gx	NWTPH-Dx	EPA 200.8	SW7470A	SW8081	SW8082
Phase 1 Surface Water Sampling (August 2010)	SW-1	SW-1_100826	8/26/10	X	X	X	X	X	X	X	X	X	X	X
	SW-2	SW-2_100826	8/26/10	X	X	X	X	X	X	X	X	X	X	X
	SW-3	SW-3_100826	8/26/10	X	X	X	X	X	X	X	X	X	X	X
	SW-4	SW-4_100827	8/27/10	X	X	X	X	X	X	X	X	X	X	X
	SW-5	SW-5_100827	8/27/10	X	X	X	X	X	X	X	X	X	X	X

Notes:

SVOCs = Semivolatile organic compounds

PAHs = Polycyclic aromatic hydrocarbons

PCB = Polychlorinated biphenyl

Table 5

Construction Data for Existing Groundwater Monitoring Wells

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Monitoring Well	Horizontal Coordinates		Ground Elevation (feet NGVD 29)	Casing Elevation (feet NGVD 29)	Screened Interval (feet bgs)		Installed By (Owner (Consultant))	Date Installed
	Northing (a)	Easting (a)			Top of Screen	Bottom of Screen		
MW-23	417783	1011276	12.9	11.10 (b)	4.0	13.0	Rayonier (Landau Associates)	2/21/1991
MW-28	417745	1011088	10.40	9.79	5.0	15.3	Rayonier (Landau Associates)	6/12/1991
MW-29	417791	1011174	11.38	10.88 (b)	5.1	15.5	Rayonier (Landau Associates)	6/12/1991
MW-51	418288	1011799	--	13.36	13.0	23.0	Rayonier (Landau Associates)	2/26/1998
MW-52	417610	1010635	--	14.10	13.0	23.0	Rayonier (Landau Associates)	2/25/1998
MW-53	417990	1011135	9.4	11.91	8.0	14.0	Rayonier (Landau Associates)	2/14/2001
MW-54	418173	1011250	10.9	13.59	7.0	23.0	Rayonier (Landau Associates)	2/14/2001
MW-55	418282	1011322	10.0	13.84	9.5	27.5	Rayonier (Landau Associates)	2/13/2001
MW-56	418194	1012044	10.6	10.86	12.0	32.0	Rayonier (Landau Associates)	2/14/2001
MW-57	418069	1011468	12.06	14.06	5.0	30.0	Rayonier (Landau Associates)	11/21/2002
MW-58	417926	1011911	10.05	12.05	5.0	20.0	Rayonier (Landau Associates)	11/21/2002
MW-59	417190	1013376	12.02	14.02	4.0	19.0	Rayonier (Landau Associates)	11/22/2002
MW-60	417636	1011053	10.57	10.11	6.0	21.0	Rayonier (GeoEngineers)	10/19/2010
MW-61	417720	1010873	9.75	9.50	6.0	21.0	Rayonier (GeoEngineers)	10/19/2010
MW-62	418060	1012203	11.36	10.90	6.0	20.0	Rayonier (GeoEngineers)	10/20/2010
MW-63	417728	1011165	11.91	11.54	5.0	25.0	Rayonier (GeoEngineers)	10/21/2010
MW-64	415231	1012869	53.75	52.96	5.0	20.0	Rayonier (GeoEngineers)	10/18/2010
MW-65	417791	1012154	8.40	7.94	4.0	26.0	Rayonier (GeoEngineers)	3/10/2011
MW-66	418101	1011805	10.24	9.90	7.0	27.4	Rayonier (GeoEngineers)	3/9/2011
MW-67	417834	1011067	8.26	7.99	4.4	24.4	Rayonier (GeoEngineers)	3/9/2011
MW-68	417714	1011128	11.52	14.31	53.2	58.2	Rayonier (GeoEngineers)	5/18/2011
MW-69	417454	1012063	8.44	8.16	4.0	24.0	Rayonier (GeoEngineers)	5/7/2011
MW-70	417324	1012249	12.67	15.04	4.0	24.0	Rayonier (GeoEngineers)	5/6/2011
PZ-2	417932	1011234	11.13	10.77 (b)	4.0	19.0	Rayonier (Harding Lawson)	8/5/1993
PZ-3	418244	1011484	10.77	10.60 (b)	4.0	19.0	Rayonier (Harding Lawson)	8/4/1993
PZ-4	417726	1011547	9.07	8.81 (b)	4.0	19.0	Rayonier (Harding Lawson)	8/9/1993
PZ-5	417284	1012067	10.13	9.91 (b)	4.0	14.0	Rayonier (Harding Lawson)	8/10/1993
PZ-6	416878	1011841	15.43	15.26 (b)	4.0	14.0	Rayonier (Harding Lawson)	8/2/1993
PZ-7	417068	1012258	20.73	20.49 (b)	4.5	19.5	Rayonier (Harding Lawson)	8/3/1993
PZ-9	417397	1012941	9.58	9.26 (b)	3.5	21.5	Rayonier (Harding Lawson)	8/5/1993
PZ-10	417164	1012938	10.60	10.33 (b)	4.0	19.0	Rayonier (Harding Lawson)	8/10/1993
PZ-11	416754	1012559	28.20	27.91 (b)	6.0	15.0	Rayonier (Harding Lawson)	8/3/1993
PZ-12	416547	1012281	30.51	30.21 (b)	7.0	22.0	Rayonier (Harding Lawson)	8/10/1993
PZ-13	416876	1013854	10.68	11.60 (b)	4.0	19.0	Rayonier (Harding Lawson)	8/6/1993
PA-1	417533	1010686	12.62	12.54	20.0	30.0	City of Port Angeles (Shannon & Wilson)	8/17/2006
PA-2	416756	1011871	17.20	16.91	70.0	80.0	City of Port Angeles (Shannon & Wilson)	8/18/2006
PA-15	417517	1011503	12.10	11.72	10.0	15.0	City of Port Angeles (Shannon & Wilson)	8/19/2009
PA-17	417455	1012067	8.31	8.21	40.0	50.0	City of Port Angeles (Shannon & Wilson)	8/19/2009
PA-19	417221	1012402	12.22	11.64	10.0	15.0	City of Port Angeles (Shannon & Wilson)	8/21/2009
PA-21	416717	1012637	29.99	29.76	10.0	15.0	City of Port Angeles (Shannon & Wilson)	8/21/2009
PA-23	416115	1012515	39.67	39.28	20.0	30.0	City of Port Angeles (Shannon & Wilson)	8/24/2009
PA-24	417573	1012615	8.58	8.39	10.0	15.0	City of Port Angeles (Shannon & Wilson)	8/24/2009

Notes:

Monitoring wells listed are constructed of 2-inch diameter PVC, except monitoring wells MW-51 and MW-52, which are constructed of 4-inch diameter PVC.

(a) Coordinates listed are relative to the Washington State Plane Coordinate System of 1983, North Zone [NAD 83(91)]. Surveys conducted by Northwestern Territories, Inc.

(b) Casing elevation based on 2001 survey data, not data on original boring/well logs.

bgs = Below ground surface.

feet NGVD 29 = Feet above National Geodetic Vertical Datum of 1929.

-- = Information not available.

Table 6

Groundwater Elevation Data

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Well ID	8/16/1993		8/16/1993		2/25/1997		2/25/1997		8/27/1997		2/21/2001		8/20/2001		12/11/2002		6/17/2003		8/28/2010		11/12/2010		2/11/2011		3/11/2011		5/17/2011		6/7/2011		7/8/2011	
	high tide		low tide		low tide		high tide		high tide		high tide		low tide		low tide		low tide		Approximate Tidal Elevation Range: 0.0 to -1.6		Approximate Tidal Elevation Range: +5.7 to +4.9		Approximate Tidal Elevation Range: +2.3 to +1.5		Approximate Tidal Elevation Range: -1.5 to -0.6		Approximate Tidal Elevation Range: -6.5 to -4.0		Approximate Tidal Elevation: -4.2		Approximate Tidal Elevation: -0.9	
	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation	DTW	Elevation
MW-23	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	6.95	4.15	8.52	2.58	7.71	3.39	8.13	2.97	8.45	2.65	7.40	3.70	6.47	4.63	NM	NM	6.65	4.45	NM	NM	NM	NM
MW-28	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	6.62	3.17	7.90	1.89	6.64	3.15	NM	NM	7.86	1.93	6.80	2.99	6.32	3.47	NM	NM	NM	NM	NM	NM	7.40	2.39
MW-29	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	7.20	3.68	8.86	2.02	7.27	3.61	8.47	2.41	9.02	1.86	7.90	2.98	7.43	3.45	NM	NM	6.60	4.28	NM	NM	NM	NM
MW-51	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	10.78	2.58	14.53	-1.17	11.51	1.85	14.69	-1.33	13.20	0.16	11.76	1.60	11.11	2.25	NM	NM	14.23	-0.87	NM	NM	NM	NM
MW-52	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	10.80	3.30	11.64	2.46	10.87	3.23	11.42	2.68	11.68	2.42	10.93	3.17	10.51	3.59	NM	NM	10.31	3.79	NM	NM	NM	NM
MW-53	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	9.87	2.04	10.80	1.11	9.47	2.44	10.77	1.14	11.06	0.85	10.16	1.75	10.18	1.73	NM	NM	10.06	1.85	NM	NM	NM	NM
MW-54	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	11.43	2.16	12.39	1.20	10.90	2.69	12.12	1.47	12.65	0.94	11.58	2.01	9.18	4.41	NM	NM	12.21	1.38	NM	NM	NM	NM
MW-55	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	11.91	1.93	13.29	0.55	11.60	2.24	13.74	0.10	13.62	0.22	12.36	1.48	12.07	1.77	NM	NM	13.36	0.48	NM	NM	NM	NM
MW-56	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	8.22	2.64	10.02	0.84	8.08	2.78	9.72	1.14	9.64	1.22	8.77	2.09	8.37	2.49	NM	NM	9.12	1.74	NM	NM	NM	NM
MW-57	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	10.87	3.19	13.22	0.84	12.50	1.56	11.49	2.57	10.77	3.29	NM	NM	12.36	1.70	NM	NM	NM	NM
MW-58	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	8.36	3.69	9.24	2.81	9.71	2.34	8.87	3.18	8.35	3.70	NM	NM	8.41	3.64	NM	NM	NM	NM
MW-59	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	11.01	3.01	12.90	1.12	12.68	1.34	11.82	2.20	11.91	2.11	NM	NM	12.06	1.96	NM	NM	NM	NM
MW-60	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	5.96	4.15	4.94	5.17	NM	NM	4.95	5.16	NM	NM	NM	NM
MW-61	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.52	2.98	6.22	3.28	NM	NM	6.27	3.23	NM	NM	NM	NM
MW-62	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	8.44	2.46	8.58	2.32	NM	NM	8.00	2.90	NM	NM	NM	NM
MW-63	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	7.94	3.60	7.01	4.53	NM	NM	7.33	4.21	NM	NM	7.38	4.16
MW-64	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.78	46.18	6.57	46.39	NM	NM	5.80	47.16	NM	NM	NM	NM
MW-65	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	4.71	3.23	4.98	2.96	NM	NM	NM	NM
MW-66	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.80	3.10	7.53	2.37	NM	NM	NM	NM
MW-67	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	5.16	2.83	5.55	2.44	NM	NM	NM	NM
MW-68	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	12.80	1.51	11.95	2.36
MW-69	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2.79	5.37	NM	NM	NM	NM
MW-70	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	7.43	7.61	NM	NM	NM	NM
PZ-2	7.07	3.70	7.36	3.41	NM	NM	7.90	2.87	7.84	2.93	8.23	2.54	9.12	1.65	8.14	2.63	NM	NM	9.30	1.47	8.32	2.45	7.93	2.84	NM	NM	7.96	2.81	NM	NM	NM	NM
PZ-3	8.39	2.21	9.91	0.69	9.46	1.14	8.66	1.94	8.95	1.65	8.30	2.30	9.61	0.99	8.21	2.39	9.72	0.88	9.68	0.92	8.73	1.87	8.59	2.01	NM	NM	9.28	1.32	NM	NM	NM	NM
PZ-4	3.35	5.46	3.39	5.42	3.22	5.59	3.21	5.60	4.13	4.68	4.08	4.73	5.97	2.84	5.13	3.68	NM	NM	6.02	2.79	4.90	3.91	3.83	4.98	NM	NM	3.91	4.90	NM	NM	NM	NM
PZ-5	4.00	5.91	4.01	5.90	3.69	6.22	3.72	6.19	3.93	5.98	3.86	6.05	4.56	5.35	4.25	5.66	4.21	5.70	4.01	5.90	3.37	6.54	3.29	6.62	NM	NM	2.68	7.23	NM	NM	NM	NM
PZ-6	5.08	10.18	5.08	10.18	4.71	10.55	4.78	10.48	5.30	9.96	5.18	10.08	5.88	9.38	5.63	9.63	8.43	6.83	5.71	9.55	5.26	10.00	4.63	10.63	NM	NM	3.87	11.39	NM	NM	NM	NM
PZ-7	9.42	11.07	9.45	11.04	9.69	10.80	9.76	10.73	8.91	11.58	8.53	11.96	11.89	8.60	9.05	11.44	11.17	9.32	11.52	8.97	9.06	11.43	7.58	12.91	NM	NM	7.45	13.04	NM	NM	NM	NM
PZ-9	7.12	2.14	7.11	2.15	6.39	2.87	6.33	2.93	6.87	2.39	6.12	3.14	7.14	2.12	5.60	3.66	6.74	2.52	7.50	1.76	6.46	2.80	6.25	3.01	NM	NM	5.91	3.35	NM	NM	NM	NM
PZ-10	7.28	3.05	7.28	3.05	5.65	4.68	5.82	4.51	6.77	3.56	6.24	4.09	7.49	2.84	6.79	3.54	7.28	3.05	7.68	2.65	6.79	3.54	5.94	4.39	NM	NM	6.13	4.20	NM	NM	NM	NM
PZ-11	7.67	20.24	7.67	20.24	6.39	21.52	5.54	22.37	6.61	21.30	6.02	21.89	7.15	20.76	6.61	21.30	8.04	19.87	8.39	19.52	5.38	22.53	4.38	23.53	NM	NM	4.03	23.88	NM	NM	NM	NM
PZ-12	14.92	15.29	14.92	15.29	13.55	16.66	13.70	16.51	14.01	16.20	13.40	16.81	15.89	14.32	14.99	15.22	15.05	15.16	15.18	15.03	13.88	16.33	12.91	17.30	NM	NM	12.53	17.68	NM	NM	NM	NM
PZ-13	10.47	1.13	NM	NM	Dry	Dry	10.01	1.59	10.39	1.21	8.92	2.68	Dry	Dry	8.94	2.66	Dry	Dry	Dry - AD	Dry - AD	Dry- AD	Dry - AD	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
PA-1	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	NM	NM	NM	NM	NM	NM	7.47	5.07	NM	NM	NM	NM
PA-2	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	NM	NM	NM	NM	NM	NM	8.80	8.11	NM	NM	NM	NM
PA-15	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	6.63	5.09	5.28	6.44	NM	NM	4.93	6.79	NM	NM	NM	NM
PA-17	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	NM	NM	4.11	4.10	NM	NM	3.90	4.31	NM	NM	NM	NM
PA-19	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.34	5.30	3.71	7.93	1.85	9.79	NM	NM	1.63	10.01	NM	NM	NM	NM
PA-21	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	NM	NM	5.21	24.55	NM	NM	4.88	24.88	NM	NM	NM	NM
PA-23	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	7.67	31.61	7.30	31.98	NM	NM	6.93	32.35	NM	NM	NM	NM
PA-24	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NM	NM	5.82	2.57	6.02	2.37	NM	NM	4.84	3.55	NM	NM	NM	NM

Notes:

DTW = Depth to groundwater (in feet below top of well casing).

Groundwater and tidal elevations are in feet referenced to National Geodetic Vertical Datum of 1929 (NGVD 29). Groundwater elevations are calculated by subtracting depth to groundwater from surveyed well casing elevation.

-- = Information not available.

NP = Well was not present on the monitoring date (not yet installed).

NM = Water level not measured.

Dry = Groundwater not present in well.

AD = Apparent damage to well (casing appeared to be approximately half-full of filter pack sand).

Table 7

Estimated Hydraulic Conductivity for Selected Monitoring Wells

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report

Port Angeles, Washington

Well	Hydraulic Conductivity (cm/s)	Hydrogeologic Unit
MW-20	8.90E-03	Fill
MW-51	1.40E-04	Fill
MW-53	4.38E-03	Fill
MW-56	1.67E-03	Fill
PZ-2	3.28E-03	Fill and intertidal deposits
PZ-4	1.20E-04	Fill and intertidal deposits
PZ-10	2.80E-03	Fill
PZ-12	1.42E-03	Fill
Mean	2.80E-03	Fill
Standard Deviation	2.90E-03	Fill

Notes:

cm/s = Centimeters per second

Hydraulic conductivity was estimated using the Bower and Rice Method.

Source: Integral 2007

Table 8

Soil Screening Levels

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report
Port Angeles, Washington

Analyte	Soil Concentration Protective of Groundwater as Marine Surface Water (MTCA Fixed Parameter Three-Phase Partitioning Model) mg/kg	Human Health Direct Contact Pathway (MTCA Method B Standard Formula Value for Unrestricted Land Use) Carcinogen mg/kg	Human Health Direct Contact Pathway (MTCA Method B Standard Formula Value for Unrestricted Land Use) Non-Carcinogen mg/kg	Ecological Indicator Soil Concentration for Protection of Terrestrial Plants and Animals (MTCA Table 749-3) mg/kg	Preliminary Screening Level (Before adjustment for background) mg/kg	Background Concentration (f) mg/kg	Preliminary Screening Level (After adjustment for background) mg/kg	PQL (e) mg/kg	Soil Screening Level (After adjustment for background and PQL) mg/kg
TPH									
Gasoline-Range Petroleum Hydrocarbons	30 (b,c)	–	30 (b,c)	100	30	–	30	5	30
Diesel-Range Petroleum Hydrocarbons	2,000 (b)	–	2,000 (b)	200	200	–	200	5	200
Heavy Oil-Range Petroleum Hydrocarbons	2,000 (b)	–	2,000 (b)	200	200	–	200	10	200
Metals									
Aluminum	NE	–	–	50	50	32,600	32,600	5.0	32,600
Antimony	580	–	32	5	5	5 (j)	5	0.2	5
Arsenic	0.057	0.67	24	7	0.057	20 (g)	20	0.2	20
Barium	NE	–	16,000	102	102	–	102	0.3	102
Beryllium	4,300	–	160	10	10	0.6	10	0.1	10
Cadmium	1.2	–	80	4	1.2	1	1.2	0.20	1.2
Chromium III	4,800,000	–	120,000	–	120,000	48 (d)	120,000	2 (d)	120,000
Chromium VI	19	–	240	–	19	–	19	5.0	19
Chromium (Total)	NE	–	–	42	42	48	48	2	48
Cobalt	NE	–	–	20	20	–	20	0.3	20
Copper	1.1	–	3,000	50	1.1	50 (k)	50	0.20	50
Lead	1,600	–	250 (b)	50	50	17	50	1.0	50
Manganese	130 (a)	–	11,000	1,100	130	1,200	1,200	0.10	1,200
Mercury	0.026	–	24	0.1	0.026	0.07	0.07	0.020	0.07
Nickel	11	–	1,600	30	11	48	48	0.50	48
Selenium	7.4	–	400	0.3	0.3	–	0.3	0.2 (h)	0.3
Silver	0.32	–	400	2	0.32	0.61 (j)	0.61	0.20	0.61
Thallium	0.67	–	5.6	1	0.67	–	0.67	0.20	0.67
Vanadium	NE	–	560	2	2	297 (l)	297	0.20	297
Zinc	100	–	24,000	86	86	85	86	1.0	86
VOCs									
1,1,1-Trichloroethane	3,300	–	72,000	–	3,300	–	3,300	0.001	3,300
1,1,2,2-Tetrachloroethane	0.022	5	–	–	0.022	–	0.022	0.001	0.022
1,1,2-Trichloroethane	0.089	18	320	–	0.089	–	0.089	0.001	0.089
1,1-Dichloroethane	NE	–	16,000	–	16,000	–	16,000	0.001	16,000
1,1-Dichloroethene	0.023	–	4,000	–	0.023	–	0.023	0.001	0.023
1,2-Dichloroethane	0.18	11	1,600	–	0.18	–	0.18	0.001	0.18
1,2-Dichloroethene	NE	–	720	–	720	–	720	0.001	720
1,2-Dichloropropane	0.077	15	–	700	0.077	–	0.077	0.001	0.077
1,3-Dichloropropene (cis-, trans-)	0.11	5.6	2,400	–	0.11	–	0.11	0.001	0.11
2-Butanone (MEK)	NE	–	48,000	–	48,000	–	48,000	0.005	48,000
4-Methyl-2-Pentanone (MIBK)	NE	–	6,400	–	6,400	–	6,400	0.005	6,400
Acetone	NE	–	8,000	–	8,000	–	8,000	0.005	8,000
Benzene	0.13	18	320	–	0.13	–	0.13	0.001	0.13
Bromodichloromethane	0.089	16	1,600	–	0.089	–	0.089	0.001	0.089
Bromoform	0.92	130	1,600	–	0.92	–	0.92	0.001	0.92
Bromomethane	4.5	–	110	–	4.5	–	4.5	0.001	4.5
Carbon Disulfide	NE	–	8,000	–	8,000	–	8,000	0.001	8,000
Carbon Tetrachloride	0.015	7.7	56	–	0.015	–	0.015	0.001	0.015
Chlorobenzene	14	–	1,600	40	14	–	14	0.001	14
Chloroethane	NE	350	32,000	–	350	–	350	0.001	350
Chloroform	1.5	160	800	–	1.5	–	1.5	0.001	1.5
Chloromethane	0.62 (a)	77	–	–	0.62	–	0.62	0.001	0.62
cis-1,2-Dichloroethene	NE	–	800	–	800	–	800	0.001	800
Dibromochloromethane	0.069	12	1,600	–	0.069	–	0.069	0.001	0.069
Ethylbenzene	18	–	8,000	–	18	–	18	0.001	18
methyl tert-butyl ether (MTBE)	NE	560	69,000	–	560	–	560	0.001	560
Methylene Chloride (Dichloromethane)	2.6	130	4,800	–	2.6	–	2.6	0.002	2.6
Styrene	NE	33	16,000	300	33	–	33	0.001	33
Toluene	110	–	6,400	200	110	–	110	0.001	110
Total Xylenes	9.1	–	16,000	–	9.1	–	9.1	0.001	9.1
Tetrachloroethene (PCE)	0.0041	1.9	800	–	0.0041	–	0.0041	0.001	0.0041
trans-1,2-Dichloroethene	54	–	1,600	–	54	–	54	0.001	54
Trichloroethene (TCE)	0.044	11	24	–	0.044	–	0.044	0.001	0.044
Vinyl Acetate	NE	–	80,000	–	80,000	–	80,000	0.005	80,000
Vinyl chloride	0.015	0.67	240	–	0.015	–	0.015	0.001	0.015
PAHs									
Acenaphthene	65	–	4,800	20	20	–	20	0.0050	20
Anthracene	12,000	–	24,000	–	12,000	–	12,000	0.0050	12,000
Dibenzofuran	NE	–	160	–	160	–	160	0.0050	160
Fluoranthene	89	–	3,200	–	89	–	89	0.0050	89
Fluorene	550	–	3,200	30	30	–	30	0.0050	30
2-Methylnaphthalene	NE	–	320	–	320	–	320	0.0050	320
Naphthalene	140	–	1,600	–	140	–	140	0.0050	140
Pyrene	3,500	–	2,400	–	2,400	–	2,400	0.0050	2,400
Total cPAHs TEC	0.35	0.14	–	12	0.14	–	0.14	0.0038	0.14

Analyte	Soil Concentration Protective of Groundwater as Marine Surface Water (MTCA Fixed Parameter Three-Phase Partitioning Model) mg/kg	Human Health Direct Contact Pathway (MTCA Method B Standard Formula Value for Unrestricted Land Use) Carcinogen mg/kg	Human Health Direct Contact Pathway (MTCA Method B Standard Formula Value for Unrestricted Land Use) Non-Carcinogen mg/kg	Ecological Indicator Soil Concentration for Protection of Terrestrial Plants and Animals (MTCA Table 749-3) mg/kg	Preliminary Screening Level (Before adjustment for background) mg/kg	Background Concentration (f) mg/kg	Preliminary Screening Level (After adjustment for background) mg/kg	PQL (e) mg/kg	Soil Screening Level (After adjustment for background and PQL) mg/kg
SVOCs									
1,2,4-Trichlorobenzene	2.6	–	800	20	2.6	–	2.6	0.020	2.6
1,2-Dichlorobenzene	15	–	7,200	–	15	–	15	0.020	15
1,3-Dichlorobenzene	11 (a)	–	–	–	11	–	11	0.020	11
1,4-Dichlorobenzene	0.080	42	–	20	0.080	–	0.080	0.020	0.080
2,6-Dinitrotoluene	NE	–	80	–	80	–	80	0.100	80
2,4,5-Trichlorophenol	130	–	8,000	4	4	–	4	0.1	4
2,4,6-Trichlorophenol	0.028	91	–	10	0.028	–	0.028	0.00625 (i)	0.028
2,4-Dichlorophenol	1.3	–	240	–	1.3	–	1.3	0.1	1.3
2,4-Dimethylphenol	4.5	–	1,600	–	4.5	–	4.5	0.020	4.5
2,4-Dinitrophenol	14	–	160	20	14	–	14	0.2	14
2,4-Dinitrotoluene	0.020	–	160	–	0.020	–	0.020	0.1	0.1
2-Chloronaphthalene	54 (a)	–	6,400	–	54	–	54	0.020	54
2-Chlorophenol	1.1	–	400	–	1.1	–	1.1	0.020	1.1
2-Methylphenol	NE	–	4,000	–	4,000	–	4,000	0.020	4,000
3,3'-Dichlorobenzidine	0.00052	2.2	–	–	0.00052	–	0.00052	0.1	0.1
4-Chloroaniline	NE	–	320	–	320	–	320	0.100	320
4-Methylphenol	NE	–	400	–	400	–	400	0.020	400
Benzyl alcohol	NE	–	24,000	–	24,000	–	24,000	0.020	24,000
Bis(2-chloro-1-methylethyl) ether	0.21	14	–	–	0.21	–	0.21	0.020	0.21
bis(2-Chloroethyl)ether	0.0029	0.91	–	–	0.0029	–	0.0029	0.020	0.020
bis(2-Chloroisopropyl) ether	240 (a)	–	3,200	–	240	–	240	0.020	240
bis (2-ethylhexyl) Phthalate	4.9	71	1,600	–	4.9	–	4.9	0.020	4.9
Butylbenzylphthalate	360	–	16,000	–	360	–	360	0.020	360
Carbazole	NE	50	–	–	50	–	50	0.020	50
Diethylphthalate	160	–	64,000	100	100	–	100	0.020	100
Dimethylphthalate	330 (a)	–	80,000	200	200	–	200	0.020	200
Di-n-butylphthalate	100	–	8,000	200	100	–	100	0.020	100
Di-n-octylphthalate	NE	–	1,600	–	1,600	–	1,600	0.020	1,600
Hexachlorobutadiene	19	13	16	–	13	–	13	0.020	13
Hexachlorocyclopentadiene	4400	–	480	10	10	–	10	0.1	10
Hexachloroethane	0.13	71	80	–	0.13	–	0.13	0.020	0.13
Isophorone	3.0	1,100	16,000	–	3.0	–	3.0	0.020	3.0
Nitrobenzene	2.9	–	40	40	2.9	–	2.9	0.020	2.9
N-Nitroso-di-n-propylamine	0.0023	0.14	–	–	0.0023	–	0.0023	0.1	0.1
N-Nitrosodiphenylamine	0.18	200	–	20	0.18	–	0.18	0.020	0.18
Pentachlorophenol	0.048	8.3	2,400	3	0.048	–	0.048	0.00625 (i)	0.048
Phenol	5,000	–	48,000	30	30	–	30	0.020	30
Dioxins/Furans									
Total Dioxins/Furans TEC	2.5E-08 (a)	1.1E-05	–	2.0E-06	2.5E-08	5.2E-06	5.2E-06	5.7E-07	5.2E-06
PCBs									
Total PCBs (sum of Aroclors)	0.00040 (a)	0.5	–	0.65	0.00040	–	0.00040	0.004	0.004
Pesticides									
Aldrin	0.000049	0.059	2.4	0.1	0.000049	–	0.000049	0.0010	0.0010
alpha-BHC	0.00029 (a)	0.16	–	–	0.00029	–	0.00029	0.0010	0.0010
alpha-Chlordane*	0.00080 (a)	2.9	40	1	0.00080	–	0.00080	0.0010	0.0010
beta-BHC	0.00080	0.56	–	–	0.00080	–	0.00080	0.0010	0.0010
4,4'-DDD	0.00029	4.2	–	0.75	0.00029	–	0.00029	0.0020	0.0020
4,4'-DDE	0.00038	2.9	–	0.75	0.00038	–	0.00038	0.0020	0.0020
4,4'-DDT	0.0030	2.9	40	0.75	0.0030	–	0.0030	0.0020	0.0030
Dieldrin	0.000028	0.063	4	0.07	0.000028	–	0.000028	0.0020	0.0020
Endosulfan I**	0.0012 (a)	–	480	–	0.0012	–	0.0012	0.0010	0.0012
Endosulfan II**	0.0012 (a)	–	480	–	0.0012	–	0.0012	0.0020	0.0020
Endosulfan Sulfate**	0.0017 (a)	–	480	–	0.0017	–	0.0017	0.0020	0.0020
Endrin	0.00051	–	24	0.2	0.00051	–	0.00051	0.0020	0.0020
Endrin Aldehyde***	0.00016 (a)	–	24	0.2	0.00016	–	0.00016	0.0020	0.0020
Endrin Ketone***	0.00046 (a)	–	24	0.2	0.00046	–	0.00046	0.0020	0.0020
gamma-BHC (Lindane)	0.0012	0.77	24	6	0.0012	–	0.0012	0.0010	0.0012
gamma-Chlordane*	0.00080 (a)	2.9	40	1	0.00080	–	0.00080	0.0010	0.0010
Heptachlor	0.000015	0.22	40	0.4	0.000015	–	0.000015	0.0010	0.0010
Heptachlor epoxide	0.000065	0.11	1.0	0.4	0.000065	–	0.000065	0.0010	0.0010
Hexachlorobenzene	0.00047	0.63	64	17	0.00047	–	0.00047	0.0010	0.0010
Methoxychlor	0.048	–	400	–	0.048	–	0.048	0.010	0.048
Toxaphene	0.00038	0.91	–	–	0.00038	–	0.00038	0.10	0.10

Notes:

- Screening levels were developed for all constituents analyzed in soil.
- Screening level is based on lowest of soil concentrations protective of groundwater, human health - direct contact (MTCA Method B standard formula values for carcinogens and non-carcinogens), and terrestrial plants and animals, adjusted for background and practical quantification limit (PQL).
- Calculated concentrations protective of groundwater as marine surface water assume unsaturated soil, and are calculated based on groundwater screening levels before adjustment for background and PQLs.
- Shading indicates basis for screening level.

– = No screening criteria available.
mg/kg = Millgrams per kilogram
NE = No surface water criterion exists; therefore, soil concentration protective of groundwater as marine surface water was not calculated.
MTCA = Washington State Model Toxics Control Act
PAHs = Polycyclic aromatic hydrocarbons
cPAHs = Carcinogenic polycyclic aromatic hydrocarbons
PCBs = Polychlorinated biphenyls
PQL = Practical quantitation limit
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
TEC = Toxic equivalent concentration
TPH = Total petroleum hydrocarbons

(a) Values for Kd and/or K_{OC} and/or Henry's Law Constant are not available from CLARC; these values were taken from EPIWIN or ORNL RAIS.
(b) MTCA Method A soil cleanup levels are used for gasoline-range, diesel-range, and heavy oil-range petroleum hydrocarbons, and lead.
(c) Value for gasoline-range petroleum hydrocarbons if benzene is present. If benzene is not present, screening level is 100 mg/kg.
(d) Value is for total chromium.
(e) PQL is lowest available value from Analytical Resources, Inc. (Tukwila, WA) or Frontier Analytical Laboratory (El Dorado Hills, CA).
(f) Unless indicated otherwise, metals background values are Puget Sound Region 90th percentile values from *Natural Background Soil Metals Concentrations in Washington State* (Ecology Publication #94-115, 1994). Total dioxins/furans TEC background value was provided by Ecology in review comments on the April 1, 2010 Draft Supplemental Upland Data Collection Work Plan.
(g) Regulatory background (MTCA Method A) value.
(h) PQL for EPA Method 7740.
(i) PQL for EPA Method 8041.
(j) Statewide 90th percentile background value from Ecology Publication #94-115, 1994. This background value differs from the value in the Supplemental Upland Data Collection Work Plan. Ecology agreed to this value in their review comments on Rayonier's 9/30/11 Draft Materials Management Plan prepared for the City's CSO project.
(k) Site-specific background concentration. This background value differs from the value in the Supplemental Upland Data Collection Work Plan. Ecology agreed to this value in their review comments on Rayonier's 9/30/11 Draft Materials Management Plan prepared for the City's CSO project.
(l) Calculated natural background concentration for Western Washington; source: Appendix F of *Terrestrial Ecological Evaluation For the Uplands Environment at The Former Rayonier Mill Site, Port Angeles, Washington* (Malcolm Pirnie, 2007a). This background value differs from the value in the Supplemental Upland Data Collection Work Plan.

* Chlordane values used for alpha- and gamma-chlordane.
** Endosulfan values used for endosulfan I, endosulfan II, and endosulfan sulfate.
*** Endrin values used for endrin aldehyde and endrin ketone.

Table 9

Groundwater Screening Levels

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report
Port Angeles, Washington

Analyte	Concentration Protective of Marine Surface Water										Preliminary Screening Level µg/L	PQL (g) µg/L	Groundwater Screening Level (After adjustment for PQL) µg/L
	AWQC for Protection of Aquatic Life (a)		National Toxics Rule (b)			National Recommended Water Quality Criteria (c)			MTCA Method B Standard Formula Value - Protection of Human Health (Consumption of Aquatic Life)				
			AWQC for Protection of Aquatic Life		AWQC for Protection of Human Health								
	Acute µg/L	Chronic µg/L	Acute µg/L	Chronic µg/L	µg/L	Protection of Aquatic Life - Acute µg/L	Protection of Aquatic Life - Chronic µg/L	Protection of Human Health µg/L	Carcinogen µg/L	Non-Carcinogen µg/L			
TPH													
Gasoline-Range Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	800 (d,e)	800	250	800
Diesel-Range Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	500 (d)	500	250	500
Heavy Oil-Range Petroleum Hydrocarbons	--	--	--	--	--	--	--	--	--	500 (d)	500	400	500
Metals													
Antimony	--	--	--	--	4,300	--	--	640	--	1,000	640	0.2	640
Arsenic	69	36	69	36	0.14	69	36	0.14	0.098	18	0.098	0.2	5 (i)
Beryllium	--	--	--	--	--	--	--	--	--	270	270	0.2	270
Cadmium	42	9.3	42	9.3	--	40	8.8	--	--	20	8.8	0.20	8.8
Chromium III	--	--	--	--	--	--	--	--	--	240,000	240,000	0.50 (f)	240,000
Chromium VI	1,100	50	1,100	50	--	1,100	50	--	--	490	50	20	50
Copper	4.8	3.1	2.4	2.4	--	4.8	3.1	--	--	2,700	2.4	0.50	2.4
Lead	210	8.1	210	8.1	--	210	8.1	--	--	--	8.1	1.0	8.1
Manganese	--	--	--	--	--	--	--	100	--	--	100	0.50	100
Mercury	1.8	0.025	2.1	0.025	0.15	1.8	0.94	0.3	--	--	0.025	0.020	0.025
Nickel	74	8.2	74	8.2	4,600	74	8.2	4,600	4,600	1,100	8.2	0.50	8.2
Phosphorus	--	--	--	--	--	--	0.10	--	--	--	0.10	16	16
Selenium	290	71	290	71	--	290	71	4,200	--	2,700	71	0.5	71
Silver	1.9	--	1.9	--	--	1.9	--	--	--	26,000	1.9	0.2	1.9
Thallium	--	--	--	--	6.3	--	--	0.47	--	1.6	0.47	0.2	0.47
Zinc	90	81	90	81	--	90	81	26,000	--	17,000	81	4.0	81
VOCs													
1,1-Dichloroethene	--	--	--	--	3.2	--	--	7,100	--	23,000	3.2	0.2	3.2
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	420,000	420,000	0.2	420,000
1,1,2-Trichloroethane	--	--	--	--	42	--	--	16	25	2,300	16	0.2	16
1,1,2,2-Tetrachloroethane	--	--	--	--	11	--	--	4	6.5	--	4	0.2	4
1,2-Dichloroethane	--	--	--	--	99	--	--	37	59	43,000	37	0.2	37
1,2-Dichloropropane	--	--	--	--	--	--	--	15	23	--	15	0.2	15
1,3-Dichloropropene (cis-, trans-)	--	--	--	--	1,700	--	--	21	19	41,000	19	0.2	19
Acrolein	--	--	--	--	780	--	--	290	--	--	290	5.0	290
Acrylonitrile	--	--	--	--	0.66	--	--	0.25	0.4	86	0.25	1.0	1.0
Benzene	--	--	--	--	71	--	--	51	23	2,000	23	0.45	23
Bromodichloromethane	--	--	--	--	22	--	--	17	28	14,000	17	0.2	17
Bromoform	--	--	--	--	360	--	--	140	220	14,000	140	0.2	140
Bromomethane	--	--	--	--	4,000	--	--	1500	--	970	970	0.5	970

Analyte	Concentration Protective of Marine Surface Water										Preliminary Screening Level µg/L	PQL (g) µg/L	Groundwater Screening Level (After adjustment for PQL) µg/L
	AWQC for Protection of Aquatic Life (a)		National Toxics Rule (b)			National Recommended Water Quality Criteria (c)			MTCA Method B Standard Formula Value - Protection of Human Health (Consumption of Aquatic Life)				
	Acute µg/L	Chronic µg/L	AWQC for Protection of Aquatic Life Acute µg/L	AWQC for Protection of Aquatic Life Chronic µg/L	AWQC for Protection of Human Health µg/L	Protection of Aquatic Life - Acute µg/L	Protection of Aquatic Life - Chronic µg/L	Protection of Human Health µg/L	Carcinogen µg/L	Non-Carcinogen µg/L			
Carbon Tetrachloride	--	--	--	--	4.4	--	--	1.6	2.7	97	1.6	0.2	1.6
Chlorobenzene	--	--	--	--	21,000	--	--	1,600	--	5,000	1,600	0.2	1,600
Chloroform	--	--	--	--	470	--	--	470	280	6,900	280	0.2	280
Chloromethane	--	--	--	--	--	--	--	--	130	--	130	0.5	130
Dibromochloromethane	--	--	--	--	34	--	--	13	21	14,000	13	0.2	13
Ethylbenzene	--	--	--	--	29,000	--	--	2,100	--	6,900	2,100	0.42	2,100
Methylene Chloride (Dichloromethane)	--	--	--	--	1,600	--	--	590	960	170,000	590	0.5	590
Toluene	--	--	--	--	200,000	--	--	15,000	--	19,000	15,000	0.48	15,000
Total Xylenes	--	--	--	--	--	--	--	--	--	1,000 (d,f)	1,000	0.78	1,000
Tetrachloroethene (PCE)	--	--	--	--	8.9	--	--	3.3	0.39	840	0.39	0.20	0.39
trans-1,2-Dichloroethene	--	--	--	--	--	--	--	10,000	--	33,000	10,000	0.20	10,000
Trichloroethene (TCE)	--	--	--	--	81	--	--	30	6.7	71	6.7	0.20	6.7
Vinyl chloride	--	--	--	--	530	--	--	2.4	3.7	6600	2.4	0.20	2.4
PAHs													
Acenaphthene	--	--	--	--	--	--	--	990	--	640	640	1.0	640
Anthracene	--	--	--	--	110,000	--	--	40,000	--	26,000	26,000	1.0	26,000
Fluoranthene	--	--	--	--	370	--	--	140	--	90	90	1.0	90
Fluorene	--	--	--	--	14,000	--	--	5,300	--	3,500	3,500	1.0	3,500
Naphthalene	--	--	--	--	--	--	--	--	--	4,900	4,900	1.0	4,900
Pyrene	--	--	--	--	11,000	--	--	4,000	--	2,600	2,600	1.0	2,600
Total cPAHs TEC	--	--	--	--	0.031	--	--	0.018	0.030	--	0.018	0.0076	0.018
SVOCs													
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	70	--	230	70	1.0	70
1,2-Dichlorobenzene	--	--	--	--	17,000	--	--	1,300	--	4,200	1,300	1.0	1,300
1,3-Dichlorobenzene	--	--	--	--	2,600	--	--	960	--	--	960	1.0	960
1,4-Dichlorobenzene	--	--	--	--	2,600	--	--	190	4.9	--	4.9	1.0	4.9
2-Chloronaphthalene	--	--	--	--	--	--	--	1,600	--	1,000	1,000	1.0	1,000
2-Chlorophenol	--	--	--	--	--	--	--	--	--	97	97	1.0	97
2,4-Dichlorophenol	--	--	--	--	790	--	--	290	--	190	190	5.0	190
2,4-Dimethylphenol	--	--	--	--	--	--	--	850	--	550	550	1.0	550
2,4-Dinitrophenol	--	--	--	--	14,000	--	--	5,300	--	3,500	3,500	10.0	3,500
2,4-Dinitrotoluene	--	--	--	--	9.1	--	--	3.4	--	1,400	3.4	5.0	5.0
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	3,600	--	--	3,600	5.0	3,600
2,4,6-Trichlorophenol	--	--	--	--	6.5	--	--	2.4	3.9	--	2.4	0.25 (h)	2.4
3,3'-Dichlorobenzidine	--	--	--	--	0.077	--	--	0.028	0.046	--	0.028	5.0000	5.0
bis(2-Chloroethyl)ether	--	--	--	--	1.4	--	--	0.53	0.85	--	0.53	1.0	1.0
Bis(2-chloro-1-methylethyl) ether	--	--	--	--	--	--	--	--	37	--	37	1.0	37
bis(2-Chloroisopropyl) ether	--	--	--	--	--	170,000	--	65,000	--	42,000	42,000	1.0	42,000
Bis (2-ethylhexyl) Phthalate	--	--	--	--	5.9	--	--	2.2	3.6	400	2.2	1.0	2.2

Analyte	Concentration Protective of Marine Surface Water										Preliminary Screening Level µg/L	PQL (g) µg/L	Groundwater Screening Level (After adjustment for PQL) µg/L
	AWQC for Protection of Aquatic Life (a)		National Toxics Rule (b)			National Recommended Water Quality Criteria (c)			MTCA Method B Standard Formula Value - Protection of Human Health (Consumption of Aquatic Life)				
	Acute µg/L	Chronic µg/L	AWQC for Protection of Aquatic Life Acute µg/L	AWQC for Protection of Aquatic Life Chronic µg/L	AWQC for Protection of Human Health µg/L	Protection of Aquatic Life - Acute µg/L	Protection of Aquatic Life - Chronic µg/L	Protection of Human Health µg/L	Carcinogen µg/L	Non-Carcinogen µg/L			
Butylbenzylphthalate	--	--	--	--	--	--	--	1,900	--	1,300	1,300	1.0	1,300
Diethylphthalate	--	--	--	--	120,000	--	--	44,000	--	28,000	28,000	1.0	28,000
Di-n-butylphthalate	--	--	--	--	12,000	--	--	4,500	--	2,900	2,900	1.0	2,900
Hexachloroethane	--	--	--	--	8.9	--	--	3.3	5.3	30	3.3	1.0	3.3
Pentachlorophenol	13	7.9	13	7.9	8.2	13	7.9	3.0	4.9	7,100	3.0	0.25 (h)	3.0
Phenol	--	--	--	--	4,600,000	--	--	1,700,000	--	1,100,000	1,100,000	1.0	1,100,000
Dimethylphthalate	--	--	--	--	2,900,000	--	--	1100000	--	72,000	72,000	1.0	72,000
Hexachlorobutadiene	--	--	--	--	50	--	--	18	30	190	18	1.0	18
Hexachlorocyclopentadiene	--	--	--	--	17,000	--	--	1,100	--	3,600	1,100	5.0	1,100
Isophorone	--	--	--	--	600	--	--	960	1,600	120,000	600	1.0	600
Nitrobenzene	--	--	--	--	1,900	--	--	690	--	450	450	1.0	450
N-Nitroso-di-n-propylamine	--	--	--	--	--	--	--	0.51	0.82	--	0.51	1.0	1.0
N-Nitrosodiphenylamine	--	--	--	--	16	--	--	6	9.7	--	6	5.0	6
Dioxins/Furans													
Total Dioxins/Furans TEC	--	--	--	--	1.4E-08	--	--	5.1E-09	--	--	5.1E-09	5.7E-06	5.7E-06
PCBs													
Total PCBs (sum of Aroclors)	10	0.030	--	0.030	0.00017	--	0.030	0.000064	0.00011	--	0.000064	0.01	0.01
Pesticides													
Aldrin	0.71	0.0019	1.3	--	0.00014	1.3	--	0.000050	0.00008	0.017	0.000050	0.00083	0.00083
alpha-BHC	--	--	--	--	0.013	--	--	0.0049	0.0079	--	0.0049	0.00083	0.0049
alpha-Chlordane*	0.090	0.0040	0.090	0.0040	0.00059	0.090	0.0040	0.00081	0.0013	0.092	0.00059	0.00083	0.00083
4,4'-DDD	0.13	0.00100	--	--	0.00084	--	--	0.00031	0.00050	--	0.00031	0.0017	0.0017
4,4'-DDE	0.13	0.0010	--	--	0.00059	--	--	0.00022	0.00036	--	0.00022	0.0017	0.0017
4,4'-DDT	0.13	0.0010	0.13	0.0010	0.00059	0.13	0.0010	0.00022	0.00036	0.024	0.00022	0.0017	0.0017
beta-BHC	--	--	--	--	0.046	--	--	0.017	0.028	--	0.017	0.00083	0.017
delta-BHC	--	--	--	--	--	--	--	0.041	--	--	0.041	0.00083	0.041
Dieldrin	0.71	0.0019	0.71	0.0019	0.00014	0.71	0.0019	0.000054	0.000087	0.028	0.000054	0.0017	0.0017
Endosulfan I**	0.034	0.0087	0.034	0.0087	--	--	--	--	--	58	0.0087	0.00083	0.0087
Endosulfan II**	0.034	0.0087	0.034	0.0087	--	--	--	--	--	58	0.0087	0.0017	0.0087
Endosulfan Sulfate**	0.034	0.0087	0.034	0.0087	--	--	--	--	--	58	0.0087	0.0017	0.0087
Endrin	0.037	0.0023	0.037	0.0023	0.8100	0.037	0.0023	0.060	--	0.1959	0.0023	0.0017	0.0023
Endrin Aldehyde***	0.037	0.0023	0.037	0.0023	0.8100	0.037	0.0023	0.060	--	0.1959	0.0023	0.0017	0.0023
Endrin Ketone***	0.037	0.0023	0.037	0.0023	0.8100	0.037	0.0023	0.060	--	0.1959	0.0023	0.0017	0.0023
gamma-BHC (Lindane)	0.16	--	0.16	--	0.063	0.16		1.8	0.038	6	0.038	0.00083	0.038
gamma-Chlordane*	0.090	0.0040	0.090	0.0040	0.00059	0.090	0.0040	0.00081	0.0013	0.092	0.00059	0.00083	0.00083
Heptachlor	0.053	0.0036	0.053	0.0036	0.00021	0.053	0.0036	0.000079	0.00013	0.12	0.000079	0.00083	0.00083
Heptachlor epoxide	--	--	0.053	0.0036	0.00011	0.053	0.0036	0.000039	0.000064	0.0030	0.000039	0.00083	0.00083

Analyte	Concentration Protective of Marine Surface Water										Preliminary Screening Level µg/L	PQL (g) µg/L	Groundwater Screening Level (After adjustment for PQL) µg/L
	AWQC for Protection of Aquatic Life (a)		National Toxics Rule (b)			National Recommended Water Quality Criteria (c)			MTCA Method B Standard Formula Value - Protection of Human Health (Consumption of Aquatic Life)				
	Acute µg/L	Chronic µg/L	AWQC for Protection of Aquatic Life Acute µg/L	AWQC for Protection of Aquatic Life Chronic µg/L	AWQC for Protection of Human Health µg/L	Protection of Aquatic Life - Acute µg/L	Protection of Aquatic Life - Chronic µg/L	Protection of Human Health µg/L	Carcinogen µg/L	Non-Carcinogen µg/L			
Hexachlorobenzene	--	--	--	--	0.00077	--	--	0.00029	0.00047	0.24	0.00029	0.00083	0.00083
Methoxychlor	--	--	--	--	--	--	0.03	--	--	8.4	0.03	0.0083	0.03
Toxaphene	0.21	0.00020	0.21	0.00020	0.00075	0.21	0.00020	0.00028	0.00045	--	0.00020	0.083	0.083
Conventionals													
Ammonia	230	35	--	--	--	--	--	--	--	--	35	10	35

Notes:

- Screening levels were developed for all constituents analyzed in groundwater.
- Screening level is based on lowest of Federal and State marine surface water concentrations protective of aquatic life and human health - consumption of aquatic life (including MTCA Method B standard formula values for carcinogens and non-carcinogens), adjusted for practical quantification limit (PQL).
- Shading indicates basis for screening level.

-- = No screening criteria available.
µg/L = Micrograms per liter
MTCA = Washington State Model Toxics Control Act
PAHs = Polycyclic aromatic hydrocarbons
cPAHs = Carcinogenic polycyclic aromatic hydrocarbons
PCBs = Polychlorinated biphenyls
PQL = Practical quantitation limit
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
TEC = Toxic equivalent concentration
TPH = Total petroleum hydrocarbons
(a) Ambient water quality criteria (AWQC) for protection of aquatic life from WAC 173-201A-240.
(b) Ambient water quality criteria (AWQC) for protection of human health from 40 CFR Part 131d (National Toxics Rule).
(c) National Recommended Water Quality Criteria, Clean Water Act Section 304 (EPA 2006).
(d) MTCA Method A groundwater cleanup levels are used for gasoline-range, diesel-range, and heavy oil-range petroleum hydrocarbons, and total xylenes and lead.
(e) Value for gasoline-range petroleum hydrocarbons if benzene is present. If benzene is not present, screening level is 1,000 µg/L.
(f) PQL for total chromium.
(g) PQL is lowest available value from Analytical Resources, Inc. (Tukwila, WA) or Frontier Analytical Laboratory (El Dorado Hills, CA).
(h) PQL for EPA Method 8041.
(i) MTCA Method A Cleanup Level; value is based on background concentrations for state of Washington (MTCA Table 720-1, footnote b). This value differs from the value in the Upland Data Collection Work Plan.
* Chlordane values used for alpha- and gamma-chlordane.
** Endosulfan values used for endosulfan I, endosulfan II, and endosulfan sulfate.
*** Endrin values used for endrin aldehyde and endrin ketone.

Table 10

Functional Use Areas

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report
Port Angeles, Washington

Functional Use Area	Facilities/Use During Mill Operations	Interim Actions Completed
Northwest Shoreline Area	• Log Yard • Temporary Boiler Ash Storage	
North Shoreline Area	• Main Process Area • Pulp Storage Warehouse • Chip Storage • Chip Screening	
East Shoreline Area	• SSL Lagoon	SSL Lagoon Interim Action – 2001
West Former Mill Area	• Fuel Oil Tanks 1 and 2 • Maintenance Shop • Wood Mill • Power House • Hog Fuel Pile • Paint Shop • Auto Shop • Sludge Building • Recovery Boiler	Fuel Oil Tank 1 Interim Action – 2006 Fuel Oil Tank 2 Interim Action – 1993, 2002 Hog Fuel Pile Interim Action – 2001 Wood Mill Interim Action – 2006
Main Former Mill Area	• Acid Plant • Digesters • Screen Room • Bleach Plant • Machine Room • Engineering Building • Machine Shop • Administration Building • Garage	Machine Shop Interim Action – 2002
Estuary Area	• Finishing Room • West Roll Storage • East Roll Storage	Finishing Room Interim Action – 1993, 1998, 2002
East Former Mill Area	• Primary Clarifier (1972) • Warehouses • SSL Lagoon • Chlorine Dioxide Generator	SSL Lagoon Interim Action – 2001
CSO Area	• No specific mill operations were performed on this portion of the property.	
Prefab Area	• Contractor Parking • New Equipment Storage	
Ennis Creek Area	• No specific mill operations were performed on this portion of the property.	
City Purchase Area	• Wastewater Secondary Treatment System (1979) • Used Equipment Storage	

Table 11

Summary of Primary Contaminants of Potential Concern (COPCs)

Port Angeles Rayonier Mill Study Area, Upland Data Summary Report
Port Angeles, Washington

Functional Use Area(s)	Media	COPCs
Northwest Shoreline Area	Groundwater	Dioxins/Furans Mn cPAHs Ammonia PCBs
	Shallow soil[1]	cPAHs Cu, Mn, Ni, Zn Dioxins/Furans
	Deep soil[2]	cPAHs Cu
North Shoreline and Main Former Mill Areas	Groundwater	Dioxins/Furans Cu, Mn Ammonia PCBs cPAHs
	Shallow soil[1]	cPAHS SVOCs PCBs Cu Dioxins/Furans
	Deep soil[2]	cPAHs SVOCs Cu Dioxins/Furans TPH
East Shoreline and East Former Mill Areas	Groundwater	Dioxins/Furans Ammonia Cu, Mn
	Shallow soil[1]	cPAHs Dioxins/Furans Cu
	Deep soil[2]	cPAHs Cu, Ni, Zn
West Former Mill Area	Groundwater	Dioxins/Furans Cu, Mn, Ni SVOCs VOCs Ammonia PCBs
	Shallow soil[1]	Dioxins/Furans cPAHs PCBs Cu, Mn, Ni, Zn TPH SVOCs
	Deep soil[2]	cPAHs TPH PCBs Dioxins/Furans Cu, Mn, Ni, Zn SVOCs

Functional Use Area(s)	Media	COPCs
Estuary Area	Groundwater	Dioxins/Furans Mn Ammonia PCBs
	Shallow soil[1]	TPH Dioxins/Furans cPAHs Cu, Ni, Zn SVOCs cPAHs PCBs
	Deep soil[2]	cPAHs PCBs Cu TPH
	Surface Water	Dioxins/Furans
CSO Area	Groundwater	Dioxins/Furans Cu, Mn, Ni
	Shallow soil[1]	Dioxins/Furans Cu
	Deep soil[2]	cPAHs Cu, Mn, Ni, Zn
Ennis Creek Area	Groundwater	Dioxins/Furans Cu, Mn, Ni
	Shallow soil[1]	cPAHs Dioxins/Furans Cr, Cu, Ni, Zn
	Deep soil[2]	Co, Cu, Cr, Ni
	Surface Water	Dioxins/Furans
City Purchase and Prefab Areas	Groundwater	PCBs Dioxins/Furans Cu, Mn, Ni, Zn
	Shallow soil[1]	cPAHs As, Cu, Mn, Ni, Zn PCBs
	Deep soil[2]	cPAHs Dioxins/Furans Cu PCBs

Notes:

COPCs = Contaminants of potential concern.
cPAHS = Carcinogenic polycyclic aromatic hydrocarbons
TPH = Total petroleum hydrocarbons
SVOCs = Semivolatile organic compounds
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
CSO = Combined sewer overflow
Mn = Manganese
Cu = Copper
Ni = Nickel
Zn = Zinc
Cr = Chromium
Co = Cobalt
As = Arsenic

[1] 0 - 2 feet below ground surface

[2] > 2 feet below ground surface

FIGURES

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N
W E
S

4,000 0 4,000

Feet

Notes:
1. The locations of all features shown are approximate.
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3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Vicinity Map

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 1

Office: SEA Path: \sea\Projects\0\0137015\GIS\0137015_03_Upland_VicinityMap.mxd Map Revised: 28 March 2012 amanza

Data Source: Base data from "RAYO0903_MILL_TOPO.dwg" (Northwestern Territories, Inc, 2009). Aerial images from DeGross Aerial Mapping, August 17, 2009. Background aerial from NAIP, 2009.

Notes:
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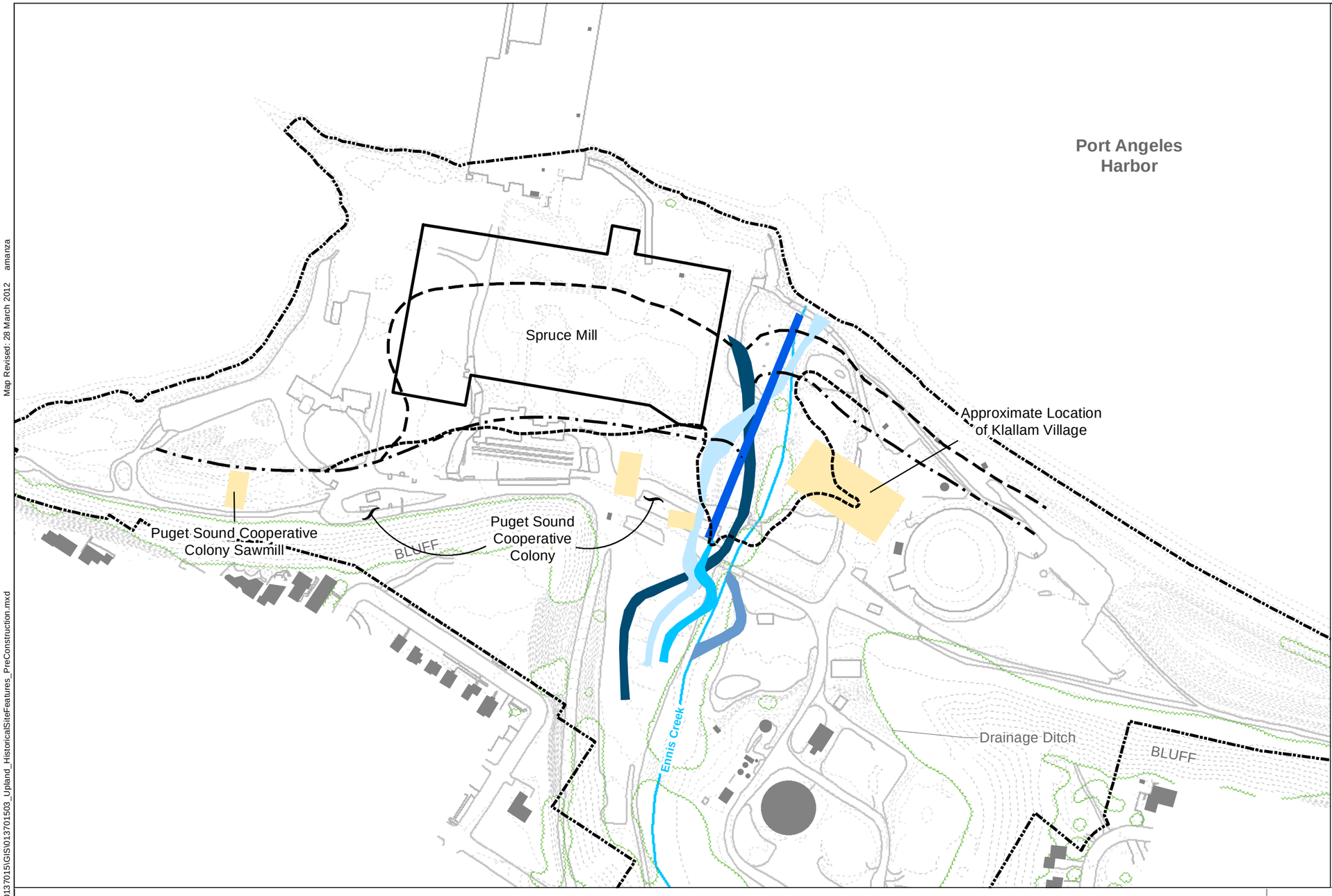
Current Study Area Conditions

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 2

Map Revised: 28 March 2012 amanza
Path: \\seal\Projects\0\0137015\GIS\0137015_Upland_CurrentSiteConditions.mxd
Office: Seattle



Explanation

- Upland Study Area Boundary
- Approximate High Tide Before 1917
- Approximate Low Tide Before 1917
- Approximate Shoreline at High Tide Before Spruce Mill Construction, 1918.
- Tree Covered Area
- Existing Structure
- 1918 Spruce Production Corporation Mill
- Historical Villages

Ennis Creek Approximate Historical Channels

- Ennis Creek Channel Before 1933
- Ennis Creek Channel (1930)
- Ennis Creek (1918)
- Wooden Flume (1918)
- Ennis Creek Channel (1887)

N W E S

250 0 250
Feet

Data Source: Topography from Northwestern Territories, 2000.
Ennis Creek Channels, Historic Locations and Tide Lines obtained from LAAS, 1997.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
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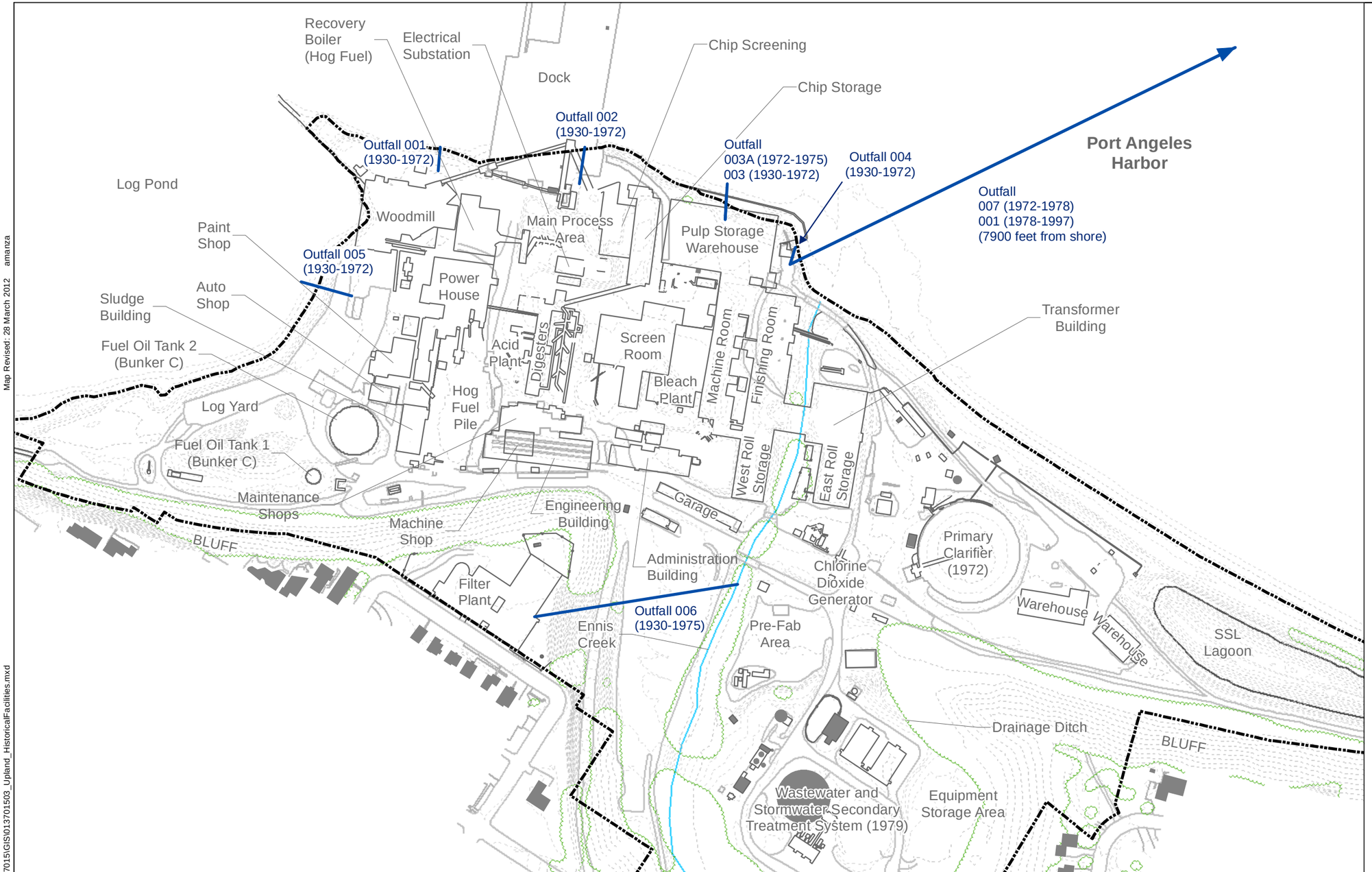
Historical Features Before Pulp Mill Construction

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 3

Map Revised: 28 March 2012 amanza
Path: \\seaProjects\0013701503\GIS\013701503_Upland_HistoricalSiteFeatures_PreConstruction.mxd
Office: SEA



Explanation

- Upland Study Area Boundary
- Former Buildings and Structures
- Historical Outfalls
- Ennis Creek
- Tree Covered Area
- Existing Structure

N
W E
S

250 0 250
Feet

Map Revised: 28 March 2012 amanza

Path: \\sea\Projects\0\013701S\GIS\013701503_Upland_HistoricalFacilities.mxd

Office: SEA

Data Source: Topography from Northwestern Territories, 2000.
Mill base features from Integral, 2007. Historic Outfalls from E & E, 1997.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
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Former Mill Facilities

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

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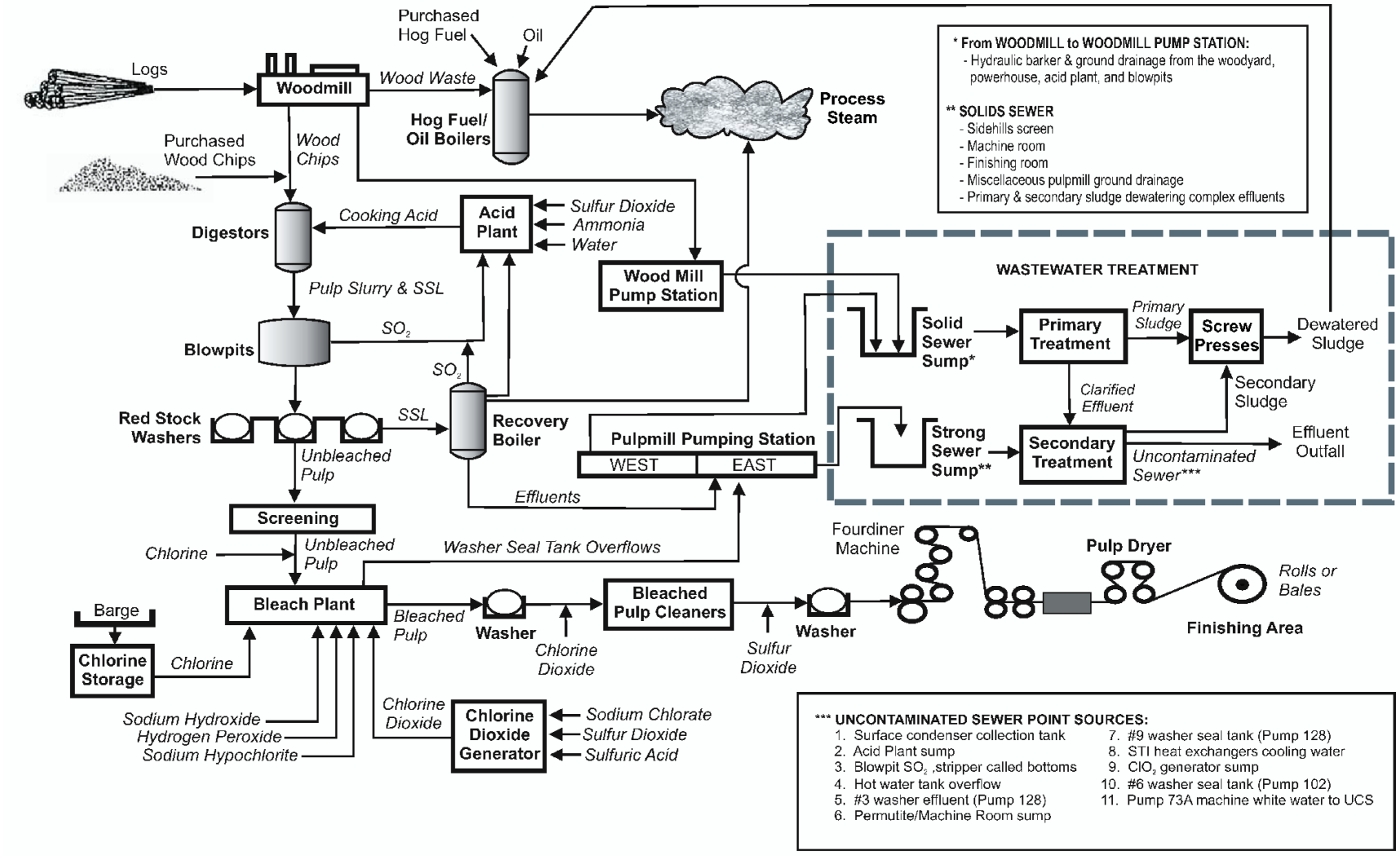
Figure 4

Office: SEA Path: \\sea\Projects\0\0137015\GIS\013701503_Upland_GeneralProcessFlow.mxd Map Revised: 17 April 2012 amanza



Data Source: Intergral 2007.

Notes:

1. The locations of all features shown are approximate.
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General Process Flow Diagram Before Dismantling

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

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Figure 5

Legend

- Existing Monitoring Well
- Former Monitoring Well
- RI Sample Locations (2003) (Post-Mill Decommissioning)
- ESI Sample Locations (1997) (Pre-Mill Decommissioning)
- Upland Study Area

Interim Action Areas & Material Quantities Removed

- Finishing Room - 10,150 tons soil (hydraulic oil/PCBs; 1993, 1998, 2002)
- Fuel Tank No. 2 - 5,400 tons soil (Bunker C; 1993, 2002)
- Hog Fuel Pile - 2,700 cy wood residue (diesel & heavy oil; 2001)
- Machine Shop - 970 tons soil (diesel & heavy oil; 2002)
- SSL Lagoon - 4,800 tons soil (2001)
- Wood Mill & Fuel Tank No.1 - 7,980 tons soil (hydraulic oil & Bunker C; 2006)

N W E S

500 0 500
Feet

Data Source: Base data from "RAYO0903 _MILL_TOPO.dwg" (Northwestern Territories, Inc, 2000)

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Upland ESI and RI Soil Sampling Locations Including Interim Action Areas

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 6

Map Revised: 17 April 2012 amanza
Path: \\seaProjects\0013701501\GIS\013701503_Upland_SamplingLocs_ActionAreas.mxd
Office: SEA

Soil Sample Locations Prior to October 1999

Monitoring Well Location

Former Monitoring Well

Upland Study Area

Interim Action Areas & Material Quantities Removed

- Finishing Room - 10,150 tons soil (hydraulic oil/PCBs; 1993, 1998, 2002)
- Fuel Tank No. 2 - 5,400 tons soil (Bunker C; 1993, 2002)
- Hog Fuel Pile - 2,700 cy wood residue (diesel & heavy oil; 2001)
- Machine Shop - 970 tons soil (diesel & heavy oil; 2002)
- SSL Lagoon - 4,800 tons soil (2001)
- Wood Mill & Fuel Tank No.1 - 7,980 tons soil (hydraulic oil & Bunker C; 2006)

Data Source: Base data from "RAYO0903 _MILL_TOPO.dwg" (Northwestern Territories, Inc, 2000)

Notes:
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Soil Sampling Locations Prior to October 1999, Including Interim Action Areas

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 7

Map Revised: 01 May 2012 amanza

Path: \\sea\Projects\0\0137015\GIS\0137015_Upland_SoilPriorOct1999.mxd

Office: SEA

Soil Sample Location After October 1999

Monitoring Well Location

Former Monitoring Well

Upland Study Area

Interim Action Areas & Material Quantities Removed

- Finishing Room - 10,150 tons soil (hydraulic oil/PCBs; 1993, 1998, 2002)
- Fuel Tank No. 2 - 5,400 tons soil (Bunker C; 1993, 2002)
- Hog Fuel Pile - 2,700 cy wood residue (diesel & heavy oil; 2001)
- Machine Shop - 970 tons soil (diesel & heavy oil; 2002)
- SSL Lagoon - 4,800 tons soil (2001)
- Wood Mill & Fuel Tank No.1 - 7,980 tons soil (hydraulic oil & Bunker C; 2006)

N W E S

200 0 200

Feet

Data Source: Base data from "RAYO0903 _MILL_TOPO.dwg" (Northwestern Territories, Inc, 2000)

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Soil Sampling Locations Between October 1999 and September 2010, Including Interim Action Areas

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 8

Map Revised: 18 April 2012 amanza

Path: \\sea\Projects\01\0137015\GIS\0137015_Upland_SoilAfterOct1999.mxd

Office: SEA

Phase 1, 2, 3 and 4 Exploration Locations

- Phase 2 Groundwater Grab Sample
- Phase 2 Soil Boring
- Phase 2 or 4 Monitoring Well
- Monitoring Well/Piezometer Installed Before 2010
- Phase 3 Test Pit
- Phase 3 Pipe Contents Sample
- Phase 1 Surface Water Sample

Interim Action Areas & Material Quantities Removed

- Finishing Room - 10,150 tons soil (hydraulic oil/PCBs; 1993, 1998, 2002)
- Fuel Tank No. 2 - 5,400 tons soil (Bunker C; 1993, 2002)
- Hog Fuel Pile - 2,700 cy wood residue (diesel and heavy oil; 2001)
- Machine Shop - 970 tons soil (diesel and heavy oil; 2002)
- SSL Lagoon - 4,800 tons soil (2001)
- Wood Mill and Fuel Tank No.1 - 7,980 tons soil (hydraulic oil and Bunker C; 2006)

- Functional Use Area
- Upland Study Area Boundary

Rayonier Property and Parcel Boundaries

- Rayonier Property Boundary
- Parcel Boundary

Easements

- New
- Existing
- Existing, To Be Abandoned
- New, Preferred but Not Required

Utilities

- CSO Project Phase I
- Exist. City Sewer

Proposed Purchases

- Abandoned Rayonier Pipe
- Storage Tank

N W E S

150 0 150
Feet

Data Source: Base data from "RAYO0903 _MILL_TOPO.dwg" (Northwestern Territories, Inc, 2000)
Aerial images from DeGross Aerial Mapping, August 17, 2000. Background aerial from NAIP, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

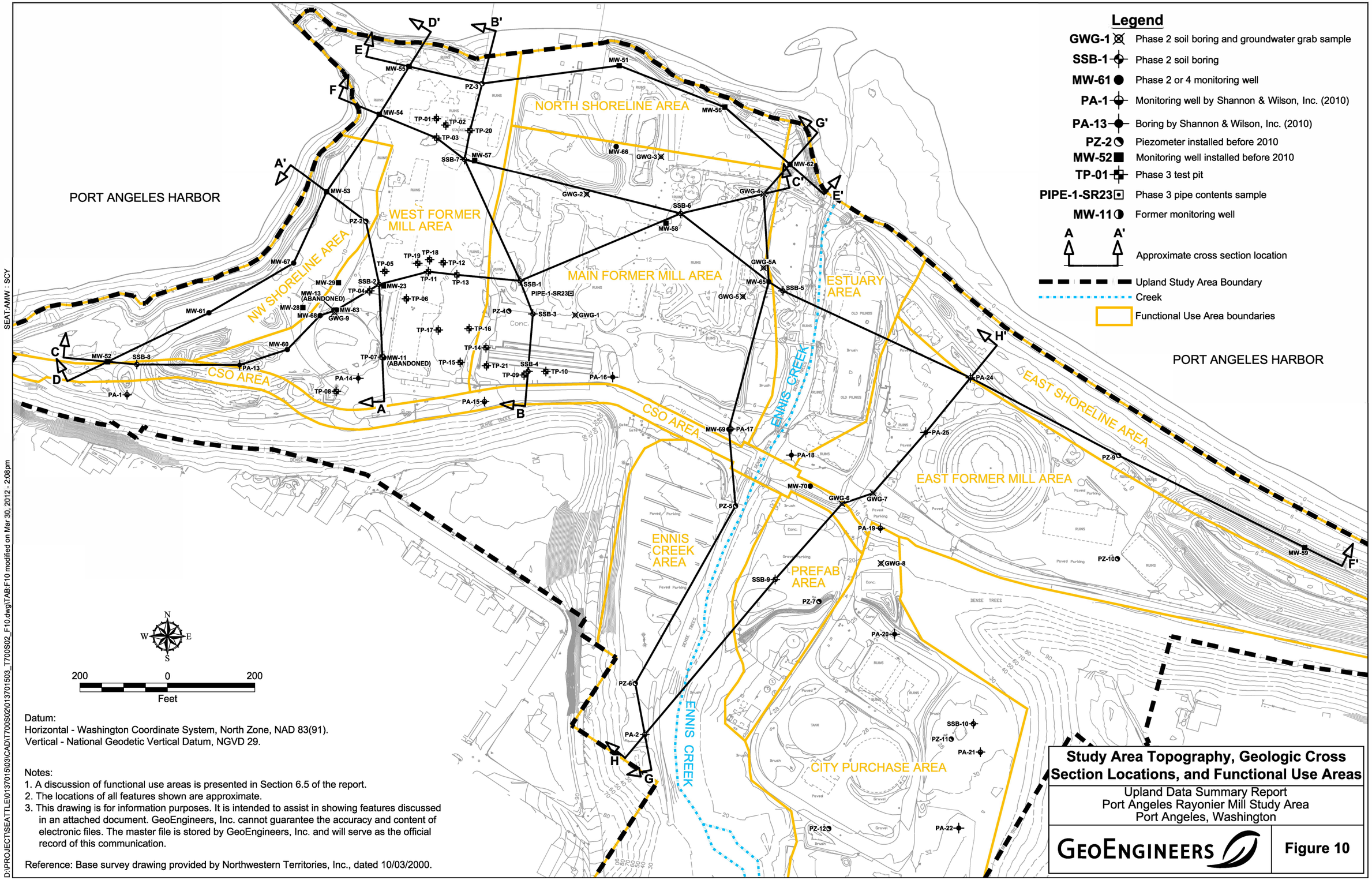
Supplemental Upland Data Collection Locations

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 9

Office: Seattle Path: \\sea\Projects\00137015\GIS\01370503_Upland_SupplementalData_CurrentMW.mxd Map Revised: 18 April 2012 amanza



Datum:
Horizontal - Washington Coordinate System, North Zone, NAD 83(91).
Vertical - National Geodetic Vertical Datum, NGVD 29.

Notes:
1. A discussion of functional use areas is presented in Section 6.5 of the report.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base survey drawing provided by Northwestern Territories, Inc., dated 10/03/2000.

Study Area Topography, Geologic Cross Section Locations, and Functional Use Areas

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 10

Map Revised: 01 May 2012 amanza

Path: \\seaProjects\0013701S\GIS\013701503_Upland_StormwaterFlow.mxd

Office:SEA

Stormwater Discharges to Harbor

Stormwater Infiltrates into Ground Between Concrete Pads

Unused Grassy Area

Stormwater Infiltration to Ground

Stormwater Sampling and Outfall Location 003

Stormwater Infiltration to Ground

Stormwater Infiltration to Ground

Stormwater Infiltration to Ground

Open Culvert

Ennis Creek

POTW

Legend

- CSO Construction Easement
- Paved Areas
- City Owned Property
- Underground Stormwater Conveyance
- Stormwater Flow Direction
- Stormwater Sheet Flow

N W E S

0 350 700

Feet

Notes:
1. Base drawing source: Landau, 2010. Aerial Image from Bing Maps, 2011.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Stormwater Flow Diagram

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

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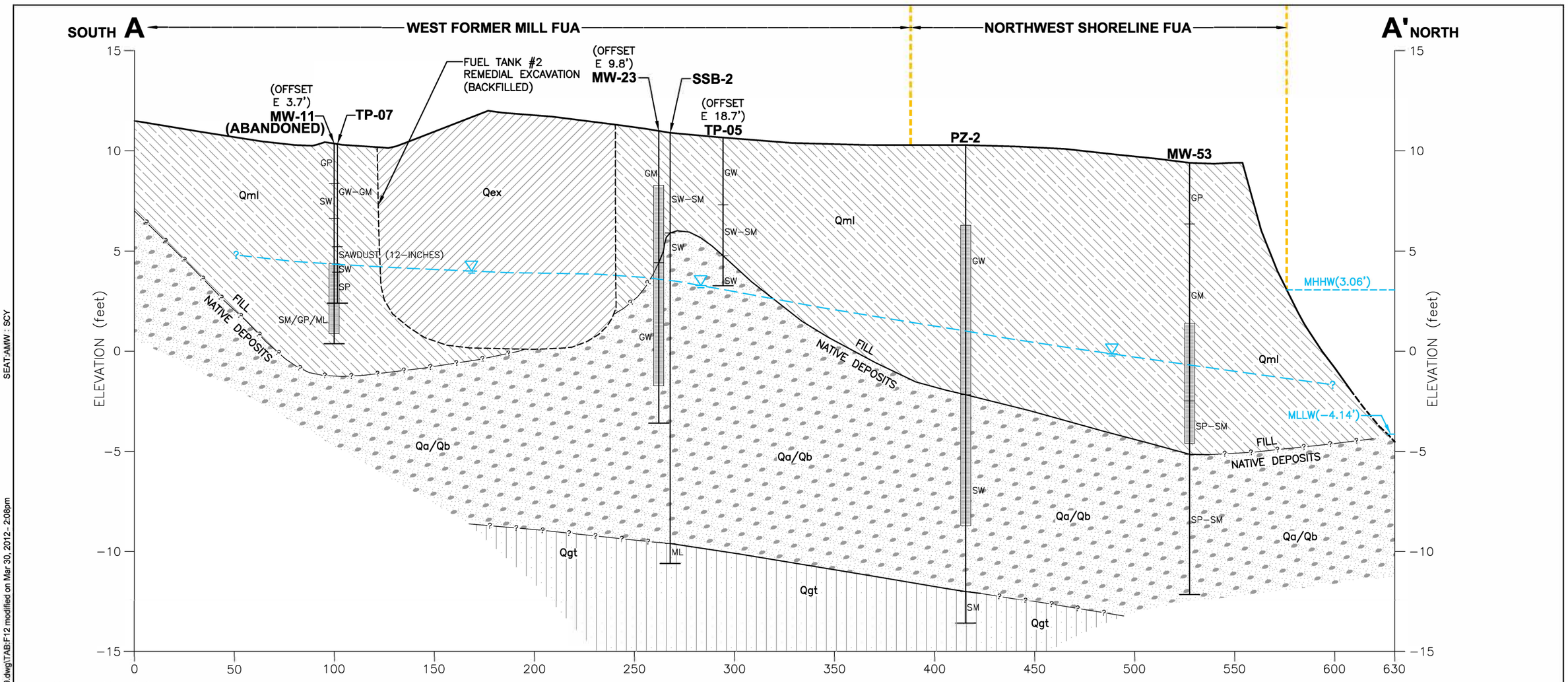
Figure 11



Geologic Descriptions:

Qex **Interim Remedial Excavations** Backfill consisting of overburden, rubble, riprap, and other suitable materials.

Qml **Modified land (recent fill)** Soil, sediment, or other material locally reworked by excavation and/or redistribution to modify topography. At the mill property, fill consists of sand and gravel w/ varying amounts of silt and construction debris. Construction debris primarily consists of concrete rubble, bricks and wood debris, scrap metal (e.g., steel rails, iron and steel pipe, steel wire) and thin horizons of apparent boiler ash and/or boiler slag (clinker) are present in some areas.

Qa/Qb **Undifferentiated Alluvial and Beach Deposits (early Holocene-recent)** Alluvial deposits consist of gravel, sand and silt; variably graded; loose to very dense; deposited by alluvial processes associated with Ennis Creek and White Creek. Beach deposits consist of sand with varying amounts of gravel, cobbles, silt and marine shell fragments; variably graded; loose to dense; deposited by shoreline processes.

Qgt **Vashon till (Pleistocene)** Well graded and highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders; permeability very low where lodgement till is well developed; most commonly matrix supported but locally clast supported; matrix more angular than water-worked sediments; cobbles and boulders commonly faceted and/or striated.

Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 10 for location of Cross Section.
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4. Vertical Datum NGVD 1929.

EXPLANATION:

(OFFSET E 9.8') **MW-23** MONITORING WELL NUMBER AND APPROXIMATE LOCATION

SM SOIL TYPE AT SAMPLE LOCATION

SCREEN LOCATION

SOIL CONTACT

INFERRED SOIL CONTACT

GROUNDWATER ELEVATION (AUGUST 2010)

MHHW MEAN HIGHER HIGH WATER

MLLW MEAN LOWER LOW WATER

FUA FUNCTIONAL USE AREA

50 0 50
Horizontal Scale in Feet

5 0 5
Vertical Scale in Feet
Vertical Exaggeration: 10X

References:
1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
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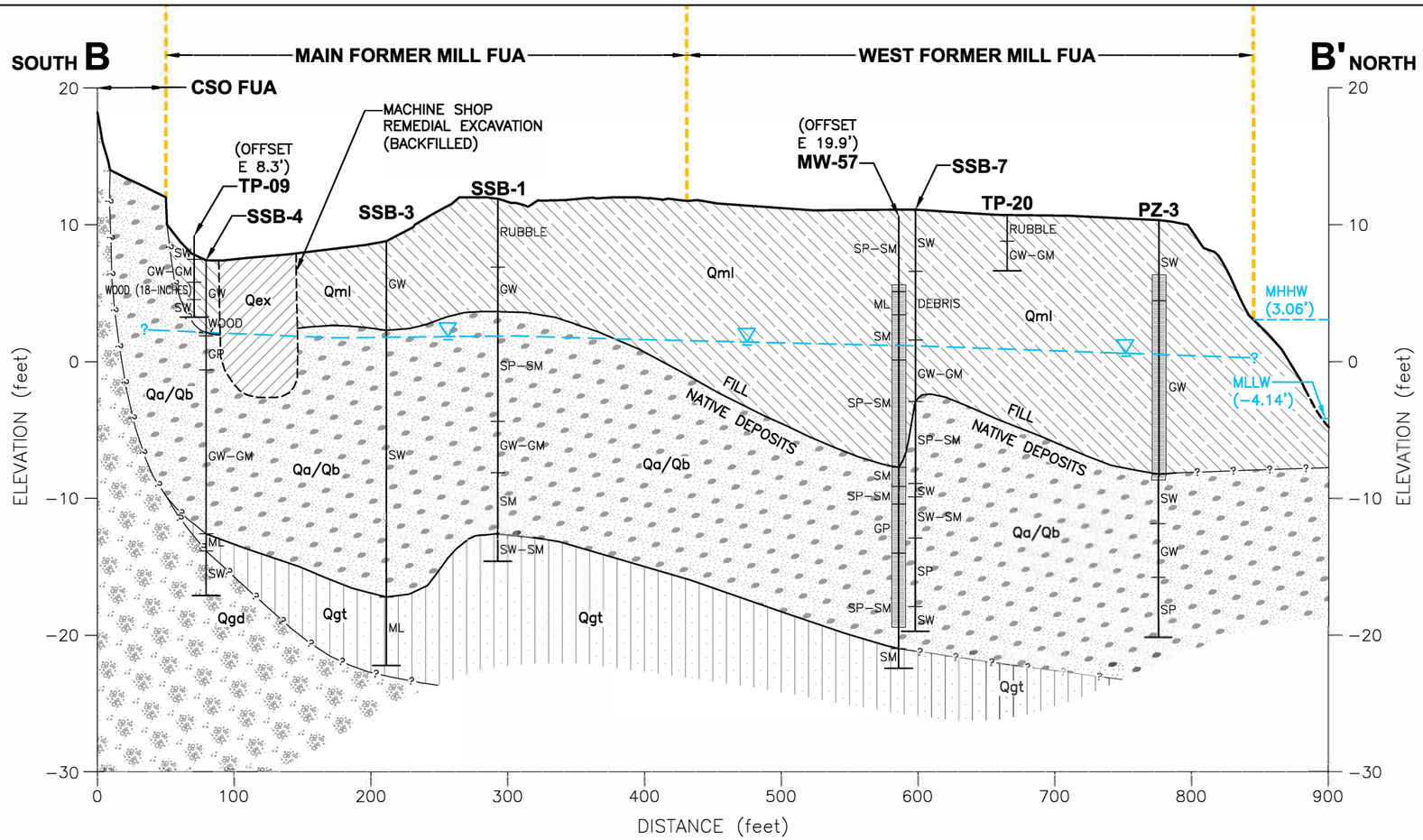
Geologic Cross Section A-A'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 12



(OFFSET E 19.9') **MW-57** EXPLANATION:

- MONITORING WELL NUMBER AND APPROXIMATE LOCATION
- SM — SOIL TYPE AT SAMPLE LOCATION
- SCREEN LOCATION
- SOIL CONTACT
- INFERRED SOIL CONTACT
- GROUNDWATER ELEVATION (AUGUST 2010)
- MHHW MEAN HIGHER HIGH WATER
- MLLW MEAN LOWER LOW WATER
- FUA FUNCTIONAL USE AREA

Geologic Descriptions:

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Notes:
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4. Vertical Datum NGVD 1929.

Horizontal Scale in Feet: 100 0 100

Vertical Scale in Feet: 10 0 10

Vertical Exaggeration: 10X

References:
1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
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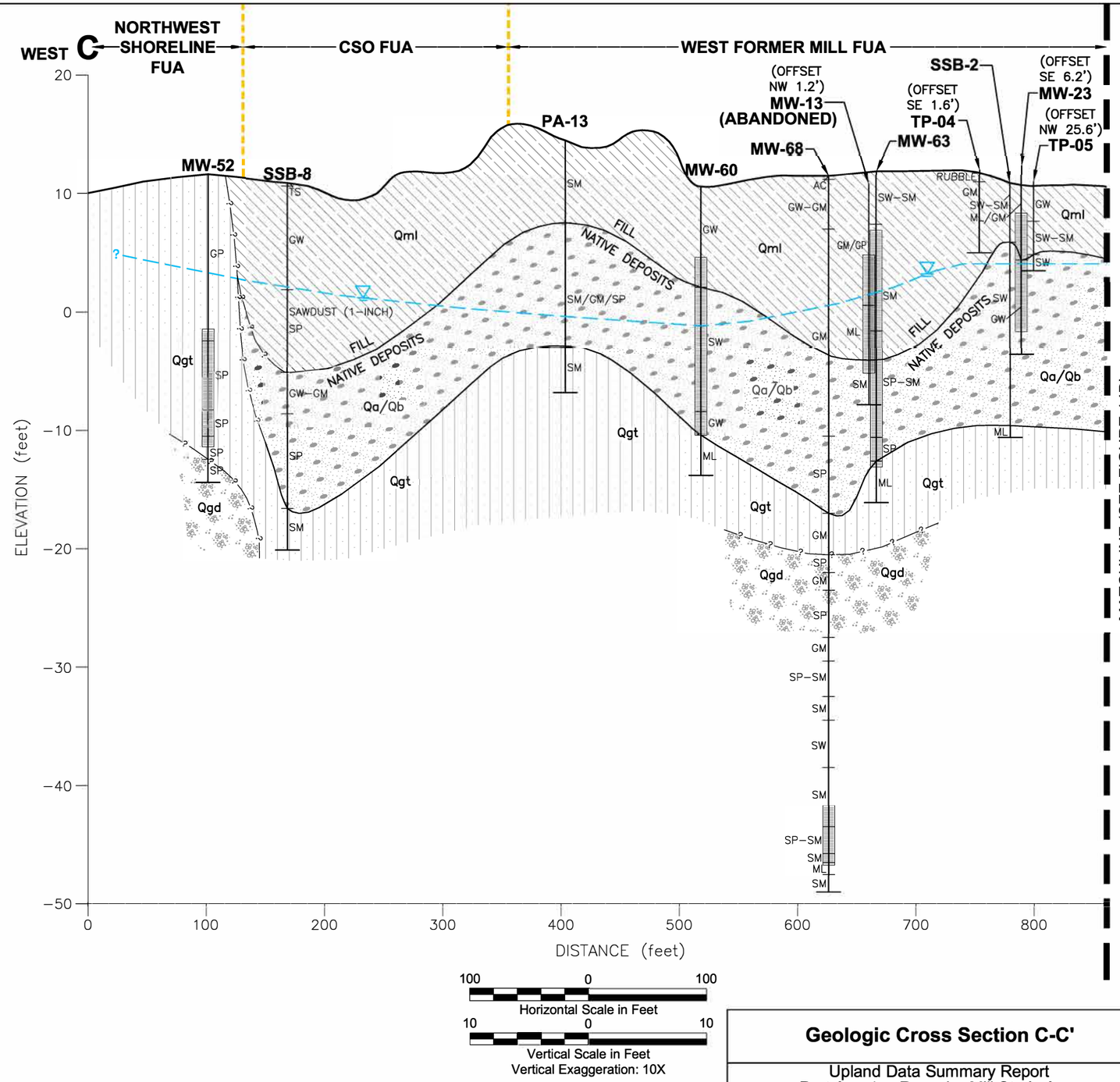
Geologic Cross Section B-B'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 13



(OFFSET SE 6.2')
MW-23

EXPLANATION:

- MONITORING WELL NUMBER AND APPROXIMATE LOCATION
- SOIL TYPE AT SAMPLE LOCATION
- SCREEN LOCATION
- SOIL CONTACT
- INFERRED SOIL CONTACT
- GROUNDWATER ELEVATION (AUGUST 2010)
- FUA — FUNCTIONAL USE AREA

Geologic Descriptions:

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4. Vertical Datum NGVD 1929.

References:

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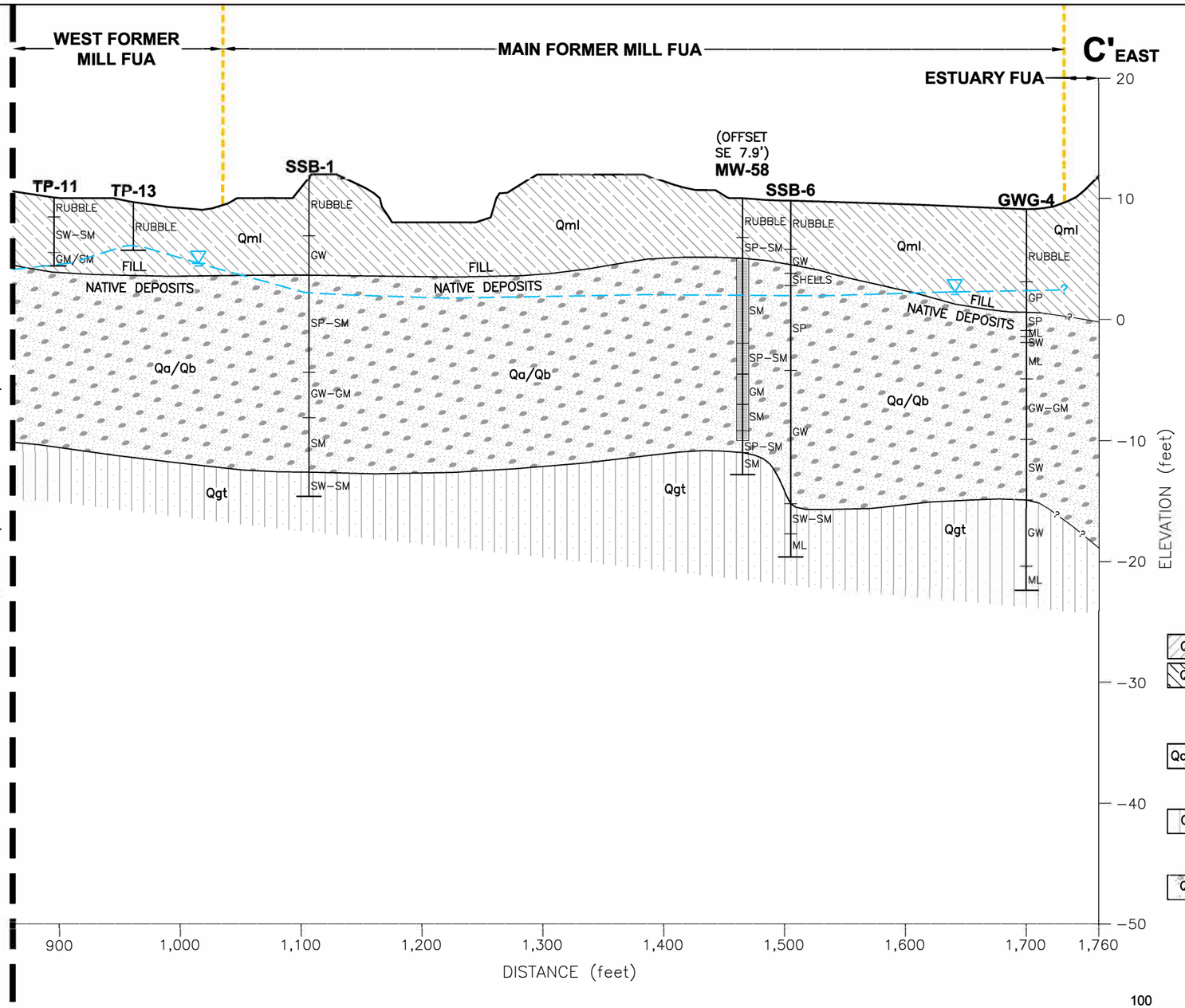
Geologic Cross Section C-C'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 14A



(OFFSET SE 7.9')
MW-58

EXPLANATION:

- MONITORING WELL NUMBER AND APPROXIMATE LOCATION
- SOIL TYPE AT SAMPLE LOCATION
- SCREEN LOCATION
- SOIL CONTACT
- INFERRED SOIL CONTACT
- GROUNDWATER ELEVATION (AUGUST 2010)
- FUA FUNCTIONAL USE AREA

Geologic Descriptions:

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100 0 100
Horizontal Scale in Feet
10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:
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4. Vertical Datum NGVD 1929.

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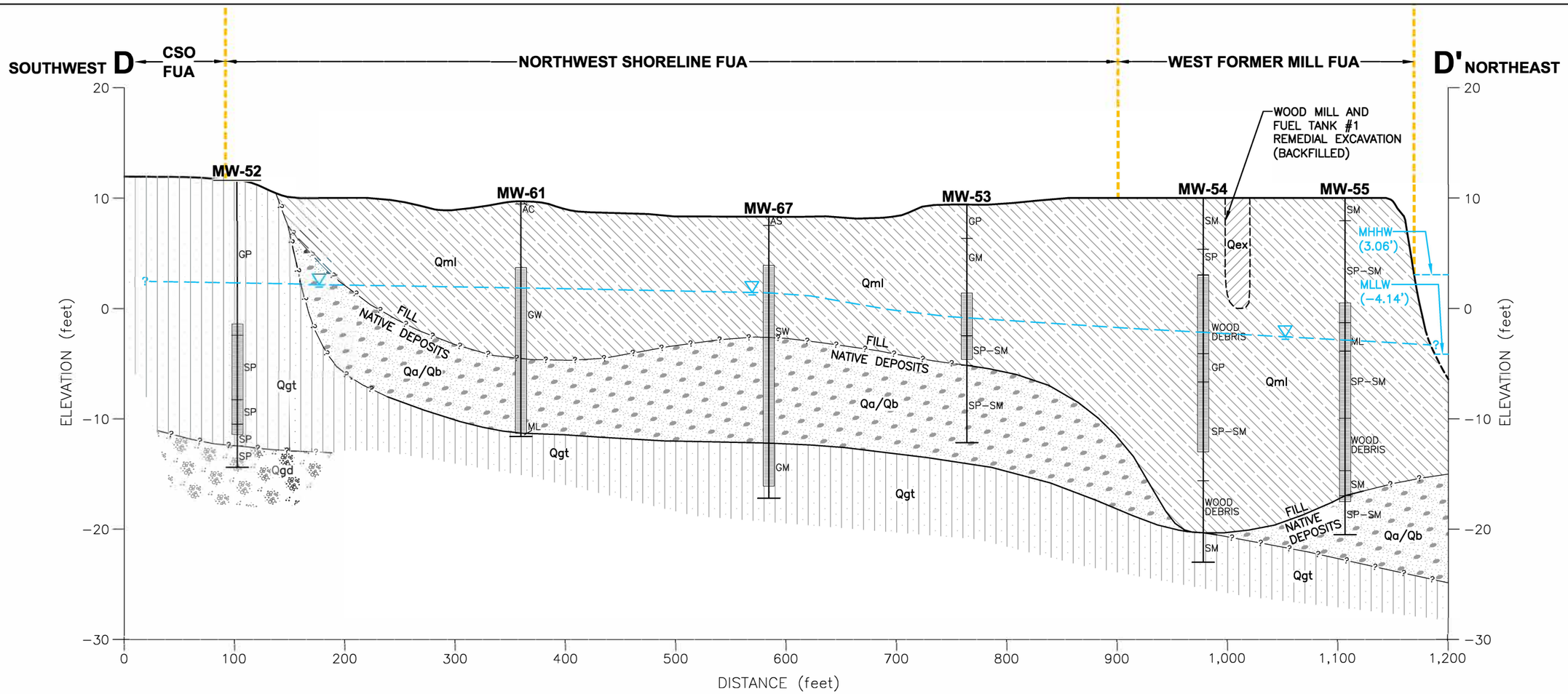
Geologic Cross Section C-C' (Continued)

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 14B



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Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

EXPLANATION:

MW-53 MONITORING WELL NUMBER AND APPROXIMATE LOCATION

SM SOIL TYPE AT SAMPLE LOCATION

SCREEN LOCATION

SOIL CONTACT

INFERRED SOIL CONTACT

GROUNDWATER ELEVATION (AUGUST 2010)

MHHW MEAN HIGHER HIGH WATER

MLLW MEAN LOWER LOW WATER

FUA FUNCTIONAL USE AREA

100 0 100
Horizontal Scale in Feet

10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:
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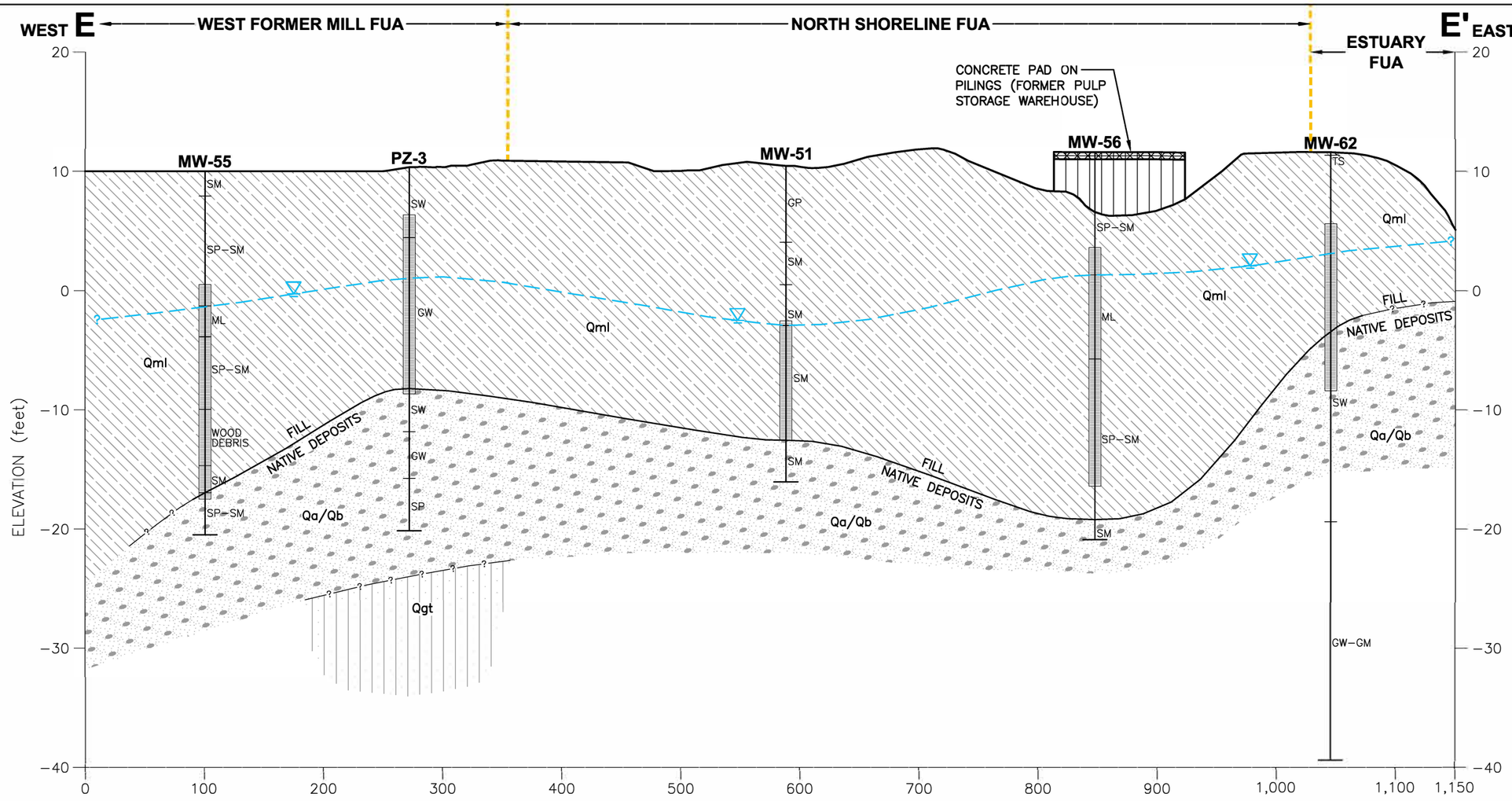
Geologic Cross Section D-D'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 15



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Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

EXPLANATION:

MW-62 MONITORING WELL NUMBER AND APPROXIMATE LOCATION

SM SOIL TYPE AT SAMPLE LOCATION

SCREEN LOCATION

SOIL CONTACT

INFERRED SOIL CONTACT

GROUNDWATER ELEVATION (AUGUST 2010)

FUA FUNCTIONAL USE AREA

100 0 100
Horizontal Scale in Feet

10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:
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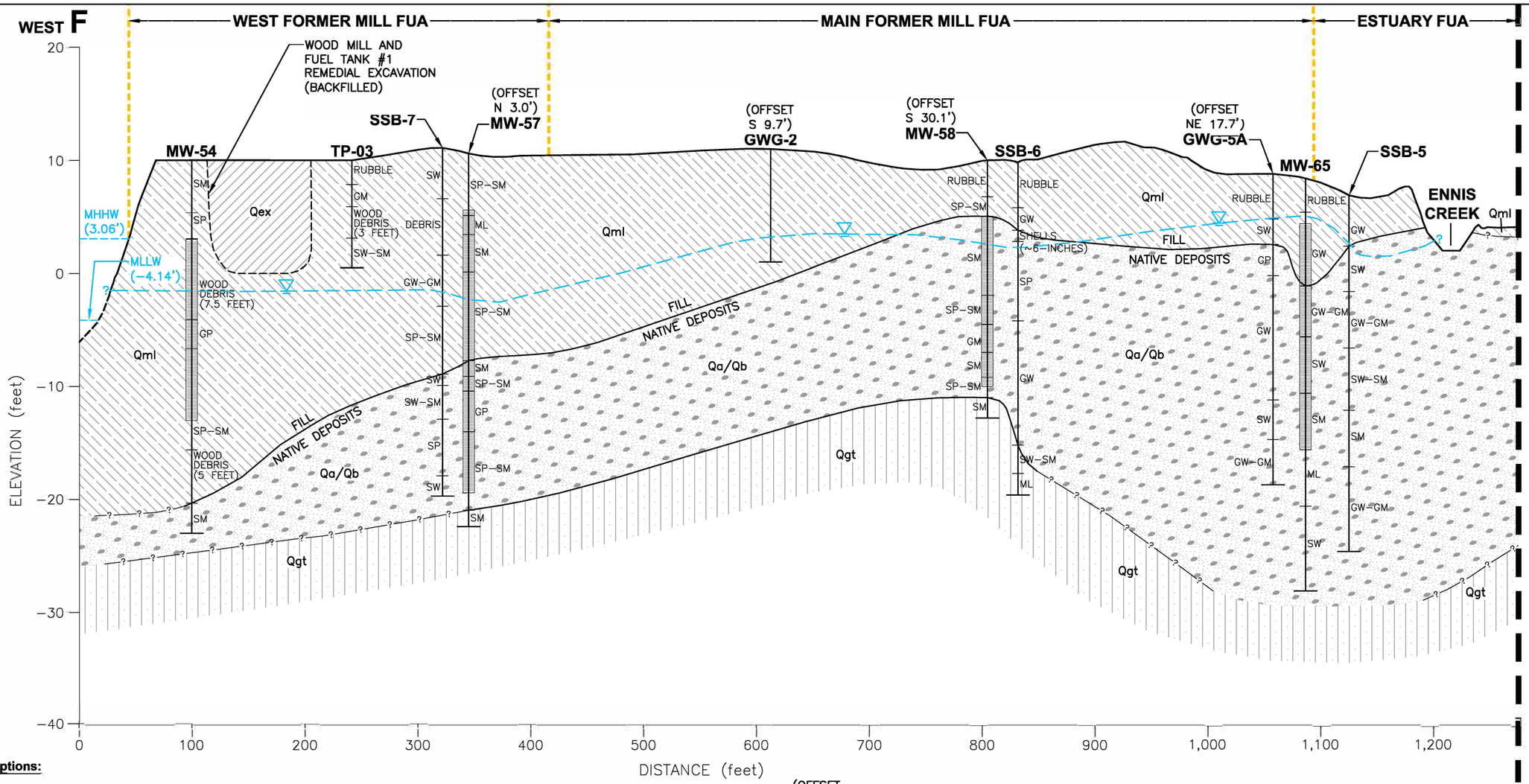
Geologic Cross Section E-E'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 16



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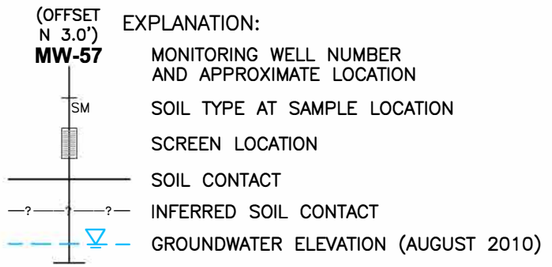

EXPLANATION:

- MONITORING WELL NUMBER AND APPROXIMATE LOCATION
- SOIL TYPE AT SAMPLE LOCATION
- SCREEN LOCATION
- SOIL CONTACT
- INFERRED SOIL CONTACT
- GROUNDWATER ELEVATION (AUGUST 2010)
- MHHW MEAN HIGHER HIGH WATER
- MLLW MEAN LOWER LOW WATER
- FUA FUNCTIONAL USE AREA

References:
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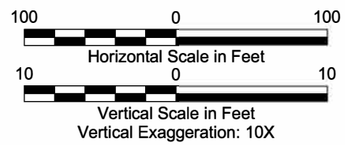


Geologic Cross Section F-F'

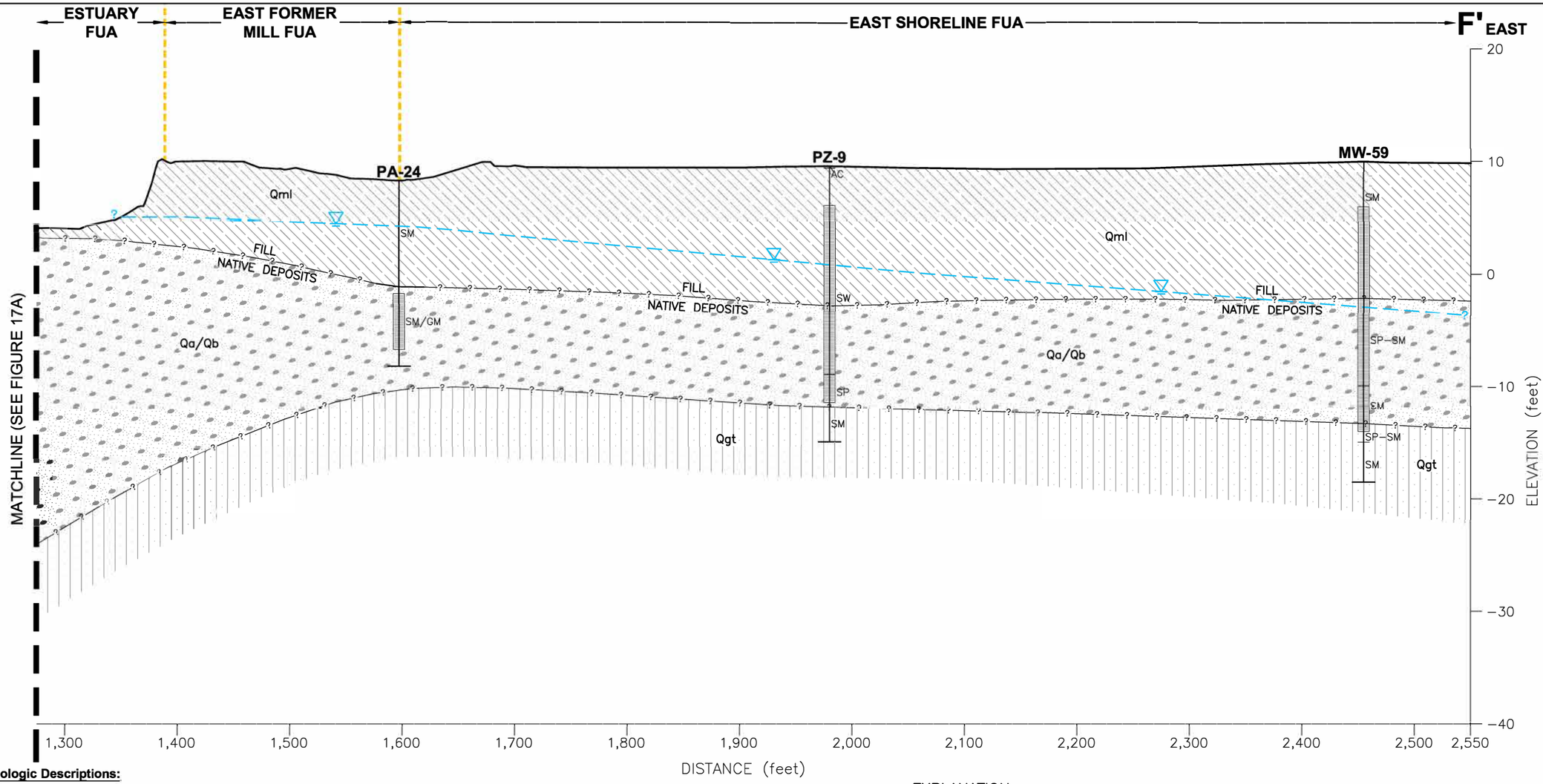
Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 17A

SEAT-AMW : SCY

D:\PROJECT\SEATTLE\0137015\03\CAD\T700S02\0137015O3_T700S02_F12 TO F19.dwg\TAB:F17A modified on Mar 30, 2012 - 2:10pm



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Qml **Modified land (recent fill)** Soil, sediment, or other material locally reworked by excavation and/or redistribution to modify topography. At the mill property, fill consists of sand and gravel w/ varying amounts of silt and construction debris. Construction debris primarily consists of concrete rubble, bricks and wood debris, scrap metal (e.g., steel rails, iron and steel pipe, steel wire) and thin horizons of apparent boiler ash and/or boiler slag (clinker) are present in some areas.

Qa/Qb **Undifferentiated Alluvial and Beach Deposits (early Holocene-recent)** Alluvial deposits consist of gravel, sand and silt; variably graded; loose to very dense; deposited by alluvial processes associated with Ennis Creek and White Creek. Beach deposits consist of sand with varying amounts of gravel, cobbles, silt and marine shell fragments; variably graded; loose to dense; deposited by shoreline processes.

Qgt **Vashon till (Pleistocene)** Well graded and highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders; permeability very low where lodgement till is well developed; most commonly matrix supported but locally clast supported; matrix more angular than water-worked sediments; cobbles and boulders commonly faceted and/or striated.

Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 10 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.
4. Vertical Datum NGVD 1929.

EXPLANATION:

MW-65 MONITORING WELL NUMBER AND APPROXIMATE LOCATION

SM SOIL TYPE AT SAMPLE LOCATION

SCREEN LOCATION

SOIL CONTACT

?—?—? INFERRED SOIL CONTACT

GROUNDWATER ELEVATION (AUGUST 2010)

FUA FUNCTIONAL USE AREA

100 0 100
Horizontal Scale in Feet

10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

References:
1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
3. Rayonier Mill Supplemental Upland Investigation field observations by GeoEngineers geologists October 2010 - May 2011.

Geologic Cross Section F-F' (Continued)

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 17B

EXPLANATION:

MW-69 MONITORING WELL NUMBER AND APPROXIMATE LOCATION

SM SOIL TYPE AT SAMPLE LOCATION

SCREEN LOCATION

SOIL CONTACT

INFERRED SOIL CONTACT

GROUNDWATER ELEVATION (AUGUST 2010)

FUA FUNCTIONAL USE AREA

Geologic Descriptions:

Qex **Interim Remedial Excavations** Backfill consisting of overburden, rubble, riprap, and other suitable materials.

Qml **Modified land (recent fill)** Soil, sediment, or other material locally reworked by excavation and/or redistribution to modify topography. At the mill property, fill consists of sand and gravel w/ varying amounts of silt and construction debris. Construction debris primarily consists of concrete rubble, bricks and wood debris, scrap metal (e.g., steel rails, iron and steel pipe, steel wire) and thin horizons of apparent boiler ash and/or boiler slag (clinker) are present in some areas.

Qa/Qb **Undifferentiated Alluvial and Beach Deposits (early Holocene-recent)** Alluvial deposits consist of gravel, sand and silt; variably graded; loose to very dense; deposited by alluvial processes associated with Ennis Creek and White Creek. Beach deposits consist of sand with varying amounts of gravel, cobbles, silt and marine shell fragments; variably graded; loose to dense; deposited by shoreline processes.

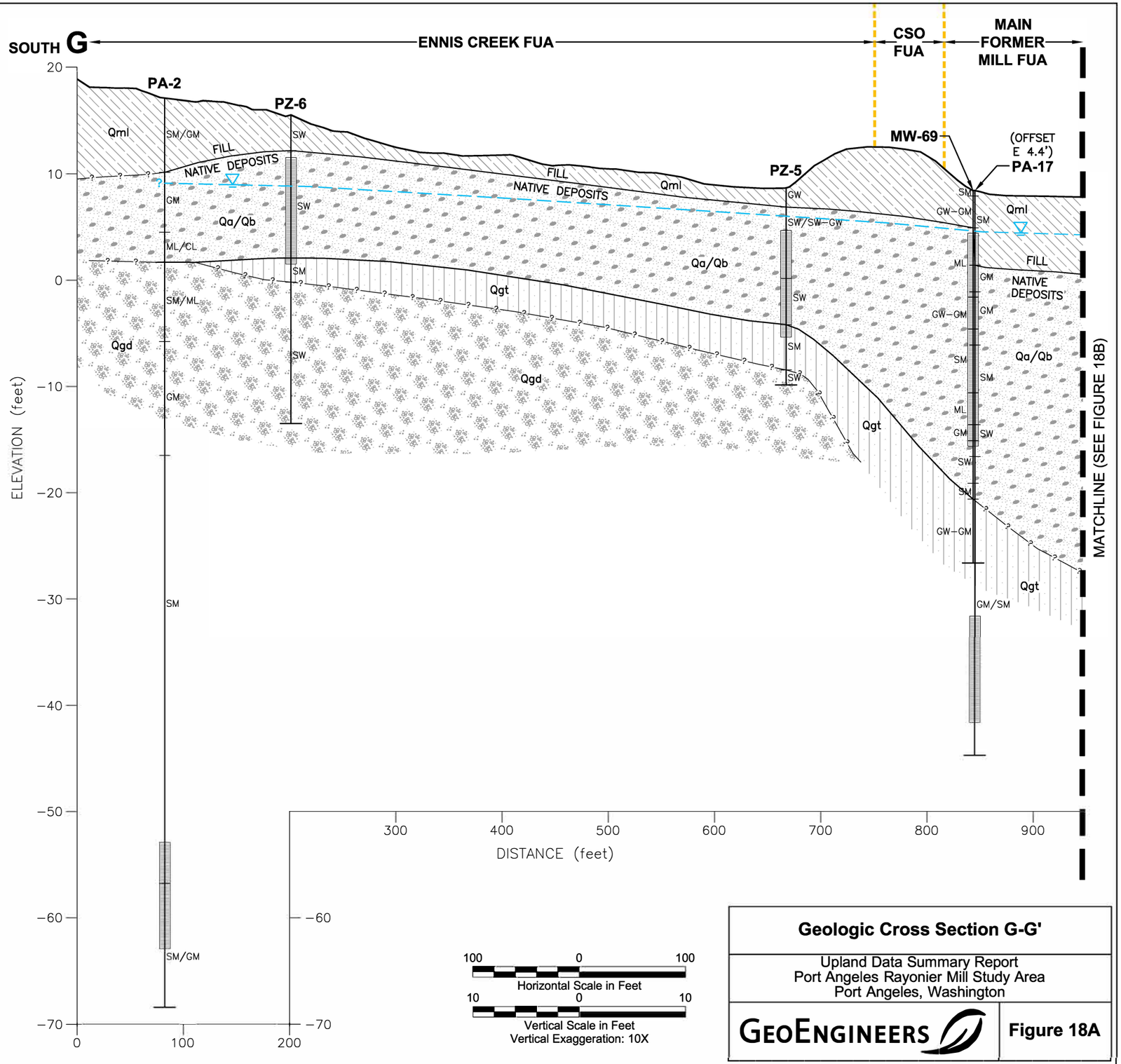
Qgt **Vashon till (Pleistocene)** Well graded and highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders; permeability very low where lodgement till is well developed; most commonly matrix supported but locally clast supported; matrix more angular than water-worked sediments; cobbles and boulders commonly faceted and/or striated.

Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 10 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.
4. Vertical Datum NGVD 1929.

References:

1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
3. Rayonier Mill Supplemental Upland Investigation field observations by GeoEngineers geologists October 2010 - May 2011.

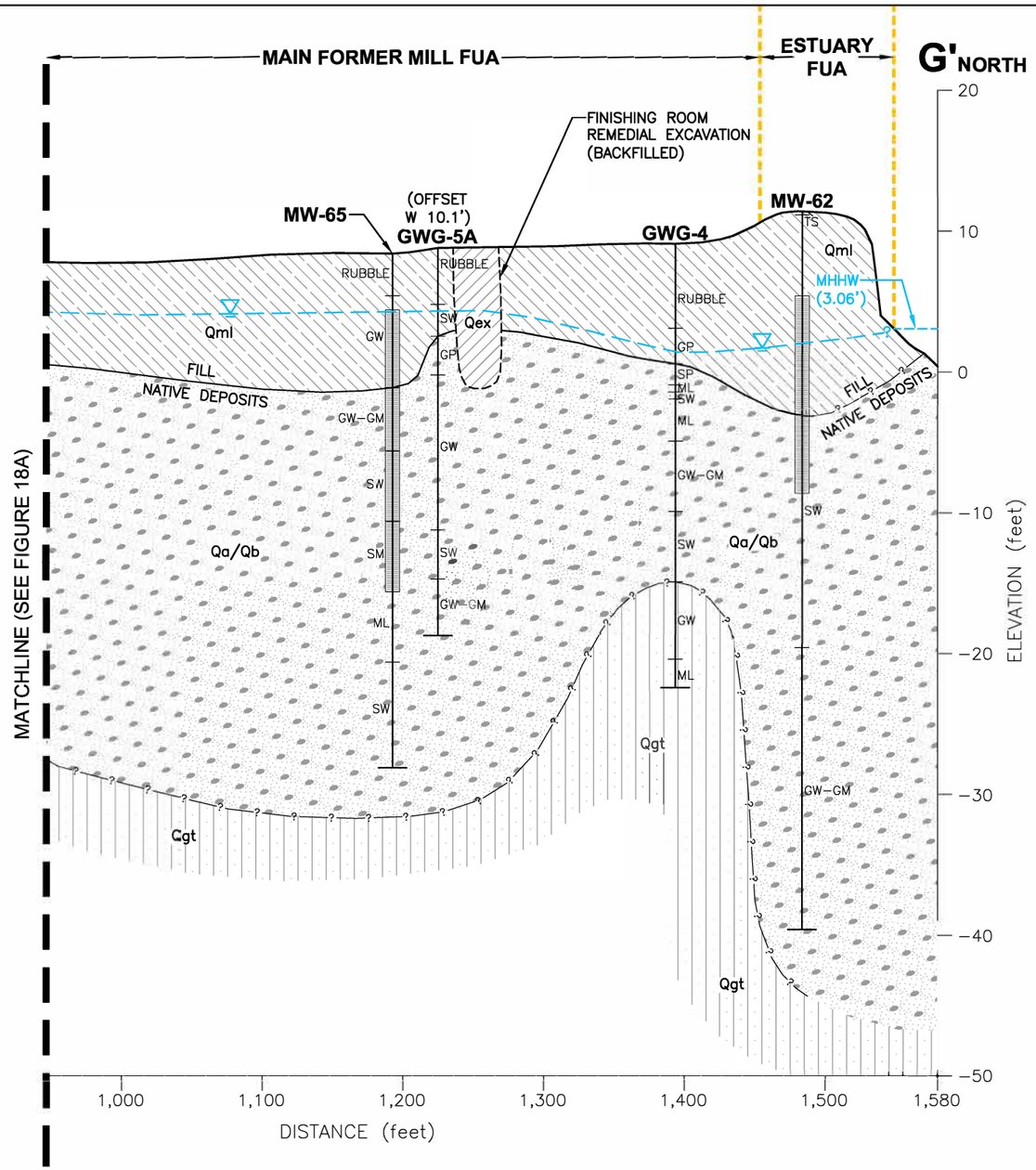


Geologic Cross Section G-G'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 18A



EXPLANATION:

MW-65	MONITORING WELL NUMBER AND APPROXIMATE LOCATION
SM	SOIL TYPE AT SAMPLE LOCATION
	SCREEN LOCATION
	SOIL CONTACT
—?—?—?—	INFERRED SOIL CONTACT
	GROUNDWATER ELEVATION (AUGUST 2010)
MHHW	MEAN HIGHER HIGH WATER
FUA	FUNCTIONAL USE AREA

Geologic Descriptions:

Qex **Interim Remedial Excavations** Backfill consisting of overburden, rubble, riprap, and other suitable materials.

Qml **Modified land (recent fill)** Soil, sediment, or other material locally reworked by excavation and/or redistribution to modify topography. At the mill property, fill consists of sand and gravel w/ varying amounts of silt and construction debris. Construction debris primarily consists of concrete rubble, bricks and wood debris, scrap metal (e.g., steel rails, iron and steel pipe, steel wire) and thin horizons of apparent boiler ash and/or boiler slag (clinker) are present in some areas.

Qa/Qb **Undifferentiated Alluvial and Beach Deposits (early Holocene-recent)** Alluvial deposits consist of gravel, sand and silt; variably graded; loose to very dense; deposited by alluvial processes associated with Ennis Creek and White Creek. Beach deposits consist of sand with varying amounts of gravel, cobbles, silt and marine shell fragments; variably graded; loose to dense; deposited by shoreline processes.

Qgt **Vashon till (Pleistocene)** Well graded and highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders; permeability very low where lodgement till is well developed; most commonly matrix supported but locally clast supported; matrix more angular than water-worked sediments; cobbles and boulders commonly faceted and/or striated.

Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

100 0 100
Horizontal Scale in Feet
10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 10 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.
4. Vertical Datum NGVD 1929.

References:

1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
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Geologic Cross Section G-G' (Continued)

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

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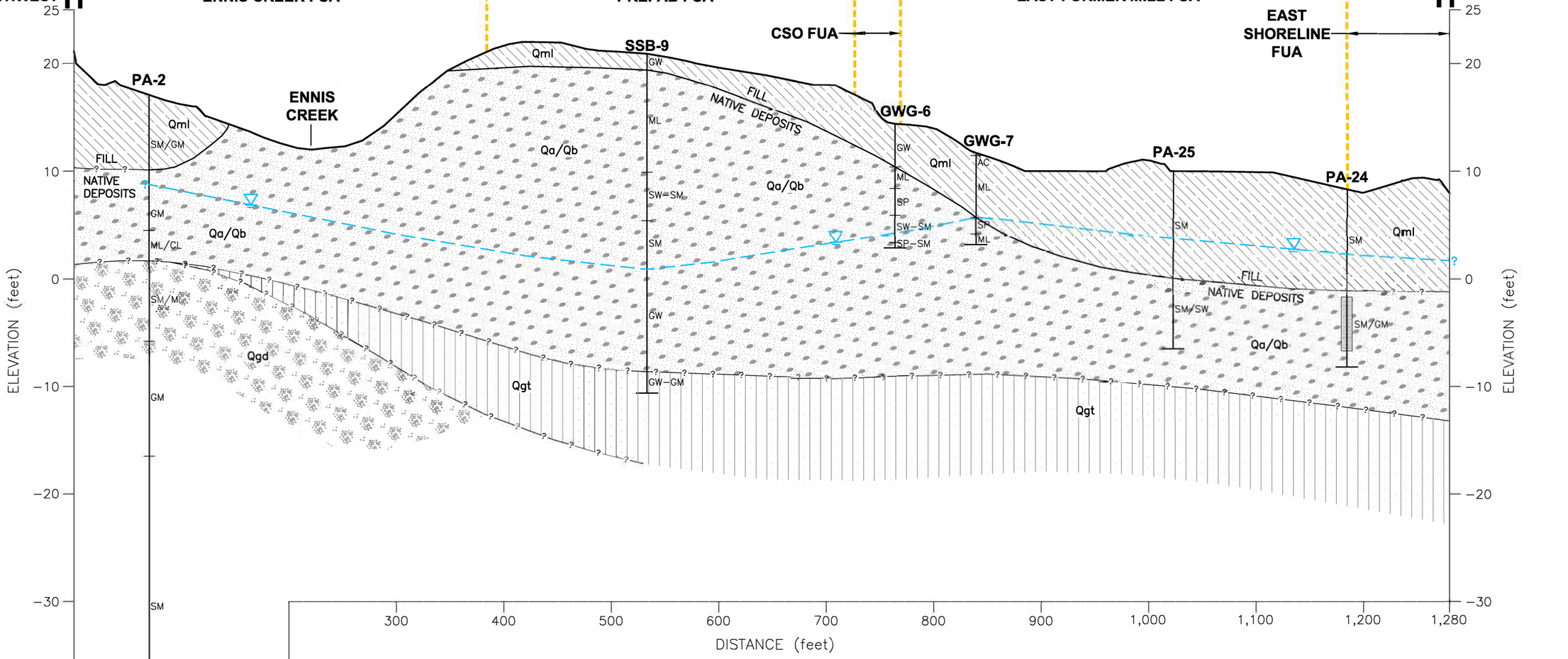
Figure 18B

SOUTHWEST H — ENNIS CREEK FUA — PREFAB FUA — CSO FUA — EAST FORMER MILL FUA — EAST SHORELINE FUA — H' NORTHEAST



EXPLANATION:

- SSB-9 — SOIL BORING NUMBER AND APPROXIMATE LOCATION
- SM — SOIL TYPE AT SAMPLE LOCATION
- SCREEN LOCATION
- SOIL CONTACT
- INFERRED SOIL CONTACT
- GROUNDWATER ELEVATION (AUGUST 2010)
- FUA — FUNCTIONAL USE AREA

Geologic Descriptions:

Qex **Interim Remedial Excavations** Backfill consisting of overburden, rubble, riprap, and other suitable materials.

Qml **Modified land (recent fill)** Soil, sediment, or other material locally reworked by excavation and/or redistribution to modify topography. At the mill property, fill consists of sand and gravel w/ varying amounts of silt and construction debris. Construction debris primarily consists of concrete rubble, bricks and wood debris, scrap metal (e.g., steel rails, iron and steel pipe, steel wire) and thin horizons of apparent boiler ash and/or boiler slag (clinker) are present in some areas.

Qa/Qb **Undifferentiated Alluvial and Beach Deposits (early Holocene-recent)** Alluvial deposits consist of gravel, sand and silt; variably graded; loose to very dense; deposited by alluvial processes associated with Ennis Creek and White Creek. Beach deposits consist of sand with varying amounts of gravel, cobbles, silt and marine shell fragments; variably graded; loose to dense; deposited by shoreline processes.

Qgt **Vashon till (Pleistocene)** Well graded and highly compacted, very dense to hard mixture of unstratified clay, silt, sand, gravel, and boulders; permeability very low where lodgement till is well developed; most commonly matrix supported but locally clast supported; matrix more angular than water-worked sediments; cobbles and boulders commonly faceted and/or striated.

Qgd **Vashon drift, undivided (Pleistocene)** Glacial deposits of Vashon age consisting of mixtures of sand, gravel, and silt; typically well rounded; loose to very dense; variably graded.

100 0 100
Horizontal Scale in Feet
10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 10 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.
4. Vertical Datum NGVD 1929.

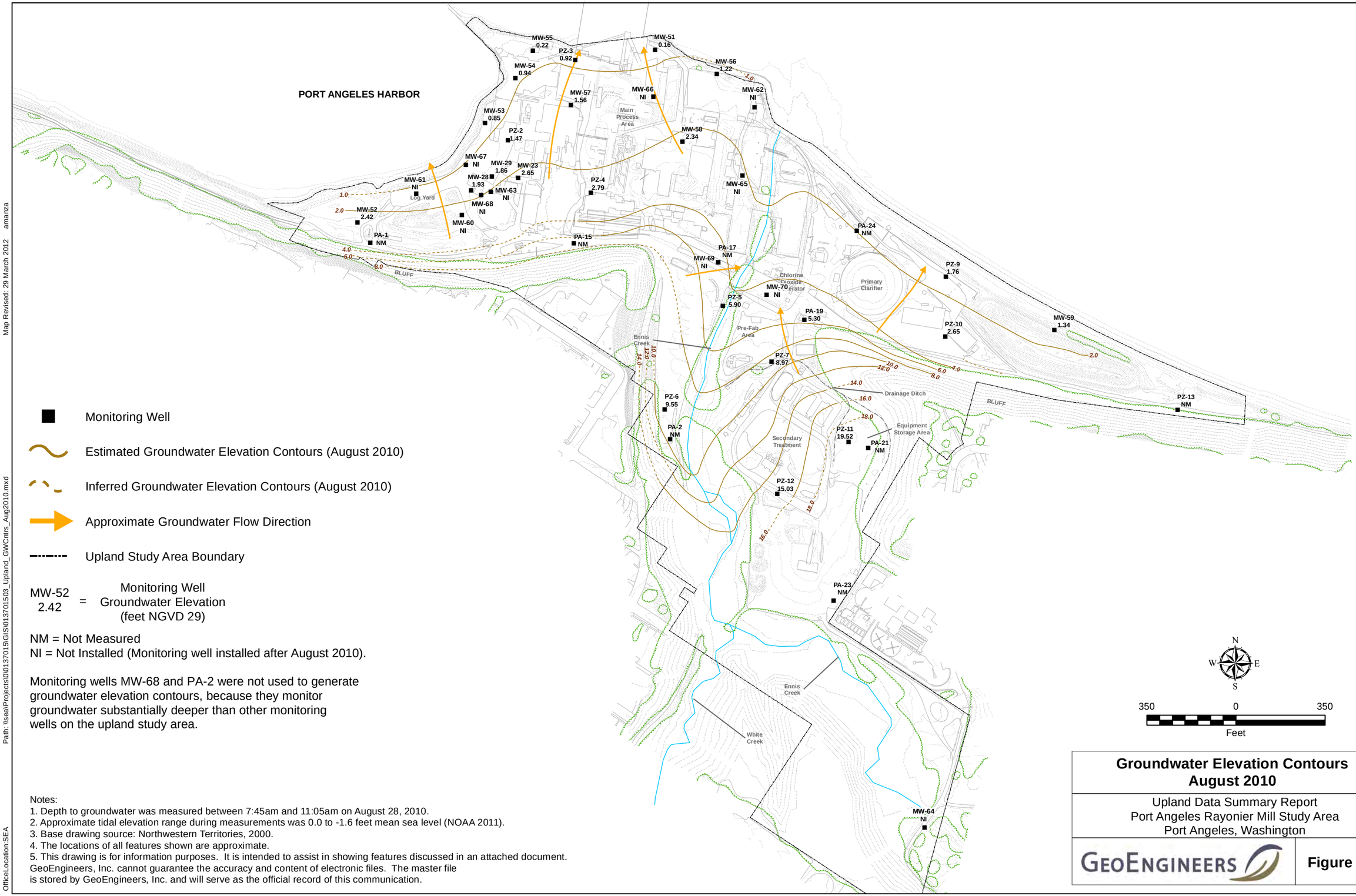
References:
1. Washington Department of Natural Resources Geologic Map of the Port Angeles and Ediz Hook 7.5-minute Quadrangles, Clallam County, Washington by Henry W. Schasse, Karl W. Wegmann, and Michael Polenz June 2004.
2. Washington Department of Natural Resources Geologic Map of the Washington Portion of the Port Angeles 1:100,000 Quadrangle by Henry W. Schasse 2003.
3. Rayonier Mill Supplemental Upland Investigation field observations by GeoEngineers geologists October 2010 - May 2011.

Geologic Cross Section H-H'

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 19



Monitoring Well

Estimated Groundwater Elevation Contours (August 2010)

Inferred Groundwater Elevation Contours (August 2010)

Approximate Groundwater Flow Direction

Upland Study Area Boundary

MW-52
2.42
= Monitoring Well
Groundwater Elevation
(feet NGVD 29)

NM = Not Measured
NI = Not Installed (Monitoring well installed after August 2010).

Monitoring wells MW-68 and PA-2 were not used to generate groundwater elevation contours, because they monitor groundwater substantially deeper than other monitoring wells on the upland study area.

Notes:
1. Depth to groundwater was measured between 7:45am and 11:05am on August 28, 2010.
2. Approximate tidal elevation range during measurements was 0.0 to -1.6 feet mean sea level (NOAA 2011).
3. Base drawing source: Northwestern Territories, 2000.
4. The locations of all features shown are approximate.
5. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Groundwater Elevation Contours
August 2010

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

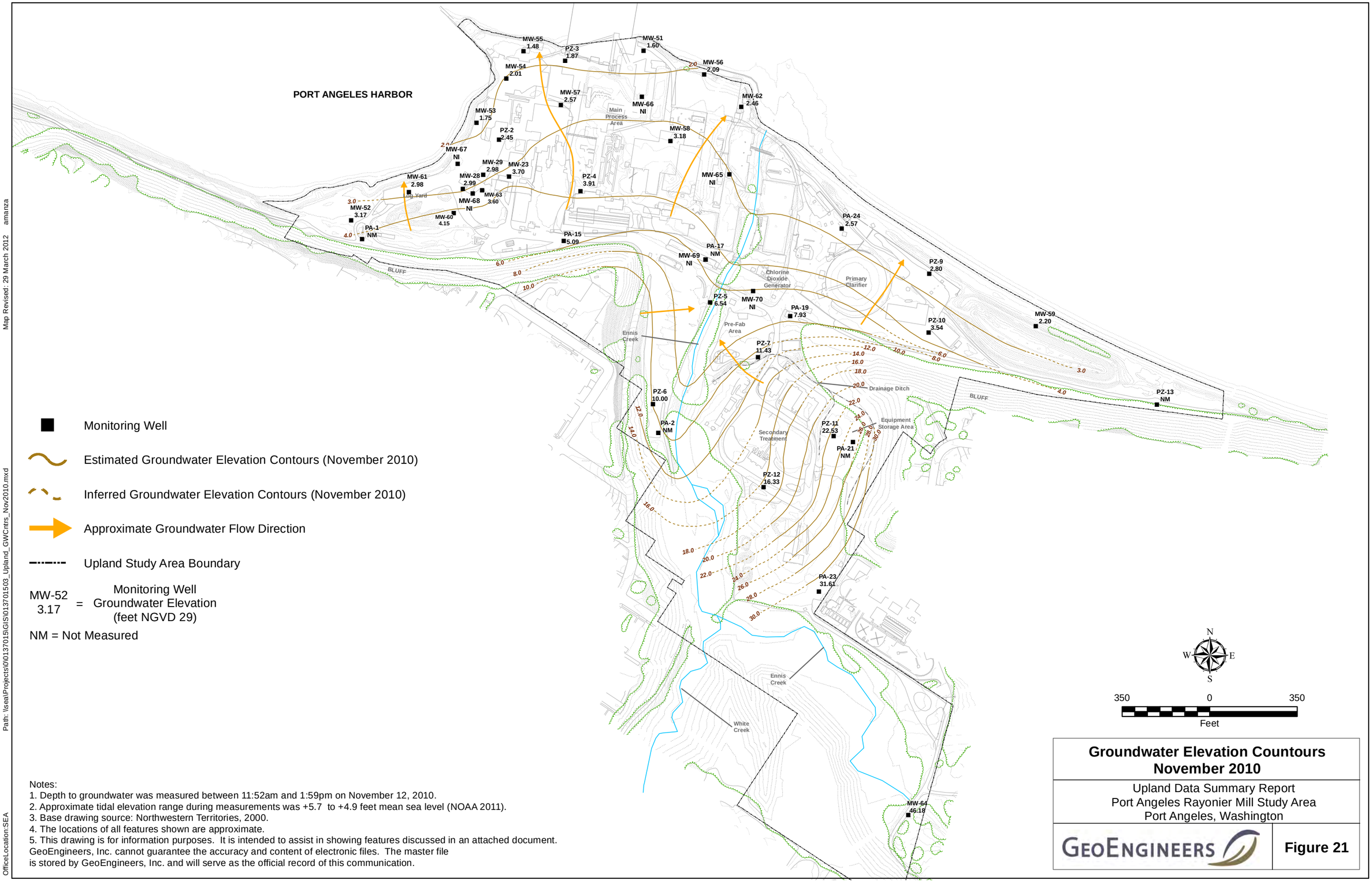
GeoEngineers

Figure 20

Map Revised: 29 March 2012 amanza

Path: \\seaProjects\0013701S\GIS\013701503_Upland_GWCntrs_Aug2010.mxd

OfficeLocation:SEA



Monitoring Well

Estimated Groundwater Elevation Contours (November 2010)

Inferred Groundwater Elevation Contours (November 2010)

Approximate Groundwater Flow Direction

Upland Study Area Boundary

MW-52 3.17 = Monitoring Well Groundwater Elevation (feet NGVD 29)

NM = Not Measured

N

W E

S

350 0 350

Feet

Notes:
1. Depth to groundwater was measured between 11:52am and 1:59pm on November 12, 2010.
2. Approximate tidal elevation range during measurements was +5.7 to +4.9 feet mean sea level (NOAA 2011).
3. Base drawing source: Northwestern Territories, 2000.
4. The locations of all features shown are approximate.
5. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Groundwater Elevation Countours November 2010

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

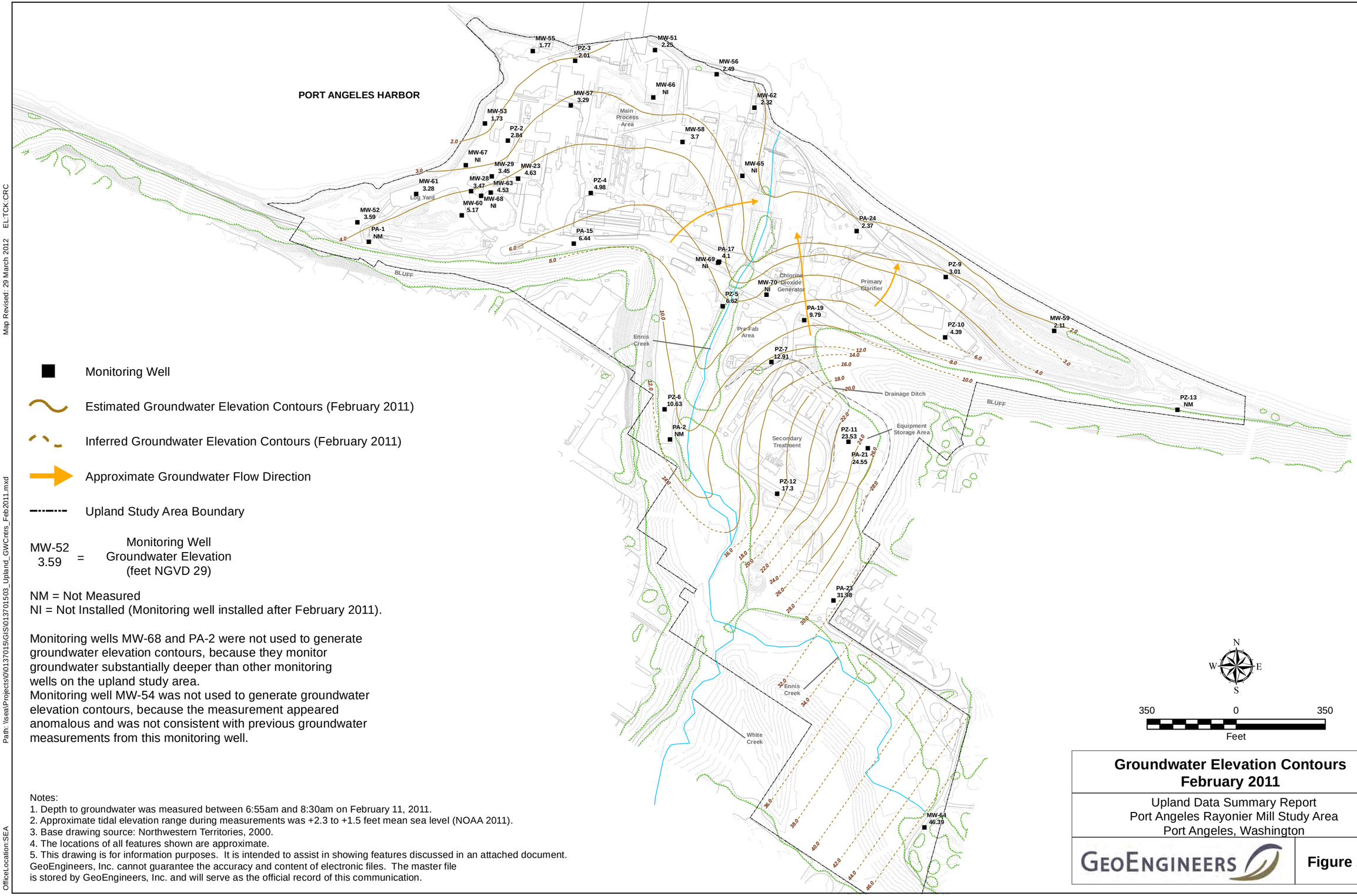
GeoEngineers

Figure 21

Map Revised: 29 March 2012 amanza

Path: \\seaProjects\0013701S\GIS\013701503_Upland_GWCntrs_Nov2010.mxd

OfficeLocation:SEA



Monitoring Well

Estimated Groundwater Elevation Contours (February 2011)

Inferred Groundwater Elevation Contours (February 2011)

Approximate Groundwater Flow Direction

Upland Study Area Boundary

MW-52 3.59 = Monitoring Well Groundwater Elevation (feet NGVD 29)

NM = Not Measured
NI = Not Installed (Monitoring well installed after February 2011).

Monitoring wells MW-68 and PA-2 were not used to generate groundwater elevation contours, because they monitor groundwater substantially deeper than other monitoring wells on the upland study area.
Monitoring well MW-54 was not used to generate groundwater elevation contours, because the measurement appeared anomalous and was not consistent with previous groundwater measurements from this monitoring well.

Notes:
1. Depth to groundwater was measured between 6:55am and 8:30am on February 11, 2011.
2. Approximate tidal elevation range during measurements was +2.3 to +1.5 feet mean sea level (NOAA 2011).
3. Base drawing source: Northwestern Territories, 2000.
4. The locations of all features shown are approximate.
5. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

N
W E
S

350 0 350
Feet

Groundwater Elevation Contours February 2011

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

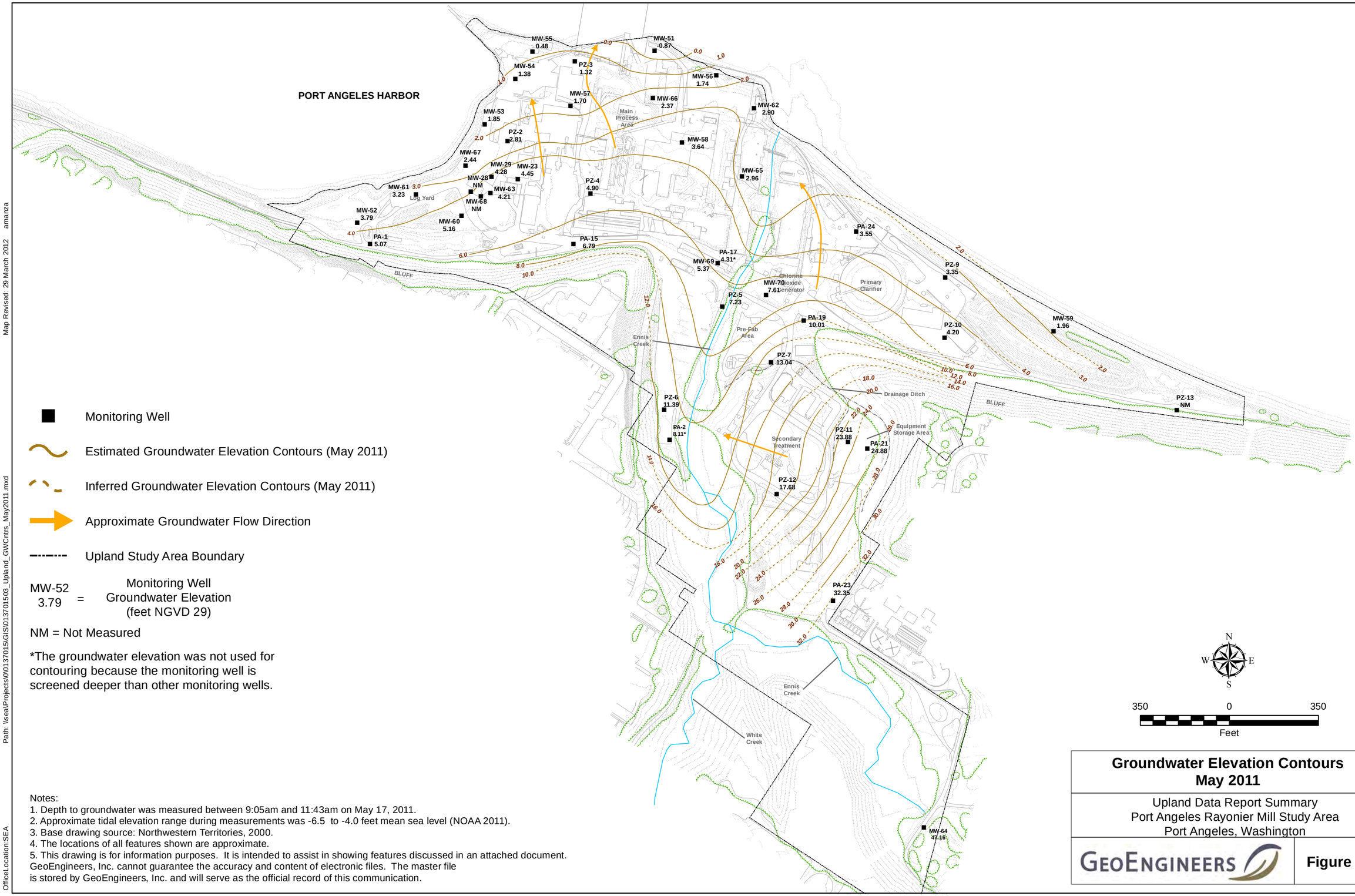
GeoEngineers

Figure 22

Map Revised: 29 March 2012 EL:TCK:CRC

Path: \\seaProjects\00137015\GIS\01370103_Upland_GWCntrs_Feb2011.mxd

OfficeLocation:SEA



Notes:
1. Depth to groundwater was measured between 9:05am and 11:43am on May 17, 2011.
2. Approximate tidal elevation range during measurements was -6.5 to -4.0 feet mean sea level (NOAA 2011).
3. Base drawing source: Northwestern Territories, 2000.
4. The locations of all features shown are approximate.
5. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Groundwater Elevation Contours
May 2011

Upland Data Report Summary
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

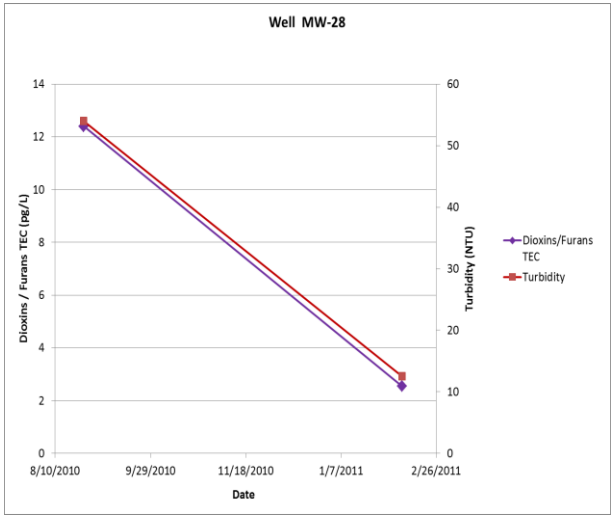
GeoEngineers

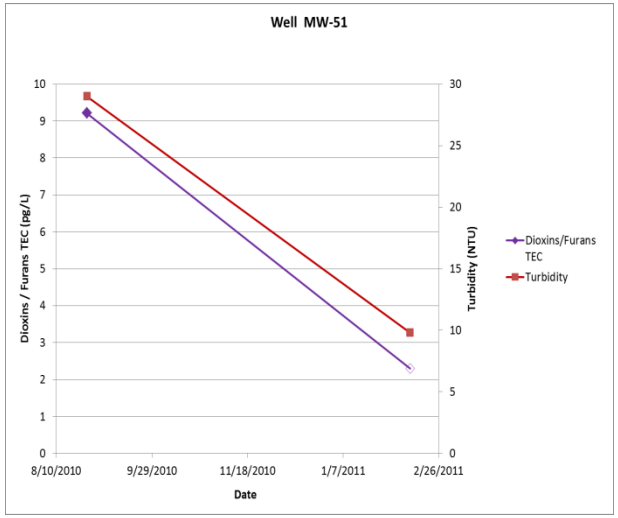
Figure 23

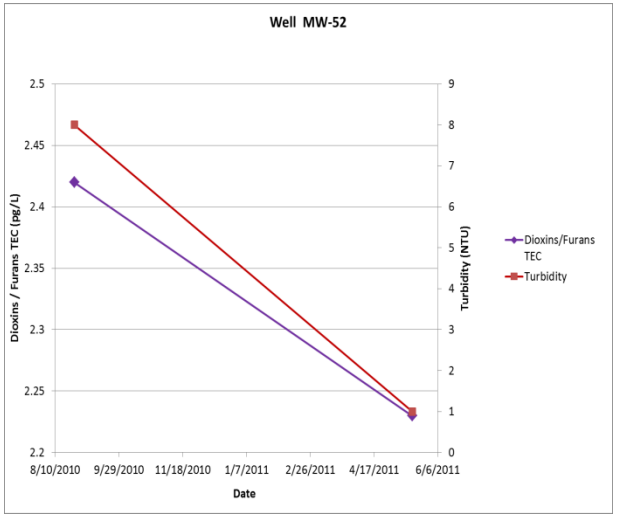
Map Revised: 29 March 2012 amanza

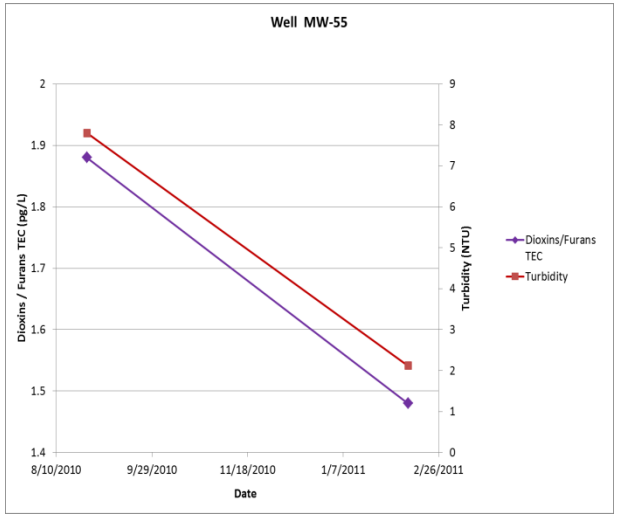
Path: \\seaProjects\0\0137015\GIS\0137015_Upland_GWCntrs_May2011.mxd

OfficeLocation:SEA









Legend

◆ Filled symbol indicates detected result

◇ Open symbol indicates non-detected result

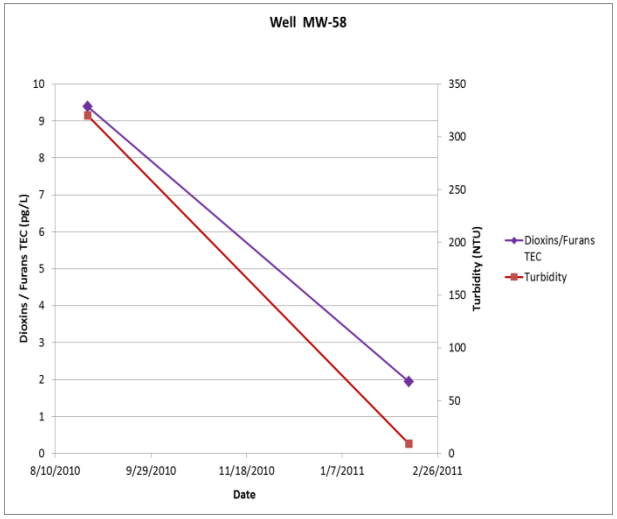
Office: SEA

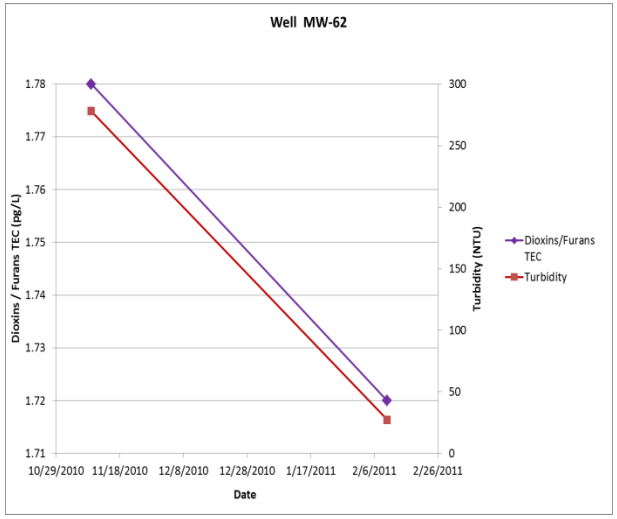
Groundwater Dioxins/Furans and Turbidity Data 2010-2011

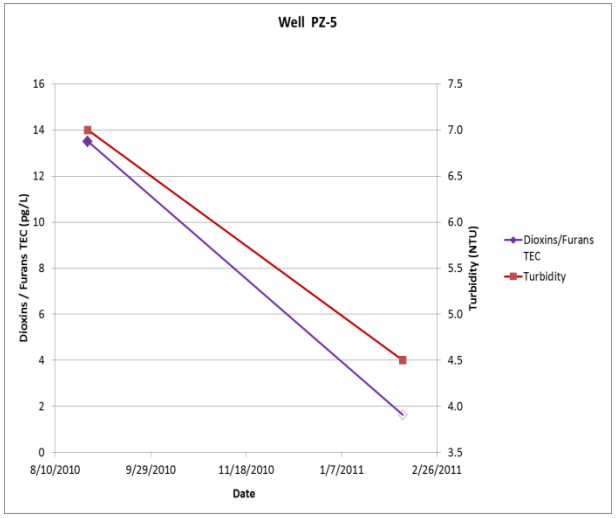
Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

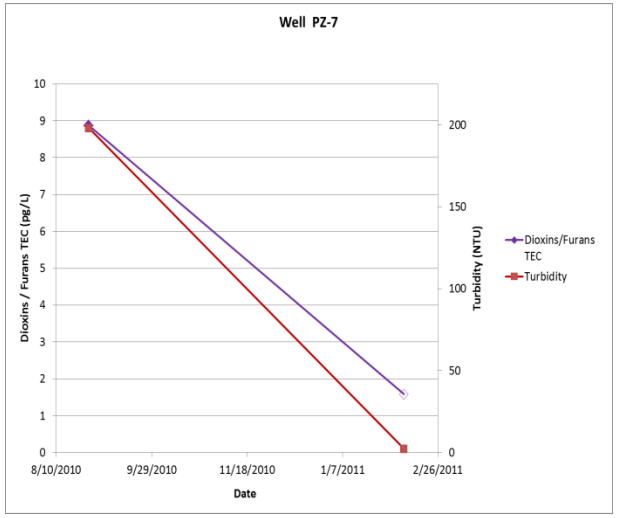
GeoEngineers

Figure 24A









Legend

◆ Filled symbol indicates detected result

◇ Open symbol indicates non-detected result

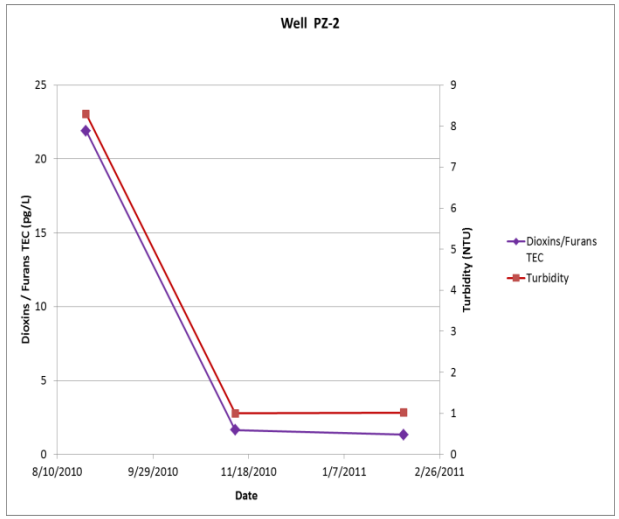
Groundwater Dioxins/Furans and Turbidity Data 2010-2011

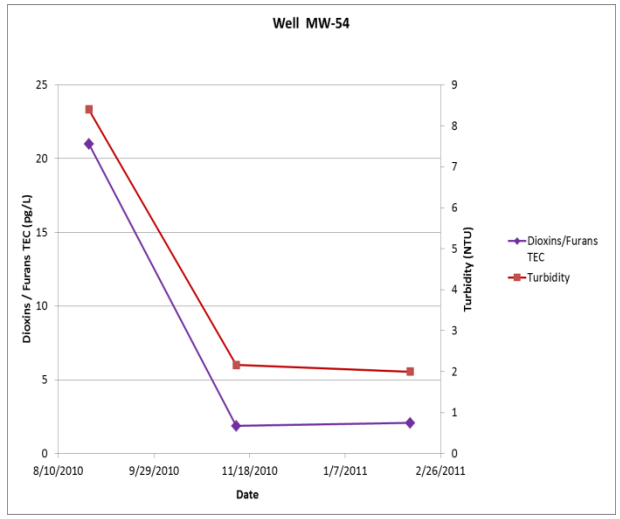
Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

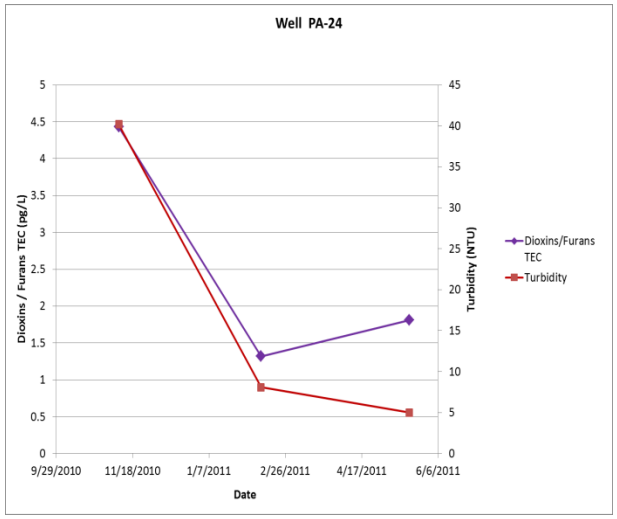
GeoEngineers

Figure 24B

Office: SEA







Legend

◆ Filled symbol indicates detected result

◇ Open symbol indicates non-detected result

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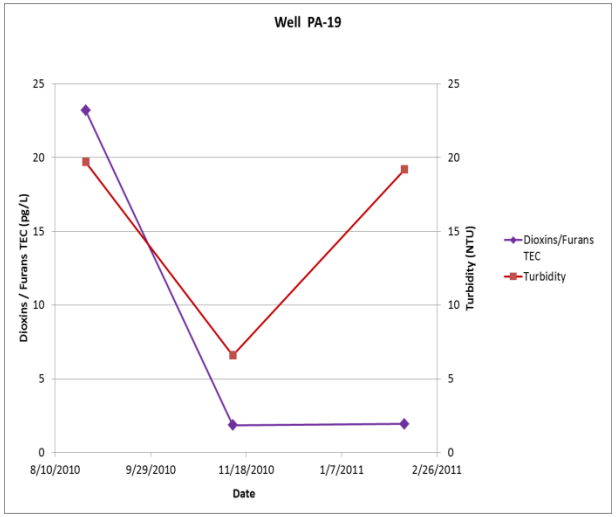
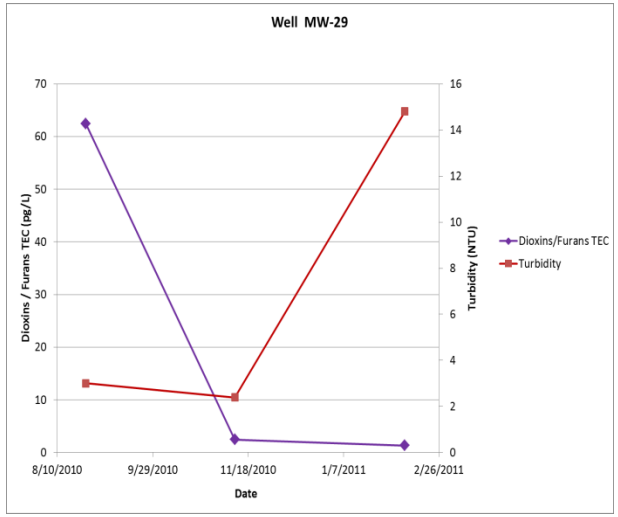
Groundwater Dioxins/Furans and Turbidity Data 2010-2011

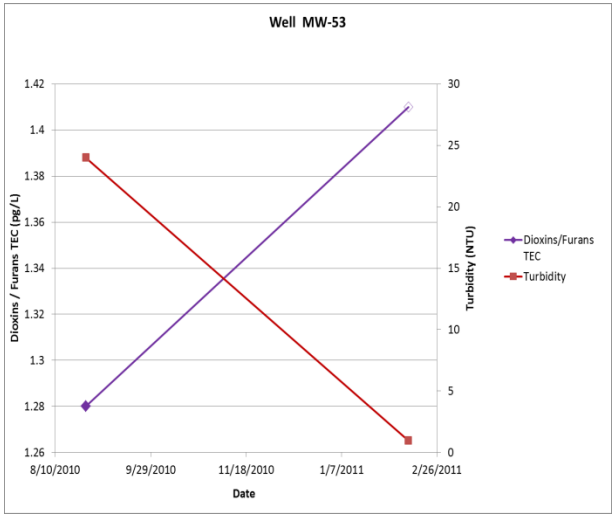
Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

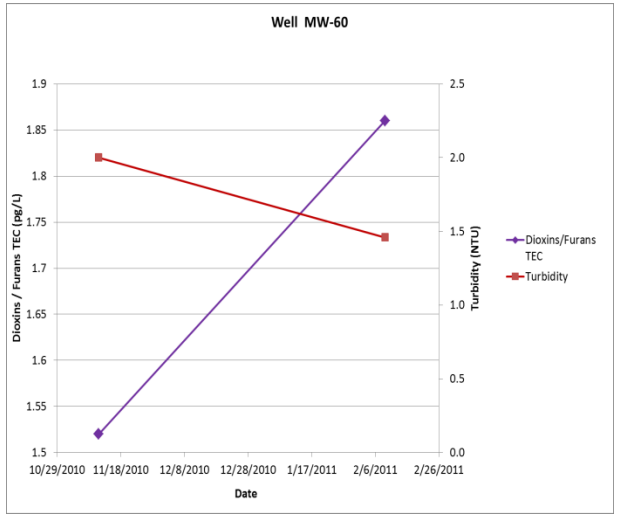
GeoEngineers

Figure 24C









Legend

◆ Filled symbol indicates detected result

◇ Open symbol indicates non-detected result

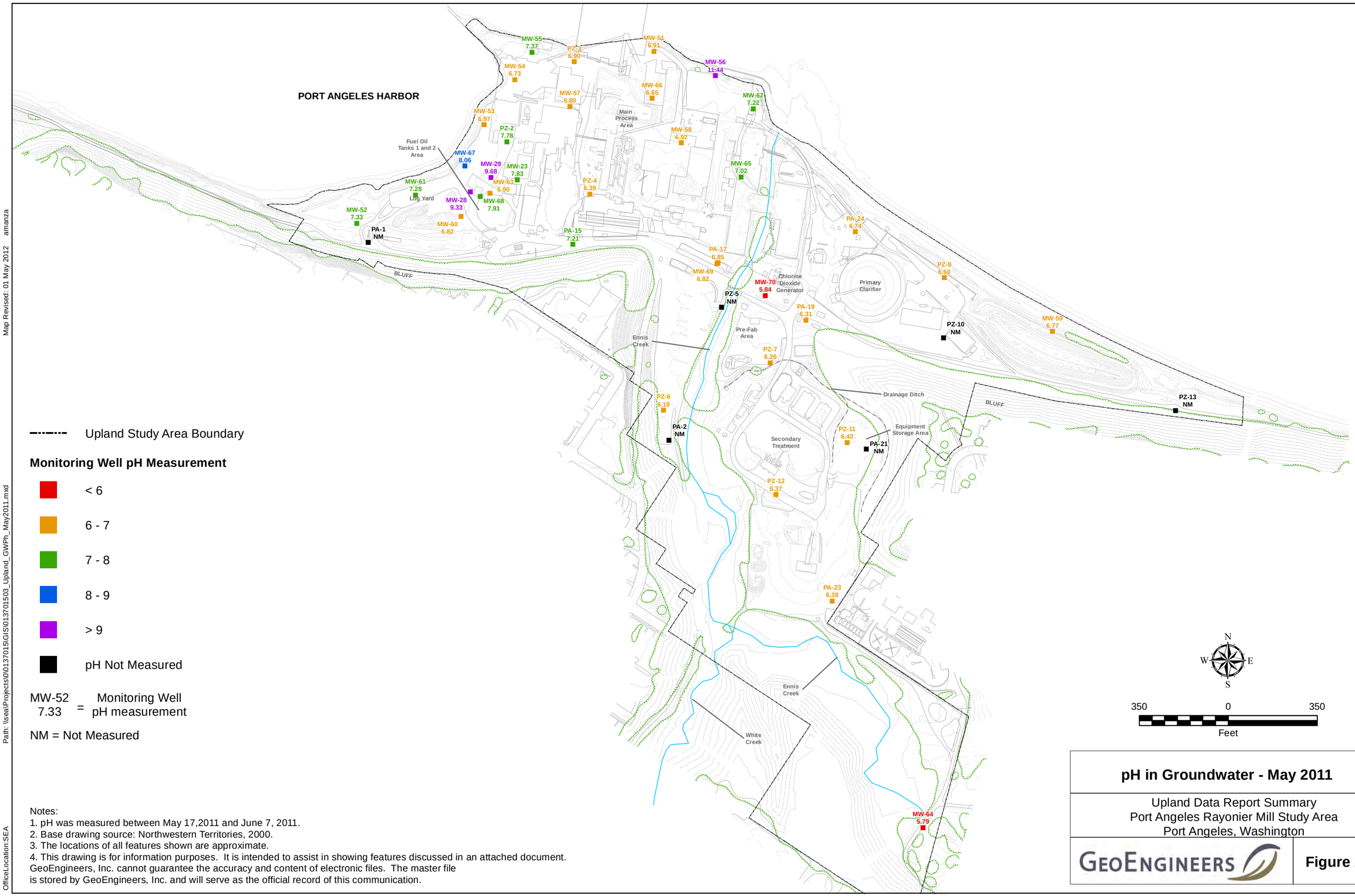
Groundwater Dioxins/Furans and Turbidity Data 2010-2011

Upland Data Summary Report
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 24D

Office: SEA



Upland Study Area Boundary

Monitoring Well pH Measurement

- < 6
- 6 - 7
- 7 - 8
- 8 - 9
- > 9
- pH Not Measured

MW-52 / 7.33 = Monitoring Well / pH measurement

NM = Not Measured

Notes:
1. pH was measured between May 17,2011 and June 7, 2011.
2. Base drawing source: Northwestern Territories, 2000.
3. The locations of all features shown are approximate.
4. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

pH in Groundwater - May 2011

Upland Data Report Summary
Port Angeles Rayonier Mill Study Area
Port Angeles, Washington

GeoEngineers

Figure 25

Map Revised: 01 May 2012 amanza

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OfficeLocation:SEA