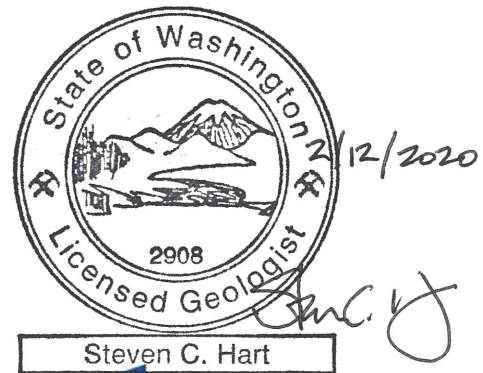


Feasibility Study Report Chemtrade Performance Chemicals US LLC Site

**Kalama, Washington
Cleanup Site No. 1784
Facility No. 24634187
VCP Project No. SW0492**

**H&H Job No. CLR-045
February 12, 2020**



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**Feasibility Study Report
Chemtrade Performance Chemicals US LLC Site
404 N Hendrickson Drive
Kalama, Washington
H&H Job No. CLR-045**

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Feasibility Study Report
Chemtrade Performance Chemicals US LLC Site
404 N Hendrickson Drive
Kalama, Washington
H&H Job No. CLR-045

1.0 Introduction

On behalf of Clariant Corporation (Clariant), Hart & Hickman, PC (H&H) has prepared this Feasibility Study (FS) report for the Chemtrade Performance Chemicals US LLC site (Cleanup Site No. 1784, Facility/Site No. 24634187) located at 404 N. Hendrickson Drive in Kalama, Cowlitz County, WA (the Site). Please note that the Site has also been referred to as the Former Clariant Corporation Chemical Plant or Facility in previous submittals. A Site location map is included as Figure 1. The Site is currently enrolled in the Washington State Department of Ecology (Ecology) Voluntary Cleanup Program (VCP Project No. SW0492).

Previous environmental investigations indicate Site soil and groundwater are impacted and that the compounds of concern (COCs) associated with the Site are the metals cadmium and zinc. The purpose of the FS is to develop and evaluate cleanup action alternatives in accordance with Model Toxics Control Act (MTCA), Washington Administrative Code (WAC) 173-340-350(8) to enable the Washington Department of Ecology (Ecology) to select a cleanup action for the Site. This report also presents background information for the Site and is organized as follows:

- Section 1 describes the purpose of the FS and outlines the organization of this report.
- Section 2 presents Site information including:
 - Location and description;
 - Historical manufacturing operations;
 - Environmental setting;
 - Preliminary cleanup standards;
 - Previous environmental investigations and interim actions; and,
 - A Conceptual Site Model including summaries of COC sources, concentrations and distribution, fate and transport mechanisms, exposure pathways, and potential

receptor risks.

- Section 3 presents cleanup action objectives and summarizes the cleanup action alternatives identified for evaluation.
- Section 4 presents a detailed evaluation of the cleanup action alternatives and selection of a preferred cleanup action alternative.
- Section 5 presents a summary of the preferred cleanup action alternative.

2.0 Site Information

2.1 Location and Description

The Site is an approximately 8-acre parcel (Cowlitz County PIN 6005401) located in the South Port area of the Port of Kalama industrial area. The Site is zoned industrial and is currently owned by Chemtrade Performance Chemicals, Inc. (Chemtrade). The Site is bordered to the west by the Columbia River, and to the north, south, and east by parcels which are zoned commercial and owned by the Port of Kalama. The parcel (PIN 410560500) to the north of the Site is developed with Hendrickson Drive and includes a paved driveway and walking path for riverfront access. The parcel (PIN 600540200) to the south of the Site is developed with rail spur lines which run along the eastern portion of the parcel, but is otherwise largely undeveloped and primarily used to stockpile river dredge spoils. The parcel (PIN 6005308) to the east of the Site is developed with Hendrickson Drive, and the parcel (PIN 60061) to the east of Hendrickson Drive is owned by Burlington Northern, Inc. and is developed with a railroad corridor (containing four railroad tracks). A Site vicinity map is included as Figure 2.

Site and manufacturing facility features are depicted in the Site map included as Figure 3. Note that manufacturing activities were ceased at the Site in mid-2016, and the Site is currently vacant. As shown in Figure 3, an approximately 17,000-square foot (sf) manufacturing building that contains office space, storage areas, loading docks, a utility room, and product manufacturing areas is located on the southeastern portion of the Site. The manufacturing building is generally constructed with steel column and beam framing, sheet metal siding, and a concrete slab-on-grade foundation, and includes a concrete-lined subgrade tank vault with two former process tanks located inside the northern portion of the building. A concrete secondary containment area which contains chillers and tanks formerly used to store wastewater, glycol, and dissolver is located adjacent to the northwestern portion of the manufacturing building. To the north and northwest of the manufacturing building are a truck loading area, an approximately 1,000-sf building that contains a former zinc oxide dryer, and two concrete secondary containment areas that contain process tanks, silos, and other equipment. A railroad spur runs along the east side of the Site structures and crosses Hendrickson Drive to the north of the

manufacturing structures, and an above ground storage tank (AST) formerly used to store sulfur dioxide is located to the east of the railroad spur near the northeastern portion of the manufacturing building. A pump house is located west of the manufacturing building near the western edge of the Site.

The areas surrounding the northern portion of the manufacturing building and secondary containment structures are paved with asphalt. An asphalt parking lot is located to the south of the manufacturing building, and an asphalt driveway runs along the western side of the Site from the parking lot to the paved area around the northern portion of building. Asphalt and concrete pavement are also present along the eastern side of the manufacturing building. The area to the south of the manufacturing building and large portions of the areas to the east and west of the building are paved. The developed southern portion of the Site is referred to as the manufacturing plant area (MPA).

To the north of the MPA, the Site is largely undeveloped where four unlined earthen settling basins were formerly located. This northern portion of the Site is referred to as the former settling basin (FSB) area. In undeveloped areas of the Site, the ground is primarily sandy and covered with upland herbaceous vegetation and/or moss. The Site is secured with an 8-ft barbed wire perimeter fence. Relatively small perimeter areas of the Site along Hendrickson Drive are located outside of the perimeter fence. In addition, an approximately 10-ft wide strip of the property which runs along the top of the bank of the Columbia River is located outside of the perimeter fence.

2.2 Historical Operations

According to the Camp Dresser & McKee (CDM) report entitled *Phase I Environmental Assessment* (CDM 2002), which is hereafter referred to as the CDM EA, and the CDM Feasibility Study (CDM 2008), which is hereafter referred to as the CDM FS, the Site was first developed in 1969 by Virginia Chemicals. At that time, the manufacturing facility contained the structures discussed above, except the structures to the north-northwest of the manufacturing building were constructed at a later date. Prior to 1969, the Site was undeveloped and was

physically built up with approximately 20 ft of dredge spoils from the Columbia River shortly before the Site was developed. Hoechst Celanese purchased the Site in 1989 and operated the facility until 1997 when Clariant and Hoechst Celanese merged. Clariant sold the Site property and manufacturing facility to Chemtrade in January 2003; however, Clariant maintained liability for historical environmental impacts associated with the Site. Chemtrade ceased manufacturing operations in mid-2016, and decommissioned and cleaned process equipment and tanks located at the Site during 2016 and 2017. Future plans for the Site are not known to Clariant.

The CDM EA indicates the Site has always been used for sodium hydrosulfite production; however, the CDM FS indicates that zinc hydrosulfite was produced at the Site from 1969 through 1973 and sodium hydrosulfite was produced from 1974 through the time of the report (2002). The plant continued to produce sodium hydrosulfite until 2016 when the plant was shut down. According to the CDM EA, sodium hydrosulfite was produced utilizing a batch process that generally included mixing zinc dust and water in a reactor tank, then reacting the mixture with sulfur dioxide to formulate zinc hydrosulfite. The zinc hydrosulfite was then reacted with sodium hydroxide (aqueous) to form sodium hydrosulfite (aqueous) and zinc oxide (non-aqueous). This formulation process was primarily completed in two process tanks located in the Make Tank Room's concrete-lined subgrade tank vault (Figure 3). Prior to 2004, cadmium sulfate solution was utilized as needed to remove lead impurities from the zinc hydrosulfite. The sodium hydrosulfite was diluted to final product specification prior to placement into tankers for off-Site shipment. After being dried, zinc oxide solids were placed into rail cars for off-Site shipment. The sodium hydrosulfite was sold for use in newspaper production, and zinc oxide byproduct was reportedly sold for use in tire manufacturing.

According to the CDM FS, from approximately 1974 until the late 1970s or early 1980s, the manufacturing process generated zinc carbonate sludge as a byproduct, and the sludge was discharged to former settling basin #2 (FSB2). The CDM FS indicates that sludge was apparently not discharged to FSB2 after 1984. Former settling basin #1 (FSB1) reportedly received minor spillage of zinc carbonate sludge from conveyance of the sludge to FSB2. Former settling basins #3 and #4 (FSB3 and FSB4, respectively) were never used. The settling

basins were closed in 1989 by removing the marketable zinc carbonate sludge from FSB2 and filling the basins with dredge spoils. FSB locations are depicted in Figure 3.

Approximately 20 ASTs were used for storage and processing of liquid materials at the Site. No underground storage tanks are known to have been present or previously used at the Site. Dry materials used in the manufacturing processes were stored in drums, totes, and bag/sacks inside the warehouse portion of the manufacturing building. Refer to the CDM EA for additional manufacturing process details and summaries of tanks and chemicals previously used at the Site. Wastewater generated during the manufacturing processes and potentially contaminated storm water collected from areas such as the secondary containment and rail car/tanker loading areas were collected and used as make-up water in the production processes.

2.3 Environmental Setting

2.3.1 Geology and Hydrogeology

The Site is located along the eastern bank of the Columbia River and is underlain by dredge spoils, alluvial deposits, and bedrock. As previously mentioned, the Site was built up with approximately 20 ft of river dredge spoils shortly before development, and the riverbank adjacent to the Site is armored with riprap. The dredge spoils consist primarily of fine to coarse-grained loose brown, gray, and black sand. The alluvium consists of fine to coarse-grained loose brown, gray, and black sand with silts and gravels. The bedrock geology in the area of the Site is complex and primarily consists of basalt flows and marine and non-marine sandstone. Based on borings installed at the Site, bedrock is present at approximately 25 to 30 ft below ground surface (bgs) beneath the northern and eastern portions of the Site and slopes downward to greater than 60 ft bgs in southern and western portions of the Site.

The Site has a relatively flat surface topography which gently slopes from east to west. As a result of the gentle slope and sandy surface soils, stormwater infiltration rates are very high in unpaved areas of the Site and storm water runoff onto and off the Site is minimal.

The Columbia River is subject to tidal fluctuations, and is freshwater at the location of the Site. Based on verified Columbia River elevation data obtained from the National Oceanic and Atmospheric Association (NOAA), the elevation of the Columbia River can fluctuate by as much as approximately seven feet between low and high tides in the vicinity of the Site. Historical groundwater elevation data collected from Site monitoring wells indicate that shallow groundwater flow at the Site is influenced by the tidal elevation variations of the Columbia River. In the eastern portion of the Site, there is a hydraulic gradient from east to west toward the river. In the western portion of the Site, hydraulic communication between the river and shallow groundwater results in a temporal mound in the groundwater table near the river that creates a relatively weak hydraulic gradient from west to east in that area. The groundwater mound near the river is temporal and its presence depends upon the timing and magnitude of the tides. The converging hydraulic gradients appear to cause groundwater in the central portion of the Site to be temporally stagnant. The groundwater mound and gradient appear to vary in magnitude with the tidal fluctuations of the river (being largest at high tide and smallest at low tide), but do not appear to vary significantly with seasonal changes in the river elevation.

In addition, groundwater elevation data indicate that groundwater elevations at the Site fluctuate in concert with seasonal changes in the level of the Columbia River. In the period between 2010 and 2017, average high and average low groundwater elevations differed by approximately eight feet at the Site as a result of seasonal changes in river levels. Depth-to-groundwater ranged from approximately 16 to 26 ft bgs during monitoring events completed during this period.

A summary of Site well construction details is included as Table 1, and 2010 through 2017 groundwater elevation data is summarized along with river elevation data in Table 2. A groundwater elevation contour map for August 2017 is included as Figure 4.

2.3.2 Land Use Classification for Exposure Scenarios

WAC 173-340-750 indicates that the area of a site where industrial property soil cleanup levels (CULs) are proposed must meet the definition of an industrial property under WAC 173-340-200. WAC 173-340-200 indicates that an "industrial property" is one that is or has been

characterized by, or is to be committed to, traditional industrial uses such as processing or manufacturing of materials, marine terminal and transportation areas and facilities, fabrication, assembly, treatment, or distribution of manufactured products, or storage of bulk materials, that are either:

- zoned for industrial use by a city or county conducting land use planning under chapter 36.70A RCW (Growth Management Act); or
- for counties not planning under chapter 36.70A of the Revised Code of Washington (RCW), commonly known as the Growth Management Act (GMA), and the cities within them, zoned for industrial use and adjacent to properties currently used or designated for industrial purposes.

The Site is zoned for industrial use and has historically been used for manufacturing of materials and distribution of manufactured products. The Site is located in Cowlitz County, which does not plan under the GMA. The *City of Kalama Comprehensive Plan 2005-2025* indicates that the City of Kalama plans under Chapter 35A.63 (Planning and Zoning in Code Cities) of the RCW, and that the elements of the plan mirror the general requirements of the GMA. The Site is located within the City of Kalama's urban growth area boundary. In addition, as previously mentioned, the Site is located within the South Port area of the Port of Kalama industrial area. The Port of Kalama industrial area includes five miles of riverfront property adjacent to the 43 ft federally-maintained deep draft navigation channel of the Columbia River, and is served by the Burlington Northern/Santa Fe and Union Pacific railroads.

Per the *Concise Explanatory Statement for the Amendments to the MTCA Cleanup Regulation* (Publication 01-09-043, February 12, 2001), when deciding if a property qualifies as industrial, Ecology refers to local zoning plans. Because there are no state-mandated requirements for what land uses are allowed in industrial zones, Ecology also refers to the land uses allowed under the local zoning industrial land use classification. WAC 173-340-750(1) provides criteria for making the evaluation.

With regard to the Site, in a letter dated July 5, 2018 issued by Ecology (July 2018 Opinion) after submittal of the March 19, 2018 *Updated Conceptual Site Model* (H&H 2018a) and the *Summary of Proposed FS Cleanup Action Alternatives* dated April 24, 2018 (H&H 2018b), Ecology indicates that it is appropriate to classify the Site as an industrial property as defined in MTCA and that the Site parcel (PIN 6005401) is an industrial property for the purpose of this MTCA cleanup. The July 2018 Opinion indicates the basis for this classification is the definition of industrial property in WAC 173-340-200, the additional factors listed in WAC 173-340-745(1)(a)(i)(A-F), and the additional considerations provided in the *Concise Explanatory Statement for the Amendments to the MTCA Cleanup Regulation*. In the July 2018 Opinion, Ecology notes that access to the Site is limited by fences and gates, that the human exposure scenario is based on adult industrial workers at the Site, and that the Site will continue to be used for industrial purposes with limited access. In addition, the July 2018 Opinion indicates that areas of the Site located outside of the Site's perimeter fence should not be considered an industrial property for MTCA cleanup exposure scenarios. Refer to the July 2018 Opinion (Ecology 2018) for additional details.

2.3.3 Wildlife and Plant Species Evaluation

In order to assist with determination of appropriate protection of terrestrial environment CULs for the Site, an evaluation was performed by Ecological Land Services, Inc. of Longview, WA (ELS) to assess the Site for potential use by threatened or endangered species, wildlife species classified by the Washington Department of Fish and Wildlife (WDFW) as a "priority species" or "species of concern" under Title 77 RCW; or a plant species classified by the Washington Department of Natural Resources (WDNR) Natural Heritage Program as "endangered," "threatened," or "sensitive" under Title 79 RCW. The evaluation included research of WDFW and WDNR databases and multiple Site visits for observation of wildlife and plant species. Based upon the evaluation, ELS concluded that there is not evidence of or likelihood for Site use by listed animal or plant species noted above and that the Site does not contain habitat suitable for use by the streaked horned lark (which is a WDFW-listed endangered species known to be present along the Columbia River).

A Priority Oak Woodland/Forested Scrub-Shrub Wetland habitat identified through WDFW's Priority Habitats and Species mapping tool is located approximately 200 ft to east of the Site. This priority habitat is separated from the Site by a two-lane paved roadway and a gravel railway corridor with four railway lines. ELS concluded that the Site is not located on, or directly adjacent to the priority habitat, and that it is highly unlikely that terrestrial species which inhabit the priority habitat would use the Site due to the presence of the roadway and railroad corridor located between the priority habitat and the Site, the Site's perimeter fencing, and the absence of wetland/forest/scrub-shrub habitat on the Site.

An approximately 30 to 50-foot wide (depending on river elevation) strip of land is located between the western edge of the Site property and the Columbia River. An approximately 5 to 10-foot wide gravel walking path runs along the top edge of the riverbank. The walking path is located on the Site parcel, but is outside of the Site's western perimeter fencing. The riverbank between the walking path and the river is steep and armored with riprap. Due to the steep slope of the riverbank and presence of riprap armoring and gravel in these areas, ELS concluded that the strip of land between the Site's western perimeter fencing and the Columbia River does not provide habitat for upland species.

Finally, as part of the wildlife and plant species evaluation, ELS contacted the Port of Kalama (owner of the land parcels adjacent to the Site) and confirmed that there are no management or land use plans which include maintenance or restoration of native or semi-native vegetation on the parcels.

The methods and results of the evaluation completed by ELS are documented in a report submitted as an attachment to the February 20, 2019 *Summary of Proposed Cleanup Standards* (H&H 2019) submitted to Ecology. In addition, ELS submitted a letter dated March 5, 2019 via email to Mr. Arthur Buchan (Ecology) in response to a request for additional information regarding the priority habitat to the east of the Site and the strip of land located between the Site and the Columbia River.

2.4 Preliminary Cleanup Standards

Establishing cleanup standards for a site includes several factors including specification of CULs (the concentration of a hazardous substance in soil, water, sediment, or air that is determined to be protective of human health and the environment under specified exposure conditions), points of compliance (POCs) for the CULs, and additional regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site. CULs, in combination with POCs, typically define the area or volume of environmental media at a site that is addressed by the cleanup action.

In the July 2018 Opinion (referenced in Section 2.3.2 above), Ecology suggests that Clariant complete evaluations of sediment and indoor air and finalize appropriate cleanup standards for the Site. In response to these suggestions, H&H submitted the August 17, 2018 *Evaluation of Sediment and Indoor Air Pathways* (H&H 2018c) and February 20, 2019 *Summary of Proposed Cleanup Standards* (H&H 2019) to Ecology. Following submittal of these documents, Ecology issued a letter dated May 20, 2019 (May 2019 Opinion) which indicates Ecology's general concurrence with the findings and cleanup standards presented in the submittals, with exceptions and clarifications noted. In addition, the May 2019 Opinion provides additional technical evaluation and/or suggestions pertaining to the sediment and indoor air pathways, sediment anti-degradation requirements, and climate change resiliency guidance. Refer to the May 2019 Opinion (Ecology 2019) for additional details.

A discussion of preliminary cadmium and zinc cleanup standards for Site (including the basis used for the standards) which incorporates the exceptions, clarifications, and additional evaluation and suggestions presented in the May 2019 Opinion is presented in the sections below. The preliminary Site cleanup standards (which appear appropriate for the Site) are summarized in Table 3. If approved by Ecology, conditional POCs (CPOCs) may be established in the cleanup action plan for the Site.

2.4.1 Soil Cleanup Standards

2.4.1.1 Soil – Direct Contact

Per WAC 173-340-740(6)(d) for unrestricted land use and WAC 173-340-745(7) for industrial land use, the (standard) POC shall be established in the soils throughout a site from the ground surface to 15 ft bgs for soil CULs based on human exposure via direct contact or other exposure pathways where contact with the soil is a complete pathway. Therefore, a soil – direct contact POC from the ground surface to 15 ft bgs is currently applicable to the Site.

Unrestricted land use soil – direct contact Method B soil CULs for substances with noncarcinogenic effects due to soil ingestion (such as cadmium and zinc) shall be determined using WAC 173-340-740(3)(b)(iii)(B)(1) Equation 740-1. The Method B unrestricted land use soil – direct contact CULs calculated using this equation are 80 milligrams per kilogram (mg/kg) for cadmium and 24,000 mg/kg for zinc. These values are the same as those presented in the Ecology May 2019 Cleanup Levels and Risk Calculation (CLARC) data tables. These unrestricted land use soil-direct contact CULs are applicable to areas of the Site which are located outside of the Site’s perimeter fence.

Industrial land use soil – direct contact Method C soil CULs for substances with noncarcinogenic effects due to soil ingestion (such as cadmium and zinc) shall be determined using WAC 173-340-745(5)(b)(iii)(B)(1) Equation 745-1. The Method C industrial soil – direct contact soil CULs calculated using this equation are 3,500 mg/kg for cadmium and 1,050,000 mg/kg for zinc. These values are the same as those presented in the CLARC data tables. These industrial land use soil-direct contact CULs are applicable to areas of the Site property located inside of the Site’s perimeter fence.

2.4.1.2 Soil – Protection of Terrestrial Environment

Per WAC 173-340-7490(4)(b), the (standard) POC shall be established in the soils throughout a site from the ground surface to 15 ft bgs for soil – protection of terrestrial environment CULs.

Therefore, a soil – protection of terrestrial environment POC from the ground surface to 15 ft bgs is currently applicable to the Site.

WAC 173-340-7490 defines the goals and procedures Ecology will use for determining whether a release of hazardous substances to soil may pose a threat to the terrestrial environment, characterizing existing or potential threats to terrestrial plants or animals exposed to hazardous substances in soil, and establishing site-specific cleanup standards for the protection of terrestrial plants and animals. Per WAC 173-340-7490(2), in the event of a release of a hazardous substance to the soil at a site, one of the following actions shall be taken:

- (a) Document an exclusion from any further terrestrial ecological evaluation using the criteria in WAC 173-340-7491;
- (b) Conduct a simplified terrestrial ecological evaluation as set forth in WAC 173-340-7492; or,
- (c) Conduct a site-specific terrestrial ecological evaluation as set forth in WAC 173-340-7493.

Based upon the criteria in WAC 173-340-7491, the Site does not currently qualify for an exclusion from terrestrial ecological evaluation. When a site does not qualify for an exclusion, WAC 173-340-7491(2) indicates that a site-specific terrestrial ecological evaluation should be performed if any of the criteria of WAC 173-340-7491(2)(a) summarized below apply:

- (i) The site is located on or adjacent to an area where management or land use plans will maintain or restore native or semi-native vegetation.
- (ii) The site is used by threatened or endangered species, wildlife species classified by the Washington Department of Fish and Wildlife as a "priority species" or "species of concern" under Title 77 RCW; or a plant species classified by the Washington Department of Natural Resources Natural Heritage Program as "endangered," "threatened," or "sensitive" under Title 79 RCW.
- (iii) The site is located on a property that contains at least 10 acres of native vegetation within 500 ft of the site, not including vegetation beyond the property boundaries.

(iv) Ecology determines that the site may present a risk to significant wildlife populations.

Based upon the wildlife and plant species evaluation performed by ELS discussed in Section 2.3.3 above, criteria (i) and (ii) do not apply to the Site, and criteria (iii) is not applicable to the Site because the Site is less than 10 acres in size. Therefore, based upon the information presented above, a Site-specific terrestrial ecological evaluation is not warranted and a simplified terrestrial ecological evaluation is appropriate for the Site. In the May 2019 Opinion, Ecology concurs that a simplified terrestrial ecological evaluation is appropriate for the Site.

WAC 173-340-7492 sets forth the procedures for conducting a simplified terrestrial ecological evaluation. The simplified terrestrial ecological evaluation process is intended to identify those sites which do not have a substantial potential for posing a threat of significant adverse effects to terrestrial ecological receptors, and thus may be removed from further ecological consideration during the remedial investigation and cleanup process. The process is structured with an intent to protect terrestrial wildlife at industrial or commercial sites, and terrestrial plants, soil biota and terrestrial wildlife at other sites, as provided under WAC 173-340-7490(3)(b).

The simplified terrestrial ecological evaluation process provides for analysis of the extent of exposure, exposure pathways, and particular contaminants as key screening steps in evaluating ecological risk at a site, and analysis of any one of these steps may be used to determine that no further evaluation is necessary to conclude that a site does not pose a substantial threat of significant adverse effects to terrestrial ecological receptors. The evaluation may be ended if one of the following conditions is met:

- (a) An extent of exposure analysis indicates the total area of soil contamination at a site is not more than 350 square feet or land use at a site and surrounding area makes substantial wildlife exposure unlikely (using Table 749-1 of WAC 173-340-900 to make this determination).
- (b) A pathways analysis indicates no potential exposure pathways to soil biota, plants, or wildlife from soil impacted with priority chemicals of ecological concern listed in Table 749-2 of WAC 173-340-900 (at or above the concentrations provided). Incomplete

pathways may be due to the presence of man-made physical barriers. To ensure that such man-made barriers are maintained, a restrictive covenant shall be required by Ecology under a consent decree, agreed order, or enforcement order.

- (c) A contaminant analysis indicates no hazardous substance listed in Table 749-2 of WAC 173-340-900 is, or will be, present in the soil at a depth not exceeding the POC at concentrations higher than the values provided in Table 749-2 of WAC 173-340-900, using the statistical compliance methods described in WAC 173-340-740(7). Refer to Appendix A for additional information regarding use of statistical compliance methods.

None of the above simplified terrestrial ecological evaluation screening step conditions steps are currently met at the Site. If none of these screening step conditions are met, the chemical concentrations listed in Table 749-2 of WAC 173-340-900 (presented for cadmium and zinc below) may be used as soil – protection of terrestrial environment CULs.

	<u>Unrestricted Land Use</u>	<u>Industrial/Commercial</u>
Cadmium	25 mg/kg	36 mg/kg
Zinc	270 mg/kg	570 mg/kg

Therefore, the unrestricted land use soil – protection of terrestrial environment CULs presented above (25 mg/kg for cadmium and 270 mg/kg for zinc) are applicable to areas located outside of the Site’s perimeter fence, and the industrial/commercial land use soil – protection of terrestrial environment CULs presented above (36 mg/kg for cadmium and 570 mg/kg for zinc) are applicable to areas located inside of the Site’s perimeter fence.

2.4.1.3 Soil – Protection of Groundwater

The saturated soil – protection of groundwater POC is throughout the Site within the saturated zone. The saturated zone is defined in WAC 173-340-200 as “the area below the water table in which all interstices are filled with water”. The unsaturated zone soil – protection of groundwater POC is throughout the Site within the unsaturated zone. As noted in the May 2019 Opinion, the unsaturated zone includes all areas of the subsurface between the ground surface



and the groundwater table where the saturated zone (as defined in WAC 173-340-200) is unmet, irrespective of depth. Note that since 2010, depth-to-groundwater in the Site wells ranged from approximately 16 to 24 ft bgs, and the average depth-to-groundwater during these monitoring events was approximately 20 ft bgs. As previously discussed, groundwater elevations at the Site fluctuate in concert with tides and seasonal changes in Columbia River levels.

Per WAC 173-340-740(3)(b)(iii)(A), the unrestricted land use Method B groundwater protection soil CULs are conservative concentrations that are unlikely to cause impact to groundwater at levels which exceed groundwater CULs established under WAC 173-340-720 as determined using the methods described in WAC 173-340-747. Saturated and unsaturated soil – protection of groundwater CULs for cadmium and zinc were calculated using the three-phase partitioning model described by WAC 173-340-747(4)(b) Equation 747-1 per WAC 173-340-747(4)(b) through (e).

The calculated unrestricted land use Method B unsaturated soil – protection of groundwater CULs for cadmium and zinc are 0.69 mg/kg and 5,970 mg/kg, respectively. The calculated unrestricted land use Method B saturated soil – protection of groundwater CULs for cadmium and zinc are 0.035 mg/kg and 299 mg/kg, respectively. These values are the same as those presented in the CLARC data tables.

2.4.2 Groundwater Cleanup Standards

Per WAC 173-340-720, groundwater CULs shall be based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future site use conditions. Ecology has determined that at most sites, use of groundwater as a source of drinking water is the beneficial use warranting the highest quality of groundwater and that exposure to hazardous substances through ingestion of drinking water and other domestic uses represents the reasonable maximum exposure. Groundwater at the Site is classified as potable to protect drinking water beneficial uses.

Potable groundwater CULs established for human health protection (GW-HH CULs) applicable to the Site are 5 micrograms per liter ($\mu\text{g/l}$) for cadmium and 4,800 $\mu\text{g/l}$ for zinc. These GW-HH CULs are based on the Method A cadmium concentration presented in Table 720-1 of WAC 173-340-900 and the Method B zinc concentration determined using WAC 173-340-720(4)(b)(iii)(A) Equation 720-1, and are the same as the values presented in the CLARC data tables. Note that the Method A cadmium concentration presented in Table 720-1 of WAC 173-340-900 is a maximum contaminant level (MCL) for drinking water based on state and federal laws which are applicable to public water systems.

Per WAC 173-340-720, potable groundwater CULs established for protection of surface water beneficial uses (GW-SW CULs) are also applicable to the Site unless it can be demonstrated that the hazardous substances are not likely to reach surface water. WAC 173-340-720 indicates that GW-SW CULs are concentrations established in accordance with the methods specified in WAC 173-340-730 (surface water cleanup standards). As such, the GW-SW CULs are equivalent to surface water CULs (discussed in Section 2.4.3 below). The GW-SW CULs established in accordance with the methods specified in WAC 173-340-730 which are applicable to the Site are 0.7 $\mu\text{g/l}$ for cadmium and 66 $\mu\text{g/l}$ for zinc. These are the chronic freshwater aquatic life protection values calculated per Table 240 of WAC 173-201A-240 using a Columbia River average hardness value of 58 milligrams per liter (mg/l).

Per WAC 173-340-720(8), the POC for groundwater is the point or points where the groundwater CULs established for a site must be attained for the site to be in compliance with the cleanup standards, and groundwater CULs shall be attained in all groundwaters from the POC to the outer boundary of the COC plume. The standard POC for groundwater CULs is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowermost depth which could potentially be affected by the Site.

According to Ecology's July 25, 2017 Implementation Memorandum No. 16 *Developing Conditional Points of Compliance at MTCA Sites Where Groundwater Discharges to Surface Water* (Ecology 2017a), before groundwater discharges into surface water, it typically enters into a transitional zone in the aquifer where some mixing of groundwater and surface water occurs,

and this zone is often called the hyporheic zone. Per WAC 173-340-200, "groundwater" means water in a saturated zone or stratum beneath the surface of land or below a surface water. This definition encompasses the transitional zone; therefore, water in this zone is considered groundwater under MTCA. As is highlighted in Implementation Memorandum No. 16, sediment porewater generally refers to interstitial water present in sediments, and the Sediment Management Standards (SMS) recognize sediment porewater as the interstitial water in an uppermost thickness of sediment that is defined on a site-specific basis as the biologically active zone. Per the Implementation Memorandum No. 16, this SMS distinction results in assigning groundwater to a location immediately below the biologically active zone.

The US EPA Ecological Risk Assessment Support Center (ERASC) *Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments* (USEPA, 2015) documents the results of a study used to develop defensible habitat-specific practical default values for the depth of the biologically active zone (where most organism-substrate interactions occur). This ERASC determination recommends that the depth of the biologically active zone be based upon the 80th percentile of abundance or biomass depth distributions, and indicates the mean 80th percentile for the lotic category (which includes river coarse grained/sand with fines such as present at the Site) and for tidal freshwater environments extends to 10 to 15 cm (approximately four to six inches), and the maximum 80th percentile extends to 15 cm (approximately six inches). The ERASC determination indicates that, in most habitats where data are available, the 80th percentile of depth distributions based on biomass exceeds respective distributions based on abundance, and that the values may be used for decisions related to ecological assessment or remediation in aquatic scenarios.

Based on the information presented above, an assumed 15-cm (approximately 6-in) depth of the biologically active zone in the Columbia River sediments adjacent to the Site is appropriate, and water in the transitional zone beneath this depth is considered to be groundwater.

2.4.3 Surface Water Cleanup Standards

As discussed in Section 2.4.2 above, the GW-SW CULs are equivalent to surface water CULs. Surface water CULs apply to those surface waters of the state affected or potentially affected by releases of hazardous substances from a site. The surface water CULs established in accordance with the methods specified in WAC 173-340-730 which are potentially applicable to the Site are 0.7 µg/l for cadmium and 66 µg/l for zinc. The POC for surface water CULs is the point or points at which hazardous substances are released to surface waters of the state unless Ecology has authorized a mixing zone in accordance with WAC 173-201A.

2.4.4 Sediment Cleanup Standards

WAC 173-204-500 establishes requirements for identifying, investigating, and cleaning up a release or threatened release of a contaminant to sediment that may pose a threat to human health or the environment. Under this section, the initial step in the process for evaluation of potentially contaminated sediments is to identify sediment station clusters of potential concern in accordance with WAC 173-204-510. Per WAC 173-204-510(2), a station cluster is defined as any number of stations that are determined by Ecology to be spatially and chemically similar. Station clusters of potential concern shall be further evaluated using the hazard assessment standards of WAC 173-204-520. Station clusters of low concern shall remain on the inventory and no further cleanup action determinations shall be taken until/unless new information is available and the stations are reexamined per WAC 173-204-510(5). Therefore, cleanup standards only need to be determined/developed for a site if the site is determined to include a station cluster of potential concern.

In the July 2018 Opinion, Ecology requests Clariant use the procedures provided in WAC 173-204-510 to determine if impacts associated with the Site have resulted in a sediment site of potential concern. In response to Ecology's request, Clariant completed an evaluation of Site sediment sample data to determine if impacts associated with the Site have resulted in a sediment site of potential concern. The evaluation is documented in the August 17, 2018 *Evaluation of Sediment and Indoor Air Pathways* (H&H 2018c) submitted to Ecology. In the May 2019

Opinion, Ecology presents an evaluation of Site sediment sample data and rationale used to conclude that no further sediment cleanup action is warranted at the Site and that sediment CULs do not currently need to be determined for the Site. A summary of these evaluations is presented below.

As mentioned above, the initial step in the process for evaluation of potentially contaminated sediments is to identify sediment station clusters of potential concern. In the May 2019 Opinion, Ecology indicates sediment sample locations SD-1 through SD-10 collected by H&H from the Columbia River in August 2017 are chemically, spatially, and temporally similar, and therefore may be considered a station cluster for determination of potential sediment impacts at the Site. In addition, the May 2019 Opinion indicates that these sample locations are more likely than not sufficient to determine if the release of hazardous substances at the Site has resulted in current sediment impacts within Columbia River sediments. A summary of sediment analytical data for the Site is included in Table 4, and sediment sample locations are depicted in Figure 5.

The process below is then used to identify station clusters of concern (or, to determine a station cluster is of low concern).

Chemical Criteria Evaluation

Per WAC 173-204-510(2)(a), the sediment station chemical criteria evaluation consists of identifying the three stations within a station cluster with the highest concentration of each chemical identified in WAC 173-204-563 (for freshwater sediment), determining the average concentration for the chemical at the three stations, and comparing the average concentration of each chemical to the sediment cleanup objectives (SCOs) presented in Table VI of WAC 173-204-563. The SCOs presented in Table VI apply to freshwater sediments for toxicity to the benthic community and establish a no adverse effects level, including no acute or chronic effects, to the benthic community in freshwater sediment. The SCOs presented in Table VI for cadmium and zinc are 2.1 and 3,200 mg/kg, respectively. In the May 2019 Opinion, Ecology indicates that it considers these SCOs to be appropriate for evaluating freshwater benthic community protection at the Site. Cadmium has not been detected above laboratory method detection limits (MDLs) in sediment samples collected from the Site. The average of the highest three cadmium

MDLs (0.773, 0.766, and 0.759 mg/kg) for sediment samples SD-1 through SD-10 is 0.766 mg/kg. The average of the highest three zinc detections (42.4, 34.1, 32.8 mg/kg) in sediment samples SD-1 through SD-10 is 36.4 mg/kg. The cadmium station MDL average of 0.766 mg/kg is lower than the Table VI cadmium SCO (2.1 mg/kg), and the zinc station average of 36.4 mg/kg is significantly lower than the Table VI zinc SCO (3,200 mg/kg).

Biological Criteria Evaluation

WAC 173-204-510(2)(b) indicates that three stations within the station cluster with the highest level of biological effects for the biological tests identified in WAC 173-204-563 should be identified and compared to the biological effects criteria in Table VII of WAC 173-204-563. The biological effects criteria in Table VII of WAC 173-204-563 establish SCOs which apply to freshwater sediments for toxicity to the benthic invertebrate community. Biological testing of Site sediment has not been completed; therefore, data are not available for comparison to the Table VII biological effects criteria. Ecology's Publication No. 12-09-057, *Sediment Cleanup User's Manual II* (SCUM II), indicates that it may be necessary to conduct biological testing when there is an exceedance of the chemical benthic criteria for any one station. As previously discussed, the cadmium MDLs and zinc concentrations do not exceed the chemical criteria in any stations, and in the May 2019 Opinion, Ecology indicates that it considers the SCOs presented in Table VI for toxicity to the benthic community to be appropriate for evaluating freshwater benthic community protection at the Site. As discussed in the August 17, 2018 *Evaluation of Sediment and Indoor Air Pathways* (H&H 2018c), the cadmium MDLs and zinc concentrations detected in Site sediment samples are lower than published cadmium and zinc concentrations in sediment which are likely to have adverse biological effects on the benthic community.

Human Health, Background, and Other Criteria Evaluation

Per WAC 173-204-510(2)(c), a station cluster shall be defined as a station cluster of potential concern if Ecology determines that each of three stations within a station cluster exceed the following criteria:

- (i) The applicable human health and regional background cleanup screening levels in

WAC 173-204-560(4);

- (ii) The other toxic, radioactive, biological, or deleterious substances criteria in WAC 173-204-563; or
- (iii) The nonanthropogenically affected criteria of WAC 173-204-563.

SCUM II indicates that, in terms of exposure to contaminants in sediment, risks to humans occur primarily through consumption of fish/shellfish, and therefore, contaminant concentrations in fish/shellfish tissue can play a critical role in assessing risks and establishing risk-based sediment concentrations. SCUM II presents two options for determining risk-based sediment concentrations for bioaccumulative COCs. One of the options (Option 1) uses sediment background concentrations (natural and regional) as SCOs and cleanup screening levels protective of human health (and, higher trophic levels) based on the fish/shellfish consumption exposure pathway. This is appropriate because risk-based sediment concentrations back-calculated from BSAFs are frequently below background, resulting in the final SCO defaulting to background (because cleanup below background is not feasible). However, Ecology has not established natural background for freshwater sediment. (Note that in the May 2019 Opinion, Ecology indicates that the process for developing natural background-based sediment CULs can be complex, and does not appear necessary for the Site.) The other option (Option 2) uses fish/shellfish tissue data to calculate site-specific biota-sediment accumulation factors which are used to back-calculate sediment concentrations from protective tissue concentrations. However, as SCUM II notes, collecting fish/shellfish tissue data can be a substantial effort that may not be necessary for smaller or less complex sites.

In the May 2019 Opinion, Ecology indicates that SCOs presented in Table VI of WAC 173-204-563 for toxicity to the benthic community are also protective of human health at the Site for the reasons listed below, and that it is Ecology's opinion that there is no need to establish risk- or background-based sediment CULs.

- Zinc does not appear on the persistent bioaccumulative toxins (PBTs) list promulgated in WAC 173-333-310.

- Cadmium appears as a “metal of concern” in WAC 173-333-315. The metals of concern category was established as an interim category pending completion of EPA's inorganic metals assessment framework process, and Ecology has not prepared a chemical action plan for cadmium.
- Based on the small size of the Site and the inaccessibility for people to be exposed to Site sediment, the exposure pathways for direct contact, ingestion, and fish consumption appear to be incomplete.
- Concentrations in sediment in the Columbia River adjacent to the Site are likely near or below any background-based values that may be established in the future.

WAC 173-204-563(4) defines “other toxic, radioactive, biological, or deleterious substances” as substances not specified in Table VI that are in, or on, sediments and cause minor adverse effects to biological resources. Cadmium and zinc are included in Table VI and there are no other known toxic, radioactive, biological, or deleterious substances associated with the Site or Site sediments. In addition, there are no nonanthropogenically affected criteria (e.g., established site-specific chemical criteria where sediment or sediment with pore water or overlying water has unusual geochemical or biochemical characteristics influencing toxicity) applicable to Site sediments.

Based on the Site sediment evaluations which are summarized above, and per the May 2019 Opinion, the sediment station cluster evaluated for the Site is of low concern. Because the station cluster of low concern represents all likely areas of impacts to sediment at the Site, no further sediment cleanup action is warranted at the Site, and sediment CULs do not currently need to be determined for the Site.

2.4.5 Protection of Air Quality Cleanup Standards

WAC 173-340-750 (cleanup standards to protect air quality) applies to ambient (outdoor) air and to air within any building (or, other structure large enough for a person to fit into) whenever it is necessary to establish air cleanup standards to determine if air emissions at a site pose a threat to

human health or the environment. Cleanup standards to protect air quality do not apply to concentrations of hazardous substances originating from an industrial/commercial process or off-site source.

Method B protection of air quality CULs protective of human health and the environment shall be determined using WAC 173-340-750(3)(b)(ii)(A) Equation 750-1 for substances with potential noncarcinogenic effects due to inhalation and using WAC 173-340-750(3)(b)(ii)(B) Equation 750-2 for substances with potential carcinogenic effects due to inhalation. The Method B protection of air quality CUL calculated for cadmium using Equation 750-2 is $0.0014 \mu\text{g}/\text{m}^3$. This value is the same as presented in the CLARC data tables.

According to EPA's Integrated Risk Information System (IRIS) Chemical Assessment Summary for zinc, available data are not suitable for the derivation of a reference concentration for chronic inhalation exposure (RfC) for zinc. As such, a protection of air quality CUL for zinc was not calculated using Equation 750-1. There is not a protection of air quality CUL for zinc presented in the CLARC data tables.

Per WAC 173-340-750(1)(a), air cleanup standards shall be established at the following sites:

- (i) where a non-potable groundwater CUL is being established for volatile organic compounds (VOCs) using a site-specific risk assessment under WAC 173-340-720(6).
- (ii) where a soil CUL that addresses vapors or dust is being established under WAC 173-340-740 or 173-340-745.
- (iii) where it is necessary to establish air emission limits for a remedial action.
- (iv) at other sites as determined by the department.

A protection of air quality CUL of $0.0014 \mu\text{g}/\text{m}^3$ for cadmium appears appropriate for ambient air throughout the Site if it is determined that one or more of the scenarios listed above applies to the Site. Per WAC 173-340-750(6), the protection of air quality POC is ambient air throughout the Site.

In the July 2018 Opinion, Ecology requests Clariant evaluate the potential for indoor air impacts at the Site based on Ecology's Publication No. 09-09-047, *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remediation*, Revised February 2016 and April 2018 (VI Guidance). The VI Guidance recommends a tiered approach to vapor intrusion (VI) assessment. The initial step in the tiered approach is to determine if a potential exists for toxic vapors to be present in the subsurface that could migrate into buildings. According to the VI Guidance, in order to pose a potential VI threat to indoor air, COCs must be both volatile and toxic enough to contaminate soil gas to unacceptable levels. Appendix B of the VI Guidance contains a list of substances that could potentially contaminate indoor air to unacceptable levels via the VI pathway. The Site COCs cadmium and zinc are not included in Appendix B of the VI Guidance. Furthermore, cadmium and zinc are inorganic, non-volatile metals which are not known to pose a potential concern via the VI pathway. The VI Guidance indicates that if chemicals of sufficient volatility and toxicity are not known or reasonably suspected to be present in the subsurface, there is no subsurface VI source and no need to conduct further investigation to assess the pathway. The above information was provided in the August 17, 2018 *Evaluation of Sediment and Indoor Air Pathways* (H&H 2018c) submitted to Ecology. In the May 2019 Opinion, Ecology concurs that the indoor air pathway is likely incomplete at the Site, and that no further evaluation of the indoor air pathway is necessary.

2.5 Previous Environmental Investigations and Interim Actions

Previous environmental assessment activities have included the collection and analysis of sediment, soil, groundwater, and surface water samples. A summary of sediment analytical data is included in Table 4 and sediment sample locations are depicted in Figure 5. A summary of soil analytical data for samples which remain at the Site (i.e., sample locations which were not removed by soil excavation activities) is included in Table 5, and remaining soil sample locations are depicted in Figure 5. A summary of groundwater analytical data for samples collected from permanent Site wells is included in Table 6 and well locations are depicted in Figure 3. A summary of PushPoint groundwater and surface water analytical data is included in Table 7 and sample locations are depicted in Figures 6A and 6B. Environmental sample location and analytical data have been uploaded to Ecology's Environmental Information Management

System (EIM) database. A summary of environmental investigation and interim actions completed at the Site is presented in the sections below.

2.5.1 Initial Environmental Assessment Activities (2002)

Soil and groundwater impacts were first identified at the Site during environmental assessment activities completed by CDM in October 2002. These assessment activities included collection of eight surface soil samples and collection of soil or groundwater samples from approximately 20 direct push technology (DPT) borings. Residual zinc carbonate sludge was observed in three DPT borings (identified as LG2, LG3, and LG4) installed within the extents in FSB1 and FSB2, and samples of the sludge were collected. Concentrations of cadmium and zinc were detected above current preliminary soil CULs in each of the sludge samples and in multiple soil samples. Concentrations of cadmium and zinc above current preliminary groundwater CULs were also identified in groundwater samples collected during the assessment.

Lead concentrations ranging from 1,140 to 3,560 mg/kg were detected above soil CULs which would currently be applicable to the Site in each of the sludge samples mentioned above, but lead was not detected above CULs which would currently be applicable to the Site in any soil samples collected during the 2002 assessment. For lead, soil – direct contact and protection of terrestrial environment CULs of 1,000 and 220 mg/kg would currently be applicable to the industrial portion of the Site, and unsaturated and saturated soil – protection of groundwater CULs of 3,000 and 150 mg/kg would currently be applicable to the Site. Lead was detected above laboratory reporting limits at a relatively low concentration of 3 µg/l in one groundwater sample collected during the 2002 assessment. This detection is lower than the potable groundwater CUL established for human health protection for lead (15 µg/l) which would be applicable to the Site. Because the residual sludge was removed during excavation activities completed at the Site during 2003 and 2010 (discussed below) and lead has not been detected in Site soil and groundwater samples above CULs which would currently be applicable to the Site, lead is not considered a COC at the Site and is not discussed further.

There were no other compounds detected in Site soil/sludge or groundwater samples above CULs which would currently be applicable to the Site during the 2002 assessment. The methods and results of the 2002 assessment activities are documented in the CDM EA (CDM 2002).

2.5.2 Contaminant Delineation Activities (2003)

In the period between March and August 2003, CDM completed a series of environmental investigation activities to evaluate the nature and extent of the impacts identified at the Site during the 2002 assessment. These investigations included excavation of a total of 24 test pits in the four FSBs and collection of soil samples from the pits, installation of approximately 20 DPT borings for soil or groundwater sample collection, collection of surface soil samples, installation and sampling of nine permanent piezometers (identified as PZ1 through PZ9), installation of two angled monitoring wells (identified as AB1 and AB2), and groundwater monitoring activities. Well locations are depicted in Figure 3. The methods and results of the 2003 investigation activities are documented in the March 3, 2004 report entitled *Contaminant Delineation* (CDM 2004a).

There was no evidence of zinc carbonate sludge observed in test pits that were installed within the extents of FSB3 and FSB4. Based upon observations made during installation of test pits within the extents of FSB1 and FSB2, pockets and thin lenses of zinc carbonate sludge were present in FSB1 to depths of approximately 5.5 ft bgs, and an apparent layer of sludge ranging in thickness from approximately 1 to 3 ft was present in FSB2 between 4 and 8 ft bgs. Results of analysis of soil samples collected from FSB1 and FSB2 generally indicated widespread elevated zinc concentrations in soil samples, primarily in the vicinity of and below areas of residual zinc carbonate sludge. Concentrations of cadmium detected in FSB soil samples were relatively low and below current preliminary CULs (with the exception of the unsaturated soil – protection of groundwater CUL).

In the MPA, results of analysis of surficial soil samples indicated concentrations of zinc and cadmium above current preliminary soil CULs. Results of analysis of groundwater samples indicated concentrations of zinc above current preliminary groundwater CULs in the FSB area,

and concentrations of cadmium and zinc above current preliminary groundwater CULs in the MPA. Based upon the results of the 2003 assessment, concentrations of zinc above CULs in groundwater appeared to extend to the Columbia River, and concentrations of cadmium above CULs in groundwater appeared to be limited to a relatively small area to the northwest of the manufacturing building.

2.5.3 Soil Removal Interim Action Activities (2003)

In September and October 2003, Clariant excavated and disposed of a total of approximately 16,000 tons of soil from the MPA and the FSB1 and FSB2 areas. Impacted surface soil located in the eastern and western portions of the MPA were excavated to an average depth of 1.5 ft bgs. Impacted soil located under the railroad spur in the MPA was not excavated; however, this area was later paved over. Impacted soil was removed to an average depth of approximately 7 ft bgs in the FSB1 area and to an average depth of approximately 15 ft bgs in the FSB2 area. Impacted soil located beneath the truck access road that crossed the southern portion of the FSB2 area was not excavated during the 2003 soil removal, and soil left in place below the access road was sloped away from either side of the road to prevent the excavation sidewalls from collapsing under the road. Sidewall confirmation samples collected from the walls of the excavation located along this portion of the access road contained concentrations of zinc and cadmium exceeding current preliminary CULs.

Overburden soil was removed from the top four feet of the FSB2 area during the 2003 excavation activities and used to backfill the bottom five feet of the 2003 FSB2 excavation (i.e., from 10 to 15 ft bgs). Approximately one-half of this soil is estimated to have subsequently been removed and disposed off-Site during excavation activities complete in 2010 (see Section 2.5.6). The remainder of the 2003 excavations were backfilled with Columbia River dredge spoils obtained from the Port of Kalama-owned property located to the south of the Site.

2003 soil excavation sidewall and base confirmation sample data for the sample locations which currently remain in-place at the Site are summarized along with backfill sample data in Table 5. The approximate horizontal extents of the 2003 excavations and sample locations which

currently remain in-place at the Site are depicted in Figure 5. The 2003 soil removal activities are documented in the *Soil Excavation Summary Report* (CDM 2004b).

2.5.4 Groundwater Extraction (2003 – 2004)

In December 2003, two extraction wells (identified as EW1A and EW2A in Figure 3) were installed in the MPA to the west of the manufacturing building, and groundwater recovery from the wells was started in an effort to remediate cadmium concentrations in groundwater. Recovery from the wells was stopped by July 2004 due to repeated biofouling of the pumps. Refer to the reports entitled *Winter 2004 Quarter – Groundwater Monitoring* (CDM 2004c) and *Evaluation of the Cadmium Plume* (CDM 2004d) for additional information.

2.5.5 Investigation and Reporting Activities (2004 – 2008)

Beginning in 2004, a two-year program of quarterly groundwater monitoring was implemented at the Site to evaluate cadmium and zinc concentrations in groundwater. Permanent piezometers PZ10 through PZ13 were also installed at the Site during July 2005. The groundwater monitoring events are documented in seven reports submitted to Ecology (CDM 2004c, CDM 2004e, CDM 2004f, CDM 2004g, CDM 2005a, CDM 2005b, and CDM 2006a). Cadmium and zinc data from these monitoring events are summarized in Table 6.

In November 2005, CDM completed a site conceptual model and a screening level ecological risk assessment (SLERA) for the Site. Because extensive environmental investigation activities and interim remedial actions have been completed at the Site since 2005, this site conceptual model is not discussed further. Based upon the SLERA, CDM concluded that environmental impacts associated with the Site were not likely to result in adverse acute or chronic effect risks to fish or benthic aquatic invertebrates in the Columbia River. Refer to the *Site Conceptual Model for Zinc and Cadmium in Groundwater* (CDM 2005c) and the *Screening Level Ecological Risk Assessment* (CDM 2005d) for additional details.

During July 2006, CDM conducted an evaluation of Columbia River tidal influence on Site groundwater. The results of the investigation indicated direct communication between the river and Site groundwater which causes a “wave-like” effect in groundwater beneath the western portion of the Site and semi-stagnant conditions in Site groundwater beneath the central portion of the Site. The evaluation did not identify consistent variation in zinc concentrations in Site groundwater resulting from tidal effects. Refer to the report entitled *Summer – 2006 Groundwater Monitoring* (CDM 2006b) for additional details.

During February 2007, CDM installed permanent piezometers PZ14 and PZ15 in the northwestern and southwestern areas of the Site, respectively, to delineate the extents of groundwater impacts and to evaluate depth to bedrock. Refer to the *Piezometer Installation and Groundwater Sampling Report – February 2007* (CDM 2007) for additional information.

CDM submitted the previously-referenced CDM FS report for the Site during October 2008 (CDM 2008). The CDM FS includes summaries of the Site history, investigation and interim actions, CULs, and remedial goals and objectives, screens remedial technologies, and presents descriptions and evaluations of remedial action alternatives. Five remedial action alternatives were evaluated as part of the CDM FS. Alternative No. 1 included implementation of stormwater controls, institutional controls, and groundwater monitored natural attenuation (MNA). Each of the remaining alternatives included the Alternative No. 1 items. Alternative No. 2 included installation of an impermeable cap, Alternative No. 3 included additional soil removal and installation of a neutralization cap, Alternative No. 4 included installation of a slurry wall and impermeable cap, and Alternative No. 5 included additional soil removal and installation of a hydraulic barrier and pump and treat system. The CDM FS recommended implementing Alternative No. 3 (soil removal and neutralization cap) using a phased approach, routine groundwater monitoring, and re-evaluation of remedy effectiveness at the end of a five-year period. The CDM FS also concluded that current cleanup technologies do not provide a long-term solution that can achieve CULs in a reasonable time frame or at reasonable cost due to: 1) hydraulic influence of the Columbia River on Site groundwater, 2) the disproportionately low surface water standard for zinc, and 3) the depth of contaminated soil.

2.5.6 Soil Removal and Groundwater Interim Action Activities (2010)

During 2010, Clariant contracted H&H to perform environmental consulting activities for the Site. In August and September 2010, Clariant performed soil removal activities targeting soil beneath the access road that crossed the southern portion of FSB2 and soil beneath the bottom depth of the portion of the 2003 excavation located to the southeast of the access road. In addition, 23 vertical injection wells and six horizontal injection wells were installed at the Site and calcium polysulfide (CaSx) was injected into the wells as described below. The soil removal and groundwater remediation activities were completed in general accordance with the *Remedial Action Work Plan* (H&H 2010).

The 2010 excavation activities consisted of access road removal, excavation and off-site disposal of impacted soils located beneath the access road to a depth of 15 ft bgs, excavation of soil beneath the previous depth of excavation within the FSB2 area southeast of the access road to a depth of 15 ft bgs, and replacement of the access road. In total, approximately 11,500 tons of soil were excavated and disposed off-Site during the 2010 excavation activities. As previously mentioned, soil removed from the top four feet of the FSB2 area during the 2003 excavation activities was used to backfill the bottom five feet of the 2003 FSB2 excavation (i.e., from 10 to 15 ft bgs). Approximately one-half of this soil is estimated to have been removed and disposed off-Site during the 2010 excavation activities. The 2010 excavation area was backfilled with Columbia River dredge spoils obtained from the Port of Kalama-owned property located to the south of the Site. Prior to backfilling the 2010 excavation, six horizontal injection wells (HIW-1 through HIW-6) were installed across the base of the open excavation. The horizontal injection well locations are depicted in Figure 3.

The approximate horizontal extents of the 2010 excavation and the locations of the excavation sidewall and base confirmation samples which currently remain in-place at the Site are depicted in Figure 5. 2010 soil excavation sidewall and base confirmation sample data for the sample locations which currently remain in-place at the Site are summarized along with backfill sample data in Table 5.

In addition to the horizontal injection wells mentioned above, 12 vertical injection wells (IW-1 through IW-12) were installed in the FSB2 area, 11 vertical injection wells (IW-13 through IW-23) were installed in the MPA, and three observation wells (OW-1 through OW-3) were installed in the FSB2 area during August and September 2010. Prior to completing groundwater injection activities, the injection wells were registered with Ecology's Underground Injection Control (UIC) Program, and Ecology issued a UIC conditional rule authorization letter for the Site (Ecology 2010). After completing a pre-injection baseline groundwater monitoring event in September 2010, CaSx was injected into the injection wells to reduce concentrations of dissolved zinc in FSB2 area groundwater and dissolved cadmium and zinc in MPA groundwater by geochemical fixation of the metal cations to relatively insoluble and immobile metal sulfide compounds. CaSx is a lime-sulfur solution designed to be used in various treatment systems as a metal precipitating agent and has been used for in-situ treatment of groundwater impacted with metals. Refer to the *Remedial Action Report* (H&H 2011a) for additional information on the 2010 soil removal, pre-injection baseline monitoring, and groundwater injection activities.

Post-injection performance groundwater monitoring events were completed approximately one month, three months, and six months after completion of the injection activities. Results of the first post-injection monitoring event completed in November 2010 indicated reductions in dissolved zinc and cadmium concentrations in Site groundwater, with significant reduction of zinc concentrations in multiple FSB2 area wells. However, results of the subsequent monitoring events completed in December 2010 and March 2011 indicated a rebound in zinc concentrations. The rebound was attributed to a significant rise in the groundwater table to historically high elevations in the period between the November and December 2010 sampling events, which may have resulted in dilution of the CaSx, oxygenation of groundwater limiting the effectiveness of the CaSx, and leaching of zinc from impacted soil between the September/November 2010 groundwater table and the depth of excavation. Further increases in groundwater elevations occurred in the period between December 2010 and March 2011. Refer to the *Post-Injection Monitoring Report & RAWP Addendum* (H&H 2011b) for additional information on the post-injection performance groundwater monitoring events completed during 2010 and 2011.

2.5.7 Groundwater Interim Action Activities (2011 – 2012)

During September 2011, a pilot-test combining groundwater extraction, ex-situ mixing of groundwater with CaSx, and injection of the groundwater/CaSx mixture was performed at the Site to evaluate enhancement of CaSx distribution and mixing throughout targeted portions of the Site aquifer. The pilot testing was initially proposed in the *Post-Injection Monitoring Report & RAWP Addendum* (H&H 2011b), and was proposed in more detail in and completed in general accordance with the September 9, 2011 *Pilot Test Plan* (H&H 2011c). The pilot test included sequentially extracting groundwater from a newly-installed extraction well (identified as EW1) into a frac tank, mixing CaSx with the extracted groundwater in the frac tank, filtering effluent from the frac tank to remove insoluble precipitates, and injecting the filtered effluent into three previously-installed injection wells (IW7, IW8, and IW11). In addition, groundwater quality parameters and elevations were monitored in three temporary monitoring wells, extraction well EW1, and monitoring wells PZ12 and OW3, and groundwater and filter sludge samples were collected for laboratory analyses to assist in the pilot test evaluation.

Results of the pilot test indicated that the groundwater injection and re-circulation processes effectively enhanced mixing and distribution of CaSx in the aquifer, significant short-term decreases in dissolved zinc concentrations in three of the four pilot test observation wells which showed evidence of injection influence during the pilot test, and significantly lower dissolved zinc concentrations in frac tank effluent compared to influent to the tank (i.e., extracted groundwater). Refer to the *Pilot Test Report* (H&H 2011d) for additional pilot test information.

Note that prior to the pilot test, the nine-month and one-year post-injection performance groundwater monitoring events proposed in the 2010 *Remedial Action Work Plan* were completed and results of the events were documented in the *Pilot Test Report* (H&H 2011d). The results of the one-year post-injection performance monitoring event (completed in September 2011) indicated zinc and cadmium concentrations in MPA groundwater which were generally similar to pre-injection concentrations and fluctuation, and zinc concentrations in FSB2 area groundwater which were generally higher than pre-injection concentrations.

During November and December 2011, additional groundwater remedial action activities were completed at the Site in general accordance with the *Post-Injection Monitoring Report & RAWP Addendum* (H&H 2011b) and a *RAWP Addendum Deviation Request* (H&H 2011e). The remedial activities included excavation of soil in FSB2 to the north of the access road to a depth of 15 ft bgs, application of CaSx to the approximately 7,500 square foot (sf) base of the excavation, and backfilling of the excavation area after CaSx application. In addition, CaSx was injected into the existing horizontal injection wells located in FSB2, and groundwater injection and re-circulation activities were performed in the FSB2 area and the MPA using the pilot test methods discussed above. A total of six additional extraction wells (identified as EW2 through EW7) were installed as part of the 2011 additional remedial action activities. Refer to the *Additional Remedial Action & Performance Monitoring Report* (H&H 2012) for additional information.

Post-injection groundwater performance monitoring was conducted approximately one month (in January 2012), three months (in March 2011), and six months (in June 2012) after completion of the 2011 additional remedial action activities. Results of the groundwater performance monitoring indicated that dissolved cadmium and zinc concentrations in the MPA initially decreased following completion of the additional remedial activities, but increased to levels similar to pre-additional RA levels in the June 2012 samples. In the FSB2 area, dissolved zinc concentrations generally increased after the additional remedial activities. The results of the post-injection monitoring events are documented in the *Additional Remedial Action & Performance Monitoring Report* (H&H 2012).

2.5.8 Geochemical Evaluation and Pilot-Scale Injection (2013)

Based upon the results of performance monitoring conducted after the 2013 additional remedial action activities discussed above, a geochemical evaluation was completed to relate post-remedial action dissolved zinc concentrations to geochemical processes in the Site aquifer. The geochemical evaluation included soil and groundwater sample collection and analyses which were used to develop a geochemical system model. The geochemical evaluation indicated that application of CaSx to the subsurface generally did not produce the anticipated reduction of

dissolved zinc concentrations in Site groundwater as a result of the oxidation of sulfide and metal sulfides, primarily because of the inability to maintain reducing conditions as a result of aquifer fluctuations and interactions with the Columbia River. In addition, it is likely that dissolution of zinc carbonate in areas where groundwater pH decreased contributed to the increased dissolved zinc concentrations in Site groundwater. The geochemical evaluation is documented in the *Geochemical Evaluation Summary & 2013 Remedial Action Work Plan* (H&H 2013).

Based upon the geochemical evaluation, a pilot-scale injection of magnesium hydroxide and ferrous sulfate was performed using four existing injection wells during June 2013 to increase aquifer pH and augment the aquifer with iron adsorbent. The pilot-scale injection was performed in the vicinity of PZ12 in the FSB2 area in general accordance with the *Geochemical Evaluation Summary & 2013 Remedial Action Work Plan* (H&H 2013). The purpose of the ferrous sulfate injection was to emplace iron hydroxide in the aquifer in order to adsorb and immobilize dissolved zinc. Injected soluble ferrous iron is converted to insoluble iron hydroxide under oxidizing conditions (such as those observed in the Site's aquifer). The purpose of injecting magnesium hydroxide was to increase the aquifer pH in order to enhance precipitation of dissolved zinc as insoluble zinc carbonate and/or hydroxide. The pilot-scale injection was performed using existing injection wells IW-8, IW-10, IW-11, and IW-12. Pre- injection baseline and post-injection performance groundwater monitoring events were completed in the MPA and FSB2 areas during May, August, and December 2013 to evaluate the performance of the pilot-scale injection activities and to evaluate groundwater conditions in the former remedial action areas.

Field observations and post-injection groundwater monitoring indicate that the pilot-scale injection was likely successful in distributing iron within the aquifer, but distribution of the insoluble magnesium hydroxide was likely limited and therefore had limited effectiveness in increasing aquifer pH. Based on the limited effectiveness of magnesium hydroxide distribution during the pilot-scale injection, it appears that a substantial volume of magnesium hydroxide (or other suitable pH-adjustment chemical) would need to be applied to the subsurface through a high density network of injection wells in order to raise the pH of the Site aquifer to levels which would effectively reduce dissolved zinc concentrations to the GW-SW CUL. Furthermore, the

long-term effectiveness of a pH-adjustment remedy is unknown due to interactions between the Columbia River and the Site aquifer. Therefore, full-scale injection of magnesium hydroxide and/or ferrous sulfate (or other suitable pH-adjustment chemical) was not completed. Refer to the *Pilot-Scale Injection Report* (H&H 2014) for additional information on the pilot-scale injection activities.

2.5.9 Sediment and Transitional Zone Groundwater Assessment Activities (2015)

During July 2015, sediment and transitional zone groundwater samples were collected at the eastern edge of the Columbia River adjacent to the Site in locations where groundwater impacted with dissolved zinc would be expected to most likely (based on the dissolved zinc groundwater plume locations and extents) to discharge from the Site aquifer into surface water. In addition, sediment and transitional zone groundwater samples were collected along the eastern edge of the river from locations upstream and downstream of the Site. As discussed in Section 2.4.2, water in the transitional zone beneath the depth of the biologically active zone (which extends to approximately six inches beneath the Columbia River sediment surface) is considered to be groundwater. The transitional zone groundwater samples were collected utilizing 24-inch long PushPoint samplers manufactured by MHE Products. The PushPoint sampler is a tool consisting of a tubular stainless-steel body constructed with an approximately 2-inch long screened zone at the bottom end and a sampling port at the top end. The screened intervals of the PushPoint samplers were installed to depths ranging from approximately 12 to 18 in below the top of sediment (i.e., below the biologically active zone and within the transitional zone groundwater).

At the time of sampling, the Columbia River level was lower than levels which had existed at the time of nearly every groundwater sampling event completed at the Site prior to 2015, the samples were collected at or near the time of low tide, and pore water potentiometric surfaces measured with the PushPoint samplers were significantly higher than the river surface. Therefore, the sampling was conducted under hydraulic conditions which favor a potentially higher rate of groundwater discharge to the river.

Results of the sediment sampling indicated zinc was detected in each sediment sample at concentrations below SCOs presented in Table VI of WAC 173-204-563, and the concentrations are likely near or below any background-based freshwater sediment values that may be established in the future. Cadmium was not detected above laboratory reporting limits in any of the sediment samples. Cadmium and zinc were not detected above laboratory reporting limits in any of the transitional zone groundwater samples. Refer to the *Sediment and Sediment Pore Water Sampling Report* (H&H 2015) for additional information on the 2015 sediment and transitional zone groundwater assessment activities.

2.5.10 Seep Study and Sitewide Groundwater Monitoring (2017)

During August 2017, a seep study and a Sitewide groundwater monitoring event were completed in general accordance with the *Seep Study Work Plan* (H&H 2017a) submitted to Ecology in response to Ecology's letter dated February 9, 2017 (February 2017 Opinion). The February 2017 Opinion (Ecology 2017b) recommends performing a seep study in sediment along the banks of the Columbia River at the Site. The seep study was performed to evaluate for the potential presence and location of areas of relatively higher hyporheic exchange (i.e., the process of water and solute exchange in both directions across a streambed) which may act as preferential pathways (or, seeps) for compounds in groundwater associated with the Site to enter sediments and surface water in the Columbia River.

According to the National Oceanic and Atmospheric Association (NOAA), low river stages in the Columbia River generally occur during August through October each year. Groundwater to surface water flux rates at the Site (and, therefore the potential for contaminant transport from Site groundwater to surface water) are expected to be relatively higher during low river stages and as the river level decreases leading up to the low river stage. In addition, groundwater to surface water flux rates are expected to be relatively higher during periods of the day when the river level is at or approaching low tide. As indicated in a letter dated June 28, 2017 issued by Ecology (June 2017 Opinion) after submittal of the *Seep Study Work Plan*, daytime negative tidal elevations were predicted for the Site on August 6-10, 2017, and Ecology indicated in the June 2017 Opinion (Ecology 2017c) this date range was acceptable for completion of seep study

activities at the Site, and that the activities should be completed at or near the period of lowest tidal elevations during the date range.

The seep study activities were completed on August 7-10, 2017 during periods of negative tidal elevations relative to the Columbia River Datum (CRD). The seep study activities included field reconnaissance of the river bank on foot to observe for visual evidence indicative of groundwater seeps, thermal imaging to observe for thermal variation potentially indicative of relatively higher hyporheic exchange, and a survey of river bed sediments to observe for areas of groundwater upwelling beneath the surface water. (Note that Ecology personnel visited the Site on August 8, 2017 during the seep study and observed the river bank on foot during the visit.) There were no areas of potential seeps identified during these activities. As previously mentioned, the river bank at the Site is armored with riprap. The riprap prevents direct observation of riverbed sediments along the majority of the river bank adjacent to the Site.

As proposed in the *Seep Study Work Plan*, because there were no areas of potential seeps identified by the seep study activities discussed above, 22 transitional zone groundwater samples (identified as PP-1 through PP-22) were collected from PushPoint samplers installed at a spacing of approximately 40 ft along the river shoreline adjacent to the Site. Transitional zone groundwater samples were also collected from locations upstream and downstream of the Site. The screened intervals of the PushPoint samplers were installed within the transitional zone beneath the depth of the biologically active zone in the Columbia River sediments. In the June 2017 Opinion, Ecology recommended use of incremental sampling methods to evaluate sediments and pore water if detection of potential seeps was limited during the visual reconnaissance and sediment survey. However, while at the Site on August 8, 2017, Mr. Adam Harris (Ecology) acknowledged that implementation of incremental sampling methods was not feasible due to Site conditions (i.e., the riprap armoring present on the river bank), and that PushPoint sampling as proposed in the *Seep Study Work Plan* was reasonable. In addition, sediment samples were collected at 12 of the PushPoint groundwater sampling locations, and surface water samples were collected from a total of three locations in the Columbia River.

Results of the seep study sampling indicate zinc was detected above the GW-SW CUL in one PushPoint (transitional zone) groundwater sample, below the GW-SW CUL in three additional PushPoint groundwater samples, and was not detected in the remaining PushPoint groundwater samples. Zinc was detected in each sediment sample at concentrations below SCOs presented in Table VI of WAC 173-204-563, and the concentrations are likely near or below background-based freshwater sediment values that may be established in the future. Zinc was not detected in any of the surface water samples, and cadmium was not detected in any of the PushPoint groundwater, sediment, or surface water samples.

Results of the Sitewide groundwater monitoring event completed during August 2017 indicated concentrations of zinc decreased in the majority of Site wells in the period between January 2015 and August 2017. Cadmium and zinc isoconcentration maps which depict August 2017 groundwater and surface water sample results are presented in Figures 6A and 6B, respectively. Refer to the *Groundwater Monitoring and Seep Study Report* (H&H 2017b) for additional information.

2.5.11 Soil Sampling (2017)

During August 2017, soil sampling activities were completed in the MPA in general accordance with the *Soil Sampling Work Plan* (H&H 2017c) which was submitted to Ecology in response to a recommendation for additional MPA soil assessment presented in the February 2017 Opinion. The February 2017 Opinion notes that industrial processes which utilized zinc were conducted in the MPA through October 2016 and those processes may have been a potential continuing source of environmental impacts since previous soil sampling was performed. Soil samples were collected from a total of 23 borings installed in the MPA during the assessment activities. Analytical results of the soil samples are summarized along with previous soil analytical data for samples which remain at the Site (i.e., sample locations which were not removed by soil excavation activities) in Table 5, and remaining soil sample locations are depicted in Figure 5. Refer to the *Soil Sampling Report* (H&H 2017d) for additional information.

2.6 Conceptual Site Model

This section presents a summary of COC sources, concentrations and distribution, fate and transport mechanisms, and an evaluation of COC exposure pathways and receptor risks. Soil, groundwater, surface water, and sediment sample locations and COC concentrations are depicted together in Figure 7, and cross-sections are included as Figures 8A and 8B. In addition, the estimated extents and amounts of soil and groundwater with COC concentrations above cleanup standards are presented in Figure 9.

2.6.1 COC Sources

As previously discussed, soil and groundwater impacts were first identified at the Site during environmental assessment activities completed by CDM in November 2002, and environmental investigations indicate the COCs associated with the Site are cadmium and zinc. There are two main areas of impact at the Site: the FSB area and the MPA. Impacts in the FSB area are associated with FSB1 and FSB2. FSB2 was an unlined basin which received zinc carbonate sludge and FSB1 was an unlined basin which received minor spillage of zinc carbonate sludge from conveyance of the sludge to FSB2.

Sources of cadmium impacts in the MPA appear to be releases from process tank systems (particularly in the area of the subgrade tank vault in the Make Tank Room) and wastewater collection system infrastructure (as evidenced by elevated cadmium concentrations detected in soil samples collected adjacent to a floor drain located near a former cadmium AST in the Formulation Room). Sources of zinc impacts in the MPA appear to be releases along the rail spur adjacent to the manufacturing building (where zinc oxide loading operations were conducted) and from wastewater collection system infrastructure. In addition, due to the relatively widespread distribution of zinc impacts in MPA soil, it appears that zinc dust may have been distributed by storm water to areas west of the manufacturing building.

2.6.2 COC Concentrations and Distribution

2.6.2.1 Soil

Cadmium and zinc data for soil samples which remain in-place at the Site (i.e., locations not removed during the 2003 and 2010 excavation activities) are summarized in Table 5 and the “remaining soil” sample locations are depicted in Figures 5 and 7. Remaining soil impacts are discussed in the sections below.

Cadmium

Cadmium was not detected above the industrial soil – direct contact CUL applicable to the industrial portion of the Site (3,500 mg/kg) in remaining Site soil samples. Cadmium concentrations are delineated to the unrestricted land use soil – direct contact CUL (80 mg/kg) applicable to the unrestricted land use portion of the Site (i.e., areas outside the Site’s perimeter fence) by remaining soil samples located within the Site’s perimeter fence. Note that cadmium was detected above 80 mg/kg in only three remaining soil samples collected from two borings installed below the manufacturing building in the MPA (boring SB-10 located near a floor drain in the Formulation Room and boring SB-21 located adjacent to the subgrade tank vault in the Make Tank Room).

Cadmium was detected above the industrial soil – protection of terrestrial environment CUL applicable to the industrial portion of the Site (36 mg/kg) in remaining soil samples collected from two borings installed below the manufacturing building in the MPA (SB-10 located near a floor drain in the Formulation Room and SB-21 located adjacent to the subgrade tank vault in the Make Tank Room). Cadmium concentrations ranging from 76.2 to 305 mg/kg were detected in the four samples collected from these two borings. There were no other cadmium detections above the industrial soil – protection of terrestrial environment CUL in remaining soil samples at the Site. Cadmium concentrations in remaining soil samples are delineated to the unrestricted land use soil – protection of terrestrial environment CUL (25 mg/kg) within the Site’s perimeter fence and do not extend outside of the fence. (Note that the cadmium detections in SB-10 and SB-21 are also the only cadmium concentrations above 25 mg/kg detected in remaining Site

soil.) In the area of SB-10 and SB-21, the manufacturing building's concrete slab currently prevents terrestrial receptors from being exposed to soil with cadmium concentrations above the industrial soil – protection of terrestrial environment CUL. Cadmium concentrations detected above the industrial soil – protection of terrestrial environment CUL in remaining soil samples are identified in Table 5 and Figure 7.

In the FSB area, cadmium was detected slightly above the unsaturated soil – protection of groundwater CUL (0.69 mg/kg) in one remaining soil sample (at a concentration of 0.88 mg/kg) and above the saturated soil – protection of groundwater CUL (0.035 mg/kg) in eight remaining soil samples (at concentrations ranging from 0.15 to 0.88 mg/kg). In the MPA, cadmium was detected above the unsaturated soil – protection of groundwater CUL in one or more remaining soil samples collected from 17 soil borings, and above the saturated soil – protection of groundwater CUL in one or more remaining soil samples collected from 19 soil borings. The maximum cadmium concentration detected in MPA soil samples is 305 mg/kg (13 to 16 ft bgs depth interval of SB-21). As previously discussed, the unsaturated zone includes all areas of the subsurface between the ground surface and the groundwater table where the saturated zone (as defined in WAC 173-340-200) is unmet, irrespective of depth.

Zinc

Zinc was not detected above the unrestricted land use or industrial soil – direct contact CULs (24,000 and 1,050,000 mg/kg, respectively) in remaining soil samples collected from the Site. Therefore, zinc concentrations in remaining Site soil do not pose an unacceptable risk to human health via the direct contact pathway.

Zinc was detected above the industrial soil – protection of terrestrial environment CUL applicable to the industrial portion of the Site (570 mg/kg) within the POC of 0 to 15 ft bgs in one of 120 remaining FSB area soil samples (OB4 at 930 mg/kg). OB4 is one of four samples collected from overburden soil removed from the surface of FSB2 and used as backfill in the bottom 5 ft of FSB2 during the 2003 excavation activities. Concentrations of zinc were detected below the industrial soil – protection of terrestrial environment CUL in the remaining three overburden samples (OB1 through OB3). (Note that approximately one-half of the overburden

soil used to backfill the 2003 FSB2 excavation is estimated to have been removed during the 2010 excavation activities.) Zinc was detected above the industrial soil – protection of terrestrial environment CUL applicable to the industrial portion of the Site within the POC of 0 to 15 ft bgs in 23 of 108 remaining MPA soil samples collected from sample locations which are generally widespread across the MPA.

Zinc concentrations above the industrial soil – protection of terrestrial environment CUL in remaining soil are identified in Table 5 and Figure 7. As shown in Figure 7, the majority of the sample locations where zinc was detected above the industrial soil – protection of terrestrial environment CUL are below the manufacturing building or paved areas. However, five of the samples were collected from locations in an unpaved strip of land which runs along the western edge of the MPA and the Site’s perimeter fence, and two samples were collected from an unpaved area between the manufacturing building and the paved driveway to the west of the building. Zinc concentrations in remaining soil samples are not delineated to the unrestricted land use soil – protection of terrestrial environment CUL (270 mg/kg) along the western edge of the Site in the MPA inside the Site’s perimeter fence, and soil samples have not been collected in that area from locations outside of the fence. Zinc concentrations detected above the industrial soil – protection of terrestrial environment CUL in remaining soil samples are identified in Table 5 and Figure 7.

Zinc was detected above the unsaturated soil – protection of groundwater CUL (5,970 mg/kg) in three remaining soil samples at the Site. One of the samples (B8) is a 2003 excavation base sample collected from FSB2 and the other two samples (SB-7 and SS7) are located in close proximity to each other in the former zinc oxide loading (rail spur) area adjacent to the eastern side of the manufacturing building. The SB-7 and SS7 sample locations are currently covered with asphalt pavement. Zinc was detected at a concentration of 6,200 mg/kg in B8 (collected from 15 ft bgs), at 19,100 mg/kg in the 0 to 0.5 ft bgs depth interval of SS7, and at 9,360 mg/kg in the 1 to 3 ft bgs depth interval of SB-7. Note that zinc was detected below the unsaturated soil – protection of groundwater CUL in the 3 to 6 ft bgs depth interval of SB-7 (2,590 mg/kg). Therefore, zinc impacts in shallow soil in the zinc loading area may not be a significant contributor to groundwater impacts in the MPA.

Zinc concentrations above the saturated soil – protection of groundwater CUL (299 mg/kg) in remaining soil are widespread at the Site. Zinc concentrations were detected above the saturated soil – protection of groundwater CUL in each remaining FSB2 excavation base sample collected from 15 ft bgs (total of 19 samples) at concentrations ranging from 462 to 6,200 mg/kg. In addition, zinc concentrations were detected above the saturated soil – protection of groundwater CUL in samples collected from 15 ft bgs or deeper in five soil borings installed in the MPA. The vertical extent of zinc concentrations detected in several MPA soil borings has not been delineated to the saturated soil – protection of groundwater CUL. As such, it is likely that zinc concentrations above the saturated soil – protection of groundwater CUL which extend to typical depths of saturated soil are widespread at the Site, particularly in the FSB2 area. Zinc was detected at relatively low concentrations above the saturated soil – protection of groundwater CUL in one soil sample collected from FSB1 (excavation base sample B2 at 410 mg/kg) and one soil sample collected from FSB3 (LG5 at 375 mg/kg). As previously discussed, the unsaturated zone includes all areas of the subsurface between the ground surface and the groundwater table where the saturated zone (as defined in WAC 173-340-200) is unmet, irrespective of depth.

2.6.2.2 Groundwater

A summary of groundwater cadmium and zinc analytical data for Site wells is included in Table 6, and a summary of PushPoint groundwater sample analytical data is included in Table 7. Cadmium and zinc isoconcentration maps for the most recent groundwater monitoring event (completed in August 2017) are included as Figures 6A and 6B, respectively.

As discussed in Section 2.4.2, potable groundwater CULs established for human health protection (GW-HH CULs) are 5 µg/l for cadmium and 4,800 µg/l for zinc, and the potable groundwater CULs established for protection of surface water beneficial uses (GW-SW CULs) are 0.7 µg/l for cadmium and 66 µg/l for zinc. Both the GW-HH CULs and the GW-SW CULs are currently applicable to Site groundwater.

MPA Cadmium

As shown in Figure 6A, cadmium concentrations were detected above the GW-HH CUL (5 µg/l) and the GW-SW CUL (0.7 µg/l) in two MPA wells (PZ4 at 9.76 µg/l and PZ5 at 64.6 µg/l) during August 2017. These detections are lower than the January 2015 cadmium concentrations detected in PZ4 (16.4 µg/l) and PZ5 (111 µg/l). Cadmium was not detected in any of the other MPA well samples and was not detected in any PushPoint groundwater samples during August 2017. Cadmium concentrations detected in MPA groundwater above the GW-SW CUL during August 2017 are inferred to extend from the north-central portion of the manufacturing plant to approximately 100 ft west of the building. Based on the data, it does not appear that the MPA cadmium groundwater plume extends off-Site.

FSB2 Area Cadmium

As shown in Figure 6A, concentrations of cadmium were detected above the GW-HH CUL (5 µg/l) and the GW-SW CUL (0.7 µg/l) in two wells (OW2 at 8.13 µg/l and PZ1 at 6.31 µg/l) located to the west of FSB2 during August 2017. In addition, concentrations of cadmium were detected above the GW-SW CUL, but below the GW-HH CUL, in two wells (AB2 at 4.69 µg/l and OW3 at 4.19 µg/l) during August 2017. These two wells are also located to the west of FSB2. During January 2015, cadmium was detected in AB2 (1.06 µg/l), OW2 (2.61 µg/l), and PZ1 (1.32 µg/l), but was not detected in OW3. Cadmium was not detected in any of the other FSB area wells during August 2017 and was not detected in any PushPoint groundwater samples. Based on the data, concentrations of cadmium detected in FSB2 groundwater above the GW-SW CUL are inferred to extend from the western edge of FSB2 off-Site toward the Columbia River, but not to transitional zone groundwater near the groundwater-surface water interface at the Columbia River.

MPA Zinc

As shown in Figure 6B, concentrations of zinc detected in MPA groundwater above the GW-SW CUL (66 µg/l) during August 2017 are inferred to extend from east of the northern portion of the manufacturing building to west of the Site toward the Columbia River. Zinc was detected above the GW-SW CUL in seven MPA wells at concentrations ranging from 250 µg/l to 6,760 µg/l. The zinc concentrations detected in PZ3 (6,760 µg/l) and PZ9 (5,940 µg/l) were the

only detections above the GW-HH CUL (4,800 µg/l) in the MPA wells. PZ3 and PZ9 are located along the western edge of the Site. The August 2017 zinc concentrations detected in the MPA wells were generally similar to historical concentrations and fluctuations.

In the period between January 2015 and August 2017, zinc concentrations decreased in PZ4 (from 2,450 to 1,180 µg/l), PZ5 (from 4,100 to 2,260 µg/l), and PZ6 (from 10,700 to 1,150 µg/l). These three wells are located to the west (downgradient) of the manufacturing building and within the area of groundwater injections completed during 2010 and 2011. In the period between January 2015 and August 2017, zinc concentrations increased in PZ3 (from 3,780 to 6,760 µg/l) and AB1 (from 447 to 854 µg/l). These two wells are located along the western edge of the Site (and, AB1 is installed at an angle beneath the bank of the Columbia River).

Prior to August 2017, PZ7, PZ8, and PZ10 were last sampled in 2005, PZ15 was last sampled in 2007, and PZ9 was last sampled in 2010. These five wells are located outside the anticipated influence of groundwater injections completed during 2010 and 2011 and, therefore were not included in injection performance monitoring events completed after the injections. Zinc was detected in PZ7 (250 µg/l) and PZ9 (5,940 µg/l) during August 2017, but was not detected in PZ8, PZ10, or PZ15.

Results of analyses of the August 2017 PushPoint (transitional zone) groundwater samples indicate zinc was detected above laboratory detection limits in three samples (PP-8 at 362 µg/l, PP-9 at 22.4 µg/l, PP-10 at 53.4 µg/l) to the west of the MPA. As previously mentioned, the zinc GW-SW CUL is 66 µg/l. Therefore, only the zinc concentration detected in PP-8 is above the GW-SW CUL. As shown in Figure 6B, the PP-8 sample location is approximately 30 ft west of the bottom of on-Site angle bore well AB1, and PP-9 and PP-10 are located approximately 40 ft and 80 ft northwest (downstream) of PP-8, respectively. The zinc concentrations detected in these PushPoint groundwater samples appear to be associated with the MPA zinc plume. Based on the data, concentrations of zinc detected in MPA groundwater above the GW-SW CUL are inferred to extend from the MPA off-Site to transitional zone groundwater near the groundwater-surface water interface at the Columbia River. Zinc concentrations in the transitional zone

groundwater have not been demonstrated to affect surface water at concentrations above the surface water CUL.

FSB2 Area Zinc

As shown in Figure 6B, concentrations of zinc detected in FSB2 area groundwater above the GW-SW CUL (66 µg/l) during August 2017 are inferred to extend from the eastern portion of FSB2 to the west toward the Columbia River. Zinc was detected above the GW-SW CUL and GW-HH CUL (4,800 µg/l) in each of seven FSB2 area wells at concentrations ranging from 6,460 µg/l to 141,000 µg/l. Consistent with previous sampling events, zinc concentrations detected in the FSB2 area plume during August 2017 were generally higher than those detected in the MPA plume.

In the period between January 2015 and August 2017, zinc concentrations decreased significantly in OW1 (from 146,000 µg/l to 41,800 µg/l), OW3 (from 73,100 µg/l to 52,100 µg/l), PZ1 (from 76,800 µg/l to 45,400 µg/l), PZ12 (from 90,900 µg/l to 6,460 µg/l), and PZ13 (from 65,900 µg/l to 28,200 µg/l). PZ12 and PZ13 are located within the extents of FSB2 and the 2010 and 2011 injections areas, OW1 and OW3 are located adjacent to the western edge of FSB2, and PZ1 is located approximately 20 ft west of FSB2. During the August 2017 event, zinc was detected at a maximum concentration of 141,000 µg/l in OW2 which is located along the western edge of the Site in the FSB2 area near angle bore well AB2. The detection is similar to the zinc concentration (145,000 µg/l) detected in OW2 during January 2015. Finally, in the period between January 2015 and August 2017, zinc concentrations increased in angle bore well AB2 (from 17,300 µg/l to 59,800 µg/l). AB2 is located at the western edge of the Site and is installed at an angle beneath the bank of the Columbia River. Zinc was not detected in PZ14 which is located northwest of FSB2 near the western edge of the Site.

Zinc was also detected at a relatively low concentration above the GW-SW CUL and below the GW-HH CUL in the August 2017 sample collected from PZ11 (415 µg/l). PZ11 is located in FSB1. Zinc was not detected in PZ2 which is located to the west of PZ11 near the western edge of the Site. Therefore, it does not appear that zinc concentrations above the GW-SW CUL likely extend to the western edge of the Site from the area of PZ11.

Results of analyses of the August 2017 PushPoint (transitional zone) groundwater samples indicate zinc was detected above laboratory detection limits in one sample (PP-20 at 58.8 µg/l) to the west-northwest of FSB2. As previously mentioned, the zinc GW-SW CUL is 66 µg/l. As shown in Figure 6B, PP-20 is located approximately 120 ft downstream of angle bore well AB2, and the zinc concentration detected in this PushPoint groundwater sample appears to be associated with the FSB2 zinc plume. Based on the data, concentrations of zinc detected in FSB2 groundwater above the GW-SW CUL are inferred to extend from FSB2 off-Site toward the Columbia River, but not to transitional zone groundwater near the groundwater-surface water interface at the Columbia River.

2.6.2.3 Surface Water

As discussed in Section 2.5.10, H&H performed seep study activities along the Columbia River bank adjacent to the Site property during August 2017 to evaluate for the potential presence and location of areas of relatively higher hyporheic exchange which may act as preferential pathways (or, seeps) for compounds in groundwater associated with the Site to enter sediments and surface water in the Columbia River. There were no groundwater seeps identified along the river bank by visual observations or sediment survey activities completed as part of the seep study.

Three surface water samples were collected from the Columbia River adjacent to the Site as part of the August 2017 seep study activities. Analytical results of the surface water samples are summarized along with the PushPoint groundwater data in Table 7, and the surface water sample locations and analytical results are depicted in Figure 7. Results of analyses of the surface water samples indicate cadmium and zinc were not detected above laboratory detection limits (1.0 and 52.0 µg/l, respectively) in any of the August 2017 surface water samples. The surface water CULs for cadmium and zinc are 0.7 and 66 µg/l, respectively. Surface water sample SW-1 was collected in the area of PushPoint sample PP-8 (which contained the highest zinc concentration in the PushPoint samples), indicating that the relatively low concentration of zinc detected in transitional zone groundwater in this area during August 2017 was not affecting surface water quality. Zinc concentrations in the transitional zone groundwater have not been demonstrated to affect surface water at concentrations above the surface water CUL.

2.6.2.4 Sediment

As discussed in Section 2.5.10, sediment samples were collected from the Columbia River adjacent to the Site as part of the August 2017 seep study activities. Sediment samples were collected at every even-numbered PushPoint sampling location starting with PP-2 and proceeding through PP-20 (total of 10 sediment samples). In addition, upstream (SD-US) and downstream (SD-DS) sediment samples were collected near the upstream and downstream boundaries of the Site. Analytical results of sediment samples collected during August 2017 are summarized along with July 2015 sediment sample data in Table 4, and the sediment sample locations and zinc analytical results for the samples are depicted in Figure 7.

Results of analyses of the 2015 and 2017 sediment samples indicate zinc was detected in each sample collected from locations west of the Site (i.e., excluding upstream and downstream sample locations) at concentrations ranging from 16.2 to 61.9 mg/kg. Zinc was detected in the 2015 upstream and downstream sample locations at concentrations of 31.1 mg/kg and 27.4 mg/kg, respectively. Zinc was detected in the 2017 upstream and downstream sample locations at concentrations of 250 mg/kg and 17.8 mg/kg, respectively. The zinc concentrations detected in each sediment sample are below SCOs presented in Table VI of WAC 173-204-563, and the concentrations are likely near or below background-based freshwater sediment values that may be established in the future. Results of analyses of the sediment samples indicate cadmium was not detected in any of the samples.

As presented in Section 2.4.4, evaluations of sediment data to determine if impacts associated with the Site have resulted in a sediment site of potential concern was previously completed for the Site during 2018 and 2019. Based on the Site sediment evaluations, and per the May 2019 Opinion, the sediment station cluster evaluated for the Site is of low concern. Because the station cluster of low concern represents likely areas of impacts to sediment at the Site, no further sediment cleanup action is warranted at the Site, and sediment CULs do not currently need to be determined for the Site.

2.6.2.5 Ambient Air

As presented in Section 2.4.5, an evaluation of the potential for indoor air impacts at the Site indicates the indoor air pathway for Site COCs is likely incomplete and that no further evaluation of the indoor air pathway is necessary.

Per WAC 173-340-750(1)(a), air cleanup standards shall be established at the following sites:

- (i) where a non-potable groundwater CUL is being established for volatile organic compounds (VOCs) using a site-specific risk assessment under WAC 173-340-720(6).
- (ii) where a soil CUL that addresses vapors or dust is being established under WAC 173-340-740 or 173-340-745.
- (iii) where it is necessary to establish air emission limits for a remedial action.
- (iv) at other sites as determined by the department.

None of the scenarios listed above currently apply to the Site; however, a protection of air quality CUL of $0.0014 \mu\text{g}/\text{m}^3$ for cadmium appears appropriate for ambient air throughout the Site if it is determined that one or more of the scenarios listed above applies to the Site. A protection of air quality CUL for zinc was not determined because available data are not suitable for the derivation of a reference concentration for chronic inhalation exposure for zinc (see Section 2.4.5 for additional discussion).

2.6.3 COC Fate and Transport

The COCs associated with the Site (i.e., cadmium and zinc) do not degrade or break down in the environment. The primary transport mechanism for the COCs at the Site is dissolution into and migration with water. These processes can occur as water infiltrates from the ground surface downward through impacted unsaturated soil and as groundwater moves through impacted saturated aquifer sediments. Within the subsurface, the fate and transport of dissolved COCs is generally controlled by processes of metals immobilization and remobilization, which are largely dependent on geochemical conditions in saturated and unsaturated zone sediments.

Generally, under oxidizing conditions, a significant amount of dissolved COC mass will be immobilized by adsorption (e.g., to iron and manganese hydroxides which are typically abundant in aquifers) and co-precipitation. Under reducing conditions, COC mass which was immobilized by adsorption and co-precipitation can be remobilized. However, note that immobile metal sulfides can also be formed under reducing conditions where sulfur is present (such as in the Site aquifer). Reducing conditions typically exist within the biologically active zone of river beds due to relatively higher metabolic activities and biological and chemical oxygen demand, and these conditions are expected to reduce the potential for accumulation of COCs in the biologically active zone of riverbed sediments. As discussed in Section 2.4.2, the biologically active zone in the Columbia River sediments adjacent to the Site is assumed to extend to six inches below the sediment surface. Aquifer pH also effects solubility of metals. As pH decreases from neutral levels, the solubility of the COCs associated with the Site increases.

Interaction of surface water and groundwater at the Site as a result of tidal and seasonal variations, and generally widespread relatively low pH conditions in Site groundwater (average of approximately 5.4 standard units during August 2017) result in complex geochemical conditions and COC transport in the Site aquifer. Based on soil, groundwater, surface water, and sediment data from the Site, it appears that migration of relatively high COC concentrations in Site groundwater toward the river is retarded by immobilization of COCs in the aquifer via absorption and precipitation processes and/or conversion to insoluble and immobile compounds in the aquifer between the western portions of the Site and the Columbia River (where relatively high pH and oxidizing conditions are present). In addition, the temporal mound in the groundwater table near the river (discussed in Section 2.3.1) appears to cause groundwater in the central portion of the Site (where maximum COC concentrations are located) to be temporally stagnant, further reducing the rate of COC mass migration toward the river. As discussed in Section 2.6.6.2, relatively low zinc concentrations appear to extend to transitional zone groundwater beneath the biologically active zone in sediments at the edge of the Columbia River adjacent to the Site, but the low concentrations do not appear to adversely affect surface water or sediment quality.

COCs in surface soil can also be dispersed on the surface by storm water and through the air as airborne particulates. In addition, terrestrial receptors can uptake COCs from soil (which can result in bioaccumulation of COCs in an organism and biomagnification of COCs at successively higher levels of food chains).

2.6.4 Exposure Pathways and Receptor Risks Evaluation

This section presents an evaluation of current and potential future exposure pathways and receptor risks for the Site. Potential exposure pathways for COCs at the Site which were evaluated include the following:

- human exposure via direct contact with COCs in soil;
- terrestrial ecological exposure to COCs in soil;
- human exposure via ingestion of COCs in groundwater;
- human and benthic community exposure to COCs in sediment;
- human and aquatic life exposure to COCs in surface water; and,
- human exposure via inhalation of COCs in ambient or indoor air.

These potential exposure pathways and associated receptor risks are discussed below.

2.6.4.1 Human Exposure via Direct Contact with COCs in Soil

As discussed in Section 2.6.2.1, zinc was not detected in remaining Site soil above the unrestricted land use or industrial soil – direct contact CULs, and cadmium was not detected in remaining Site soil above the industrial soil – direct contact CUL. Cadmium was detected above the unrestricted land use soil – direct contact CUL in remaining soil samples collected from two borings installed beneath the manufacturing building, and these cadmium concentrations are delineated to the unrestricted land use soil – direct contact CUL applicable to the unrestricted land use portion of the Site (i.e., portions of the Site property located outside the Site’s perimeter fence) by remaining soil samples located within the Site’s perimeter fence. Therefore, COC

concentrations in Site soil do not pose an unacceptable risk for industrial use of the Site.

In the future, the soil – direct contact pathway could pose an unacceptable risk if the Site were to no longer qualify as industrial for exposure scenarios and the manufacturing building’s concrete slab were removed in the area of soil impacted with cadmium above the unrestricted land use soil – direct contact CUL.

2.6.4.2 Terrestrial Ecological Exposure to COCs in Soil

As discussed in Section 2.4.1.2 and Appendix A, the simplified terrestrial ecological evaluation process includes analysis of contaminants as a screening step in evaluating ecological risk at a site. The evaluation may be ended if a contaminant analysis indicates COCs are not, or will not be, present at concentrations above soil – protection of terrestrial environment CULs, using the statistical compliance methods described in WAC 173-340-740(7). However, per WAC 173-340-740(7)(e), for all data analysis methods used:

- (i) No single sample concentration shall be greater than two times the soil CUL; and,
- (ii) Less than 10 percent of the sample concentrations shall exceed the soil CUL.

As presented in Appendix A, upper one-sided ninety-five percent confidence limits on the true mean soil concentration (95% UCLs) for cadmium and zinc in remaining Site soil were calculated for multiple scenarios for comparison to soil – protection of terrestrial environment CULs. 95% UCL concentrations determined for cadmium and zinc in remaining Sitewide soil are 6.4 and 544 mg/kg, respectively. 95% UCL concentrations determined for cadmium and zinc in remaining uncovered Site soil (i.e., soil not covered by existing Site structures or pavement) are 1.3 and 172 mg/kg, respectively. Refer to Appendix A for additional information pertaining to the use and determination of the 95% UCLs.

Cadmium

The 95% UCL concentrations determined for cadmium in remaining Sitewide soil (6.4 mg/kg) and uncovered Site soil (1.3 mg/kg) are less than the unrestricted land use and industrial soil –

protection of terrestrial environment CULs (25 and 36 mg/kg, respectively). Significantly less than 10 percent of samples in the Sitewide and uncovered Site soil data sets contained cadmium concentrations above the CULs.

As discussed in Section 2.6.2.1, cadmium was detected above the industrial soil – protection of terrestrial environment CUL (36 mg/kg) applicable to the industrial portion of the Site in remaining soil samples collected from two borings installed beneath the manufacturing building. Cadmium concentrations ranging from 76.2 to 305 mg/kg were detected in four samples collected from these two borings. These detections are each greater than two times the industrial soil – protection of terrestrial environment CUL. These cadmium concentrations are also higher than the unrestricted land use soil – protection of terrestrial environment CUL applicable to the unrestricted land use portion of the Site (i.e., portions of the Site property located outside the Site’s perimeter fence), but are delineated to the unrestricted soil – protection of terrestrial environment CUL by remaining soil samples located within the Site’s perimeter fence. The manufacturing building prevents terrestrial exposure to soil impacted with cadmium above the soil – protection of terrestrial environment CULs.

Based on the information presented above, cadmium concentrations in remaining Site soil do not pose an unacceptable risk to terrestrial ecological receptors. In the future, cadmium could pose an unacceptable risk for terrestrial ecological receptor exposure if the manufacturing building’s concrete slab were to be removed in the area of soil impacted with cadmium above the soil – protection of terrestrial environment CULs.

Zinc

The 95% UCL concentration determined for zinc in remaining Sitewide soil (544 mg/kg) is less than the industrial soil – protection of terrestrial environment CUL (570 mg/kg), and higher than the unrestricted land use soil – protection of terrestrial environment CUL (270 mg/kg). The 95% UCL concentration determined for zinc in remaining uncovered Site soil (170 mg/kg) is lower than both the unrestricted land use and industrial soil – protection of terrestrial environment CULs.

Approximately 22 and 10.5 percent of samples in the Sitewide soil data set contained zinc concentrations above the unrestricted land use and industrial soil – protection of terrestrial environment CULs, respectively. Approximately 14 and four percent of samples in the uncovered Site soil data set contained zinc concentrations above the unrestricted land use and industrial soil – protection of terrestrial environment CULs, respectively. Zinc concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CUL were detected in 24 of the remaining Sitewide soil samples and in seven of the remaining uncovered soil samples. Zinc concentrations greater than two times the industrial soil – protection of terrestrial environment CUL were detected in 13 of the remaining Sitewide soil samples and in four of the remaining uncovered soil samples. Note that zinc concentrations in these four uncovered samples range from 1,290 to 1,300 mg/kg and are only slightly higher than two times the industrial soil – protection of terrestrial environment CUL (1,140 mg/kg).

As discussed in Section 2.3.3, a wildlife and plant species evaluation was previously completed at the Site. The evaluation determined that the use of the Site (including portions of the Site located outside of the Site’s perimeter fence) by terrestrial species in the area of the Site is highly unlikely because the Site does not provide suitable habitat for upland species.

Based on the information presented above, the pathway for exposure of terrestrial ecological receptors to zinc in Site soil appears incomplete and zinc concentrations in remaining Site soil do not appear to pose an unacceptable risk to terrestrial ecological receptors; however, per WAC 173-340-740(7)(e)(i), uncovered soil with zinc concentrations greater than two times the industrial soil – protection of terrestrial environment CUL would need to be addressed in order to utilize the statistical compliance methods described in WAC 173-340-740(7). Because uncovered soil located in the western portion of the MPA near the Site’s perimeter fence contains zinc concentrations greater than two times the unrestricted land use and industrial soil – protection of terrestrial environment CULs, sampling may need to be performed to verify that zinc concentrations do not exceed two times the unrestricted land use soil – protection of terrestrial environment CUL outside of the Site’s perimeter fence.

In the future, the pathway for terrestrial ecological receptor exposure to zinc in Site soil could become complete if the Site were to no longer qualify as industrial for exposure scenarios, or existing Site structures and/or pavement were to be removed in areas of soil impacted with zinc.

2.6.4.3 Human Exposure via Ingestion of COCs in Groundwater

As discussed in Section 2.6.2.2, concentrations of cadmium and zinc above GW-HH CULs are present in the FSB2 area and MPA groundwater. August 2017 groundwater sample data indicate cadmium above the GW-HH CUL may extend off-Site a short distance to the west of the FSB2 area, but no concentrations of cadmium were detected above laboratory MDLs in PushPoint groundwater samples collected along the Columbia River bank adjacent to the Site during August 2017. August 2017 groundwater sample data indicate concentrations of zinc above the GW-HH CUL extend off-Site to the west of the MPA and FSB2 area toward the Columbia River, but concentrations of zinc were not detected above the GW-HH CUL in the August 2017 PushPoint groundwater samples. Concentrations of COCs above GW-HH CULs do not appear to extend off-Site to the north, east, or south of the Site.

Groundwater from the Site is not used as a source of potable water. There are no potable wells located within 1,000 ft of the Site, municipal water is available to properties located within the Kalama city limits, and the City of Kalama's municipal water source is groundwater obtained from horizontal collection pipes installed in the Kalama River streambed (located two miles east of the confluence of the Kalama and Columbia Rivers).

Based on the information presented above, the human exposure pathway to Site COCs via ingestion of groundwater pathway is currently incomplete, and COCs in Site groundwater do not pose an unacceptable risk to human health. Based on the extents of the groundwater plumes associated with the Site and transport mechanisms which limit migration of the Site COCs in the aquifer, it does not appear that COCs in Site groundwater pose a potential risk to human health on off-Site properties where potable wells could be installed in the future. Therefore, in the future, the pathway for human exposure to COCs associated with the Site via ingestion of groundwater would only be complete if Site groundwater was to be used for potable purposes.

2.6.4.4 Human and Benthic Community Exposure to COCs in Sediment

As discussed in Section 2.4.4, evaluations have been completed to determine if COCs associated with the Site have resulted in a sediment site of potential concern. Based on the Site sediment evaluations which are summarized in Section 2.4.4, and per Ecology's May 2019 Opinion, the sediment station cluster evaluated for the Site represents likely areas of impacts to sediment associated with the Site, and the cluster is of low concern. Station clusters of low concern shall remain on the inventory and no further cleanup action determinations shall be taken until/unless new information is available and the stations are reexamined per WAC 173-204-510(5). The May 2019 Opinion indicates that SCOs presented in Table VI for toxicity to the benthic community are also protective of human health at the Site (and provides rationale for this determination), and indicates that there is no need to establish risk- or background-based sediment CULs for the Site.

Based on the information presented above, the pathway for human and benthic community exposure to COCs in sediment is incomplete. Based upon the low mobility of the COCs, removal of significant source mass, and length of time since soil and groundwater impacts occurred, the sediment exposure pathway is not likely to become complete in the future.

2.6.4.5 Human and Aquatic Life Exposure to COCs in Surface Water

As discussed in Section 2.5.10, H&H performed a seep study along the Columbia River bank adjacent to the Site during August 2017 to evaluate for the potential presence and location of areas of relatively higher hyporheic exchange which may act as preferential pathways (or, seeps) for compounds in groundwater associated with the Site to enter sediments and surface water in the Columbia River. There were no groundwater seeps identified along the river bank by visual observations or sediment survey activities completed as part of the seep study.

As discussed in Section 2.6.2.2, it does not appear that cadmium concentrations above the GW-SW CUL extend to transitional zone groundwater near the groundwater-surface water interface at the Columbia River. Based on August 2017 groundwater sample data, zinc concentrations

above the GW-SW CUL are inferred to extend from the MPA and FSB2 area off-Site toward the Columbia River to transitional zone groundwater near the groundwater-surface water interface at the Columbia River. Note that zinc was detected above the GW-SW CUL in one PushPoint groundwater sample (PP-8 at 362 µg/l) collected from transitional zone groundwater beneath the biologically active zone in the Columbia River sediments during August 2017.

Cadmium and zinc were not detected above laboratory detection limits in August 2017 surface water samples collected from the Columbia River adjacent to the Site, including a surface water sample collected in the area of PushPoint sample PP-8. The GW-SW CULs are the same as the surface water CULs for cadmium and zinc, and are based on levels which are protective of aquatic life (see Section 2.4.2). Surface water zinc concentration criteria protective of human health for consumption of water and/or organisms are higher than the levels which are protective of aquatic life, and surface water cadmium concentration criteria protective of human health are not established.

Based on the information presented above, the relatively low concentrations of zinc detected in transitional zone groundwater near the groundwater-surface water interface at the Columbia River are not likely to affect surface water quality. It is unlikely that COCs in Site groundwater have the potential to measurably affect surface water quality due to the low rate of COC mass migration toward the river resulting from transport mechanisms which limit migration of the Site COCs in the aquifer, and due to the effects of COC dilution and dispersion within transitional zone groundwater near the groundwater-surface water interface. Therefore, the pathway for human and aquatic life exposure to COCs associated with the Site in surface water is incomplete and, for the reasons noted above for sediment, is not likely to become complete in the future.

2.6.4.6 Human Exposure via Inhalation of COCs in Ambient or Indoor Air

As presented in Section 2.4.5, an evaluation of the potential for indoor air impacts at the Site indicates the indoor air pathway for Site COCs is likely incomplete and that no further evaluation of the indoor air pathway is necessary. As discussed in Sections 2.4.5 and 2.6.2.5, a protection

of air quality CUL of 0.0014 $\mu\text{g}/\text{m}^3$ for cadmium appears appropriate for ambient air throughout the Site if it is determined that one or more of the scenarios listed in WAC 173-340-750(1)(a) applies to the Site. A protection of air quality CUL was not determined for zinc because available data are not suitable for the derivation of a reference concentration for chronic inhalation exposure for zinc. None of the scenarios listed in WAC 173-340-750(1)(a) currently apply to the Site.

Note that the statewide 90th percentile natural background concentration of cadmium in Washington State surface soils is 1 mg/kg (as reported in Ecology's Publication No. 94-115, *Natural Background Soil Metals Concentrations in Washington State*). A total of 68 remaining shallow soil (0 to 3 ft bgs) samples have been collected from uncovered areas of the Site (i.e., not covered by existing structures or pavement) and analyzed for cadmium. Cadmium was detected in eight of 68 samples at concentrations ranging from 0.56 to 1.8 mg/kg, and was only detected in three of the samples above 1 mg/kg. The average of the eight cadmium detections (1.04 mg/kg) is consistent with the 90th percentile natural background concentration of cadmium in Washington State surface soils. Based on this information, it does not appear that cadmium concentrations in uncovered shallow Site soil are likely to result in cadmium concentrations in airborne particulates higher than would be expected from background concentrations of cadmium in shallow soil.

Based on the information presented above, the inhalation pathway is currently incomplete for the Site COCs. In the future, the inhalation pathway for cadmium could be complete under certain scenarios (e.g., increased potential for cadmium-impacted airborne particulates resulting from soil disturbance/removal activities or removal of Site structures and/or pavement which currently covers cadmium impacts in shallow soil).

3.0 Cleanup Action Objectives and Alternatives Identification

Per WAC 173-340-350(1), the purpose of the remedial investigation/FS is to collect, develop, and evaluate sufficient information regarding a site to select a cleanup action under WAC 173-340-360 through WAC 173-340-390. In the July 2018 Opinion, Ecology indicates that sufficient information appears to have been collected at the Site to select a cleanup action under WAC 173-340-360 through WAC 173-340-390. Cleanup action objectives (CAOs) and cleanup action alternatives identified for evaluation in accordance with the requirements of WAC 173-340-360 are presented in the following sections.

3.1 Cleanup Action Objectives

Development of CAOs is needed before identification and evaluation of cleanup action alternatives can be completed. CAOs for the Site include meeting the following minimum threshold requirements for cleanup actions presented in WAC 173-340-360(2)(a):

- (i) Protection of human health and the environment;
- (ii) Compliance with cleanup standards;
- (iii) Compliance with applicable state and federal laws; and,
- (iv) Provision for compliance monitoring.

These minimum threshold requirements are discussed below.

Protection of Human Health and the Environment

Protection of human health and the environment (including, as appropriate, aquatic and terrestrial ecological receptors) may be achieved by a cleanup action alternative which eliminates, reduces, or otherwise controls risks posed through exposure pathways and migration routes. Protection of human health and the environment can largely occur through achieving cleanup standards applicable to a site.

Compliance with Cleanup Standards

Per WAC 173-340-350(8)(a), if concentrations of hazardous substances do not exceed the CUL at a standard POC, no further action is necessary. Therefore, further action is necessary to address the following concentrations of hazardous substances at the Site:

- cadmium concentrations in Site soil which exceed soil – direct contact cleanup standards;
- cadmium and zinc concentrations in Site soil which exceed soil – protection of terrestrial environment cleanup standards;
- cadmium and zinc concentrations in Site soil which exceed soil – protection of groundwater cleanup standards; and,
- cadmium and zinc concentrations in Site groundwater which exceed groundwater cleanup standards.

The estimated areal extents of the COCs which exceed the above standards are depicted in Figure 9. A tabular summary of these areas and the estimated area and volume of soil and groundwater associated with the areas is also included in Figure 9.

Note that the estimated areal extents of Site soil above the soil – protection of terrestrial environment cleanup standards in Figure 9 assume that after this soil is addressed, statistical compliance methods will be used to demonstrate that COCs are not present at concentrations above the soil – protection of terrestrial environment CULs (refer to Section 2.4.1.2 and Appendix A). In addition, the estimated areal extents of soil impacts above the soil – protection of terrestrial environment cleanup standards in Figure 9 include individual sample concentrations greater than two times the applicable soil – protection of terrestrial environment CULs, and removal of these samples will reduce the total number of individual sample concentrations above the applicable soil – protection of terrestrial environment CULs to less than 10 percent, as required by WAC 173-340-740(7)(e). Finally, removal of Site soils impacted with concentrations of COCs above soil – protection of groundwater CULs to standard POCs will also adequately address COC concentrations in Site soil which exceed the soil – protection of terrestrial environment cleanup standards.

Per WAC 173-340-740(6)(f), cleanup actions that include containment of a hazardous substance may be determined to comply with soil cleanup standards provided that the cleanup action:

- (i) is permanent to the maximum extent practicable (using the procedures in WAC 173-340-360);
- (ii) is protective of human health;
- (iii) is protective of terrestrial ecological receptors;
- (iv) includes institutional controls (ICs) put in place to prohibit/limit activities that could interfere with the long-term integrity of the containment system; and,
- (v) identifies the types, levels, and amounts of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances.

In addition, where it can be demonstrated that it is not practicable to meet groundwater CULs throughout a site within a reasonable restoration time frame, Ecology may approve a CPOC for groundwater in accordance with WAC 173-340-720(8)(c).

Applicable State and Federal Laws

Cleanup actions must comply with applicable state and federal laws, as outlined in WAC 173-340-710. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines, based on consideration of the criteria in WAC 173-340-710(4), are relevant and appropriate requirements. Legally applicable requirements include those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations adopted under state or federal law that specifically address a hazardous substance, cleanup action, location or other circumstances at a site. Relevant and appropriate requirements include those cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to a particular site. WAC 173-340-710 through 173-340-760 identifies several requirements Ecology shall consider relevant and appropriate for establishing cleanup standards. The person conducting a cleanup action shall

identify all applicable state and federal laws, and Ecology shall make the final interpretation on whether these requirements have been correctly identified and are legally applicable or relevant and appropriate. Potentially applicable state and federal laws for cleanup of the Site are summarized in Table 8.

Compliance Monitoring

Compliance monitoring shall be performed for all cleanup actions, as outlined in WAC 173-340-410. There are three types of compliance monitoring associated with cleanup actions. Protection monitoring is used to confirm adequate protection of human health and the environment, performance monitoring is used to confirm attainment of cleanup standards (and, other performance standards, as appropriate), and conformational monitoring is used to confirm the long-term effectiveness of the cleanup action once cleanup standards (and, other performance standards, as appropriate) have been attained. Where the cleanup action includes engineered controls or ICs, the monitoring may need to include documentation of observations on the performance of these controls. Long-term monitoring shall be performed if on-site disposal, isolation, or containment is the selected cleanup action for a site or a portion of a site. Such measures shall be required until residual hazardous substance concentrations no longer exceed CULs at the Site. A compliance monitoring plan will be prepared and submitted to Ecology for review and approval after issuance of the cleanup action plan.

3.2 Cleanup Action Alternatives

Per WAC 173-340-350(8)(c), a FS shall include:

- Cleanup action alternatives that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route.
- Evaluation of a reasonable number and type of alternatives, taking into account the characteristics and complexity of the facility, including current site conditions and physical constraints.

- Cleanup action alternatives with the standard POC for each environmental media containing hazardous substances, and, as appropriate, alternatives with CPOCs.
- At least one permanent cleanup action alternative to serve as a baseline against which other alternatives shall be evaluated for the purpose of determining whether the selected cleanup action is permanent to the maximum extent practicable. A “permanent cleanup action”, as defined in WAC 173-340-200, means a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances.

Alternatives may consist of one or more cleanup action components, including, but not limited to, components that reuse or recycle the hazardous substances, destroy or detoxify the hazardous substances, immobilize or solidify the hazardous substances, provide for on-site or off-site disposal of the hazardous substances in an engineered, lined and monitored facility, on-site isolation or containment of the hazardous substances with attendant engineering controls, and ICs and monitoring.

The *Summary of Proposed FS Cleanup Action Alternatives* (H&H 2018b) submitted to Ecology included seven cleanup action alternatives for evaluation in a FS for the Site. In the July 2018 Opinion, Ecology indicated its concurrence that the proposed alternatives appear to encompass a range of alternatives designed to meet the minimum threshold requirements of MTCA. A “No Action” alternative was not included in the proposed alternatives or in this FS because such an alternative does not meet the minimum threshold requirements of MTCA. Brief descriptions of each alternative (including an eighth additional alternative) are presented in the sections below. Modifications have been made to the proposed alternatives included in the *Summary of Proposed FS Cleanup Action Alternatives* submittal as a result of considerations, evaluations, and determinations associated with the Site which occurred after submittal of the summary.

Please note that each cleanup action alternative includes implementation of an IC to prevent use of Site groundwater for potable purposes until GW-HH CULs are achieved, although

implementation of this IC is not necessarily noted in each alternative description presented below. This IC (and, any other ICs included in the cleanup action) will be implemented in accordance with the requirements of WAC 173-340-440 and shall remain effective in perpetuum unless the conditions at the Site requiring an IC no longer exist, the property owner submits a request to Ecology for removal of the IC, and Ecology approves the request.

3.2.1 Alternative #1 (Facility Demolition, Complete Soil Removal, P&T)

Alternative #1 includes excavation and off-Site disposal of Site soils impacted with concentrations of COCs above unrestricted land use soil – direct contact, unrestricted land use soil – protection of terrestrial environment (as determined by statistical compliance methods used to evaluate ecological risk at a site and discussed in Section 2.6.4.2), and soil – protection of groundwater CULs to standard POCs. Note that removal of Site soils impacted with concentrations of COCs above soil – protection of groundwater CULs to standard POCs will also address soils impacted with concentrations of COCs above unrestricted land use soil – direct contact cleanup standards and soil – protection of terrestrial environment cleanup standards (as determined using statistical compliance methods discussed in Section 2.4.1.2 and Appendix A). Alternative #1 also includes installation and operation of a groundwater pump and treat (P&T) system to accelerate reduction of COC concentrations in groundwater throughout the Site to below GW-HH CULs and/or GW-SW CULs.

The soil removal areas for this alternative are identified in Figure 10. As shown in Figure 10, removal of a significant percentage of the existing Site structures and pavement will be required for completion of the soil removal activities. Therefore, implementation of this alternative requires consent from the Site property/facility owner (Chemtrade) for removal of these structures. Because the facility is not currently active, it is assumed that Chemtrade will grant permission for demolition and removal of Site structures and pavement; however, it is anticipated that Chemtrade will require removal of all Site structures and pavement (not just the structures and pavement present in the soil excavation areas) and compensation for the structures, and will not grant approval for partial demolition and post-excavation reconstruction of the structures.

The average depth of soil removal in the excavation areas is assumed to be 30 ft bgs. Sampling will be completed during excavation activities to confirm removal of soil impacts to CULs and to minimize the amount of soil removed. Shoring of excavation sidewalls at depths beneath the high water table will be performed using temporary sheet piling in order to prevent collapse of the sidewalls and to minimize infiltration of groundwater into the excavation areas (note that the sandy Site soils have very low cohesive strength). Shoring of excavation sidewalls will be performed at shallower depths in western portions of the Site where the distance of soil impacts from the property boundary prevents adequate sloping of excavation sidewalls. Clean overburden soil used to backfill previous excavations in the FSB area will be removed and temporarily stockpiled in the undeveloped northern portion of the Site, and the excavation areas will be backfilled with this stockpiled soil and with clean import fill. Removed soil will be transported off-Site for disposal in accordance with applicable laws. It is assumed that the soil will be disposed in a Subtitle D landfill.

After completion of the soil removal activities, quarterly groundwater monitoring will be completed for approximately one year to evaluate the effects of the soil removal activities on COC concentrations in Site groundwater and to assist with groundwater P&T system design. H&H expects that the soil removal activities will result in significant reduction of COC concentrations and plume extents in Site groundwater, and that concentrations of COCs above the GW-HH CUL and/or GW-SW CUL will only remain in groundwater beneath western portions of the Site after completion of the soil removal activities. Therefore, it is anticipated that groundwater will only be recovered from western portions of the Site aquifer. H&H assumed the groundwater P&T system will include a total of eight groundwater extraction wells installed along the western edge of the Site (Figure 10), that the system will discharge untreated groundwater to a Publicly-Owned Treatment Works (POTW), that the system will be operated for 10 years in order to reduce COC concentrations below GW-SW CULs throughout the Site, and that groundwater monitoring will be completed on an annual basis while the groundwater P&T system is in operation. Existing wells located within the extents of the excavation areas will be removed/abandoned and new wells will be installed as needed for post-remediation performance monitoring.

Alternative #1 appears to be a permanent cleanup action alternative.

3.2.2 Alternative #2 (Facility Demolition, Complete Soil Removal, pH Buffering)

Alternative #2 includes the same soil and Site structures removal and post-remediation groundwater monitoring activities which are included in Alternative #1. In addition, Alternative #2 includes pH buffering of the aquifer along the western edge of the Site where groundwater impacts are expected to persist after soil removal to assist with reduction of dissolved COC concentrations below GW-SW CULs. Magnesium hydroxide (pH buffering chemical) will be emplaced in the aquifer via injection into approximately 45 temporary direct-push technology (DPT) injection wells installed along the western edge of the Site to target areas where COCs are anticipated to remain above the GW-HH CUL and/or GW-SW CUL in groundwater after completion of soil excavation activities. The temporary injection well locations are depicted in Figure 10. The purpose of injecting magnesium hydroxide is to accelerate the increase of aquifer pH conditions in the injection areas (where low pH conditions currently exist) to levels more typical of natural background conditions so that dissolved COCs will be converted to relatively insoluble carbonates and/or hydroxides. This pH adjustment is expected to assist natural attenuation processes with reduction of dissolved COC concentrations.

Please note that in situ chemical reduction (ISCR) was previously implemented at the Site and was eliminated from consideration as a groundwater treatment technology in this FS based on the results of the previous remediation actions (see Section 2.5.8). Existing wells located within the extents of the excavation areas will be removed/abandoned and new wells will be installed as needed for post-remediation performance monitoring.

Alternative #2 appears to be a permanent cleanup action alternative.

3.2.3 Alternative #3 (Facility Demolition, Limited Soil Removal, ISS, pH Buffering)

Alternative #3 includes excavation and off-Site disposal of Site soils impacted with concentrations of COCs above unrestricted land use soil – direct contact and unrestricted land

use soil – protection of terrestrial environment CULs to the standard POC of 15 ft bgs, and removal of soils impacted with concentrations of COCs above soil – protection of groundwater CULs to 15 ft bgs (which is not the standard POC of soil throughout the Site). For this alternative, removal of Site structures and pavement, and soil removal and backfilling methods will be the same as those included in Alternative #1.

In-situ soil solidification (ISS) of soils impacted with COC concentrations above soil – protection of groundwater CULs at depths greater than 15 ft bgs will be performed by mixing Portland cement into the soil using an excavator with a blending head attachment. Amendment of soil with Portland cement will reduce the leachability of COCs from the treated soil by significantly reducing soil permeability and by increasing soil pH. Reducing soil permeability results in a degree of COC “encapsulation”, and increasing pH results in conversion of dissolved COCs to relatively insoluble and immobile carbonate and/or hydroxide compounds. ISS with Portland cement will not reduce COC mass in treated areas and therefore does not achieve soil – protection of groundwater CULs. However, leach testing and/or empirical demonstration may be used in accordance with WAC 173-340-747 to establish COC concentrations for the ISS soil which will not cause an exceedance of applicable groundwater CULs.

Finally, this alternative includes pH buffering of the aquifer along the western edge of the Site to assist natural attenuation processes in reduction of dissolved COC concentrations in Site groundwater to the west of the ISS areas. Implementation of pH buffering for this alternative will be the same as included in Alternative #2. H&H assumed that groundwater monitoring will be completed on an annual basis for 10 years to demonstrate reduction of COC concentrations below GW-SW CULs. Wells located within the extents of the ISS area will be removed/abandoned and new wells will be installed outside of the ISS areas as needed for post-remediation performance monitoring.

Alternative #3 may become a permanent cleanup action alternative if it can be demonstrated that COCs in ISS soil will not result in future exceedance of groundwater CULs.

3.2.4 Alternative #4 (Limited Soil Removal, P&T, ICs)

Alternative #4 includes excavation and off-Site disposal of uncovered Site soils with concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs, and establishing a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs. The estimated horizontal extent of the excavation area is depicted in Figure 11. Establishing this CPOC eliminates the need to remove uncovered Site soils with concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs which were previously detected in two remaining uncovered soil samples (PZ5-10' and OB4) located deeper than six feet bgs. Removal of Site soils with COC concentrations above CULs from areas which are currently covered with Site structures and pavement will not be completed as part of this alternative.

In order to address COC concentrations in Site groundwater above GW-HH CULs and GS-SW CULs, a groundwater P&T system will be installed and operated to reduce COC mass in the Site aquifer. Soil-bentonite slurry walls (SBSWs) will be installed around areas targeted for groundwater recovery to limit off-site migration of the COC plumes and to reduce inflow of water with relatively low COC concentrations (including water from tidal influence of the Columbia River) into the areas targeted for groundwater recovery. (Note that the cost of installation of SBSWs is significantly lower than installation of sheet pile walls.) The SBSW locations are depicted in Figure 12.

The P&T system will treat recovered groundwater to water quality standards established for groundwaters of the state of Washington, and treated effluent from the system will then be injected into wells located within the areas targeted for groundwater recovery for the purpose of maintaining water levels in the aquifer so that the groundwater extraction wells function properly (i.e., in order to maintain adequate water levels in the aquifer for continued groundwater and COC mass removal by the P&T system) and to control potential subsidence which may occur if significant dewatering of areas targeted for groundwater recovery occurs. Per WAC 173-218-100, this type of injection well appears to be considered a Class V UIC rule authorized well. In

addition, injection of the treated water may assist with removal of COC mass from unsaturated soil. H&H assumed that the P&T system will recover groundwater from seven existing extraction wells (identified as EW1 through EW7) and 18 newly-installed groundwater extraction wells (Figure 12).

For this alternative, H&H assumed that the P&T system will be operated for 30 years in order to reduce COC concentrations in groundwater below GW-SW CULs throughout the Site, or to reduce COC concentrations in groundwater below GW-HH CULs throughout the Site and to demonstrate that the COCs in Site groundwater are not likely to reach surface water (in which case GW-SW CULs would no longer be applicable at the Site, per WAC 173-340-720). Groundwater monitoring will be completed on an annual basis while the P&T system is in operation. Alternative #4 relies on natural attenuation of COC concentrations to below the GW-SW CULs in areas located outside the influence of the recovery system (i.e., in western portions of the Site outside the SBSW). Soil cover integrity inspections (see below) will be completed during the monitoring events, then one time every five years after the end of groundwater monitoring. Soil cover maintenance will be completed as needed to maintain cover integrity.

In order to prohibit activities that could result in exposure to hazardous substances at the Site or interfere with the integrity of the cleanup action, additional ICs will be utilized as part of Alternative #4 for the items listed below.

- Prevention of soil disturbance or excavation from deeper than six feet bgs at the Site unless approved by Ecology (under a cleanup action, if necessary) prior to such soil disturbance or excavation activities. Per WAC 173-340-7490(4)(a), for sites with ICs to prevent excavation of deeper soil, a CPOC for soil – protection of terrestrial environment cleanup standards may be set at the biologically active soil zone which is assumed to extend to a depth of six feet bgs.
- Prevention of disturbance or removal of those portions of existing Site structure concrete slabs or pavement located over areas of COC concentrations above soil – direct contact CULs and two times greater than soil – protection of terrestrial environment CULs,

unless approved by Ecology (under a cleanup action, if necessary) prior to such disturbance or removal. The area included in this IC is depicted in Figure 11.

- Requirement to maintain the integrity of Site structure concrete slabs and pavement located in areas of COC concentrations above soil – direct contact CULs and two times greater than the unrestricted land use soil – protection of terrestrial environment CULs in order to prevent potential exposure to these COC concentrations by human and terrestrial ecological receptors, respectively. The area included in this IC is depicted in Figure 11.

As discussed in Section 2.4.1.2, the simplified terrestrial ecological evaluation process includes analysis of pathways and contaminants as screening steps in evaluating ecological risk at a site. The evaluation may be ended if there are no potential exposure pathways from soil contamination, and incomplete pathways may be due to the presence of man-made physical barriers, either currently existing or to be placed as part of a remedy or land use. The evaluation may also be ended if a contaminant analysis indicates COCs are not, or will not be present at concentrations above the soil – protection of terrestrial environment CULs, using the statistical compliance methods described in WAC 173-340-740(7). However, per WAC 173-340-740(7)(e), for all data analysis methods used:

- (i) No single sample concentration shall be greater than two times the soil CUL; and,
- (ii) Less than 10 percent of the sample concentrations shall exceed the soil CUL.

The soil removal activities and ICs included in this alternative adequately address current and future risk posed to terrestrial ecological receptors. As discussed in Section 2.6.4.2, a statistical contaminant analysis indicates COCs in uncovered Site soil are below unrestricted land use soil – protection of terrestrial environment CULs. After soil removal activities are completed under this alternative, concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs in uncovered Site soil will be removed to the CPOC (six feet bgs) and less than 10 percent of the remaining soil sample concentrations will be above unrestricted land use soil – protection of terrestrial environment CULs in uncovered Site soil. The pathway for exposure to COC concentrations greater than two times these CULs which will

remain in place after the cleanup action will be incomplete due to the presence of Site structure concrete slabs or pavement.

The soil removal activities and ICs included in this alternative also appear to adequately address current and future risk posed to human health. Per WAC 173-340-740(6)(f), for cleanup actions that involve containment of hazardous substances, the soil CULs will typically not be met at all soil POCs including the POC for soil CULs based on human exposure via direct contact (or other direct contact exposure pathways), soil CULs based on the protection of groundwater, and soil CULs based on ecological considerations. In these cases, the cleanup action may be determined to comply with soil cleanup standards, provided:

- the remedy is permanent to the maximum extent practicable;
- the cleanup action is protective of human health (in which case Ecology may require a site-specific human health risk assessment to demonstrate that the cleanup action is protective of human health);
- ICs are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system;
- the types, levels, and amount of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the draft cleanup action plan; and,
- compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system.

Based on the information presented above and the assumption that each of the requirements presented above will be met as part of the cleanup action, it does not appear that an IC restricting Site land use to industrial is needed for Alternative #4 to achieve soil – direct contact or soil – protection of terrestrial environment CULs.

3.2.5 Alternative #5 (Limited Soil Removal, pH Buffering, ICs)

Alternative #5 includes the same soil removal activities and ICs included in Alternative #4. Like Alternative #4, this alternative also includes establishing a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs. As such, per the information presented in Section 3.2.4 (Alternative #4), the soil removal activities and ICs included in this alternative appear to adequately address current and future risk posed to terrestrial ecological receptors and human health without implementation of an IC restricting Site land use to industrial.

For groundwater, Alternative #5 includes pH buffering of the Site aquifer to increase aquifer pH conditions to levels more typical of natural background conditions so that dissolved COCs will be converted to relatively insoluble carbonates and/or hydroxides. Magnesium hydroxide (pH buffering chemical) will be emplaced in the aquifer via injection into approximately 900 temporary DPT injection wells targeting areas where COCs remain above GW-SW CULs in groundwater. The temporary injection well locations are depicted in Figure 11. The estimated number of DPT injection wells assumes that the injection wells will be spaced 10 ft on-center (using an estimated 5-ft radius of influence) and will be installed within the estimated extents of COC concentrations above GW-SW CULs in accessible on-Site locations.

Alternative #5 also relies on natural attenuation processes for reduction of COC concentrations in groundwater below GW-SW CULs in areas located outside of the injection areas (i.e., in western portions of the Site). H&H assumed that groundwater monitoring will be completed biennially for 30 years to demonstrate reduction of COC concentrations below GW-SW CULs. It is also possible that the groundwater monitoring may be used to demonstrate that the COCs in Site groundwater are not likely to reach surface water (in which case GW-SW CULs would no longer be applicable at the Site, per WAC 173-340-720). Soil cover integrity inspections will be completed during the groundwater monitoring events, then one time every five years after the end of groundwater monitoring. Soil cover maintenance will be completed as needed to maintain cover integrity.

3.2.6 Alternative #6 (Limited Soil Removal, Slurry Wall, ICs)

Alternative #6 includes the same soil removal activities and ICs included in Alternative #4, as well as establishing a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs. As such, per the information presented in Section 3.2.4 (Alternative #4), the soil removal activities and ICs included in this alternative appear to adequately address current and future risk posed to terrestrial ecological receptors and human health without implementation of an IC restricting Site land use to industrial.

For groundwater, Alternative #6 includes installation of SBSWs around portions of the groundwater COC plumes to prevent migration of COCs in Site groundwater toward the Columbia River, and relies on natural attenuation processes for reduction of COC concentrations in groundwater below GW-SW CULs in areas located outside of the SBSWs (i.e., in western portions of the Site). The SBSW locations are depicted in Figure 12. For this alternative, H&H assumed that monitoring of groundwater will be completed once every five years for a period of 200 years to demonstrate reduction of COC concentrations below GW-SW CULs outside of the SBSWs (which is expected to be achieved in a relatively shorter timeframe compared to inside the SBSW), to monitor the long-term effectiveness of the SBSWs at preventing off-Site migration of COCs in groundwater, and to demonstrate Site-wide reduction of COC concentrations in groundwater below GW-HH CULs. Note that H&H assumed that after demonstrating that the COCs in Site groundwater are not likely to reach surface water as a result of the SBSWs, GW-SW CULs will no longer be applicable at the Site (per WAC 173-340-720).

H&H expects that the SBSWs will restrict more favorable geochemical conditions for natural attenuation processes which are present near the river from affecting the upgradient sides of the SBSWs, thus leading to slower decreases in COC concentrations at the Site. As a result, the anticipated restoration time frame for this alternative (200 years) is relatively long compared to other alternatives which rely on natural attenuation only (i.e., Alternatives #7 and #8). Soil cover integrity inspections will be completed during the groundwater monitoring events, then one time every five years after the end of groundwater monitoring period. Soil cover maintenance will be completed as needed to maintain cover integrity.

3.2.7 Alternative #7 (Limited Soil Removal, ICs, Off-Property CPOC)

Alternative #7 includes the same soil removal activities and ICs included in Alternative #4, as well as establishing a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs. As such, per the information presented in Section 3.2.4 (Alternative #4), the soil removal activities and ICs included in this alternative appear to adequately address current and future risk posed to terrestrial ecological receptors and human health without implementation of an IC restricting Site land use to industrial.

Alternative #7 also includes establishing an off-property CPOC for meeting GW-SW CULs. Per WAC 173-340-720(8)(c), where it can be demonstrated under WAC 173-340-350 through 173-340-390 that it is not practicable to meet the CUL throughout a site within a reasonable restoration time frame using all practicable methods of treatment in the site cleanup, Ecology may approve a CPOC that shall be as close as practicable to the source of hazardous substances. Per WAC 173-340-720(8)(d), the CPOC shall not exceed the site property boundary, except under the following three off-property situations:

- Source property abutting surface water;
- Source property near, but not abutting, surface water; or,
- Source property located in an area with “area-wide” contamination.

The Site abuts the Columbia River. WAC 173-340-720(8)(d)(i) includes an extensive list of conditions for approving a CPOC at properties abutting surface water, but this list of conditions is applicable to CPOCs located within the surface water. As is highlighted in Implementation Memorandum No. 16, this rule does not indicate what conditions must be followed in approving a CPOC for properties abutting surface water where the CPOC would be located within groundwater upgradient of the surface water, and the memorandum notes that WAC 173-340-720(8)(d)(i) states that Ecology may approve a CPOC for an abutting property, implying that approval can be given or withheld depending on circumstances.

Assuming that it is adequately demonstrated (by the remedy selection requirements in WAC 173-340-350 through 173-340-390) that it is not practicable to meet GW-SW CULs throughout the Site within a reasonable restoration time frame using all practicable methods of treatment in the Site cleanup, we believe it is reasonable to establish an off-property CPOC in transitional zone groundwater. We believe it is likely that COC concentrations in transitional zone groundwater will decrease to below GW-SW CULs within a reasonable restoration timeframe as a result of natural attenuation processes. The proposed off-property CPOC for this alternative is discussed below. Note that the proposed off-property CPOC for this alternative appears to be consistent with examples of potential off-property CPOCs located in groundwater presented in Implementation Memorandum No. 16.

The off-property CPOC proposed for this alternative is located in transitional zone groundwater along the river shoreline adjacent to the Site. Monitoring of the transitional zone groundwater will be performed using temporary PushPoint groundwater samplers to collect transitional zone groundwater from the approximate locations of the PP-1 through PP-22 locations (depicted in Figures 6A, 6B, and 7) which were sampled during August 2017.

The proposed off-property CPOC is believed to be as close as practicable to the source of COCs in groundwater because of limitations posed by the steeply sloped river bank and rip-rap armoring present on the river bank. We do not believe it is practicable to install permanent groundwater monitoring wells closer to the source of COCs due to restricted accessibility by a drill rig and safety concerns. Furthermore, we do not believe it technically possible to install a well closer to the source of COCs using manual methods (e.g., via a hand auger) because it would not be possible to prevent borehole collapse during well installation. In addition, such a well would be subject to damage from being struck by falling rip-rap or other moving objects (during periods when the river level is above the well elevation) and/or being obscured as a result of rip-rap movement or sedimentation. Finally, the depth of installation of a PushPoint sampler is limited by the available lengths of the samplers from the manufacturer and the lack of rigidity which would be required to advance such a narrow-diameter sampler significantly deeper than three to four ft bgs. As a result, the PushPoint sampler could not be installed a significant distance upgradient of the shoreline.

Transitional zone groundwater samples will be collected from the CPOC during periods of negative tidal elevations relative to the CRD (or, around the dates/times of relatively low predicted river elevations) on an annual basis for a minimum of 20 years. After 20 years, it is assumed that the monitoring will be performed every five years for a period of 80 years. At the time of transitional zone groundwater sample collection, surface water samples will also be collected near multiple PushPoint groundwater sample locations. In addition, on-Site groundwater samples will be collected from a limited number of wells to monitor COC concentrations in groundwater upgradient of the transitional zone groundwater. Soil cover integrity inspections will be completed during the groundwater monitoring events, then one time every five years after the end of groundwater monitoring. Soil cover maintenance will be completed as needed to maintain cover integrity.

This alternative assumes that natural attenuation processes will result in reduction of COC concentrations in Site-wide groundwater below GW-HH CULs in 100 years and below GW-SW CULs at the CPOC in 20 years. Reduction of COC concentrations in Site-wide groundwater below GW-SW CULs would not be accomplished in a reasonable restoration timeframe due to relatively high COC concentrations relative to the GW-SW CULs present in a large portion of the Site groundwater plumes.

As previously mentioned, per WAC 173-340-720, GW-SW CULs are applicable to the Site unless it can be demonstrated that hazardous substances are not likely to reach surface water (and, this demonstration must be based on factors other than implementation of a cleanup action at the Site). As an alternative to establishing an off-property CPOC for meeting GW-SW CULs, it may be possible that monitoring of transitional zone groundwater could be used to demonstrate that COCs associated with the Site are not likely to reach surface water, in which case GW-SW CULs would no longer be applicable to the Site. However, criteria for demonstration that COCs are not likely to reach surface water need to be established.

3.2.8 Alternative #8 (Facility Demolition, Limited Soil Removal, ICs, Off-Property CPOC)

Alternative #8 includes removal of Site structures and pavement as described in Alternative #1, excavation and off-Site disposal of Site soil with concentrations of COCs greater than the unrestricted land use soil – direct contact CULs to the standard POC of 15 ft bgs, removal of soil with concentration of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs, establishing a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs, and implementation of an IC to prevent soil disturbance or excavation from deeper than six feet bgs at the Site unless approved by Ecology (under a cleanup action, if necessary) prior to such soil disturbance or excavation activities. The soil removal areas for this alternative are identified in Figure 13. The soil removal activities and ICs included in this alternative appear to adequately address current and future risk posed to terrestrial ecological receptors and human health without implementation of an IC restricting Site land use to industrial.

Alternative #8 also includes establishing the same off-property CPOC for meeting GW-SW CULs and the same groundwater monitoring included in Alternative #7, and assumes that natural attenuation processes will result in reduction of COC concentrations in Site-wide groundwater below GW-HH CULs in 100 years and below GW-SW CULs at the CPOC in 20 years. Reduction of COC concentrations in Site-wide groundwater below GW-SW CULs would not be accomplished in a reasonable restoration timeframe due to relatively high COC concentrations relative to the GW-SW CULs present in a large portion of the Site groundwater plume. As an alternative to establishing an off-property CPOC for meeting GW-SW CULs, it may be possible that monitoring of transitional zone groundwater could be used to demonstrate that COCs associated with the Site are not likely to reach surface water (in which case GW-SW CULs will no longer be applicable at the Site, per WAC 173-340-720). However, criteria for demonstration that COCs are not likely to reach surface water need to be established in this case.

4.0 Detailed Alternatives Evaluation and Selection of Preferred Alternative

WAC 173-340-360 describes the minimum requirements and procedures for selecting cleanup actions. Per WAC 173-340-360(2), cleanup actions must meet the following minimum threshold requirements:

- (i) Protect human health and the environment;
- (ii) Comply with cleanup standards;
- (iii) Comply with applicable state and federal laws; and,
- (iv) Provide for compliance monitoring.

Each of the eight cleanup action alternatives presented in Section 3.2 appear to meet the minimum threshold requirements. Each alternative is protective of human health and the environment and complies with cleanup standards by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route as discussed in the alternative descriptions (Section 3.2). Note that several of the cleanup action alternatives include containment of hazardous substances; however, it appears that each alternative (if selected as the cleanup action for the Site) would meet the requirements of WAC 173-340-740(6)(f) for compliance with soil cleanup standards. Furthermore, it appears that each cleanup action alternative complies with potentially applicable state and federal laws which are summarized in Table 8. Finally, each of the eight alternatives provide for compliance monitoring as discussed in Section 3.2. As previously mentioned, a compliance monitoring plan will be prepared and submitted to Ecology for review and approval after issuance of the cleanup action plan.

Each of the alternatives addresses anti-degradation requirements of WAC 173-204-120(1)(c) for protection of sediment quality adjacent to the Site by either controlling (i.e., containment by concrete slabs and pavement) or removing COC concentrations above SCOs in Site soil (to a minimum depth of six ft bgs) so that existing surface sediment quality adjacent to the Site is protected from contamination due to soil runoff, slumping, flooding, etc. As previously discussed, the SCOs are appropriate for evaluating freshwater benthic community protection at the Site. Finally, climate change impacts are not expected to pose significant increased risk for

adverse impacts from the Site under any of the cleanup action alternatives. The Washington State RiskMAP Program indicates the Site is adjacent to a regulatory floodway and is not located within an area subject to a 1% annual chance of flooding (i.e., the 100-year floodplain). In addition, the Site is not located in an area prone to landslides, and the river bank adjacent to the Site is stabilized with rip-rap. Finally, depending on the cleanup action alternative, COC impacts in Site soils will either be removed or will be contained by covers which are monitored and maintained into the future. Therefore, the vulnerability of the Site to increased chance of inundation, flooding, and erosion resulting from climate change are believed to be low for all of the cleanup action alternatives.

Per WAC 173-340-360(2)(b), when selecting from cleanup action alternatives that fulfill the threshold requirements listed above, the selected cleanup action shall also:

- (i) Use permanent solutions to the maximum extent practicable;
- (ii) Provide for a reasonable restoration time frame; and,
- (iii) Consider public concerns.

These requirements and evaluation of the alternatives based on the requirements are discussed in the sections below.

4.1 Use of Permanent Solutions to the Maximum Extent Practicable

WAC 173-340-360(3) describes the requirements and procedures for determining whether a cleanup action uses permanent solutions to the maximum extent practicable. Per WAC 173-340-200, a “permanent solution” or “permanent cleanup action” is a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal of any residue from the treatment of hazardous substances. When selecting a cleanup action, preference shall be given to permanent solutions to the maximum extent practicable. Per WAC 173-340-200, “practicable” means capable of being designed, constructed, and implemented in a reliable and effective manner including consideration of cost.

When considering cost, an alternative shall not be considered practicable if the incremental costs of the alternative are disproportionate to the incremental degree of benefits provided by the alternative over other lower cost alternatives.

To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis (DCA) shall be used. The DCA compares the costs and benefits of the cleanup action alternatives evaluated in the FS. Per WAC 173-340-360(3)(e)(i), costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative. Per WAC 173-340-360(3)(e)(ii), the DCA procedure includes the following:

- (A) The alternatives evaluated in the FS shall be ranked from most to least permanent, based on evaluation of the alternative as specified in WAC 173-340-360(3)(f), and the definition of a permanent solution.
- (B) The most practicable permanent solution evaluated in the FS shall be the baseline cleanup action alternative against which cleanup action alternatives are compared. If no permanent solution has been evaluated in the FS, the cleanup action alternative evaluated in the feasibility study that provides the greatest degree of permanence shall be the baseline cleanup action alternative.
- (C) The comparison of benefits and costs may be quantitative but will often be qualitative and require the use of best professional judgment.

Per WAC 173-340-360(3)(f), the criteria below shall be used to evaluate and compare each cleanup action alternative when conducting a DCA to determine whether a cleanup action is permanent to the maximum extent practicable.

- (i) Protectiveness: overall protectiveness of human health and the environment (including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality);

- (ii) Permanence: degree to which the toxicity, mobility, or volume of hazardous substances is permanently reduced (including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated);
- (iii) Cost: the cost of alternative implementation (including the cost of construction, the net present value of any long-term operations, maintenance, monitoring, and IC costs, and agency oversight costs that are cost recoverable);
- (iv) Long-term effectiveness: the degree of certainty for success of the alternative, the reliability of the alternative while concentrations of hazardous substances above CULs remain, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining waste;
- (v) Management of short-term risks: the risk to human health and the environment associated with construction and implementation of the alternative, and the effectiveness of measures that will be taken to manage such risks;
- (vi) Technical and administrative implementability: ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions; and,
- (vii) Consideration of public concerns: the extent to which the alternative addresses potential concerns the community may have regarding the alternative. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site.

Except for cost, the criteria listed above are hereafter referred to as benefits criteria. A DCA of the eight cleanup action alternatives presented in Section 3.2 was performed to determine whether a cleanup action uses permanent solutions to the maximum extent practicable. The DCA methods and conclusions are presented in the sections below.

4.1.1 DCA Benefits and Costs Determination

The DCA of the eight cleanup action alternatives presented in Section 3.2 was completed by determining a benefits ranking score and estimated cost for each alternative, then comparing the benefits and costs of the alternatives. The benefits ranking score for each alternative was determined by assigning a benefits criterion ranking of one to eight for each of the benefits criteria (i.e., the criteria presented in Section 4.1 above except cost) to each of the alternatives, then summing the benefits criterion rankings for each alternative. The assignment of benefits criterion rankings is based on a comparison of how well the alternative satisfies each benefits criterion relative to the other alternatives. An assigned benefits criterion ranking of one indicates that the alternative satisfies the individual benefit criterion to a lower degree than the remaining seven alternatives, whereas an assigned ranking of eight indicates that the alternative satisfies the individual benefit criterion to a higher degree than the remaining seven alternatives.

The benefits criterion rankings and the total benefits ranking scores for each alternative are presented in Table 9. Estimated cost details (including notes and assumptions) for the alternatives are presented in Table 10. Assignment of benefits criteria rankings to the cleanup action alternatives for each of the benefits criterion is discussed in the sections below.

4.1.1.1 Protectiveness Criterion Rankings

The protectiveness criterion refers to the overall protectiveness of human health and the environment provided by the cleanup action alternative and takes into account the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-Site and off-Site risks resulting from implementing the alternative, and improvement of the overall environmental quality. Please note that each of the eight cleanup action alternatives is protective of human health and the environment; however, the alternatives satisfy the protectiveness criterion to varying degrees.

Alternatives #1, #2, and #3 were assigned the highest rankings (7, 8, and 6, respectively) because these alternatives reduce risks and attain cleanup standards in the shortest timeframe and remove

soil with COC concentrations above soil – direct contact and protection of terrestrial environment cleanup standards. Except for Alternative #8, the other alternatives rely on ICs to address these cleanup standards. (Each alternative includes removal of uncovered soil with COC concentrations above protection of the terrestrial environment cleanup standards.) Alternatives #1 and #2 are ranked higher than Alternative #3 because the alternatives also remove soil with COC concentrations above soil – protection of groundwater cleanup standards, whereas Alternative #3 relies on ISS to address the source of COC impacts in groundwater. Alternative #2 was assigned a higher ranking than Alternative #1 because of the potential risk of release of COCs to the environment due to failure of above ground recovery system components.

Alternatives #4 and Alternative #5 were assigned the next highest rankings (5 and 4, respectively) because these alternatives include active measures to address COC concentrations in groundwater (which are considered less reliable than use of ISS as part of Alternative #3), whereas Alternatives #6, #7, and #8 rely on natural attenuation processes for reduction of COC concentrations in groundwater. Alternative #4 was assigned a higher ranking than Alternative #5 because it includes COC mass removal from groundwater whereas Alternative #5 relies on pH adjustment for immobilizing COCs in groundwater. Therefore, it is more likely that the potential risk posed to surface water by COCs in Site groundwater would be lower for Alternative #4 over the long term.

Alternatives #6, #7, and #8 were assigned the lowest rankings for protectiveness (2, 1, and 3, respectively). Although Alternative #6 reduces potential risk posed to surface water by COCs in Site groundwater in a shorter timeframe than Alternative #8, such risk is believed to be very low for all of the alternatives; therefore, Alternative #8 was assigned a higher ranking than Alternative #6 because it includes removal of soil with COC concentrations above soil – direct contact and protection of terrestrial environment cleanup standards, and is expected to achieve groundwater cleanup standards in a shorter timeframe than Alternative #6. Alternative #7 was assigned the lowest protectiveness ranking because it does not include soil removal (except removal of uncovered soil with COC concentrations above protection of the terrestrial environment cleanup standards) or active measures to reduce the low risk posed to surface water by COC concentrations in Site groundwater.

4.1.1.2 Permanence Criterion Rankings

The permanence criterion is evaluated based on the degree to which the toxicity, mobility, or volume of hazardous substances is permanently reduced (including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated). The permanence criterion is closely correlated with the protectiveness criterion, and the permanence criterion rankings for the alternatives are the same as those assigned to each alternative for the protectiveness criterion.

Alternatives #1, #2, and #3 were assigned the highest rankings (8, 7, and 6, respectively) because these alternatives reduce the toxicity, mobility, and/or volume of COCs to a greater degree than the other alternatives. Each of these three alternatives significantly reduces the mobility and/or volume of hazardous substances in Site soil and groundwater; however, Alternative #3 utilizes ISS which is subject to potential reversibility over the long term, and was therefore assigned the lowest ranking of the three alternatives. Alternative #2 was assigned a higher ranking than Alternative #1 because of the quantity of groundwater generated by the groundwater P&T system included in Alternative #1 and because of the low anticipated likelihood of pH adjustment reversibility resulting in persistence of COC concentrations above groundwater cleanup standards.

Alternatives #4 and Alternative #5 were assigned the next highest rankings (5 and 4, respectively) because the alternatives include active measures to reduce the mobility and/or volume of COCs in groundwater, whereas Alternative #6 relies on a SBSW to limit mobility of COCs in groundwater towards surface water, but does not actively reduce the mobility or volume of COCs in Site groundwater located upgradient of the SBSW, and Alternatives #7 and #8 rely on natural attenuation processes for reduction of COC mobility in groundwater. Alternative #4 was assigned a higher ranking than Alternative #5 because it includes COC mass removal from groundwater whereas Alternative #5 relies on pH adjustment (which is potentially subject to reversibility) for immobilizing COCs in groundwater.

Alternatives #6, #7, and #8 were assigned the lowest rankings (2, 1, and 3, respectively). Alternative #8 was assigned the highest ranking of these three alternatives because it includes a greater degree of reduction of COC volume as a result of soil removal than the other two alternatives. Alternative #6 was assigned a higher ranking than Alternative #7 because it utilizes a SBSW to reduce mobility of COCs in groundwater towards surface water. Alternative #7 includes reduction of COC mobility as a result of natural attenuation processes, but does not include active measures to reduce COC toxicity, mobility, or volume (except for removal of uncovered soil with COC concentrations above protection of the terrestrial environment cleanup standards).

4.1.1.3 Long-Term Effectiveness Criterion Rankings

The long-term effectiveness criterion is evaluated based on the degree of certainty for success of the alternative, the reliability of the alternative while concentrations of hazardous substances above CULs remain, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining waste. The long-term effectiveness criterion is closely correlated with the protectiveness and permanence criteria, and the long-term effectiveness criterion rankings for the alternatives are similar to those assigned to the alternatives for the protectiveness and permanence criteria (presented above).

Alternatives #1, #2, and #3 were assigned the highest rankings (8, 7, and 6, respectively) because the three alternatives provide a significantly higher degree of certainty for success and long-term reliability than the other alternatives. These alternatives include removal of soil with COC concentrations above soil – direct contact and protection of terrestrial environment cleanup standards and address COC concentrations in groundwater using active measures. Except for Alternative #8, the other alternatives rely on ICs to address these soil cleanup standards. (Each alternative includes removal of uncovered soil with COC concentrations above protection of the terrestrial environment cleanup standards.) These ICs inherently provide a lesser degree of certainty for success and long-term reliability than soil removal. Alternatives #1 and #2 are ranked higher than Alternative #3 because these two alternatives also remove soil with COC concentrations above soil – protection of groundwater cleanup standards, whereas Alternative #3

relies on ISS to address the source of COC impacts in groundwater and there is potential long-term reliability risk with ISS reversibility. Alternative #1 was assigned a higher ranking than Alternative #2 because it includes COC mass removal from groundwater whereas Alternative #2 relies on pH adjustment for immobilizing COCs in groundwater.

Alternatives #4 and Alternative #5 were assigned the next highest rankings (5 and 4, respectively) because the alternatives include active measures to address COC concentrations in groundwater (which are considered less reliable than use of ISS as part of Alternative #3), whereas Alternatives #6, #7, and #8 rely on natural attenuation processes for reduction of COC concentrations in groundwater (which has less certainty for success than the active measures). Alternative #4 was assigned a higher ranking than Alternative #5 because it includes COC mass removal from groundwater whereas Alternative #5 relies on pH adjustment for immobilizing COCs in groundwater. Mass removal is considered to provide a higher degree of certainty for success and long-term reliability than pH adjustment.

Alternatives #6, #7, and #8 were assigned the lowest rankings (1, 2, and 3, respectively). Alternative #8 was assigned a higher ranking than Alternatives #6 and #7 because it includes removal of soil with COC concentrations above soil – direct contact and protection of terrestrial environment cleanup standards, whereas the other alternatives rely on ICs to address these soil cleanup standards. Although Alternative #6 reduces potential risk posed to surface water by COCs in Site groundwater in a shorter timeframe than Alternative #7; however, there is uncertainty associated with the effectiveness of a SBSW over the long term. In addition, Alternative #7 and is expected to achieve groundwater cleanup standards in a shorter timeframe than Alternative #6. Therefore, Alternative #7 was assigned a higher ranking than Alternative #6.

4.1.1.4 Management of Short-Term Risks Criterion Rankings

The management of short-term risks criterion is evaluated based on the degree of the risk to human health and the environment associated with construction and implementation of the alternative, and the effectiveness of measures that will be taken to manage such risks.

Alternatives #1, #2, #3, and #8 were assigned the lowest rankings (2, 1, 3, and 4, respectively) because of the relatively higher risks posed to workers by facility demolition hazards and potential exposure to COC concentrations in shallow soil located beneath the Site structures and pavement. The other alternatives do not include facility demolition. Alternatives #1 and #2 were assigned the lowest rankings of these alternatives because of the relatively higher inherent risks posed to workers by excavation of soil to greater depths than Alternatives #3 and #8, including from beneath the water table. Alternative #2 was assigned a lower ranking than Alternative #1 because of the risk to workers from handling pH adjustment chemicals, and Alternative #3 was assigned a lower ranking than Alternative #8 because of the risk to worker from handling ISS chemicals and from ISS blending equipment operations.

Alternatives #4, #5, #6, and #7 were assigned rankings of 5, 6, 7, and 8, respectively. Alternative #4 was assigned the lowest ranking of these alternatives due to the potential risk of release of COCs to the environment due to failure of above ground P&T system components. Alternative #5 was assigned a lower ranking than Alternative #6 due to the risk to workers associated with the handling of pH adjustment chemicals. Alternative #7 was assigned the highest ranking because it poses the lowest risk to workers while not posing higher short-term risk to the environment than Alternatives #4, #5, and #6.

4.1.1.5 Implementability Criterion Rankings

The technical and administrative implementability criterion takes into consideration the technical possibility of alternative implementation, availability of necessary off-Site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.

Alternatives #1, #2, #3, and #8 were assigned the lowest rankings (1, 2, 4, and 3, respectively) because each of these alternatives require approval by the Site property and facility owner for demolition of facility structures, whereas the other alternatives do not include demolition of facility structures. Alternatives #1 and #2 were assigned the lowest rankings of these four

alternatives because of the technical challenges associated with deep excavation of soil below the water table, and Alternative #1 was assigned a lower ranking than Alternative #2 because it requires approval and permitting for discharge of recovery system effluent to the POTW and due to the relatively higher complexity of recovery system operation. Alternative #8 was assigned a lower ranking than Alternative #3 because it includes an off-property CPOC which will need to be approved by Ecology, and the administrative requirements for approval of the CPOC may be difficult to meet.

Alternatives #4, #5, #6, and #7 were assigned rankings of 5, 8, 7, and 6, respectively. Alternative #4 was assigned the lowest ranking of these alternatives due to the complexity of P&T system, and Alternative #7 was assigned a lower ranking than Alternatives #5 and #6 due to the potential difficulty of meeting administrative requirements for approval of the off-property CPOC included in the alternative. Alternatives #5 and #6 were assigned the highest rankings because these alternatives do not include significant implementation challenges relative to the other alternatives. Alternative #5 was assigned the highest ranking because of the relatively lower anticipated challenges associated with DPT injection (included in Alternative #5) versus those associated with installation of a SBSW (included in Alternative #6).

4.1.1.6 Consideration of Public Concerns Criterion Rankings

The consideration of public concerns criterion is evaluated based on the extent to which the alternative addresses potential concerns the community may have regarding the alternative. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. The consideration of public concerns criterion is closely correlated with the protectiveness criterion because it is anticipated that the public concerns associated with the cleanup action alternatives evaluated in this FS will primarily be tied to the perceived overall protectiveness of the alternatives. Therefore, the consideration of public concerns criterion rankings for the alternatives are the same as those assigned to each alternative for the protectiveness criterion.

4.1.2 DCA Evaluation and Conclusions

Benefits ranking scores and estimated cleanup action costs are presented in Table 9. Table 9 also presents a benefit to cost ratio (i.e., the benefits ranking score divided by the cost in millions of dollars) for each alternative. As shown in Table 9, the benefit to cost ratios for the alternatives range from 1.1 (Alternative #4) to 29.8 (Alternative #7). Alternatives #1, #2, #3, and #4 have the lowest benefit to cost ratios (2.2, 2.5, 3.0, and 1.1, respectively), and Alternatives #5, #6, #7, and #8 have the highest benefit to cost ratios (8.6, 14.8, 29.8, and 5.6, respectively). A comparison of the benefits and costs of the cleanup action alternatives using the benefit to cost ratios indicates that Alternative #7 provides a significantly higher degree of benefit relative to cost of the seven alternatives.

Table 9 also presents benefits ranking score factors for each alternative relative to Alternative #7 (i.e., the benefits ranking score of the alternative divided by the benefits ranking score for Alternative #7), and cost factors for each alternative relative to Alternative #7 (i.e., the cost of the alternative divided by the cost of Alternative #7). These factors are indicative of the incremental degree of benefit and the incremental cost of an alternative relative to Alternative #7. As previously mentioned, Alternative #7 has the lowest benefits ranking score and the lowest estimated cost of the eight alternatives. A review of the benefits ranking score and cost factors presented in Table 9 indicates that the incremental cost of each individual alternative over that of Alternative #7 exceeds the incremental degree of benefits achieved by the same individual alternative over that of Alternative #7. (For example, the incremental cost of Alternative #6 is a factor of 2.2 over Alternative #7 whereas the incremental benefit of Alternative #6 is a factor of 1.1 over Alternative #7.) As such, this analysis indicates that the cost of each alternative other than Alternative #7 is disproportionate to the benefits of the same alternative.

As previously discussed, when considering cost, an alternative shall not be considered practicable if the incremental cost of the alternative is disproportionate to the incremental degree of benefits provided by the alternative over other lower cost alternatives. Based on the information presented above, the DCA indicates that Alternative #7 is practicable. As such, based upon the DCA, Alternative #7 is considered the preferred alternative.

4.2 Reasonable Restoration Timeframe

WAC 173-340-360(4) describes the procedures for determining whether a cleanup action provides for a reasonable restoration time frame. Per WAC 173-340-360(4)(b), to determine whether a cleanup action provides for a reasonable restoration time frame, the factors to be considered include:

- (i) Potential risks posed by the site to human health and the environment;
- (ii) Practicability of achieving a shorter restoration time frame;
- (iii) Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
- (iv) Potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
- (v) Availability of alternative water supplies;
- (vi) Likely effectiveness and reliability of ICs;
- (vii) Ability to control and monitor migration of hazardous substances from the site;
- (viii) Toxicity of the hazardous substances at the site; and
- (ix) Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

As previously discussed, potential risks posed by the Site to human health and the environment during or after implementation of the cleanup action alternatives evaluated as part of this FS are low. The Site is located in the Port of Kalama Industrial area, is surrounded to the north, east, and south by parcels owned by the Port of Kalama which are zoned commercial and are either largely undeveloped or developed with roadways or rail spur lines. In addition, land to the east of the Site (east of the parcel developed with Hendrickson Drive) is developed with an active railroad corridor owned by Burlington Northern, Inc. The Site is connected to municipal water service, and the properties surrounding the Site are located within an area serviced by municipal water service. Furthermore, based on the extents of the groundwater plumes associated with the Site and transport mechanisms which limit migration of the Site COCs in the aquifer, it does not appear that COCs in Site groundwater pose a potential risk to human health on off-Site

properties where potable wells could be installed in the future. Future use of the Site and surrounding off-Site properties is not expected to change significantly.

Each of the alternatives provides protection against exposure to COCs in Site soil by humans and ecological receptors. Several of the alternatives (including the preferred Alternative #7) rely on ICs to prevent exposure to COCs in Site soil, and all of the alternatives include an IC to prevent use of Site groundwater for potable purposes. These ICs will be included in a legally-binding restrictive covenant which shall run with the land. Routine checks, inspections, and maintenance activities which will be included in the cleanup action plan and/or associated compliance monitoring plan will be completed (as appropriate) to confirm compliance with the ICs. Therefore, it is anticipated that these ICs will be effective and reliable in the future.

Zinc concentrations have been detected at relatively low levels in transitional zone groundwater near the Columbia River adjacent to the Site; however, COCs associated with the Site have not been detected in surface water samples collected from the river. It is unlikely that COCs in Site groundwater have the potential to measurably affect surface water quality due to the low rate of COC mass migration toward the river resulting from transport mechanisms which limit migration of the Site COCs in the aquifer, and due to the effects of COC dilution and dispersion within transitional zone groundwater near the groundwater-surface water interface. Each of the alternatives significantly reduces the potential for COCs in Site groundwater to adversely affect surface water quality and/or provides for monitoring to confirm that COCs in Site groundwater do not adversely affect surface water quality in the future.

Restoration timeframe is the period of time needed to achieve the cleanup standards established for a site. As previously discussed, each of the eight cleanup action alternatives evaluated as part of the FS are expected to comply with cleanup standards. However, demonstration that COCs in Site groundwater are not likely to reach surface water is needed for Alternatives #6, #7, and #8 (and, possibly Alternatives #4 and #5) so that GW-SW CULs will no longer be applicable to the Site. Alternatives #6, #7, and #8 are not expected to result in reduction of COC concentrations below GW-SW CULs throughout the Site within a reasonable restoration timeframe, but are expected to result in reduction of COC concentrations below the relatively higher GW-HH CULs

throughout the Site within a reasonable restoration timeframe. Alternatives #6, #7, and #8 are expected to have the longest restoration timeframes (200, 100, and 100 years, respectively). Alternatives #1, #2, and #3 are expected to have the shortest restoration timeframes (approximately 10 years), followed by Alternatives #4 and #5 (30 years). However, based on the results of the DCA, it is not considered practicable to achieve these relatively shorter restoration timeframes, and it is not practicable to meet GW-SW CULs throughout the Site within a reasonable restoration time frame using all practicable methods of treatment in the Site cleanup.

The estimated restoration timeframes for the alternatives are uncertain, particularly for the alternatives with relatively longer estimated restoration time frames that rely on natural attenuation of COC concentrations to achieve groundwater cleanup standards. Natural attenuation processes are expected to reduce COC concentrations in Site groundwater, particularly as generally widespread low pH conditions in the Site aquifer increase to levels consistent with natural background levels. Based on soil, groundwater, surface water, and sediment data from the Site, it appears that migration of relatively high COC concentrations in Site groundwater toward the river is retarded by immobilization of COCs in the aquifer via absorption and precipitation processes and/or conversion to insoluble and immobile compounds in the aquifer between the western portions of the Site and the Columbia River (where relatively high pH and oxidizing conditions are present). In addition, the temporal mound in the groundwater table near the river appears to cause groundwater in the central portion of the Site (where maximum COC concentrations are located) to be temporally stagnant, further reducing the rate of COC mass migration toward the river and the natural attenuation processes which are expected to increase aquifer pH and decrease COC concentrations in groundwater.

Based on the information presented above, the preferred cleanup action alternative (Alternative #7) provides for a reasonable restoration timeframe.

4.3 Consideration of Public Concerns

Public participation is an integral part of Ecology's responsibilities under MTCA. Ecology's goal is to provide the public with timely information and meaningful opportunities for

participation that are commensurate with the Site. Ecology will meet this goal through a public participation program that includes (as determined necessary): development of a Site-specific public participation plan; the provision of public notices; a site register; public meetings or hearings; and the participation of regional citizens' advisory committees. In order to promote effective and meaningful public participation, Ecology will evaluate public participation needs at the Site and may determine that public participation opportunities are appropriate and should be provided.

Whenever public notice is required by chapter 70.105D RCW, Ecology shall, at a minimum, provide or require notice as described in WAC 173-340-600(4). In addition to any required public notice, Ecology may provide information to the public through press releases, fact sheets, public meetings, publications, personal contact by Ecology employees, posting signs at the facility, notice in a publication called the *Site Register*, notice through the internet, etc. Ecology shall regularly publish, make available electronically, and maintain the *Site Register* in order to provide notice of the items in WAC 173-340-600(7)(a-q). In addition to any other applicable public participation requirements, Ecology shall provide a notice of availability of draft or final cleanup action plans and a brief description of the proposed or selected alternative in the *Site Register* and provide public notice of the draft cleanup action plan. At a minimum, the public notice shall briefly describe the Site, identify Ecology's proposed cleanup action and provide an explanation for its selection, and invite public comment on the draft cleanup action plan. The public comment period shall run for at least 30 days from the date of publication of the public notice. In addition, whenever the cleanup action plan proposes a restrictive covenant as part of the draft cleanup plan, Ecology shall provide notice to and seek comments from the city or county department with land use planning authority for real property subject to the restrictive covenant. The purpose of this notification is to solicit comment on whether the proposed restrictive covenant is consistent with current or proposed land use plans.

5.0 Preferred Cleanup Action Alternative

Eight cleanup action alternatives were developed and evaluated as part of this FS to address concentrations of cadmium and zinc in soil and groundwater at the Chemtrade Performance Chemicals US LLC Site. Based upon the evaluation of the alternatives presented in Section 4.0, Alternative #7 is the preferred cleanup action alternative for the Site. Alternative #7 meets the minimum threshold requirements of WAC 173-340-360 for a cleanup action, uses permanent cleanup solutions to the maximum extent practicable, provides for a reasonable restoration timeframe, and considers public concerns. Below is a list of the items included in the proposed Alternative #7 cleanup action.

- Establishment of a CPOC extending to six feet bgs for soil – protection of terrestrial environment CULs in order to eliminate the need to remove uncovered Site soils with concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs located deeper than six feet bgs. Per WAC 173-340-7490(4)(a), for sites with ICs to prevent excavation of deeper soil, a CPOC for soil – protection of terrestrial environment cleanup standards may be set at the biologically active soil zone which is assumed to extend to a depth of six feet bgs.
- Excavation and off-Site disposal of approximately 700 cubic yards of uncovered Site soils with concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs. The estimated horizontal extent of the uncovered soil which will be removed to a depth of six feet bgs is depicted in Figure 11.
- The following ICs which will be implemented in accordance with the requirements of WAC 173-340-440, and which shall remain effective in perpetuum unless the conditions at the Site requiring the IC no longer exist, the property owner submits a request to Ecology for removal of the IC, and Ecology approves the request.
 - An IC preventing use of Site groundwater for potable purposes.

- An IC preventing soil disturbance or excavation below six feet bgs at the Site unless approved by Ecology (under a cleanup action, if necessary) prior to such soil disturbance or excavation activities.

- An IC preventing disturbance or removal of those portions of existing Site structure concrete slabs or pavement located over areas of COC concentrations above soil – direct contact CULs and two times greater than soil – protection of terrestrial environment CULs, unless approved by Ecology (under a cleanup action, if necessary) prior to such disturbance or removal. The area included in this IC is depicted in Figure 11.

- An IC requiring maintenance of the integrity of Site structure concrete slabs and pavement located over areas of COC concentrations above soil – direct contact CULs and two times greater than the unrestricted land use soil – protection of terrestrial environment CULs in order to prevent potential exposure to these COC concentrations by human and terrestrial ecological receptors, respectively. The area included in this IC is depicted in Figure 11.

The ICs will be included in a legally-binding restrictive covenant which shall run with the land.

- Routine checks, inspections, and maintenance activities to confirm compliance with the ICs presented above. Inspection of concrete slabs and pavement to remain in place over impacted soil will be completed during groundwater sampling events, and once every five years after termination of groundwater sampling events. Maintenance activities will be completed as needed to maintain cover integrity. Details for these activities will be included in the cleanup action plan and/or associated compliance monitoring plan.

- Establishment of an off-property CPOC for meeting GW-SW CULs. The off-property CPOC proposed for this alternative is located in transitional zone groundwater along the river shoreline adjacent to the Site. Monitoring of the transitional zone groundwater will

be performed using temporary PushPoint groundwater samplers to collect transitional zone groundwater from the approximate locations of the PP-1 through PP-22 locations (depicted in Figures 6A, 6B, and 7) which were sampled during August 2017. Refer to Section 3.2.7 for a discussion of the rationale and support for establishing this off-property CPOC. If it is not possible to establish an off-property CPOC for meeting GW-SW CULs, it may be possible that monitoring of transitional zone groundwater could be used to demonstrate that COCs associated with the Site are not likely to reach surface water (in which case GW-SW CULs will no longer be applicable at the Site, per WAC 173-340-720). However, criteria for demonstration that COCs are not likely to reach surface water need to be established in this case.

- Transitional zone groundwater and surface water monitoring on an annual basis for a minimum of 20 years to confirm COC concentrations are below GW-SW CULs at the off-property CPOC and that COCs in groundwater do not adversely affect surface water quality. During these annual events, groundwater samples will also be collected from select on-Site wells to evaluate COC concentrations upgradient of transitional zone groundwater. If COC concentrations are demonstrated to be below GW-SW CULs at the off-property CPOC for a minimum of five consecutive years, or demonstrated to not likely reach surface water, the groundwater and surface water monitoring frequency will be reduced to once every five years starting no earlier than 20 years after implementation of the cleanup action plan. Monitoring will then be completed once every five years until COC concentrations in on-Site groundwater are demonstrated to be less than GW-HH CULs. Transitional zone groundwater and surface water sampling will be continued during this period to demonstrate that COCs remain below GW-SW CULs at the CPOC, or that COC concentrations are not likely to reach surface water. Detail of the monitoring activities will be included in the cleanup action plan and/or associated compliance monitoring plan.

The soil removal activities and ICs included in this cleanup action adequately address current and future risk posed to terrestrial ecological receptors. As discussed in Section 2.6.4.2, a statistical contaminant analysis indicates COCs in uncovered Site soil are below unrestricted land

use soil – protection of terrestrial environment CULs. After soil removal activities are completed under this alternative, concentrations of COCs greater than two times the unrestricted land use soil – protection of terrestrial environment CULs in uncovered Site soil will be removed to the CPOC (six feet bgs) and less than 10 percent of the remaining soil sample concentrations will be above unrestricted land use soil – protection of terrestrial environment CULs in uncovered Site soil. Thereafter, the pathway for exposure to COC concentrations greater than two times these CULs will be incomplete due to the presence of Site structure concrete slabs or pavement.

The soil removal activities and ICs included in this alternative will adequately address current and future risk posed to human health. Per WAC 173-340-740(6)(f), for cleanup actions that involve containment of hazardous substances, the soil CULs will typically not be met at all soil POCs including the POC for soil CULs based on human exposure via direct contact (or other direct contact exposure pathways), soil CULs based on the protection of groundwater, and soil CULs based on ecological considerations. In these cases, the cleanup action may be determined to comply with soil cleanup standards, provided:

- the remedy is permanent to the maximum extent practicable;
- the cleanup action is protective of human health;
- ICs are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system;
- the types, levels, and amount of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the draft cleanup action plan; and,
- compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system.

Because each of the requirements presented above will be met by the proposed cleanup action alternative, an IC restricting Site land use to industrial does not appear warranted to achieve soil – direct contact or soil – protection of terrestrial environment CULs.

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Table 1
Summary of Site Well Construction Details
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Installation Date	Well Diameter (inches)	Total Depth (ft bgs)	Screen Interval (ft bgs)	TOC Elevation (ft CRD)
Monitor Wells					
PZ1	04/15/03	1	32	17-32	28.99
PZ2	04/15/03	1	32	17-32	30.16
PZ3	04/15/03	1	32	17-32	28.47
PZ4	04/15/03	1	32	17-32	26.78
PZ5	04/16/03	1	32	17-32	26.86
PZ6	04/16/03	1	32	17-32	27.58
PZ7	04/16/03	1	31	16-31	28.06
PZ8	04/16/03	1	31	15.5-30.5	28.17
PZ9	05/06/03	1	32	17-32	27.54
PZ10	07/26/05	0.75	32	17-32	26.94
PZ11	07/27/05	0.75	32	17-32	30.39
PZ12	07/27/05	0.75	32	17-32	30.53
PZ13	07/27/05	0.75	30	15-30	30.40
PZ14	02/06/07	0.75	32	17-32	29.09
PZ15	02/06/07	0.75	32	17-32	27.79
AB1	07/01/03	2	28	14.1-28.2	27.53
AB2	07/01/03	2	30	14.4-30.0	28.41
OW1	09/20/10	2	35	20-35	26.51
OW2	09/20/10	2	35	20-35	25.99
OW3	09/20/10	2	35	20-35	26.13
Injection Wells					
IW-1	09/22/10	2	30	20-30	NS
IW-2	09/22/10	2	30	20-30	NS
IW-3	09/24/10	2	30	20-30	NS
IW-4	09/24/10	2	30	20-30	NS
IW-5	09/21/10	2	35	25-35	NS
IW-6	09/21/10	2	35	25-35	NS
IW-7	09/22/10	2	35	23-35	NS
IW-8	09/22/10	2	35	25-35	NS
IW-9	09/24/10	2	35	25-35	NS
IW-10	09/17/10	2	35	25-35	NS
IW-11	09/21/10	2	35	25-35	NS
IW-12	09/21/10	2	35	25-35	NS
IW-13	09/15/10	2	30	20-30	NS
IW-14	09/14/10	2	30	20-30	NS
IW-15	09/13/10	2	30	20-30	NS
IW-16	09/13/10	2	30	20-30	NS
IW-17	09/14/10	2	30	20-30	NS
IW-18	09/14/10	2	30	20-30	NS
IW-19	09/14/10	2	30	20-30	NS
IW-20	09/13/10	2	30	20-30	NS
IW-21	09/15/10	2	35	25-35	NS
IW-22	09/15/10	2	30	20-30	NS
IW-23	09/17/10	2	35	25-35	NS
Extraction Wells					
EW-1	09/26/11	8	35	10-35	NS
EW-2	12/05/11	8	35	10-35	NS
EW-3	12/06/11	8	35	10-35	NS
EW-4	12/06/11	8	35	10-35	NS
EW-5	12/07/11	8	35	10-35	NS
EW-6	12/07/11	8	35	10-35	NS
EW-7	12/05/11	8	35	10-35	NS

Notes:

ft bgs = feet below ground surface

ft CRD = elevation in ft relative to Columbia River Datum

TOC = Top of Casing; NS = not surveyed

Survey of well elevations based on NAVD88 and adjusted to CRD by subtracting 3.8 ft

OW1 through OW3 TOC elevations have not been surveyed

Depth and screen interval of AB1 and AB2 account for 45° and 35° angles of installation relative to vertical, respectively.

Table 2
Summary of Groundwater Elevation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Date Measured	TOC Elevation ¹ (ft CRD)	Depth to Water (ft below TOC)	Water Elevation ¹ (ft CRD)	Time Measured	High (CRD) ²		Low (CRD) ²	
						Time	Elevation (ft)	Time	Elevation (ft)
PZ1	02/04/10	28.99	23.65	5.34	8:29 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ1	09/01/10		26.84	2.15	9:54 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ1	11/02/10		25.50	3.49	11:19 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75
PZ1	12/20/10		22.68	6.31	11:13 a.m.	--	--	10:09 a.m.	4.25
PZ1	12/20/10		21.74	7.25	2:25 p.m.	2:27 p.m.	7.11	--	--
PZ1	03/21/11		21.64	7.35	3:52 p.m.	--	--	2:15 p.m.	4.77
PZ1	03/23/11		21.34	7.65	8:32 a.m.	7:18 a.m.	7.27	--	--
PZ1	06/21/11		18.43	10.56	3:17 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ1	06/22/11		18.49	10.50	8:20 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
PZ1	09/23/11		26.97	2.02	8:45 a.m.	--	--	9:06 a.m.	-0.73
PZ1	09/28/11		25.31	3.68	3:25 p.m.	5:27 p.m.	4.72	--	--
PZ1	01/12/12		24.59	4.40	8:26 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
PZ1	03/20/12		20.72	8.27	9:30 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
PZ1	06/26/12		19.87	9.12	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
PZ1	10/31/12		24.11	4.88	1:20 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
PZ1	05/31/13		21.99	7.00	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
PZ1	08/27/13		25.68	3.31	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
PZ1	12/19/13		25.31	3.68	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
PZ1	01/07/15		23.32	5.67	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
PZ1	08/07/17		25.06	3.93	9:45 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03
PZ2	02/04/10	30.16	24.74	5.42	9:05 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ2	09/01/10		28.04	2.12	9:51 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ2	12/20/10		23.86	6.30	11:28 a.m.	--	--	10:09 a.m.	4.25
PZ2	12/20/10		22.80	7.36	2:34 p.m.	2:27 p.m.	7.11	--	--
PZ2	03/21/11		22.86	7.30	4:06 p.m.	--	--	2:15 p.m.	4.77
PZ2	03/23/11		22.44	7.72	8:41 a.m.	7:18 a.m.	7.27	--	--
PZ2	06/21/11		19.67	10.49	3:33 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ2	06/22/11		19.72	10.44	8:06 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
PZ2	09/23/11		28.24	1.92	8:45 a.m.	--	--	9:06 a.m.	-0.73
PZ2	09/28/11		26.52	3.64	3:25 p.m.	5:27 p.m.	4.72	--	--
PZ2	01/12/12		25.78	4.38	8:42 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
PZ2	03/20/12		21.92	8.24	9:28 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
PZ2	06/26/12		21.02	9.14	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
PZ2	10/31/12		23.61	6.55	2:18 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
PZ2	05/31/13		23.21	6.95	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
PZ2	08/27/13		26.82	3.34	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
PZ2	12/19/13		26.45	3.71	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
PZ2	01/07/15		24.62	5.54	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
PZ2	08/07/17		26.85	3.31	9:23 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03
PZ3	02/04/10		28.47	22.99	5.48	9:19 a.m.	7:39 a.m.	5.47	2:45 p.m.
PZ3	09/01/10	26.30		2.17	09:45 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ3	11/02/10	24.55		3.92	11:59 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75
PZ3	12/20/10	22.08		6.39	11:32 a.m.	--	--	10:09 a.m.	4.25
PZ3	12/20/10	20.96		7.51	2:38 p.m.	2:27 p.m.	7.11	--	--
PZ3	03/21/11	20.98		7.49	4:34 p.m.	--	--	2:15 p.m.	4.77
PZ3	03/23/11	20.70		7.77	9:07 a.m.	7:18 a.m.	7.27	--	--
PZ3	06/21/11	17.96		10.51	3:38 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ3	06/22/11	18.01		10.46	7:45 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
PZ3	09/23/11	26.66		1.81	8:45 a.m.	--	--	9:06 a.m.	-0.73
PZ3	09/28/11	24.66		3.81	3:25 p.m.	5:27 p.m.	4.72	--	--
PZ3	01/12/12	24.07		4.40	8:45 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
PZ3	03/20/12	20.23		8.24	9:24 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
PZ3	06/26/12	19.29		9.18	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
PZ3	10/31/12	23.61		4.86	1:47 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
PZ3	05/31/13	21.31		7.16	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
PZ3	08/27/13	25.04		3.43	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
PZ3	12/19/13	24.70		3.77	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
PZ3	01/07/15	22.92		5.55	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
PZ3	08/07/17	24.72		3.75	9:15 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03
PZ4	02/04/10	26.78	NM	NM	NM	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ4	09/01/10		24.61	2.17	10:18 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ4	11/02/10		23.16	3.62	11:52 a.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
PZ4	12/20/10		20.41	6.37	10:30 a.m.	--	--	10:09 a.m.	4.25
PZ4	12/20/10		19.60	7.18	2:44 p.m.	2:27 p.m.	7.11	--	--
PZ4	03/21/11		19.17	7.61	4:11 p.m.	--	--	2:15 p.m.	4.77
PZ4	03/23/11		19.14	7.64	9:12 a.m.	7:18 a.m.	7.27	--	--
PZ4	06/21/11		16.07	10.71	2:55 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ4	06/22/11		16.26	10.52	7:42 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
PZ4	09/23/11		24.60	2.18	8:45 a.m.	--	--	9:06 a.m.	-0.73
PZ4	09/28/11		23.13	3.65	3:25 p.m.	5:27 p.m.	4.72	--	--
PZ4	01/12/12		22.39	4.39	8:48 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
PZ4	03/20/12		18.49	8.29	9:55 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
PZ4	06/26/12		17.69	9.09	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
PZ4	10/31/12		21.87	4.91	1:54 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
PZ4	05/31/13		19.74	7.04	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
PZ4	08/27/13		23.44	3.34	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
PZ4	12/19/13		23.30	3.48	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
PZ4	01/07/15		21.08	5.70	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
PZ4	08/07/17		23.20	3.58	9:05 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03
PZ5	02/04/10	26.86	21.70	5.16	9:27 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ5	09/01/10		24.73	2.13	10:22 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ5	11/02/10		23.34	3.52	11:56 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75
PZ5	12/20/10		20.41	6.45	11:36 a.m.	--	--	10:09 a.m.	4.25
PZ5	12/20/10		19.83	7.03	2:42 p.m.	2:27 p.m.	7.11	--	--
PZ5	03/21/11		19.19	7.67	4:56 p.m.	--	--	2:15 p.m.	4.77
PZ5	03/23/11		19.30	7.56	9:17 a.m.	7:18 a.m.	7.27	--	--
PZ5	06/21/11		16.06	10.80	2:53 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ5	06/22/11		16.29	10.57	7:39 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
PZ5	09/23/11		24.47	2.39	8:45 a.m.	--	--	9:06 a.m.	-0.73
PZ5	09/28/11		23.22	3.64	3:25 p.m.	5:27 p.m.	4.72	--	--
PZ5	01/12/12		22.51	4.35	8:50 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
PZ5	03/20/12		18.51	8.35	10:00 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
PZ5	06/26/12		17.85	9.01	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
PZ5	10/31/12		21.91	4.95	1:50 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
PZ5	05/31/13		19.78	7.08	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
PZ5	08/27/13		23.57	3.29	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
PZ5	12/19/13		23.24	3.62	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
PZ5	01/07/15		21.06	5.80	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
PZ5	08/07/17		22.69	4.17	9:02 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03

Table 2
Summary of Groundwater Elevation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Date Measured	TOC Elevation ¹ (ft CRD)	Depth to Water (ft below TOC)	Water Elevation ¹ (ft CRD)	Time Measured	High (CRD) ²		Low (CRD) ²		
						Time	Elevation (ft)	Time	Elevation (ft)	
PZ6	02/04/10	27.58	22.54	5.04	9:23 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ6	09/01/10		25.46	2.12	10:10 a.m.					
PZ6	09/01/10		24.80	2.78	10:15 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ6	11/02/10		24.10	3.48	11:48 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75	
PZ6	12/20/10		21.15	6.43	10:21 a.m.	--	--	10:09 a.m.	4.25	
PZ6	12/20/10		20.65	6.93	2:52 p.m.	2:27 p.m.	7.11	--	--	
PZ6	03/21/11		19.92	7.66	4:47 p.m.	--	--	2:15 p.m.	4.77	
PZ6	03/23/11		20.16	7.42	8:50 a.m.	7:18 a.m.	7.27	--	--	
PZ6	06/21/11		16.70	10.88	2:30 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ6	06/22/11		16.99	10.59	7:50 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ6	09/23/11		25.11	2.47	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ6	09/28/11		23.96	3.62	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ6	01/12/12		NM	NM	NM	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ6	03/20/12		19.33	8.25	10:10 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ6	06/26/12		18.61	8.97	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ6	10/31/12		22.57	5.01	1:52 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ6	05/31/13		20.58	7.00	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ6	08/27/13		24.35	3.23	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ6	12/19/13		24.15	3.43	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ6	01/07/15		21.68	5.90	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ6	08/07/17	24.16	3.42	9:10 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03		
PZ7	02/04/10	28.06	24.80	3.26	10:40 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ7	12/20/10		20.89	7.17	10:55 a.m.	--	--	10:09 a.m.	4.25	
PZ7	12/20/10		20.84	7.22	3:03 p.m.	2:27 p.m.	7.11	--	--	
PZ7	03/21/11		19.52	8.54	4:25 p.m.	--	--	2:15 p.m.	4.77	
PZ7	03/23/11		19.17	8.89	9:00 a.m.	7:18 a.m.	7.27	--	--	
PZ7	06/21/11		16.61	11.45	2:42 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ7	06/22/11		16.91	11.15	7:55 p.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ7	09/23/11		24.61	3.45	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ7	09/28/11		23.77	4.29	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ7	01/12/12		NM	NM	NM	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ7	03/20/12		19.40	8.66	9:15 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ7	06/26/12		18.20	9.86	2:30 p.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ7	10/31/12		NM	NM	NM	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ7	05/31/13		NM	NM	NM	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ7	08/27/13		NM	NM	NM	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ7	12/19/13		NM	NM	NM	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ7	01/07/15		21.20	6.86	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ7	08/07/17		23.00	5.06	8:45 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
PZ8	02/04/10		28.17	21.02	7.15	9:35 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ8	09/01/10			21.54	6.63	10:10 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ8	12/20/10	20.39		7.78	11:05 a.m.	--	--	10:09 a.m.	4.25	
PZ8	12/20/10	20.35		7.82	2:55 p.m.	2:27 p.m.	7.11	--	--	
PZ8	03/21/11	19.35		8.82	4:15 p.m.	--	--	2:15 p.m.	4.77	
PZ8	03/23/11	19.84		8.33	8:54 a.m.	7:18 a.m.	7.27	--	--	
PZ8	06/21/11	16.59		11.58	2:38 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ8	06/22/11	16.89		11.28	7:58 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ8	09/23/11	21.83		6.34	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ8	09/28/11	21.68		6.49	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ8	01/12/12	21.09		7.08	9:04 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ8	03/20/12	19.31		8.86	9:10 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ8	06/26/12	17.52		10.65	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ8	10/31/12	20.31		7.86	2:30 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ8	05/31/13	20.02		8.15	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ8	08/27/13	21.58		6.59	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ8	12/19/13	21.26		6.91	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ8	01/07/15	20.19		7.98	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ8	08/07/17	21.50		6.67	8:40 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
PZ9	02/04/10	27.54		22.04	5.50	9:42 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ9	09/01/10		25.34	2.20	9:47 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ9	12/20/10		21.06	6.48	11:40 a.m.	--	--	10:09 a.m.	4.25	
PZ9	12/20/10		19.97	7.57	2:40 p.m.	2:27 p.m.	7.11	--	--	
PZ9	03/21/11		19.98	7.56	4:39 p.m.	--	--	2:15 p.m.	4.77	
PZ9	03/23/11		19.73	7.81	9:23 a.m.	7:18 a.m.	7.27	--	--	
PZ9	06/21/11		16.98	10.56	3:40 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ9	06/22/11		17.06	10.48	7:36 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ9	09/23/11		25.67	1.87	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ9	09/28/11		23.68	3.86	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ9	01/12/12		23.07	4.47	8:53 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ9	03/20/12		19.23	8.31	9:20 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ9	06/26/12		18.32	9.22	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ9	10/31/12		23.61	3.93	2:21 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ9	05/31/13		20.50	7.04	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ9	08/27/13		24.01	3.53	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ9	12/19/13		23.82	3.72	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ9	01/07/15		22.00	5.54	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ9	08/07/17		23.82	3.72	8:58 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
PZ10	02/04/10		26.94	NM	NM	NM	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ10	09/01/10	24.62		2.32	10:05 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ10	12/20/10	20.26		6.68	11:51 p.m.	2:27 p.m.	7.11	10:09 a.m.	4.25	
PZ10	12/20/10	19.73		7.21	3:10 p.m.	2:27 p.m.	7.11	10:09 a.m.	4.25	
PZ10	03/21/11	19.02		7.92	4:57 p.m.	--	--	2:15 p.m.	4.77	
PZ10	03/23/11	19.26		7.68	9:27 a.m.	7:18 a.m.	7.27	--	--	
PZ10	06/21/11	15.79		11.15	3:04 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ10	06/22/11	16.06		10.88	7:33 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ10	09/23/11	24.00		2.94	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ10	09/28/11	23.08		3.86	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ10	01/12/12	22.45		4.49	8:59 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ10	03/20/12	18.26		8.68	9:05 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ10	06/26/12	17.82		9.12	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ10	05/31/13	19.66		7.28	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ10	08/27/13	23.51		3.43	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ10	12/19/13	23.28		3.66	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ10	01/07/15	20.87		6.07	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ10	08/07/17	22.64		4.30	8:50 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	

Table 2
Summary of Groundwater Elevation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Date Measured	TOC Elevation ¹ (ft CRD)	Depth to Water (ft below TOC)	Water Elevation ¹ (ft CRD)	Time Measured	High (CRD) ²		Low (CRD) ²		
						Time	Elevation (ft)	Time	Elevation (ft)	
PZ11	02/04/10	30.39	25.26	5.13	9:10 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ11	09/01/10		28.39	2.00	10:02 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ11	12/20/10		24.11	6.28	11:26 a.m.	--	--	10:09 a.m.	4.25	
PZ11	12/20/10		23.50	6.89	2:31 p.m.	2:27 p.m.	7.11	--	--	
PZ11	03/21/11		22.92	7.47	4:03 p.m.	--	--	2:15 p.m.	4.77	
PZ11	03/23/11		22.98	7.41	8:38 a.m.	7:18 a.m.	7.27	--	--	
PZ11	06/21/11		19.73	10.66	3:10 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ11	06/22/11		19.92	10.47	8:08 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ11	09/23/11		28.17	2.22	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ11	09/28/11		26.86	3.53	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ11	01/12/12		26.17	4.22	8:40 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ11	03/20/12		22.14	8.25	9:50 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ11	06/26/12		21.42	8.97	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ11	10/31/12		23.70	6.69	2:24 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ11	05/31/13		23.40	6.99	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ11	08/27/13		27.25	3.14	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ11	12/19/13		26.90	3.49	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ11	01/07/15	24.72	5.67	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19		
PZ11	08/07/17	27.18	3.21	9:20 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03		
PZ12	02/04/10	30.53	25.42	5.11	8:34 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ12	09/01/10		NM	NM	NM	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ12	11/02/10		27.18	3.35	11:37 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75	
PZ12	12/20/10		24.25	6.28	11:20 a.m.	--	--	10:09 a.m.	4.25	
PZ12	12/20/10		23.50	7.03	3:12 p.m.	2:27 p.m.	7.11	--	--	
PZ12	03/21/11		23.06	7.47	3:33 p.m.	--	--	2:15 p.m.	4.77	
PZ12	03/23/11		23.21	7.32	8:08 a.m.	7:18 a.m.	7.27	--	--	
PZ12	06/21/11		19.91	10.62	3:12 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ12	06/22/11		20.11	10.42	8:11 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ12	09/23/11		28.27	2.26	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ12	09/28/11		NM	NM	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ12	01/12/12		26.32	4.21	8:38 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ12	03/20/12		22.27	8.26	9:45 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ12	06/26/12		21.60	8.93	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ12	10/31/12		25.61	4.92	5:42 a.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ12	05/31/13		23.58	6.95	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ12	08/27/13		27.44	3.09	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ12	12/19/13	27.31	3.22	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69		
PZ12	01/07/15	24.83	5.70	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19		
PZ12	08/07/17	26.89	3.64	9:30 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03		
PZ13	02/04/10	30.40	25.50	4.90	8:32 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ13	09/01/10		28.21	2.19	9:59 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ13	11/02/10		26.93	3.47	11:30 a.m.	1:15 p.m.	4.42	8:42 a.m.	0.75	
PZ13	12/20/10		23.89	6.51	11:18 a.m.	--	--	10:09 a.m.	4.25	
PZ13	12/20/10		23.56	6.84	2:22 p.m.	2:27 p.m.	7.11	--	--	
PZ13	03/21/11		23.57	6.83	3:36 p.m.	--	--	2:15 p.m.	4.77	
PZ13	03/23/11		23.11	7.29	8:05 a.m.	7:18 a.m.	7.27	--	--	
PZ13	06/21/11		19.50	10.90	3:14 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ13	06/22/11		19.75	10.65	8:14 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ13	09/23/11		27.82	2.58	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ13	09/28/11		26.63	3.77	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ13	01/12/12		26.12	4.28	8:30 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ13	03/20/12		21.81	8.59	9:40 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ13	06/26/12		21.36	9.04	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ13	10/31/12		25.31	5.09	5:42 a.m.	5:42 a.m.	5.17	12:45 p.m.	2.67	
PZ13	05/31/13		23.19	7.21	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ13	08/27/13		27.17	3.23	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ13	12/19/13	26.95	3.45	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69		
PZ13	01/07/15	24.35	6.05	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19		
PZ13	08/07/17	26.50	3.90	9:30 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03		
PZ14	02/04/10	29.09	23.74	5.35	8:20 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34	
PZ14	09/01/10		26.94	2.15	9:57 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93	
PZ14	06/21/11		18.55	10.54	3:17 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39	
PZ14	06/22/11		18.62	10.47	8:16 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ14	09/23/11		27.15	1.94	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ14	09/28/11		25.44	3.65	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ14	01/12/12		24.72	4.37	8:35 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ14	03/20/12		21.02	8.07	9:35 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ14	06/26/12		19.57	9.52	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ14	05/31/13		22.10	6.99	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ14	08/27/13		25.85	3.24	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ14	12/19/13		25.52	3.57	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ14	01/07/15		23.56	5.53	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ14	08/07/17		25.96	3.13	9:27 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
PZ15	02/04/10		27.79	22.22	5.57	9:45 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
PZ15	09/01/10			25.58	2.21	9:50 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
PZ15	06/21/11			NM	NM	NM	8:48 a.m.	9.36	5:06 p.m.	8.39
PZ15	06/22/11	NM		NM	NM	9:48 a.m.	9.13	6:54 a.m.	8.71	
PZ15	09/23/11	26.04		1.75	8:45 a.m.	--	--	9:06 a.m.	-0.73	
PZ15	09/28/11	23.91		3.88	3:25 p.m.	5:27 p.m.	4.72	--	--	
PZ15	01/12/12	23.31		4.48	8:56 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02	
PZ15	03/20/12	19.51		8.28	9:18 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92	
PZ15	06/26/12	18.30		9.49	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35	
PZ15	05/31/13	20.81		6.98	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80	
PZ15	08/27/13	24.23		3.56	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01	
PZ15	12/19/13	23.95		3.84	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
PZ15	01/07/15	22.05		5.74	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
PZ15	08/07/17	24.26		3.53	8:55 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	

Table 2
Summary of Groundwater Elevation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Date Measured	TOC Elevation ¹ (ft CRD)	Depth to Water (ft below TOC)	Water Elevation ¹ (ft CRD)	Time Measured	High (CRD) ²		Low (CRD) ²	
						Time	Elevation (ft)	Time	Elevation (ft)
AB1 ³	02/04/10	27.53	30.08	6.26	9:17 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
AB1 ³	09/01/10		34.71	2.99	10:27 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
AB1 ³	11/02/10		32.19	4.77	12:03 p.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
AB1 ³	12/20/10		29.08	6.97	11:30 a.m.	--	--	10:09 a.m.	4.25
AB1 ³	12/20/10		28.32	7.50	2:36 p.m.	2:27 p.m.	7.11	--	--
AB1 ³	03/21/11		27.65	7.98	4:32 p.m.	--	--	2:15 p.m.	4.77
AB1 ³	03/23/11		27.07	8.39	8:30 a.m.	7:18 a.m.	7.27	--	--
AB1 ³	06/21/11		23.48	10.93	3:36 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
AB1 ³	06/22/11		23.49	10.92	7:46 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
AB1 ³	09/23/11		35.19	2.65	8:45 a.m.	--	--	9:06 a.m.	-0.73
AB1 ³	09/28/11		32.64	4.45	3:25 p.m.	5:27 p.m.	4.72	--	--
AB1 ³	01/12/12		31.76	5.07	8:46 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
AB1 ³	03/20/12		26.52	8.78	9:23 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
AB1 ³	06/26/12		25.13	9.76	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
AB1 ³	10/31/12		31.11	5.53	1:45 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
AB1 ³	05/31/13		28.32	7.50	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
AB1 ³	08/27/13		32.97	4.22	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
AB1 ³	12/19/13	32.59	4.49	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
AB1 ³	01/07/15	30.29	6.11	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
AB1 ³	08/07/17	32.80	4.34	9:17 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
AB2 ³	02/04/10	28.41	27.23	6.10	8:27 a.m.	7:39 a.m.	5.47	2:45 p.m.	1.34
AB2 ³	09/01/10		31.21	2.84	10:30 a.m.	9:42 p.m.	2.62	5:33 a.m.	-0.93
AB2 ³	11/02/10		29.56	4.19	11:21 a.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
AB2 ³	12/20/10		26.36	6.82	11:16 a.m.	--	--	10:09 a.m.	4.25
AB2 ³	12/20/10		24.97	7.95	2:26 p.m.	2:27 p.m.	7.11	--	--
AB2 ³	03/21/11		25.20	7.77	3:54 p.m.	--	--	2:15 p.m.	4.77
AB2 ³	03/23/11		24.63	8.23	8:30 a.m.	7:18 a.m.	7.27	--	--
AB2 ³	06/21/11		21.36	10.91	3:21 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
AB2 ³	06/22/11		21.35	10.92	8:19 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
AB2 ³	09/23/11		31.66	2.47	8:45 a.m.	--	--	9:06 a.m.	-0.73
AB2 ³	09/28/11		29.45	4.28	3:25 p.m.	5:27 p.m.	4.72	--	--
AB2 ³	01/12/12		28.60	4.98	8:25 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
AB2 ³	03/20/12		24.03	8.72	9:32 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
AB2 ³	06/26/12		22.93	9.63	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
AB2 ³	10/31/12		28.01	5.46	1:23 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
AB2 ³	05/31/13		25.56	7.47	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
AB2 ³	08/27/13		29.80	4.00	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
AB2 ³	12/19/13	29.47	4.27	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69	
AB2 ³	01/07/15	27.17	6.15	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19	
AB2 ³	08/07/17	29.29	4.42	9:40 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
OW1	11/02/10	26.51	23.00	3.51	11:26 a.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
OW1	12/20/10		20.22	6.29	11:10 a.m.	--	--	10:09 a.m.	4.25
OW1	12/20/10		19.38	7.13	2:20 p.m.	2:27 p.m.	7.11	--	--
OW1	03/21/11		19.15	7.36	3:40 p.m.	--	--	2:15 p.m.	4.77
OW1	03/23/11		18.97	7.54	8:20 a.m.	7:18 a.m.	7.27	--	--
OW1	06/21/11		15.93	10.58	3:26 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
OW1	06/22/11		16.05	10.46	8:21 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
OW1	09/23/11		24.43	2.08	8:45 a.m.	--	--	9:06 a.m.	-0.73
OW1	09/28/11		22.79	3.72	3:25 p.m.	5:27 p.m.	4.72	--	--
OW1	01/12/12		22.16	4.35	8:26 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
OW1	03/20/12		18.25	8.26	10:20 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
OW1	06/26/12		17.41	9.10	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
OW1	10/31/12		21.62	4.89	1:26 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
OW1	05/31/13		19.49	7.02	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
OW1	08/27/13		23.25	3.26	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
OW1	12/19/13		23.00	3.51	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
OW1	01/07/15		20.85	5.66	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
OW1	08/07/17	22.66	3.85	9:35 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	
OW2	11/02/10	25.99	22.45	3.54	11:24 p.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
OW2	12/20/10		19.71	6.28	11:08 a.m.	--	--	10:09 a.m.	4.25
OW2	12/20/10		18.56	7.43	3:14 p.m.	2:27 p.m.	7.11	--	--
OW2	03/21/11		18.64	7.35	3:58 p.m.	--	--	2:15 p.m.	4.77
OW2	03/23/11		18.37	7.62	8:27 a.m.	7:18 a.m.	7.27	--	--
OW2	06/21/11		15.48	10.51	3:24 a.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
OW2	06/22/11		15.51	10.48	8:23 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
OW2	09/23/11		23.99	2.00	8:45 a.m.	--	--	9:06 a.m.	-0.73
OW2	09/28/11		22.85	3.14	3:25 p.m.	5:27 p.m.	4.72	--	--
OW2	01/12/12		21.62	4.37	8:28 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
OW2	03/20/12		17.81	8.18	10:25 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
OW2	06/26/12		16.87	9.12	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
OW2	10/31/12		21.14	4.85	1:30 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
OW2	05/31/13		19.01	6.98	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
OW2	08/27/13		22.67	3.32	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
OW2	12/19/13		22.35	3.64	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
OW2	01/07/15		20.34	5.65	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
OW2	08/07/17	22.21	3.78	9:35 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03	

Table 2
Summary of Groundwater Elevation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Well ID	Date Measured	TOC Elevation ¹ (ft CRD)	Depth to Water (ft below TOC)	Water Elevation ¹ (ft CRD)	Time Measured	High (CRD) ²		Low (CRD) ²	
						Time	Elevation (ft)	Time	Elevation (ft)
OW3	11/02/10	26.13	22.62	3.51	11:28 a.m.	13:15 p.m.	4.42	8:42 a.m.	0.75
OW3	12/20/10		19.83	6.30	11:13 a.m.	--	--	10:09 a.m.	4.25
OW3	12/20/10		19.98	6.15	2:28 p.m.	2:27 p.m.	7.11	--	--
OW3	03/21/11		18.76	7.37	3:42 p.m.	--	--	2:15 p.m.	4.77
OW3	03/23/11		18.60	7.53	8:14 a.m.	7:18 a.m.	7.27	--	--
OW3	06/21/11		15.55	10.58	3:30 p.m.	8:48 a.m.	9.36	5:06 p.m.	8.39
OW3	06/22/11		15.65	10.48	8:24 a.m.	9:48 a.m.	9.13	6:54 a.m.	8.71
OW3	09/23/11		24.05	2.08	8:45 a.m.	--	--	9:06 a.m.	-0.73
OW3	09/28/11		22.52	3.61	3:25 p.m.	5:27 p.m.	4.72	--	--
OW3	01/12/12		21.76	4.37	8:07 a.m.	5:57 a.m.	4.01	1:48 p.m.	1.02
OW3	03/20/12		17.90	8.23	10:30 a.m.	4:09 a.m.	7.83	11:24 a.m.	5.92
OW3	06/26/12		17.03	9.10	10:30 a.m.	10:27 p.m.	6.27	5:20 p.m.	3.35
OW3	10/31/12		21.22	4.91	1:33 p.m.	5:42 a.m.	5.17	12:45 p.m.	2.67
OW3	05/31/13		19.15	6.98	1:00 p.m.	5:42 a.m.	10.15	5:00 p.m.	3.80
OW3	08/27/13		22.87	3.26	10:30 a.m.	4:00 p.m.	6.91	8:21 a.m.	2.01
OW3	12/19/13		22.70	3.43	10:00 a.m.	2:39 p.m.	8.48	4:15 a.m.	1.69
OW3	01/07/15		20.46	5.67	2:30 p.m.	4:53 p.m.	5.85	1:33 a.m.	3.19
OW3	08/07/17		22.51	3.62	9:40 a.m.	4:03 a.m.	4.13	12:54 p.m.	-0.03

Notes:

Pre-2010 data not shown in table

- 1) Survey based on NAVD88 and adjusted to CRD by subtracting 3.8 feet. Control point was taken from the I-5 intersection at the Todd Road overpass located at the northeast corner of the interchange.
- 2) Tidal data are from NOAA Co-ops web site <http://co-ops.nos.noaa.gov>. Verified times and high/low water level data from the Longview and St. Helens stations were used. Tides for Kalama were estimated by using the difference between the times and water level data at these two stations (assuming Kalama is located approximately at the midpoint). These elevations are based on MLLW.
- 3) Water elevations in the angle monitoring wells are approximated by the following calculations (where WL = depth to water):
 - AB1 (27.53 - WL COS 45°)
 - AB2 (28.41 - WL COS 35°)

ft TOC = feet below top of casing; CRD = Columbia River Datum; NM = n

Table 3
Summary of Preliminary Site Cleanup Standards
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Media - Pathway	Cadmium CUL	Zinc CUL	POC
Soil - Direct Contact Unrestricted Land Use Portion of Site ⁽¹⁾	80 mg/kg	24,000 mg/kg	Soil throughout the Site from the ground surface to 15 ft bgs
Soil - Direct Contact Industrial Portion of Site ⁽²⁾	3,500 mg/kg	1,050,000 mg/kg	Soil throughout the Site from the ground surface to 15 ft bgs
Soil - Protection of Terrestrial Environment Unrestricted Land Use Portion of Site ⁽¹⁾	25 mg/kg	270 mg/kg	Soil throughout the Site from the ground surface to 15 ft bgs
Soil - Protection of Terrestrial Environment Industrial Portion of Site ⁽²⁾	36 mg/kg	570 mg/kg	Soil throughout the Site from the ground surface to 15 ft bgs
Unsaturated Soil - Protection of Groundwater	0.69 mg/kg	5,970 mg/kg	Soil throughout the Site within the unsaturated zone (i.e., all areas of the subsurface between the ground surface and the groundwater table where the saturated zone (as defined in WAC 173-340-200) is unmet, irrespective of depth.
Saturated Soil - Protection of Groundwater	0.035 mg/kg	299 mg/kg	Soil throughout the Site within the saturated zone (defined in WAC 173-340-200 as "the area below the water table in which all interstices are filled with water")
Groundwater - Human Health Protection	5 µg/l	4,800 µg/l	Groundwater throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site.
Groundwater - Surface Water Protection	0.7 µg/l	66 µg/l	Groundwater throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site.
Surface Water ⁽³⁾	0.7 µg/l	66 µg/l	The point or points at which dissolved COCs associated with the Site discharge to the Columbia River
Sediment	Not Determined*	Not Determined*	Not Applicable*
Ambient Air ⁽⁴⁾	0.0014 µg/m ³	Not Determined*	Ambient air throughout the Site

Notes:

CUL - cleanup level; POC - point of compliance

⁽¹⁾ Unrestricted land use portion of the Site is that portion of the Site property located outside of the Site's perimeter fence

⁽²⁾ Industrial portion of the Site is that portion of the Site property located inside of the Site's perimeter fence

⁽³⁾ Potentially applicable if it is determined that surface waters of the state are affected or potentially affected by releases of hazardous substances from the Site. Impacts to surface waters by hazardous substances from the Site have not been identified.

⁽⁴⁾ Potentially applicable if it is determined that one of more of the scenarios identified in WAC173-340-750(1)(a) applies to the Site. None of these scenarios is currently applicable to the Site.

mg/kg = milligrams per kilogram; µg/l = micrograms per liter; µg/m³ = micrograms per cubic meter

ft bgs = feet below ground surface

* Refer to FS Report for additional information

Table 4
Summary of Sediment Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Cadmium (mg/kg)	Zinc (mg/kg)
SED AB1-A	07/21/15	<1.24	47.9
SED AB1-B	07/21/15	<1.29	44.5
SED AB1-C	07/21/15	<1.25	61.9
SED AB2-A	07/21/15	<1.27	55.1
SED AB2-B	07/21/15	<1.22	35.1
SED AB2-C	07/21/15	<1.08	51.7
SED-US (Background)	07/22/15	<1.20	31.1
SED-DS	07/22/15	<1.28	27.4
SD-1	08/11/17	<0.545	16.9
SD-2	08/11/17	<0.773	34.1
SD-3	08/11/17	<0.766	32.8
SD-4	08/11/17	<0.745	26.8
SD-5	08/11/17	<0.669	26.8
SD-6	08/11/17	<0.759	42.4
SD-7	08/11/17	<0.651	17.6
SD-8	08/11/17	<0.624	18.0
SD-9	08/11/17	<0.608	16.2
SD-10	08/11/17	<0.751	26.9
SD-US (Background)	08/11/17	<1.26	250
SD-DS	08/11/17	<0.529	17.8
Sediment Cleanup Objective⁽¹⁾		2.1	3,200

Notes:

mg/kg = milligrams per kilogram

"<" indicates not detected (non-detect values for the 2017 samples are method detection limit (MDL) and are method reporting limits (MRLs) for the 2015 samples

Samples were analyzed by EPA Method 6010/6020 for cadmium and zinc only

⁽¹⁾ Freshwater Sediment Cleanup Objective (SCO) from Table VI of Washington Administrative Code (WAC) 173-204-563 Sediment Management Standards.

Table 5
Summary of Remaining Soil Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Sample Depth (ft bgs)	Cadmium (mg/kg)	Zinc (mg/kg)
Former Settling Basin (FSB) Areas				
1	09/05/2003	5	<0.53	33
3	09/05/2003	3	<0.52	33
4	09/05/2003	5	<0.51	26
5	09/05/2003	1	<0.51	33
6	09/05/2003	3	<0.51	32
8	09/05/2003	1	0.56	280
9	09/09/2003	3	<0.53	31
10	09/09/2003	5	<0.54	33
11	09/09/2003	1	0.88	270
12	09/09/2003	3	<0.54	28
13	09/09/2003	3	<0.54	27
14	09/09/2003	5	<0.54	31
15	09/09/2003	1	<0.54	31
16	09/09/2003	3	<0.54	31
17	09/09/2003	1	<0.54	32
32	10/02/2003	1	<0.52	34
34	10/02/2003	5	<0.52	47
35	10/02/2003	7	<0.52	40
45	10/08/2003	7	<0.53	24
46	09/25/2003	5	<0.53	27
47	09/16/2003	9	<0.53	22
48	09/25/2003	3	<0.53	29
49	09/16/2003	7	<0.53	29
50	09/25/2003	1	<0.53	35
51	09/16/2003	5	<0.53	32
52	09/25/2003	3	<0.53	29
53	09/16/2003	9	<0.53	29
54	09/25/2003	1	<0.53	33
55	09/16/2003	7	<0.53	23
56	09/16/2003	5	<0.53	24
57	09/16/2003	5	<0.53	24
58	09/25/2003	1	<0.53	34
59	09/16/2003	7	<0.53	32
60	09/25/2003	3	<0.53	32
61	09/16/2003	9	<0.53	36
62	09/25/2003	5	<0.53	33
2R	09/12/2003	1	--	210
33R	10/02/2003	3	<0.52	36
63R	10/06/2003	7	<0.53	34
7R	09/12/2003	5	--	100
ARSW-1	09/16/2010	7-8	<2.16	92
ARSW-2	09/16/2010	7-8	<2.16	283
ARSW-3	09/16/2010	7-8	<2.07	141
ARSW-4	09/16/2010	7-8	<2.08	146
B1	09/16/2003	7-8	<5.3	32
B2	09/05/2003	9	<0.53	410
B3	09/12/2003	5.5	<0.52	27
B8	10/02/2003	15	<0.53	6,200
B9	10/02/2003	15	<0.53	1,300
B10	09/25/2003	15	<0.53	2,400
B11	09/25/2003	15	<0.53	4,500
B12	09/19/2003	15	<0.53	2,700
B13	09/19/2003	15	<0.53	2,100
EB-1	08/20/2010	15	0.34	780
EB-2	08/20/2010	15	0.35	480
EB-3	08/20/2010	15	0.34	560
EB-4	09/02/2010	15	<0.534	462
EB-5	09/02/2010	15	<2.68	793
EB-6	09/02/2010	15	<2.63	738
EB-7	09/16/2010	15	<2.12	2,110
EB-8	09/16/2010	15	<2.16	1,380
EB-9	09/16/2010	15	<2.14	1,800
EB-10	09/16/2010	15	<2.12	950
EB-11	09/16/2010	15	<2.12	1,160
EB-12	09/16/2010	15	<2.14	1,220
EB-13	09/16/2010	15	<2.16	729
ESW-1	08/17/2010	7-8	<2.1	55
ESW-2B	08/23/2010	7-8	0.15	44
ESW-3A	08/20/2010	7-8	0.32	<46.7
ESW-4A	08/20/2010	7-8	0.30	<48.0
ESW-5A	08/27/2010	7-8	<0.532	37
ESW-6A	08/27/2010	7-8	<0.521	40
ESW-7	08/17/2010	7-8	<2.1	43
ESW-8	08/27/2010	7-8	<0.532	52
LG5	10/23/2002	5	<0.2	376
LG6	10/23/2002	5	<0.2	47
NSW-0A	08/31/2010	7-8	<0.531	169
NSW-1	08/17/2010	7-8	<2.11	49
NSW-2	08/17/2010	7-8	<2.00	63
NSW-3	08/17/2010	7-8	<2.04	126
NSW-4	08/17/2010	7-8	<2.08	79
NSW-5	08/17/2010	7-8	<2.15	49
NSW-6	08/17/2010	7-8	<2.15	48
OB1*	09/16/2003	10-15	<0.52	390
OB2*	09/16/2003	10-15	0.56	510
OB3*	09/16/2003	10-15	<0.52	120
OB4*	09/16/2003	10-15	<0.52	930
SB1-Surf-1	10/16/2003	0-0.5	<0.55	35
SB1-Surf-2	10/16/2003	0-0.5	<0.54	71
SB1-Surf-3	10/16/2003	0-0.5	<0.56	98
SB1-Surf-4	10/16/2003	0-0.5	<0.55	40
SB2-Surf-1	10/16/2003	0-0.5	<0.56	99
SB2-Surf-2	10/16/2003	0-0.5	<0.56	49
SB2-Surf-3	10/16/2003	0-0.5	<0.56	38
SB2-Surf-4	10/16/2003	0-0.5	<0.56	52
SS11A	03/11/2003	0-3	<0.50	76
SSW-1	08/17/2010	7-8	<2.12	85
SSW-2	08/17/2010	7-8	<2.13	48
SSW-3	08/17/2010	7-8	<2.1	54
SSW-4	08/17/2010	7-8	<2.16	49
SSW-5	08/17/2010	7-8	<2.14	50
SSW-6	08/30/2010	7-8	<0.52	80
SSW-7	08/30/2010	7-8	<0.516	44
TP1	03/11/2003	7	<0.50	30
TP1	03/11/2003	5	<0.50	49
TP1	03/11/2003	3	<0.50	34
TP1	03/11/2003	1	<0.50	34
TP10	03/11/2003	3	<0.50	46
TP11	03/11/2003	7	<0.50	38
TP11	03/11/2003	5	<0.50	48
TP11	03/11/2003	3	<0.50	62
TP11	03/11/2003	1	<0.50	38
TP12	03/11/2003	3	<0.50	65
TP2	03/11/2003	7	<0.50	22
TP2	03/11/2003	5	<0.50	28
TP2	03/11/2003	3	<0.50	23
TP2	03/11/2003	1	<0.50	49
TP3	03/11/2003	0-3	<0.50	34
TP4	03/11/2003	3	<0.50	26
TP5	03/11/2003	7	<0.50	27
TP5	03/11/2003	5	<0.50	31
TP5	03/11/2003	3	<0.50	37
TP5	03/11/2003	1	<0.50	37
TP7	03/11/2003	3	<0.50	31
TP8	03/11/2003	7	<0.50	28
TP8	03/11/2003	5	<0.50	42
TP8	03/11/2003	3	<0.50	31
TP8	03/11/2003	1	<0.50	38
W1	10/15/2003	0-0.2	<0.54	160
W2	10/15/2003	0-0.2	<0.56	140
W3	10/15/2003	0-0.2	<0.67	26
W4	10/15/2003	0-0.2	<0.51	71
WSW-1	08/17/2010	7-8	<2.15	46
WSW-2	08/17/2010	7-8	<2.14	42
WSW-3	08/17/2010	7-8	<2.12	44
WSW-4	08/17/2010	7-8	<2.12	48
WSW-5	08/17/2010	7-8	<2.12	61
Manufacturing Plant Area (MPA)				
E-1	10/08/2003	1.4	<0.56	120
E-2	10/08/2003	1.5	<0.56	250
E-3	10/08/2003	1.5	<0.56	140
E-4	10/08/2003	1	<0.56	340
E-5	10/08/2003	0-0.25	<0.56	63
E-6	10/08/2003	0-0.25	<0.56	100
E-7	10/08/2003	0-0.25	0.65	120
E-8	10/08/2003	0-0.25	<0.56	480
E-9	10/08/2003	0-0.25	<0.56	390
PZ3A	04/15/2003	1	1.5	1,300
PZ3A	04/15/2003	20	<0.50	700
PZ3A	04/15/2003	15	<0.50	370
PZ3A	04/15/2003	10	<0.50	220
PZ3A	04/15/2003	8	<0.50	230
PZ4	04/15/2003	1	0.78	270
PZ4	04/15/2003	20	1.0	280
PZ4	04/15/2003	25	5.2	250
PZ4	04/15/2003	15	<0.50	410
PZ4	04/15/2003	10	<0.50	80
PZ4	04/15/2003	5	<0.50	45

Table 5
Summary of Remaining Soil Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Sample Depth (ft bgs)	Cadmium (mg/kg)	Zinc (mg/kg)
PZ5	04/15/2003	5	0.88	530
PZ5	04/15/2003	10	1.5	1,300
PZ5	04/15/2003	20	4.2	200
PZ5	04/15/2003	25	13	240
PZ5	04/15/2003	15	<0.50	180
PZ5	04/15/2003	1	<0.50	100
PZ6	04/15/2003	25	<0.50	110
PZ6	04/15/2003	20	<0.50	180
PZ6	04/15/2003	15	<0.50	190
PZ6	04/15/2003	10	<0.50	180
PZ6	04/15/2003	5	<0.50	360
PZ6	04/15/2003	1	<0.50	150
PZ7	04/15/2003	5	0.61	470
PZ7	04/15/2003	25	0.75	180
PZ7	04/15/2003	1	3.4	2,100
PZ7	04/15/2003	20	<0.50	86
PZ7	04/15/2003	15	<0.50	130
PZ7	04/15/2003	10	<0.50	530
PZ8	04/15/2003	25	<0.50	66
PZ8	04/15/2003	20	<0.50	29
PZ8	04/15/2003	15	<0.50	36
PZ8	04/15/2003	10	<0.50	61
PZ8	04/15/2003	5	<0.50	34
PZ8	04/15/2003	1	<0.50	84
PZ9	05/06/2003	20	<0.50	33
PZ9	05/06/2003	15	<0.50	32
PZ9	05/06/2003	10	<0.50	28
PZ9	05/06/2003	5	<0.50	26
PZ9	05/06/2003	1	<0.50	37
SS1	10/23/2002	0-0.5	0.60	400
SS2	10/23/2002	0.5-1	1.8	1,290
SS3	10/23/2002	0-0.5	1.7	868
SS4	10/24/2002	0-0.5	1.1	2,330
SS5	10/24/2002	0-0.5	<0.2	116
SS7	10/24/2002	0-0.5	8.5	19,100
SS10	04/16/2003	0.5-1	<0.50	170
SS11B	04/16/2003	0.5-1	0.78	1,200
SS12	04/16/2003	0.5-1	<0.50	27
SS13	04/16/2003	0.5-1	<0.50	220
W-1	10/02/2003	1.5	<0.53	210
W-2	10/02/2003	1.5	<0.53	26
W-3	10/02/2003	1.5	<0.53	420
W-4	10/02/2003	1	<0.53	60
W6	04/16/2003	25	<0.50	150
W6	04/16/2003	20	<0.50	88
W6	04/16/2003	15	<0.50	89
W6	04/16/2003	10	<0.50	74
W6	04/16/2003	5	<0.50	160
W6	04/16/2003	1	<0.50	490
W7	04/16/2003	1	0.82	900
W7	04/16/2003	25	<0.50	160
W7	04/16/2003	20	<0.50	110
W7	04/16/2003	15	<0.50	91
W7	04/16/2003	10	<0.50	500
W7	04/16/2003	5	<0.50	170
W8	04/16/2003	10	2.3	61
W8	04/16/2003	25	<0.50	75
W8	04/16/2003	20	<0.50	180
W8	04/16/2003	15	<0.50	140
W8	04/16/2003	5	<0.50	350
W8	04/16/2003	1	<0.50	230
W9	04/16/2003	20	<0.50	110
W9	04/16/2003	15	<0.50	330
W9	04/16/2003	10	<0.50	45
W9	04/16/2003	5	<0.50	36
W9	04/16/2003	1	<0.50	37
W10	04/16/2003	1	0.65	280
W10	04/16/2003	20	<0.50	56
W10	04/16/2003	15	<0.50	510
W10	04/16/2003	10	<0.50	180
W10	04/16/2003	5	<0.50	88
W11	04/16/2003	20	<0.50	38
W11	04/16/2003	15	<0.50	30
W11	04/16/2003	10	<0.50	35
W11	04/16/2003	5	<0.50	22
W11	04/16/2003	1	<0.50	31
W12	04/16/2003	1	5.5	620
W12	04/16/2003	20	<0.50	360
W12	04/16/2003	15	<0.50	260
W12	04/16/2003	10	<0.50	330
W12	04/16/2003	5	<0.50	330
SB-1	08/10/2017	0-3	<1.29	15.4
SB-1	08/10/2017	3-6	<1.32	<13.2
SB-2	08/09/2017	0-3	<1.26	94.5
SB-2	08/09/2017	3-6	<1.30	209
SB-3	08/10/2017	0-3	<1.29	299
SB-3	08/10/2017	3-6	<1.33	17.9
SB-4	08/10/2017	0-3	<1.29	36.3
SB-4	08/10/2017	3-6	<1.31	<13.1
SB-5	08/10/2017	0-3	<5.12	238
SB-5	08/10/2017	3-6	<5.13	119
SB-6	08/09/2017	1-3	5.92	5,250
SB-6	08/09/2017	3-6	5.30	3,200
SB-7	08/09/2017	1-3	7.37	9,360
SB-7	08/09/2017	3-6	<5.29	2,590
SB-8	08/10/2017	1-3	<5.33	652
SB-8	08/10/2017	3-6	<5.21	441
SB-9	08/10/2017	0-3	<5.00	97.4
SB-9	08/10/2017	3-6	<4.92	91.9
SB-10	08/10/2017	0-3	107	367
SB-10	08/10/2017	3-6	76.2	627
SB-11	08/10/2017	1-3	<5.03	592
SB-11	08/10/2017	3-6	<5.01	166
SB-12	08/10/2017	0-3	<4.99	754
SB-12	08/10/2017	3-6	<5.18	91.9
SB-13	08/10/2017	0-3	<5.19	1,300
SB-13	08/10/2017	3-6	<5.13	113
SB-14	08/10/2017	0-3	<2.54	488
SB-14	08/10/2017	3-6	<2.60	109
SB-15	08/10/2017	0-3	<2.51	372
SB-15	08/10/2017	3-6	<2.62	513
SB-16	08/10/2017	0-3	<2.52	387
SB-16	08/10/2017	3-6	<2.59	32.7
SB-17	08/10/2017	0-3	<2.55	303
SB-17	08/10/2017	3-6	<2.66	166
SB-18	08/10/2017	0-3	<2.59	46.8
SB-18	08/10/2017	3-6	<2.69	38.4
SB-19	08/11/2017	0-3	<2.58	<25.8
SB-19	08/11/2017	3-6	<2.60	<26.0
SB-20	08/11/2017	0-3	<2.67	594
SB-20	08/11/2017	3-4	<2.56	813
SB-21	08/11/2017	10-13	91.6	150
SB-21	08/11/2017	13-16	305	255
SB-22	08/11/2017	0-3	<2.56	160
SB-23	08/10/2017	1-3	<5.04	728
SB-23	08/10/2017	3-6	<5.26	4,260
Backfill and Background Samples				
Backfill	08/18/2010	0-15	<2.05	39.4
SP1	09/19/2003	0-15	<0.53	37
SP2	09/19/2003	0-15	<0.53	32
SP3	09/19/2003	0-15	<0.53	38
SP4	09/19/2003	0-15	<0.53	31
SP5	09/19/2003	0-15	<0.53	27
BG1	10/23/2002	0-0.5	<0.5	83
BG2	10/23/2002	0-0.5	<0.2	49.1
BG3	10/23/2002	0-0.5	0.30	43.3
Preliminary Soil CULs ¹				
Soil - Direct Contact (Unrestricted Land Use Portion of Site)			80	24,000
Soil - Protection of Terrestrial Environment (Unrestricted Land Use Portion of Site)			25	270
Soil - Direct Contact (Industrial Portion of Site)			3,500	1,050,000
Soil - Protection of Terrestrial Environment (Industrial Portion of Site)			36	570
Unsaturated Soil - Protection of Groundwater			0.69	5,970
Saturated Soil - Protection of Groundwater			0.035	299

Notes:

bgs = below ground surface; mg/kg = milligrams per kilogram; -- indicates sample not analyzed for constituent

¹ Refer to FS Report for discussion of preliminary soil cleanup levels (CULs)

All samples were collected from the industrial portion of the Site with the exception of the backfill and background samples

Bold concentration exceeds Preliminary Soil - Protection of Terrestrial Environment CUL (industrial portion of Site). Only those samples collected within the point of compliance (0-15 ft bgs) compared to CUL.

No detections exceed Soil - Direct Contact CULs (industrial portion of Site). Detections above Soil - Protection of Groundwater CULs are not identified in table.

*Samples OB1 through OB4 were collected from former settling basin #2 (FSB2) overburden soil which was used as backfill in the bottom 5 ft of FSB2 during the 2003 excavation activities. Approximately one-half of this backfill soil is estimated to have been removed during the 2010 excavation activities.

Table 6
Summary of Groundwater Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Zinc		Cadmium	
		Total	Dissolved	Total	Dissolved
µg/L					
PZ1	04/15/03	--	2,100	--	<4.4
PZ1	07/18/03	--	3,500	--	--
PZ1	08/13/03	7,300	--	<4.4	--
PZ1	01/28/04	10,000	--	--	--
PZ1	04/29/04	--	13,000	--	--
PZ1	07/29/04	--	16,000	--	--
PZ1	10/27/04	--	13,000	--	--
PZ1	01/27/05	--	16,100	--	--
PZ1	05/03/05	--	16,800	--	--
PZ1	07/26/05	--	20,500	--	<2.0
PZ1	10/26/05	--	12,600	--	--
PZ1	07/12/06	--	11,500	--	0.7
PZ1	02/04/10	--	8,440	--	0.5
PZ1	09/02/10	5,630	--	<1.0	--
PZ1	11/02/10	--	7,290	--	<1.0
PZ1	12/20/10	--	6,720	--	<1.0
PZ1	03/22/11	--	12,300	--	<10.0
PZ1	06/21/11	--	14,700	--	<10.0
PZ1	09/22/11	--	17,800	--	<1.0
PZ1	01/12/11	--	40,000	--	<10.0
PZ1	03/21/12	--	70,000	--	5.1 J
PZ1	06/26/12	--	84,500	--	<100
PZ1	10/31/12	--	29,900	--	3
PZ1	05/30/13	--	85,400	--	2.1
PZ1	08/28/13	--	51,000	--	1.5
PZ1	12/20/13	--	44,200	--	<10.0
PZ1	01/06/15	76,800	--	1.32	--
PZ1	08/07/17	45,400	--	6.31	--
PZ2	04/15/03	--	<28	--	<4.4
PZ2	08/13/03	<28	--	<4.4	--
PZ2	01/28/04	<28	--	--	--
PZ2	04/28/04	--	<50	--	--
PZ2	07/29/04	--	<50	--	--
PZ2	10/27/04	--	<50	--	--
PZ2	01/27/05	--	27	--	--
PZ2	05/03/05	--	14	--	--
PZ2	07/26/05	--	15	--	<2.0
PZ2	10/26/05	--	15	--	--
PZ2	07/12/06	--	11	11	<0.2
PZ2	02/05/10	--	8	--	<0.2
PZ2	08/07/17	<25.0	--	<1.0	--
PZ3	04/15/03	--	7,200	--	<4.4
PZ3	05/06/03	--	11,000	--	<4.4
PZ3	05/21/03	--	12,000	--	<4.0
PZ3	07/18/03	--	12,000	--	--
PZ3	08/13/03	7,400	--	<4.4	--
PZ3	01/28/04	8,300	--	<4.4	--
PZ3	04/28/04	--	11,000	--	<4.0
PZ3	07/29/04	--	6,600	--	<4.0
PZ3	10/27/04	--	4,300	--	<4.0
PZ3	01/27/05	--	8,920	--	<2
PZ3	05/03/05	--	7,160	--	<2
PZ3	07/25/05	--	6,850	--	<2.0
PZ3	10/27/05	--	4,140	--	<2.0
PZ3	07/13/06	--	7,510	--	1.0
PZ3	07/13/06	--	850	--	0.3
PZ3	02/05/10	--	3,690	--	0.5
PZ3	09/01/10	2,670	--	<1.0	--
PZ3	11/03/10	--	1,940	--	<1.0
PZ3	12/21/10	--	2,280	--	<1.0
PZ3	03/22/11	--	4,370	--	<10.0
PZ3	09/22/11	--	2,930	--	<10.0
PZ3	06/21/11	--	4,420	--	<1.0
PZ3	01/12/12	--	4,530	--	<10.0
PZ3	03/21/12	--	11,000	--	1.7 J
PZ3	06/27/12	--	6,480	--	1.0
PZ3	10/31/12	--	3,530	--	<1.0
PZ3	05/30/13	--	6,240	--	<1.0
PZ3	08/27/13	--	4,480	--	0.7 J
PZ3	12/19/13	--	4,570	--	<1.0
PZ3	01/07/15	--	3,780	--	<1.0
PZ3	08/08/17	6,760	--	<1.0	--
PZ4	04/15/03	--	3,300	--	46
PZ4	05/21/03	--	650	--	9.2
PZ4	08/13/03	720	--	9.6	--
PZ4	01/28/04	6,600	--	64	--
PZ4	04/28/04	--	2,300	--	27
PZ4	07/29/04	--	3,500	--	37
PZ4	10/27/04	--	1,700	--	16
PZ4	01/27/05	--	8,060	--	82
PZ4	05/03/05	--	2,090	--	19
PZ4	07/25/05	--	1,190	--	10
PZ4	10/26/05	--	1,450	--	13
PZ4	07/13/06	--	620	--	7.7
PZ4	07/13/06	--	420	--	5.3
PZ4	09/01/10	2,210	--	16.6	--
PZ4	11/03/10	--	1,890	--	15.6
PZ4	12/21/10	--	896	--	6.61

Table 6
Summary of Groundwater Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Zinc		Cadmium	
		Total	Dissolved	Total	Dissolved
µg/L					
PZ4	03/22/11	--	3,980	--	36.9
PZ4	06/21/11	--	5,310	--	38.3
PZ4	09/22/11	--	2,810	--	26.1
PZ4	01/12/12	--	437	--	<10.0
PZ4	03/21/12	--	1,700	--	10.0
PZ4	06/26/12	--	4,880	--	31.2
PZ4	10/31/12	--	2,770	--	21.5
PZ4	05/30/13	--	1,720	--	11.6
PZ4	08/27/13	--	1,710	--	13.4
PZ4	12/19/13	--	1,930	--	12.6
PZ4	01/07/15	--	2,450	--	16.4
PZ4	08/07/17	1,180	--	9.76	--
PZ5	04/16/03	--	3,600	--	180
PZ5	05/21/03	--	3,000	--	120
PZ5	08/13/03	4,300	--	160	--
PZ5	01/28/04	3,700	--	110	--
PZ5	04/28/04	--	6,700	--	200
PZ5	07/29/04	--	8,800	--	320
PZ5	10/27/04	--	34,000	--	1,100
PZ5	01/27/05	--	7,930	--	326
PZ5	05/03/05	--	5,850	--	244
PZ5	07/25/05	--	7,550	--	302
PZ5	10/26/05	--	14,100	--	628
PZ5	07/13/06	--	3,390	--	152
PZ5	07/13/06	--	3,250	--	146
PZ5	02/05/10	--	3,060	--	107
PZ5	09/01/10	4,350	--	118	--
PZ5	11/03/10	--	2,080	--	69.7
PZ5	12/21/10	--	2,880	--	91.8
PZ5	03/22/11	--	2,980	--	84.7
PZ5	06/21/11	--	35,800	--	1,150
PZ5	09/22/11	--	2,390	--	102
PZ5	01/12/12	--	394	--	<10.0
PZ5	03/21/12	--	2,100	--	43
PZ5	06/26/12	--	1,680	--	4.3
PZ5	10/31/12	--	141	--	1.8
PZ5	05/30/13	--	2,110	--	47
PZ5	08/27/13	--	2,410	--	94.6
PZ5	12/19/13	--	3,480	--	151
PZ5	01/07/15	--	4,100	--	111
PZ5	08/08/17	2,260	--	64.6	--
PZ6	04/16/03	--	1,500	--	<4.4
PZ6	05/21/03	--	1,400	--	<4.0
PZ6	08/13/03	2,100	--	<4.4	--
PZ6	01/28/04	2,600	--	--	--
PZ6	04/28/04	--	1,400	--	--
PZ6	07/29/04	--	4,600	--	--
PZ6	10/27/04	--	2,600	--	--
PZ6	01/27/05	--	5,370	--	--
PZ6	05/03/05	--	12,500	--	--
PZ6	07/25/05	--	26,200	--	6
PZ6	10/27/05	--	16,800	--	6
PZ6	07/13/06	3,800	--	1.7	--
PZ6	09/01/10	1,310	--	<1.0	--
PZ6	11/03/10	--	1,190	--	<1.0
PZ6	12/20/10	--	553	--	<1.0
PZ6	03/22/11	--	740	--	<10.0
PZ6	06/21/11	--	1,660	--	<10.0
PZ6	09/22/11	--	500	--	<1.0
PZ6	01/12/12	--	26.3	--	<10.0
PZ6	03/21/12	--	980	--	<10.0
PZ6	06/26/12	--	3,570	--	<1.0
PZ6	11/01/12	--	6,360	--	2.2
PZ6	05/30/13	--	1,650	--	<1.0
PZ6	08/27/13	--	565	--	<1.0
PZ6	12/19/13	--	4,080	--	<1.0
PZ6	01/07/15	--	10,700	--	3.60
PZ6	08/07/17	1,150	--	<1.0	--
PZ7	04/16/03	--	570	--	<4.4
PZ7	08/13/03	--	<25	--	<4.0
PZ7	07/26/05	--	22	--	<2
PZ7	08/08/17	250	--	<1.0	--
PZ8	04/16/03	--	390	--	<4.4
PZ8	08/13/03	--	<25	--	<4.0
PZ8	07/25/05	--	15	--	<2.0
PZ8	08/09/17	<25.0	--	<1.0	--
PZ9	05/06/03	--	1,300	--	<4.4
PZ9	08/13/03	<28	--	<4.4	--
PZ9	01/28/04	2,900	--	--	--
PZ9	04/28/04	--	4,100	--	--
PZ9	07/29/04	--	3,400	--	--
PZ9	10/27/04	--	2,700	--	--
PZ9	01/27/05	--	2,230	--	--
PZ9	05/03/05	--	2,580	--	--
PZ9	07/25/05	--	4,050	--	<2.0
PZ9	10/26/05	--	4,240	--	--
PZ9	07/13/06	--	5,530	--	0.8
PZ9	02/05/10	--	2,910	--	1.2
PZ9	08/08/17	5,940	--	<1.0	--
PZ10	07/26/05	--	46	--	<2.0
PZ10	08/08/17	<25.0	--	<1.0	--

Table 6
Summary of Groundwater Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Zinc		Cadmium	
		Total	Dissolved	Total	Dissolved
µg/L					
PZ11	07/27/05	--	592	--	<2.0
PZ11	10/26/05	--	900	--	--
PZ11	07/12/06	--	600	--	0.4
PZ11	02/04/10	--	330	--	0.2
PZ11	08/07/17	415	--	<1.0	--
PZ12	07/27/05	--	57,300	--	<2.0
PZ12	10/26/05	--	44,600	--	--
PZ12	07/12/06	--	37,400	--	0.4
PZ12	02/04/10	--	34,200	--	0.6
PZ12	09/02/10	37,800	--	<1.0	--
PZ12	11/03/10	--	1,940	--	<1.0
PZ12	12/21/10	--	87,100	--	<1.0
PZ12	03/22/11	--	112,000	--	<10.0
PZ12	06/21/11	--	74,100	--	<10.0
PZ12	09/22/11	--	88,100	--	<1.0
PZ12	01/12/12	--	83,600	--	<200
PZ12	03/21/12	--	300,000	--	6.7 J
PZ12	06/27/12	--	352,000	--	<100
PZ12	11/01/12	--	68,500	--	1.0
PZ12	05/30/13	--	118,000	--	2.9
PZ12	08/28/13	--	135,000	--	10.9
PZ12	12/19/13	--	175,000	--	27
PZ12	01/07/15	--	90,900	--	2.40
PZ12	08/07/17	6,460	--	<1.0	--
PZ13	07/27/05	--	17,300	--	<2.0
PZ13	09/02/10	18,400	--	<1.0	--
PZ13	11/02/10	--	151	--	<1.0
PZ13	12/21/10	--	79,000	--	<1.0
PZ13	03/22/11	--	68,200	--	<10.0
PZ13	06/21/11	--	21,100	--	<10.0
PZ13	09/22/11	--	<10.0	--	<1.0
PZ13	01/12/12	--	2,140	--	<10.0
PZ13	03/21/12	--	89,000	--	2.4 J
PZ13	06/27/12	--	210	--	<1.0
PZ13	11/01/12	--	<50	--	<1.0
PZ13	05/30/13	--	749,000	--	<1.0
PZ13	08/28/13	--	70,400	--	<1.0
PZ13	12/19/13	--	208,000	--	<10.0
PZ13	01/07/15	--	65,900	--	<1.0
PZ13	08/07/17	28,200	--	<1.0	--
PZ14	02/07/07	--	15	--	<0.2
PZ14	08/07/17	<25.0	--	<1.0	--
PZ15	02/07/07	--	19	--	<0.2
PZ15	08/08/17	<25.0	--	<1.0	--
AB1	07/07/03	1,200	1,100	<4.4	<4.0
AB1	07/18/03	--	610	--	--
AB1	08/13/03	--	810	--	<4.0
AB1	01/28/04	680	--	--	--
AB1	04/28/04	--	1,200	--	--
AB1	07/29/04	--	1,100	--	--
AB1	10/27/04	--	660	--	--
AB1	01/27/05	--	1,050	--	--
AB1	05/03/05	--	1,330	--	--
AB1	07/25/05	--	1,280	--	<2.0
AB1	10/27/05	--	697	--	--
AB1	07/13/06	--	630	--	0.3
AB1	07/13/06	--	9,000	--	1.2
AB1	02/05/10	--	980	--	0.3
AB1	09/01/10	996	--	<1.0	--
AB1	11/03/10	--	613	--	<1.0
AB1	12/21/10	--	463	--	<1.0
AB1	03/22/11	--	439	--	<10.0
AB1	06/21/11	--	304	--	<10.0
AB1	09/22/11	--	1090	--	<1.0
AB1	01/12/12	--	923	--	<10.0
AB1	03/21/12	--	950	--	<10.0
AB1	06/27/12	--	736	--	<1.0
AB1	10/31/12	--	877	--	<1.0
AB1	05/30/13	--	1,130	--	<1.0
AB1	08/27/13	--	772	--	0.4 J
AB1	12/19/13	--	1,380	--	<1.0
AB1	01/07/15	--	447	--	<1.0
AB1	08/08/17	854	--	<1.0	--
AB2	07/07/03	3,700	3,600	<4.0	<4.0
AB2	07/18/03	--	3,200	--	--
AB2	08/12/03	--	2,700	--	<4.0
AB2	01/28/04	3,500	--	--	--
AB2	04/28/04	--	1,200	--	--
AB2	07/29/04	--	6,200	--	--
AB2	10/27/04	--	4,800	--	--
AB2	01/27/05	--	8,490	--	--
AB2	05/03/05	--	10,600	--	--
AB2	07/26/05	--	7,960	--	<2.0
AB2	10/26/05	--	7,540	--	--
AB2	07/13/06	--	8,010	--	0.8
AB2	07/13/06	--	4,840	--	0.5
AB2	02/04/10	--	5,840	--	0.4
AB2	09/02/10	9,290	--	<1.0	--
AB2	11/02/10	--	7,310	--	<1.0
AB2	12/20/10	--	6,310	--	<1.0
AB2	03/22/11	--	5,630	--	<10.0
AB2	06/21/11	--	4,210	--	<10.0
AB2	09/22/11	--	14,300	--	<1.0
AB2	01/12/12	--	19,500	--	<10.0

Table 6
Summary of Groundwater Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Zinc		Cadmium	
		Total	Dissolved	Total	Dissolved
µg/L					
AB2	03/21/12	--	20,000	--	1.5 J
AB2	06/26/12	--	33,300	--	<1.0
AB2	10/31/12	--	9,600	--	<1.0
AB2	05/30/13	--	15,300	--	1.1
AB2	08/28/13	--	13,700	--	1.3
AB2	12/20/13	--	16,900	--	<10.0
AB2	01/06/15	17,300	--	1.06	--
AB2	08/07/17	59,800	--	4.69	--
OW1	09/23/10	--	15,200	--	<1.0
OW1	11/02/10	--	14,800	--	<1.0
OW1	12/20/10	--	14,600	--	<1.0
OW1	03/22/10	--	12,500	--	<10.0
OW1	06/21/11	--	21,100	--	<10.0
OW1	09/22/11	--	28,600	--	1.18
OW1	01/12/12	--	44,500	--	<100
OW1	03/21/12	--	46,000	--	2.8 J
OW1	06/26/12	--	23,900	--	<100
OW1	10/31/12	--	22,200	--	<1.0
OW1	05/30/13	--	26,300	--	1.4
OW1	08/28/13	--	68,100	--	<1.0
OW1	12/20/13	--	106,000	--	<10.0
OW1	01/06/15	146,000	--	<2.0	--
OW1	08/07/17	41,800	--	<1.0	--
OW2	09/23/10	--	11,700	--	<1.0
OW2	11/02/10	--	9,790	--	<1.0
OW2	12/20/10	--	7,750	--	<1.0
OW2	03/22/11	--	19,900	--	<10.0
OW2	06/21/11	--	28,600	--	<10.0
OW2	09/22/11	--	31,100	--	1.62
OW2	01/12/12	--	52,500	--	<100
OW2	03/21/12	--	91,000	--	8.4 J
OW2	06/26/12	--	91,400	--	<100
OW2	10/31/12	--	71,800	--	<1.0
OW2	05/30/13	--	76,200	--	2.4
OW2	08/28/13	--	77,100	--	0.2 J
OW2	12/20/13	--	38,100	--	<10.0
OW2	01/06/15	145,000	--	2.61	--
OW2	08/07/17	141,000	--	8.13	--
OW3	09/23/10	--	13,200	--	<1.0
OW3	11/02/10	--	16,700	--	<1.0
OW3	12/21/10	--	22,400	--	<1.0
OW3	03/22/11	--	35,100	--	<10.0
OW3	06/21/11	--	22,400	--	<10.0
OW3	09/22/11	--	41,600	--	1.72
OW3	01/12/12	--	8,100	--	<10
OW3	03/21/12	--	11,000	--	<10.0
OW3	06/26/12	--	47,700	--	<100
OW3	10/31/12	--	10,800	--	3.5
OW3	05/30/13	--	52,500	--	<1.0
OW3	08/28/13	--	28,800	--	0.6 J
OW3	12/20/13	--	23,600	--	<10.0
OW3	01/07/15	--	73,100	--	<1.0
OW3	08/07/17	52,100	--	4.19	--
Preliminary Groundwater CULs¹					
Human Health Protection		4,800		5	
Surface Water Protection		66		0.7	

Notes:

µg/L = micrograms per liter; -- indicates not analyzed

¹ Refer to FS Report for discussion of groundwater cleanup levels (CULs)

"J" indicates estimated concentration above the laboratory minimum detection limit and below the laboratory minimum reporting limit

Table 7
Summary of PushPoint Groundwater and Surface Water Analytical Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Sample Time (PDT/LST)	Dissolved Zinc (µg/L)	Dissolved Cadmium (µg/L)
Pushpoint Groundwater Samples				
PW AB1-A	07/21/15	10:25	<50.0	<1.0
PW AB1-B	07/21/15	11:15	<50.0	<1.0
PW AB1-C	07/21/15	12:00	<50.0	<1.0
PW AB2-A	07/21/15	14:25	<50.0	<1.0
PW AB2-B	07/21/15	15:05	<50.0	<1.0
PW AB2-C	07/21/15	15:35	<50.0	<1.0
PW-US (Background)	07/22/15	10:45	<50.0	<1.0
PW-DS	07/22/15	10:00	<50.0	<1.0
PP-1	08/09/17	13:10	<52.0	<1.0
PP-2	08/09/17	13:15	<52.0	<1.0
PP-3	08/09/17	13:30	<52.0	<1.0
PP-4	08/09/17	13:40	<52.0	<1.0
PP-5	08/09/17	13:55	<52.0	<1.0
PP-6	08/09/17	14:10	<52.0	<1.0
PP-7	08/09/17	14:20	<52.0	<1.0
PP-8	08/09/17	14:40	362	<1.0
PP-9	08/09/17	15:00	22.4 J	<0.1
PP-10	08/09/17	15:10	53.4 J	<1.0
PP-11	08/10/17	13:15	<52.0	<1.0
PP-12	08/10/17	13:30	<52.0	<1.0
PP-13	08/10/17	13:45	<52.0	<1.0
PP-14	08/10/17	14:00	<52.0	<1.0
PP-15	08/11/17	13:30	<52.0	<1.0
PP-16	08/10/17	14:20	<52.0	<1.0
PP-17	08/10/17	14:30	<52.0	<1.0
PP-18	08/10/17	14:45	<52.0	<1.0
PP-19	08/10/17	15:15	<52.0	<1.0
PP-20	08/11/17	13:40	58.8 J	<1.0
PP-21	08/11/17	13:50	<52.0	<1.0
PP-22	08/11/17	14:00	<52.0	<1.0
PP-US (Background)	08/10/17	16:00	<52.0	<1.0
PP-DS	08/11/17	14:45	<52.0	<1.0
Surface Water Samples				
River	11/01/12	10:30	<50.0	<1.0
SW-1	08/11/17	14:35	<52.0	<1.0
SW-2	08/11/17	14:40	<52.0	<1.0
SW-3	08/11/17	14:45	<52.0	<1.0
Preliminary Groundwater - Surface Water Protection CUL¹			66	0.7

Notes:

µg/L = micrograms per liter

PDT = Pacific Daylight Time; LST = local standard time

Samples were field-filtered and analyzed by EPA Method 6010/6020 for dissolved cadmium and zinc only

¹Refer to FS Report for discussion of groundwater cleanup levels (CULs) established for protection of surface water

Bold concentration exceeds the groundwater cleanup level

"J" indicates estimated concentration above the laboratory minimum detection limit and below the laboratory minimum reporting limit

Table 8
Summary of Potentially Applicable State and Federal Laws for Site Cleanup
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Potentially Applicable State or Federal Law	Description	Applicability
Model Toxics Control Act (MTCA) Soil Cleanup Standards (WAC 173-340-740, -745, -747, -900 [Table 749-2], -7490, -7492)	Provides soil cleanup standards for soils affected or potentially affected by a release or threatened release of a hazardous substance at a site, including soil - direct contact (unrestricted and industrial land use), soil - protection of terrestrial environment (unrestricted and industrial land use), and soil - protection of groundwater cleanup standards.	Soil cleanup standards are applicable to soils affected by releases of hazardous substances at the Site.
MTCA Groundwater Cleanup Standards (WAC 173-340-720, -900 [Table 749-2])	Provides groundwater cleanup standards for groundwater affected or potentially affected by a release or threatened release of a hazardous substance at a site, including potable groundwater cleanup standards established for human health protection and for protection of surface water beneficial uses.	Groundwater cleanup standards are applicable to groundwater affected by releases of hazardous substances at the Site. The potable groundwater cleanup established for protection of surface water beneficial uses would not be applicable to the Site if it can be demonstrated that the hazardous substances are not likely to reach surface water.
MTCA Surface Water Cleanup Standards (WAC 173-340-730)	Provides surface water cleanup standards for those surface waters of the state affected or potentially affected by releases of hazardous substances from sites.	Surface water cleanup standards are potentially applicable in the event of a release of a hazardous substance from the Site to surface water. Hazardous substances associated with the Site have not been demonstrated to affect surface water quality at concentrations above surface water cleanup standards.
MTCA Cleanup Standards to Protect Air Quality (WAC 173-340-750)	Provides air cleanup standards and compliance monitoring requirements to determine if air emissions at a site pose a threat to human health or the environment.	Air cleanup standards are potentially applicable if concentrations of hazardous substances in air originating from contaminated media or a remedial action are present at the Site.
MTCA Sediment Management Standards (WAC 173-204)	Establishes and applies standards for the quality of surface sediments to reduce and eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination.	Based on Site sediment evaluations, the sediment station cluster evaluated for the Site is of low concern, no further sediment cleanup action is warranted at the Site, and sediment cleanup standards do not currently need to be determined for the Site.
Underground Injection Control (UIC) Program (WAC 173-218)	Regulates the discharge of fluids into UIC wells. Satisfies the intent and requirements of Part C of the Federal Safe Drinking Water Act (SDWA) and the Washington state Water Pollution Control Act, chapter 90.48 RCW	Applicable to cleanup action activities which include injection of fluids into the Site aquifer.
Stormwater Discharges (40 CFR Part 122.26)	Provides conditions for which a permit is required to establish storm water controls to prevent discharge of pollutants from construction activities.	A permit may be required if cleanup action construction activities disturb one or more acres; however, a permit is not likely to be required because any precipitation would infiltrate completely into the ground at the Site.
National Pollutant Discharge Elimination System Permit Program (Chapter 173-220 WAC)	Establishes a state individual permit program, applicable to the discharge of pollutants and other wastes and materials to the surface waters of the state, operating under state law as a part of the National Pollutant Discharge Elimination System (NPDES) created by section 402 of the Federal Water Pollution Control Act (FWPCA). Permits issued under this chapter are designed to satisfy the requirements for discharge permits under both section 402(b) of the FWPCA and chapter 90.48 RCW.	Permitting may be required if cleanup action construction activities disturb one or more acres and precipitation would not infiltrate completely into the ground at the Site.
National Ambient Air Quality Standards (40 CFR Part 50)	Provides ambient air standards for "criteria" air pollutants.	Potentially applicable to cleanup action activities with the potential for releases of criteria air pollutants.
Resource Conservation and Recovery Act (RCRA) Hazardous Waste Regulations (40 CFR Parts 260-273)	Provides regulations for hazardous waste identification, classification, generation, management, and disposal.	These regulations are potentially applicable to solid wastes generated as part of a cleanup action.
Dangerous Waste Regulations (WAC 173-303)	Provides standards for designation of solid wastes which are dangerous and for surveillance and monitoring of dangerous wastes until they are detoxified, reclaimed, neutralized, or disposed of safely. Implements chapter 70.105 RCW, the Hazardous Waste Management Act of 1976 as amended, and implements, in part, chapters 70.105A, 70.105D, and 15.54 RCW, and Subtitle C of Public Law 94-580, the Resource Conservation and Recovery Act, which the legislature has empowered the department to implement.	These regulations are potentially applicable to solid wastes generated as part of a cleanup action.
Solid Waste Handling Standards (WAC 173-350)	Provides standards for handling solid waste.	These regulations are potentially applicable to solid wastes generated as part of a cleanup action.
US Department of Transportation Hazardous Materials Regulations (49 CFR Parts 100-180)	Provides regulations for transportation of hazardous materials.	These regulations are potentially applicable to off-site transportation of materials generated as part of a cleanup action.
Minimum Standards for Construction and Maintenance of Wells (WAC 173-160)	Provides minimum standards for the construction and decommissioning of all wells.	These regulations are applicable to the installation and decommissioning of Site wells
Shoreline Management Act (RCW 90.58; WAC 173-18; Cowlitz County Shoreline Master Program)	Provides regulations intended to protect shoreline natural resources including the land, vegetation, wildlife, and aquatic habitats against adverse environmental effects.	Potentially applicable if cleanup action activities performed within 200 ft from the ordinary high water mark of the Columbia River.
State Environmental Policy Act (SEPA) (WAC 197-11)	SEPA is intended to ensure that environmental values are considered during decision-making by state and local agencies.	SEPA checklist may be required prior to implementation of a cleanup action unless associated potential impacts are addressed by other applicable laws and no conditions will be required under SEPA.
City of Kalama Municipal Code (Title 12 – Water and Sewers)	Local codes provide standards for water supply, sanitary sewer, and stormwater.	Applicable if cleanup action require a water supply source, discharge to the sanitary sewer, or discharge to stormwater sewer.
City of Kalama Municipal Code (Title 12 – Building and Construction)	Local codes provide standards for all building and construction activities, including demolition and land-disturbing activities.	Plan review and permitting may be required if cleanup activities necessitate the construction or demolition of buildings/structures, and/or land-disturbing activities.
City of Kalama Municipal Code (Title 15.04 – Environmental Policy)	Adopted under the State Environmental Policy Act (SEPA), RCW 43.21C.120 and the SEPA Rules, WAC 197-11-904.	SEPA checklist may be required prior to implementation of a cleanup action unless associated potential impacts are addressed by other applicable laws and no conditions will be required under SEPA.

Table 9
Summary of Cleanup Action Alternatives Evaluation
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8
	Facility Demolition, Complete Soil Removal, Groundwater Recovery	Facility Demolition, Complete Soil Removal, Groundwater pH Buffering	Facility Demolition, Soil Removal, ISS, Groundwater pH Buffering	Limited Soil Removal, Groundwater P&T, ICs	Limited Soil Removal, Groundwater pH Buffering, ICs	Limited Soil Removal, Slurry Wall, ICs	Limited Soil Removal, ICs, Off-Property CPOC	Facility Demolition, Limited Soil Removal, ICs, Off-Property CPOC
Minimum Threshold Criteria								
Protects Human Health and the Environment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complies with Cleanup Standards	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complies with Applicable State and Federal Laws	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provides for Compliance Monitoring	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Restoration Time Frame								
Anticipated Time to Achieve Cleanup Action Objectives (CAOs)	10 Years	10 Years	10 Years	30 Years	30 Years	200 Years ⁽¹⁾	100 Years ⁽¹⁾	100 Years ⁽¹⁾
Benefits Ranking Analysis								
Overall Protectiveness	7	8	6	5	4	2	1	3
Permanence	7	8	6	5	4	2	1	3
Long-Term Effectiveness	8	7	6	5	4	1	2	3
Management of Short-Term Risk	2	1	3	5	6	7	8	4
Implementability	1	2	4	5	8	7	6	3
Consideration of Public Concerns	7	8	6	5	4	2	1	3
Benefits Ranking Score	32	34	31	30	30	21	19	19
Disproportionate Cost Analysis								
Estimated Cleanup Action Cost (from Table 10)	\$14,574,230	\$13,781,955	\$10,281,315	\$26,268,550	\$3,506,800	\$1,422,850	\$637,450	\$3,372,380
Benefit to Cost Ratio (Benefits Ranking Score per \$million)	2.2	2.5	3.0	1.1	8.6	14.8	29.8	5.6
Benefits Ranking Score Factor Relative to Alternative #7 ⁽²⁾	1.7	1.8	1.6	1.6	1.6	1.1	1.0	1.0
Cost Factor Relative to Alternative #7 ⁽²⁾	22.9	21.6	16.1	41.2	5.5	2.2	1.0	5.3
Ranking of Permanent Solution to the Maximum Extent Practicable ⁽²⁾	7	6	5	8	4	2	1	3

Notes:

⁽¹⁾ Alternatives #6, #7, and #8 restoration time frames are for achieving GW-HH CULs in Site groundwater.

⁽²⁾ Refer to FS Report for explanation of benefits ranking score and cost factors, and ranking of permanent solutions.

Table 10
Cleanup Action Alternatives Estimated Cost Details
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Cleanup Action Alternative Task	Quantity	Unit	Unit Cost	Total Cost	Task Notes/Assumptions
Alternative 1					
Compensation Paid to Chemtrade for Site Structures and Pavement	1	LS	\$1,108,800	\$1,108,800	Improvement value from Cowlitz County's online Assessor's Parcel Search application
Demolition and off-Site T&D of Facility Building Structures	18,000	SF	\$8	\$144,000	Disposed in C&D Landfill
Demolition and off-Site T&D of Concrete Slabs and Asphalt	115,000	SF	\$6	\$690,000	Disposed in C&D Landfill
Excavation and Stockpiling of Clean FSB Overburden Soil	14,500	CY	\$15	\$217,500	Removal and stockpiling of clean FSB overburden soil (previous excavation backfill) from 0 to 10 ft bgs and soil removed to provide a 1:1 slope
Excavation of Impacted Soil	69,000	CY	\$20	\$1,380,000	Includes removal of soil with COC concentrations above soil - protection of groundwater cleanup standards to 30 ft bgs (see notes)
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	14,000	CY	\$20	\$280,000	Soil removed around excavation perimeters to provide a 1:1 slope to a depth of 20 ft bgs (disposed off-Site)
Off-Site T&D of Excavated Soil	107,900	Tons	\$60	\$6,474,000	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	83,000	CY	\$12	\$996,000	Backfill with imported river dredge spoils from property adjacent to Site
Temporary Sheet Piling for Excavation Sidewall Stabilization	20,000	SF	\$20	\$400,000	2,000 LF Installed from 20 to 30 ft bgs
Recovery System Extraction Well Installation	280	FT	\$50	\$14,000	Eight 4-inch diameter PVC wells installed using hollow stem auger drill rig to 35 ft bgs
Recovery System Equipment, Construction, and Installation	1	LS	\$400,000	\$400,000	
Contractor Mobilization and Per Diem	1	LS	\$80,000	\$80,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$100,000	\$100,000	
Cleanup Action Construction Oversight	100	Days	\$3,200	\$320,000	Two people, 10 hour days, per diem and travel, sampling costs
Recovery System O&M (Years 1-10)	1	NPV LS	\$425,000	\$425,000	NPV cost for 10 years of O&M at \$50,000 per year; 3% discount rate
Groundwater Monitoring and Reporting (Years 1-10)	1	NPV LS	\$170,000	\$170,000	NPV cost for 10 years of annual monitoring, reporting, communications, etc. at \$20,000 per event; 3% discount rate
Ecology Fees	1	NPV LS	\$50,000	\$50,000	NPV cost for \$30,000 in fees during year 1, \$2,000 in fees during years 2-9, and \$10,000 in fees during year 10; 3% discount rate
10% Contingency	1	LS	\$1,324,930	\$1,324,930	
Alternative 1 - Total Estimate Cost				\$14,574,230	
Alternative 2					
Compensation Paid to Chemtrade for Site Structures and Pavement	1	LS	\$1,108,800	\$1,108,800	Improvement value from Cowlitz County's online Assessor's Parcel Search application
Demolition and off-Site T&D of Facility Building Structures	18,000	SF	\$8	\$144,000	Disposed in C&D Landfill
Demolition and off-Site T&D of Concrete Slabs and Asphalt	115,000	SF	\$6	\$690,000	Disposed in C&D Landfill
Excavation and Stockpiling of Clean FSB Overburden Soil	14,500	CY	\$15	\$217,500	Removal and stockpiling of clean FSB overburden soil (previous excavation backfill) from 0 to 10 ft bgs and soil removed to provide a 1:1 slope
Excavation of Impacted Soil	69,000	CY	\$20	\$1,380,000	Includes removal of soil with COC concentrations above soil - protection of groundwater cleanup standards to 30 ft bgs (see notes)
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	14,000	CY	\$20	\$280,000	Soil removed around excavation perimeters to provide a 1:1 slope to a depth of 20 ft bgs (disposed off-Site)
Off-Site T&D of Excavated Soil	107,900	Tons	\$60	\$6,474,000	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	83,000	CY	\$12	\$996,000	Backfill with imported river dredge spoils from property adjacent to Site
Temporary Sheet Piling for Excavation Sidewall Stabilization	20,000	SF	\$20	\$400,000	2,000 LF Installed from 20 to 30 ft bgs
pH Buffer Injection	25	Days	\$4,000	\$100,000	Installation of 45 DPT injection wells; MgOH injectate preparation and injection
pH Buffer (MgOH)	25	Tons	\$750	\$18,750	Chemical cost including freight; 1 ton MgOH per well
Contractor Mobilization and Per Diem	1	LS	\$80,000	\$80,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$100,000	\$100,000	
Cleanup Action Construction Oversight	100	Days	\$3,200	\$320,000	Two people, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring and Reporting (Years 1-10)	1	NPV LS	\$170,000	\$170,000	NPV cost for 10 years of annual monitoring, reporting, communications, etc. at \$20,000 per event; 3% discount rate
Ecology Fees	1	NPV LS	\$50,000	\$50,000	NPV cost for \$30,000 in fees during year 1, \$2,000 in fees during years 2-9, and \$10,000 in fees during year 10; 3% discount rate
10% Contingency	1	LS	\$1,252,905	\$1,252,905	
Alternative 2 - Total Estimate Cost				\$13,781,955	
Alternative 3					
Compensation Paid to Chemtrade for Site Structures and Pavement	1	LS	\$1,108,800	\$1,108,800	Improvement value from Cowlitz County's online Assessor's Parcel Search application
Demolition and off-Site T&D of Facility Building Structures	18,000	SF	\$8	\$144,000	Disposed in C&D Landfill
Demolition and off-Site T&D of Concrete Slabs and Asphalt	115,000	SF	\$6	\$690,000	Disposed in C&D Landfill
Excavation and Stockpiling of Clean FSB Overburden Soil	14,500	CY	\$15	\$217,500	Removal and stockpiling of clean FSB overburden soil (previous excavation backfill) from 0 to 10 ft bgs and soil removed to provide a 1:1 slope
Excavation of Impacted Soil	30,000	CY	\$20	\$600,000	Includes removal of soil with COC concentrations above soil - protection of groundwater cleanup standards to 15 ft bgs (see notes)
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	7,000	CY	\$20	\$140,000	Soil removed around excavation perimeters to provide a 1:1 slope to a depth of 15 ft bgs (disposed off-Site)
Off-Site T&D of Excavated Soil	48,100	Tons	\$60	\$2,886,000	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	37,000	CY	\$12	\$444,000	Backfill with imported river dredge spoils from property adjacent to Site
ISS Blending	39,000	CY	\$35	\$1,365,000	ISS blending from 15 to 30 ft bgs
Portland Cement used in ISS	3,042	Ton	\$300	\$912,600	6 wt% Portland cement mix; soil density = 1.3 tons per CY; \$300/ton Portland cement
pH Buffer Injection	25	Days	\$4,000	\$100,000	Installation of 45 DPT injection wells spaced 10 ft on-center (5 ft ROI); MgOH injectate preparation and injection
pH Buffer (MgOH)	25	Tons	\$750	\$18,750	Chemical cost including freight; 1 ton MgOH per well
Contractor Mobilization and Per Diem	1	LS	\$80,000	\$80,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$100,000	\$100,000	
Cleanup Action Construction Oversight	100	Days	\$3,200	\$320,000	Two people, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring and Reporting (Years 1-10)	1	NPV LS	\$170,000	\$170,000	NPV cost for 10 years of annual monitoring, reporting, communications, etc. at \$20,000 per event; 3% discount rate
Ecology Fees	1	NPV LS	\$50,000	\$50,000	NPV cost for \$30,000 in fees during year 1, \$2,000 in fees during years 2-9, and \$10,000 in fees during year 10; 3% discount rate
10% Contingency	1	LS	\$934,665	\$934,665	
Alternative 3 - Total Estimate Cost				\$10,281,315	
Alternative 4					

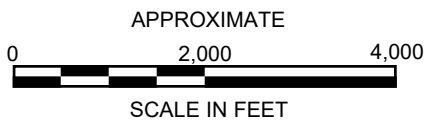
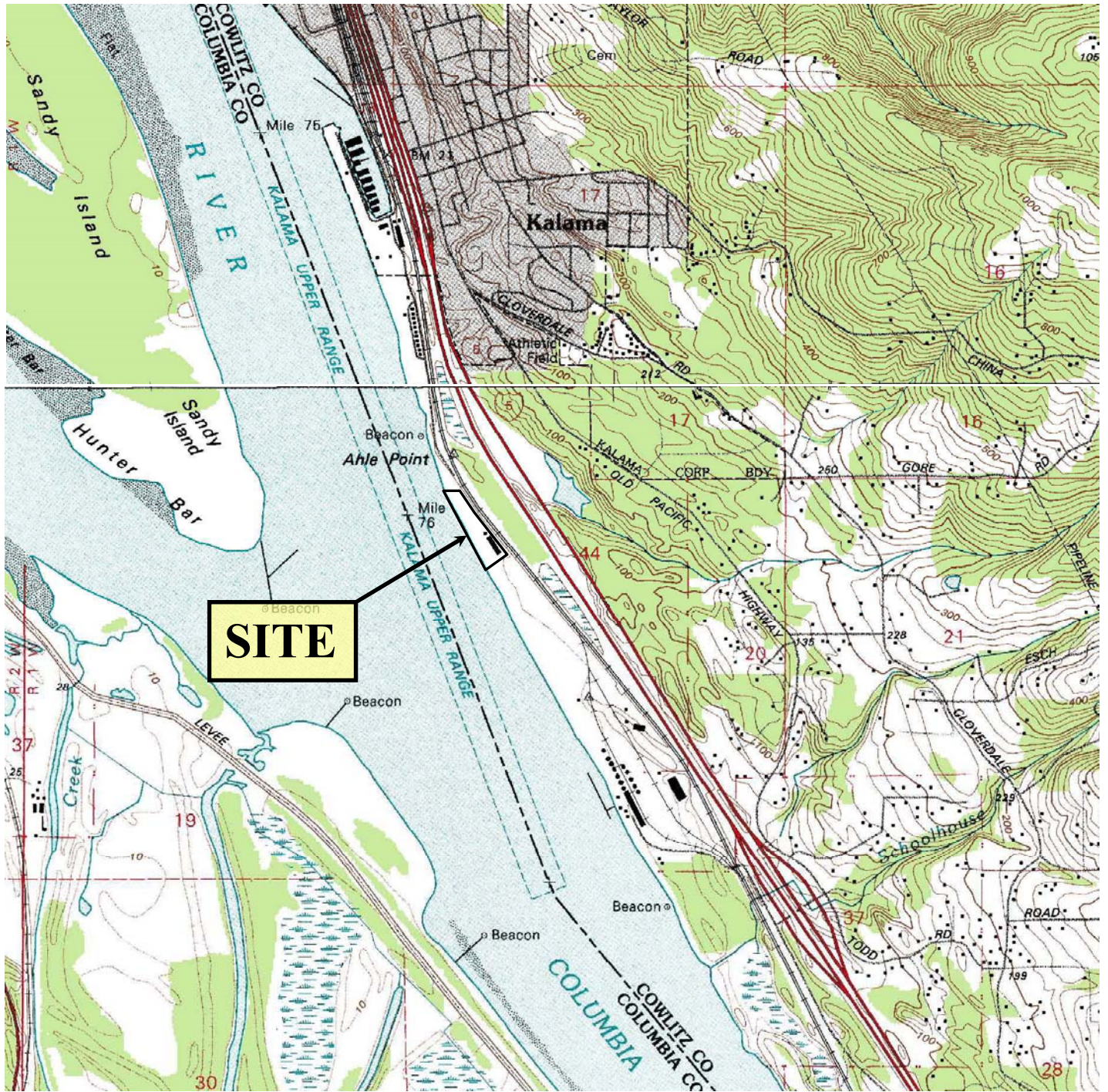
Table 10
Cleanup Action Alternatives Estimated Cost Details
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Cleanup Action Alternative Task	Quantity	Unit	Unit Cost	Total Cost	Task Notes/Assumptions
Excavation of Impacted Soil	650	CY	\$20	\$13,000	Includes removal of uncovered soil with COC concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	100	CY	\$20	\$2,000	Soil removed around excavation perimeters to provide a 1:1 slope (disposed off-Site)
Off-Site T&D of Excavated Soil	975	Tons	\$60	\$58,500	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	750	CY	\$12	\$9,000	Backfill with imported river dredge spoils from property adjacent to Site
Recovery System Extraction Well Installation	630	FT	\$50	\$31,500	Eighteen 4-inch diameter PVC wells installed using hollow stem auger drill rig to 35 ft bgs
P&T System Equipment, Construction, and Installation	1	LS	\$3,750,000	\$3,750,000	Based on \$15 per 1,000 gallons recovered per year and 250 MG per year recovery
Soil-Bentonite Slurry Wall (SBSW) Installation	30,500	VSF	\$14	\$427,000	Installation of approximately 870 linear ft of 4-ft wide SBSW to an average depth of 35 ft bgs
Bentonite used in SBSW	410	Tons	\$900	\$369,000	7 wt% bentonite mix; soil density = 1.3 tons per CY; \$300/ton Portland cement
Sheet Piling Installation	35,000	SF	\$90	\$3,150,000	1,000 LF Installed from 0 to 35 ft bgs
Contractor Mobilization and Per Diem	1	LS	\$80,000	\$80,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$150,000	\$150,000	
Cleanup Action Construction Oversight	200	Days	\$1,700	\$340,000	One person, 10 hour days, per diem and travel, sampling costs (significant portion of time is for sheet piling installation)
P&T System O&M	1	NPV LS	\$15,000,000	\$15,000,000	NPV cost for 30 years of O&M at \$750,000 per year (\$3 per 1,000 gallons recovered per year and 250 MG per year recovery); 3% discount rate
Groundwater Monitoring, Soil Cover Integrity Inspections, and Reporting (Years 1-30)	1	NPV LS	\$400,000	\$400,000	NPV cost for 30 years of annual monitoring and soil cover integrity inspections at \$20,000 per event; 3% discount rate
Soil Cover Integrity Inspections and Reporting (Years 35-200)	1	NPV LS	\$10,500	\$10,500	NPV cost for soil cover integrity inspections every five years at \$4,000 per event starting year 35; 3% discount rate
Soil Cover Maintenance (Years 10-200)	1	NPV LS	\$30,000	\$30,000	NPV cost for soil cover (concrete slab/pavement) maintenance, \$10,000 in repairs every 10 years starting year 10; 3% discount rate
Ecology Fees	1	NPV LS	\$60,000	\$60,000	NPV cost for \$30,000 in fees during year 1, \$1,000 in fees during years 2-199, and \$10,000 in fees during year 200; 3% discount rate
10% Contingency	1	LS	\$2,388,050	\$2,388,050	
Alternative 4 - Total Estimate Cost				\$26,268,550	
Alternative 5					
Excavation of Impacted Soil	650	CY	\$20	\$13,000	Includes removal of uncovered soil with COC concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	100	CY	\$20	\$2,000	Soil removed around excavation perimeters to provide a 1:1 slope (disposed off-Site)
Off-Site T&D of Excavated Soil	975	Tons	\$60	\$58,500	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	750	CY	\$12	\$9,000	Backfill with imported river dredge spoils from property adjacent to Site
pH Buffer Injection	200	Days	\$8,000	\$1,600,000	Installation of approximately 900 DPT injection wells spaced 10 ft on-center (5 ft ROI); magnesium hydroxide injectate preparation and injection by two crews
pH Buffer (MgOH)	900	Tons	\$750	\$675,000	Chemical cost including freight; 1 ton MgOH per well
Contractor Mobilization and Per Diem	1	LS	\$86,000	\$86,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$75,000	\$75,000	
Cleanup Action Construction Oversight	220	Days	\$1,700	\$374,000	One person, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring, Soil Cover Integrity Inspections, and Reporting (Years 2-30)	1	NPV LS	\$195,000	\$195,000	NPV cost for 30 years of biennial monitoring and soil cover integrity inspections, reporting, etc. starting year 2 at \$20,000 per event; 3% discount rate
Soil Cover Integrity Inspections and Reporting (Years 35-200)	1	NPV LS	\$10,500	\$10,500	NPV cost for soil cover integrity inspections every five years at \$4,000 per event starting year 35; 3% discount rate
Soil Cover Maintenance (Years 10-200)	1	NPV LS	\$30,000	\$30,000	NPV cost for soil cover (concrete slab/pavement) maintenance, \$10,000 in repairs every 10 years starting year 10; 3% discount rate
Ecology Fees	1	NPV LS	\$60,000	\$60,000	NPV cost for \$30,000 in fees during year 1, \$1,000 in fees during years 2-199, and \$10,000 in fees during year 200; 3% discount rate
10% Contingency	1	LS	\$318,800	\$318,800	
Alternative 5 - Total Estimate Cost				\$3,506,800	
Alternative 6					
Excavation of Impacted Soil	650	CY	\$20	\$13,000	Includes removal of uncovered soil with COC concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	100	CY	\$20	\$2,000	Soil removed around excavation perimeters to provide a 1:1 slope (disposed off-Site)
Off-Site T&D of Excavated Soil	975	Tons	\$60	\$58,500	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	750	CY	\$12	\$9,000	Backfill with imported river dredge spoils from property adjacent to Site
Soil-Bentonite Slurry Wall (SBSW) Installation	30,500	VSF	\$14	\$427,000	Installation of approximately 870 linear ft of 4-ft wide SBSW to an average depth of 35 ft bgs
Bentonite used in SBSW	410	Tons	\$900	\$369,000	7 wt% bentonite mix; soil density = 1.3 tons per CY; \$300/ton Portland cement
Contractor Mobilization and Per Diem	1	LS	\$38,000	\$38,000	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$60,000	\$60,000	
Cleanup Action Construction Oversight	60	Days	\$1,700	\$102,000	One person, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring, Soil Cover Integrity Inspections, and Reporting (Years 1-200)	1	NPV LS	\$125,000	\$125,000	NPV cost for 200 years of monitoring and soil cover integrity inspections completed every five years at \$20,000 per event; 3% discount rate
Soil Cover Maintenance (Years 10-200)	1	NPV LS	\$30,000	\$30,000	NPV cost for soil cover (concrete slab/pavement) maintenance, \$10,000 in repairs every 10 years starting year 10; 3% discount rate
Ecology Fees	1	NPV LS	\$60,000	\$60,000	NPV cost for \$30,000 in fees during year 1, \$1,000 in fees during years 2-199, and \$10,000 in fees during year 200; 3% discount rate
10% Contingency	1	LS	\$129,350	\$129,350	
Alternative 6 - Total Estimate Cost				\$1,422,850	

Table 10
Cleanup Action Alternatives Estimated Cost Details
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Cleanup Action Alternative Task	Quantity	Unit	Unit Cost	Total Cost	Task Notes/Assumptions
Alternative 7					
Excavation of Impacted Soil	650	CY	\$20	\$13,000	Includes removal of uncovered soil with COC concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	100	CY	\$20	\$2,000	Soil removed around excavation perimeters to provide a 1:1 slope (disposed off-Site)
Off-Site T&D of Excavated Soil	975	Tons	\$60	\$58,500	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	750	CY	\$12	\$9,000	Backfill with imported river dredge spoils from property adjacent to Site
Contractor Mobilization and Per Diem	1	LS	\$11,500	\$11,500	
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$20,000	\$20,000	
Cleanup Action Construction Oversight	5	Days	\$1,800	\$9,000	One person, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring, Soil Cover Integrity Inspections, and Reporting (Years 1-20)	1	NPV LS	\$300,000	\$300,000	NPV cost for 20 years of annual monitoring and soil cover integrity inspections at \$20,000 per event; 3% discount rate
Groundwater Monitoring, Soil Cover Integrity Inspections, and Reporting (Years 25-100)	1	NPV LS	\$65,000	\$65,000	NPV cost for monitoring and soil cover integrity inspections every five years at \$20,000 per event starting year 25; 3% discount rate
Soil Cover Integrity Inspections and Reporting (Years 105-200)	1	NPV LS	\$1,500	\$1,500	NPV cost for soil cover integrity inspections and reporting every five years at \$4,000 per event starting year 105; 3% discount rate
Soil Cover Maintenance (Years 10-200)	1	NPV LS	\$30,000	\$30,000	NPV cost for soil cover (concrete slab/pavement) maintenance, \$10,000 in repairs every 10 years starting year 10; 3% discount rate
Ecology Fees	1	NPV LS	\$60,000	\$60,000	NPV cost for \$30,000 in fees during year 1, \$1,000 in fees during years 2-199, and \$10,000 in fees during year 200; 3% discount rate
10% Contingency	1	LS	\$57,950	\$57,950	
Alternative 7 - Total Estimate Cost				\$637,450	
Alternative 8					
Compensation Paid to Chemtrade for Site Structures and Pavement	1	LS	\$1,108,800	\$1,108,800	Improvement value from Cowlitz County's online Assessor's Parcel Search application
Demolition and off-Site T&D of Facility Building Structures	18,000	SF	\$8	\$144,000	Disposed in C&D Landfill
Demolition and off-Site T&D of Concrete Slabs and Asphalt	115,000	SF	\$6	\$690,000	Disposed in C&D Landfill
Excavation of Impacted Soil	4,000	CY	\$20	\$80,000	Includes removal of soil with COC concentrations above soil - direct contact cleanup standards to 15 ft bgs and removal of soil with COC concentrations greater than two times the unrestricted land use soil – protection of terrestrial environment CULs to a depth of six feet bgs
Excavation of Perimeter Soil for Sidewall Stabilization (1:1 slope)	600	CY	\$20	\$12,000	Soil removed around excavation perimeters to provide a 1:1 slope (disposed off-Site)
Off-Site T&D of Excavated Soil	5,980	Tons	\$60	\$358,800	Soil density = 1.3 tons per CY; disposal in Subtitle D Landfill (as non-hazardous waste); includes soils removed for sloping
Excavation Backfilling	4,600	CY	\$12	\$55,200	Backfill with imported river dredge spoils from property adjacent to Site
Contractor Mobilization and Per Diem	1	LS	\$43,500	\$43,500	Estimated costs for all contractors
Cleanup Action Planning, Permitting, Reporting, etc.	1	LS	\$75,000	\$75,000	
Cleanup Action Construction Oversight	45	Days	\$1,600	\$72,000	One person, 10 hour days, per diem and travel, sampling costs
Groundwater Monitoring and Reporting (Years 1-20)	1	NPV LS	\$300,000	\$300,000	NPV cost for 20 years of annual monitoring, reporting, communications, etc. at \$20,000 per event; 3% discount rate
Groundwater Monitoring and Reporting (Years 25-100)	1	NPV LS	\$65,000	\$65,000	NPV cost for groundwater monitoring and reporting every five years at \$20,000 per event starting year 25; 3% discount rate
Ecology Fees	1	NPV LS	\$61,500	\$61,500	NPV cost for \$30,000 in fees during year 1, \$1,000 in fees during years 2-99, and \$10,000 in fees during year 100; 3% discount rate
10% Contingency	1	LS	\$306,580	\$306,580	
Alternative 8 - Total Estimate Cost				\$3,372,380	

Notes:
LS = lump sum; SF = square feet; CY = cubic yards; FT = feet; bgs = below ground surface; VSF = vertical square feet; MG = million gallons
T&D = transport and disposal; NPV = net present value; O&M = operations and maintenance; MgOH = magnesium hydroxide; ROI = radius of influence
Removal of soil with COC concentrations above soil - protection of groundwater cleanup standards also removes soils impacted with concentrations of COCs above unrestricted land use soil – direct contact cleanup standards and will also address the soil – protection of terrestrial environment because COCs will no longer be present at concentrations above the soil – protection of terrestrial environment CULs, as determined using statistical compliance methods.



U.S.G.S. QUADRANGLE MAP
DEER ISLAND & KALAMA, WA 7.5 MIN.
TOPOGRAPHIC QUADRANGLES
 QUADRANGLE
 7.5 MINUTE SERIES (TOPOGRAPHIC)

TITLE	SITE LOCATION MAP	
PROJECT	CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE ID No. 24634187 KALAMA, WASHINGTON	
	 SMARTER ENVIRONMENTAL SOLUTIONS	2923 South Tryon Street – Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f)
DATE: 07/12/19	REVISION NO. 0	
JOB NO: CLR-045	FIGURE NO. 1	

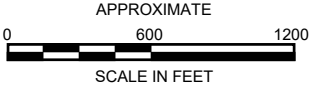


Columbia River


SITE

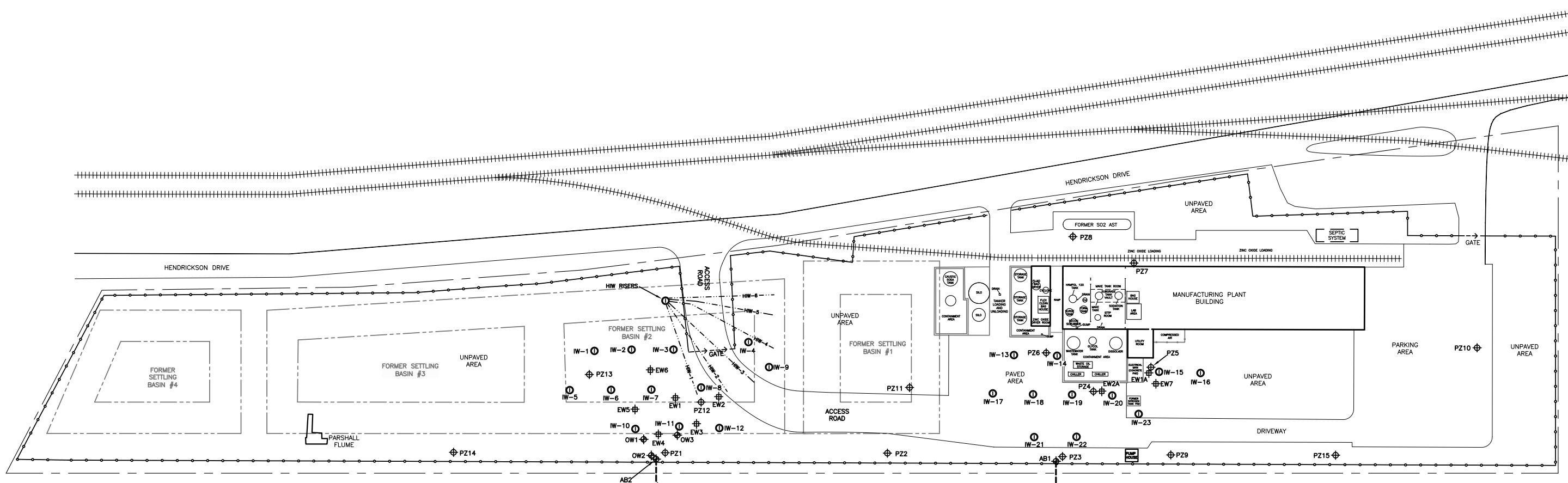
LEGEND

- Site Property Boundary
- Off-Site Property Boundary
- Kalamia City Boundary
- 600540200 Property Identification Number (PIN)



- Notes**
1. Map Source: Cowlitz County NetMaps
 2. PINs shaded red are outside Kalamia City limits

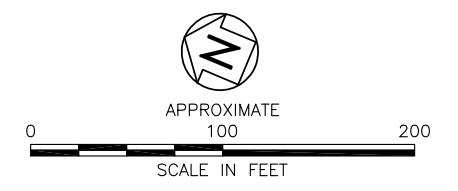
TITLE		SITE VICINITY MAP	
PROJECT		CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE ID No. 24634187 KALAMA, WASHINGTON	
		2923 South Tryon Street – Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f)	
DATE: 07/12/19	REVISION NO. 0		
JOB NO: CLR-045	FIGURE NO. 2		



COLUMBIA RIVER COLUMBIA RIVER COLUMBIA RIVER

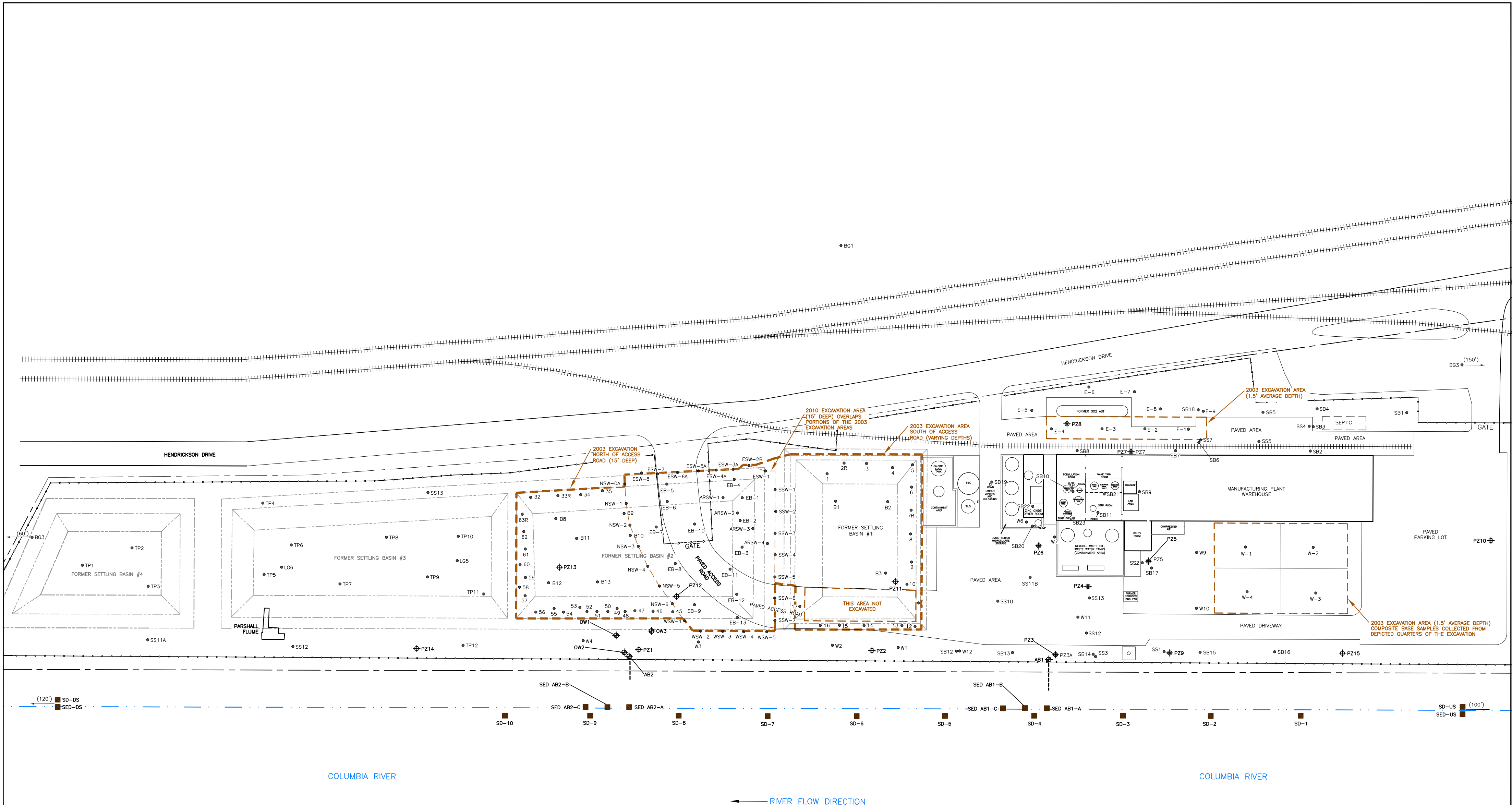
← RIVER FLOW DIRECTION

- LEGEND**
- — — — — PROPERTY LINE
 - ○ — ○ — FENCE LINE
 - + + + + + RAILROAD TRACK
 - · · · — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
 - - - - - EXTENT OF FORMER SETTLING BASIN
 - ⊕ MONITORING/OBSERVATION WELL
 - ⊕ PIEZOMETER
 - ⊙ INJECTION WELL
 - ⊕ RECOVERY WELL
 - - - - - EXTENT OF HORIZONTAL INJECTION WELL



NOTE: MANUFACTURING ACTIVITIES WERE CEASED AT THE SITE IN MID-2016, EQUIPMENT AND TANKS WERE DECOMMISSIONED AND CLEANED DURING 2016 AND 2017.

TITLE SITE MAP	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
 2923 South Tryon Street-Suite 100 Charlotte, North Carolina 28203 704-586-0007(p) 704-586-0373(f) License # C-1269 / #C-245 Geology	
DATE: 08-29-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 3



COLUMBIA RIVER

COLUMBIA RIVER

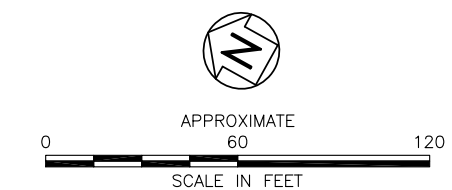
← RIVER FLOW DIRECTION

LEGEND

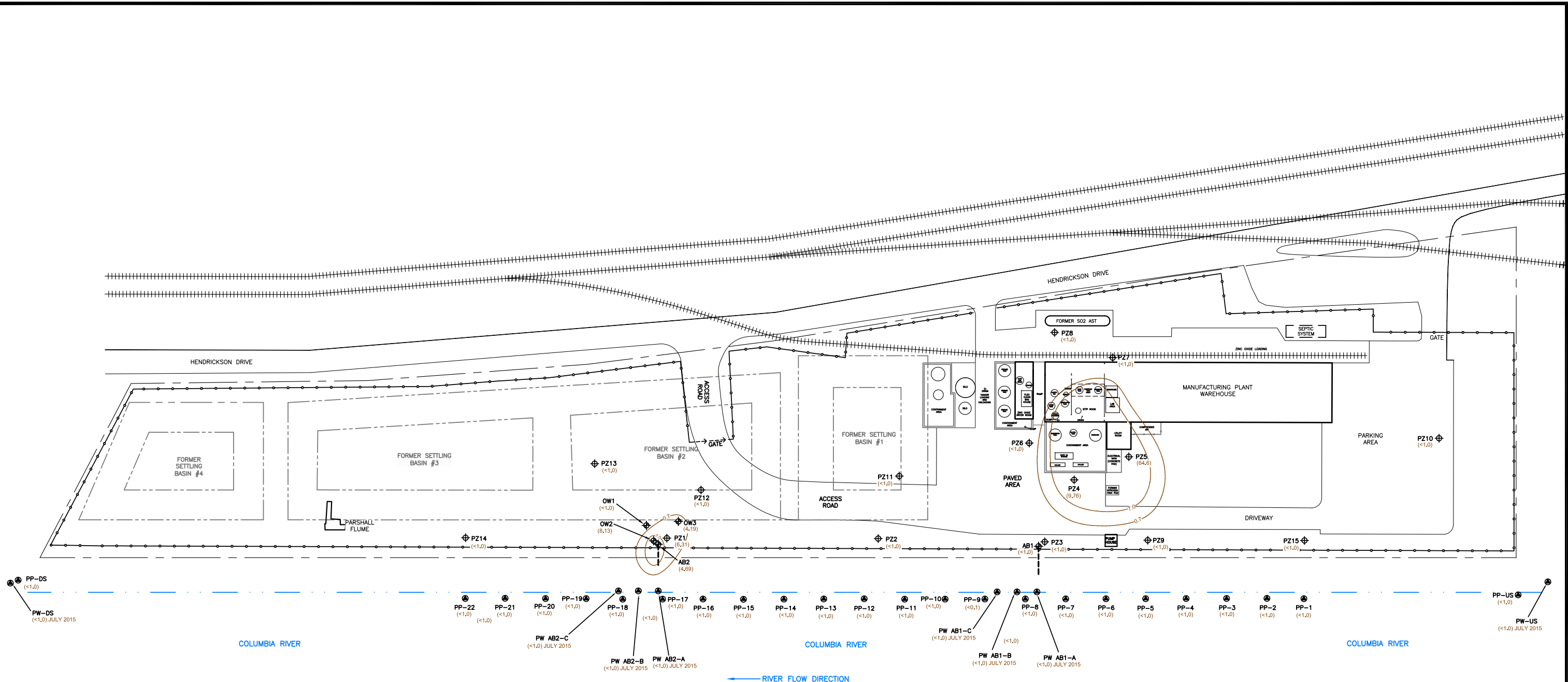
- — — — — PROPERTY LINE
- — — — — FENCE LINE
- — — — — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- ||||| RAILROAD TRACK
- — — — — EXTENT OF FORMER SETTLING BASIN (FSB)
- - - - - PERIMETER OF FORMER SOIL EXCAVATION
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION

NOTES

1. SOIL SAMPLE LOCATIONS ARE FROM SOIL WHICH REMAINS IN PLACE AT THE SITE AFTER COMPLETION OF EXCAVATION ACTIVITIES (REMAINING SOIL). SOIL SAMPLE LOCATIONS WHICH WERE REMOVED BY EXCAVATION ACTIVITIES ARE NOT DEPICTED.
 2. IMPORTED COLUMBIA RIVER DREDGE SPOILS OBTAINED FROM ADJACENT PROPERTY SOUTH OF THE SITE WERE USED TO BACKFILL EXCAVATIONS.
 3. SAMPLES OB1 THROUGH OB4, SB1-SURF-1/2/3/4, AND SB2-SURF-1/2/3/4 REPRESENT SOIL WITHIN THE EXTENTS OF FSB1 AND FSB2, BUT SAMPLE LOCATIONS ARE NOT KNOWN AND ARE NOT DEPICTED.



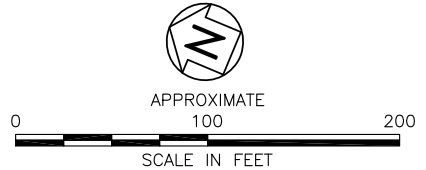
REMAINING SOIL SAMPLE AND SEDIMENT LOCATIONS	
PROJECT: CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
2923 South Tryon Street, Suite 100 Charlotte, North Carolina 28203 704-586-0077 (p) 704-586-0373 (f) License # C-1269 / #C-245 Geology	
DATE: 9-11-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 5



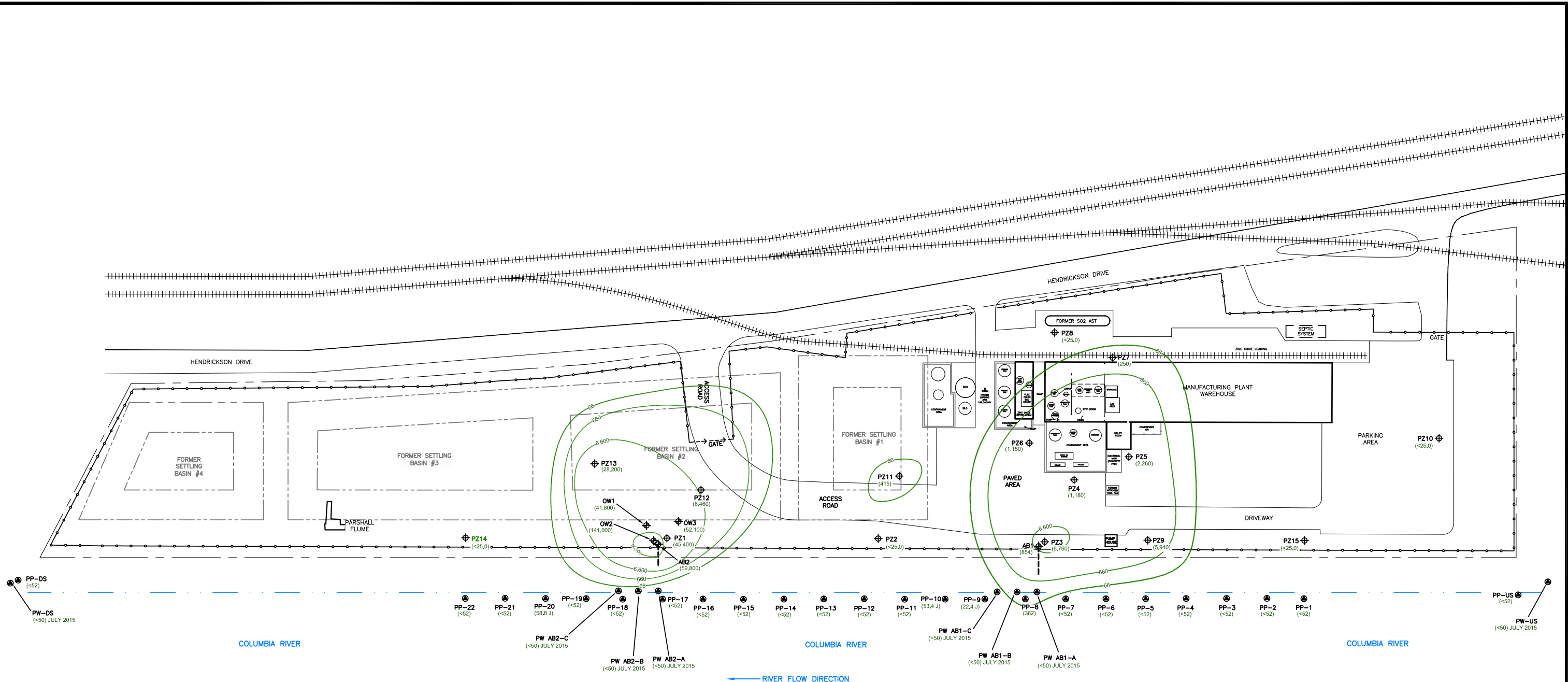
- LEGEND**
- — — — — PROPERTY LINE
 - ○ — ○ — FENCE LINE
 - + + + + + RAILROAD TRACK
 - · · · — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
 - - - - - EXTENT OF FORMER SETTLING BASIN
 - ⊕ MONITORING/OBSERVATION WELL
 - ⊕ PIEZOMETER
 - PUSHPOINT GROUNDWATER SAMPLE LOCATION
 - ▲ SURFACE WATER SAMPLE LOCATION
 - (4.19) CADMIUM CONCENTRATION IN µg/L
 - 0.7 — INFERRED GROUNDWATER CADMIUM ISOCONCENTRATION CONTOUR IN µg/L

NOTES

1. µg/L = MICROGRAMS PER LITER
2. THE BOTTOM OF ANGLE WELLS AB1 AND AB2 ARE LOCATED APPROXIMATELY 30 AND 20 FEET (RESPECTIVELY) SOUTHWEST OF THE WELL LOCATION DEPICTED ON THE MAP. THE DASHED LINES EXTENDING TOWARD THE COLUMBIA RIVER FROM THOSE WELLS INDICATES THE ESTIMATED LATERAL EXTENT OF EACH WELL IN THAT DIRECTION.
3. DATA IS FROM AUGUST 2017 UNLESS INDICATED OTHERWISE
4. PUSHPOINT GROUNDWATER SAMPLES WERE COLLECTED BELOW THE DEPTH OF THE BIOLOGICALLY ACTIVE ZONE AND WITHIN THE TRANSITIONAL GROUNDWATER ZONE.



TITLE CADMIUM ISOCONCENTRATION MAP (AUGUST 2017)	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
 2923 South Tryon Street-Suite 100 Charlotte, North Carolina 28203 704-586-0007(p) 704-586-0373(f) License # C-1269 / #C-245 Geology	
DATE: 09-11-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 6A

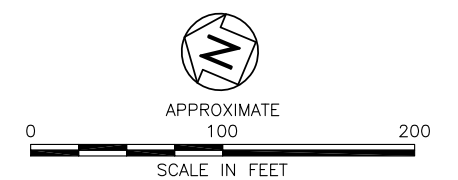


LEGEND

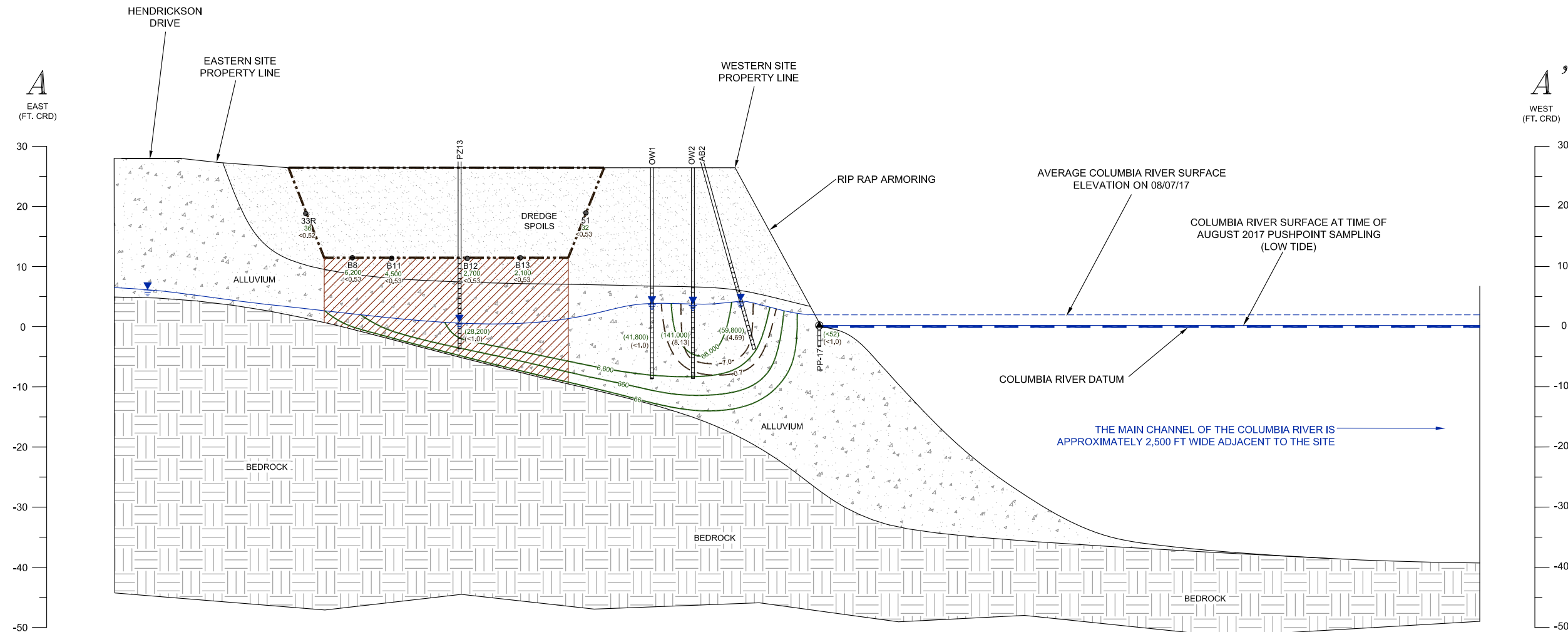
- — — — — PROPERTY LINE
- ○ — ○ — FENCE LINE
- +++++ RAILROAD TRACK
- · · · — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- - - - - EXTENT OF FORMER SETTLING BASIN
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- PUSHPOINT GROUNDWATER SAMPLE LOCATION
- ▲ SURFACE WATER SAMPLE LOCATION
- (6,460) ZINC CONCENTRATION IN µg/L
- 660 — INFERRED GROUNDWATER ZINC ISOCONCENTRATION CONTOUR IN µg/L

NOTES

1. µg/L = MICROGRAMS PER LITER
2. THE BOTTOM OF ANGLE WELLS AB1 AND AB2 ARE LOCATED APPROXIMATELY 30 AND 20 FEET (RESPECTIVELY) SOUTHWEST OF THE WELL LOCATION DEPICTED ON THE MAP. THE DASHED LINES EXTENDING TOWARD THE COLUMBIA RIVER FROM THOSE WELLS INDICATES THE ESTIMATED LATERAL EXTENT OF EACH WELL IN THAT DIRECTION.
3. DATA IS FROM AUGUST 2017 UNLESS INDICATED OTHERWISE
4. PUSHPOINT GROUNDWATER SAMPLES WERE COLLECTED BELOW THE DEPTH OF THE BIOLOGICALLY ACTIVE ZONE AND WITHIN THE TRANSITIONAL GROUNDWATER ZONE.



TITLE ZINC ISOCONCENTRATION MAP (AUGUST 2017)	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
 2923 South Tryon Street-Suite 100 Charlotte, North Carolina 28203 704-586-0007(p) 704-586-0373(f) License # C-1269 / #C-245 Geology	
DATE: 09-11-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 6B

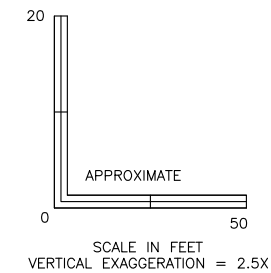


LEGEND

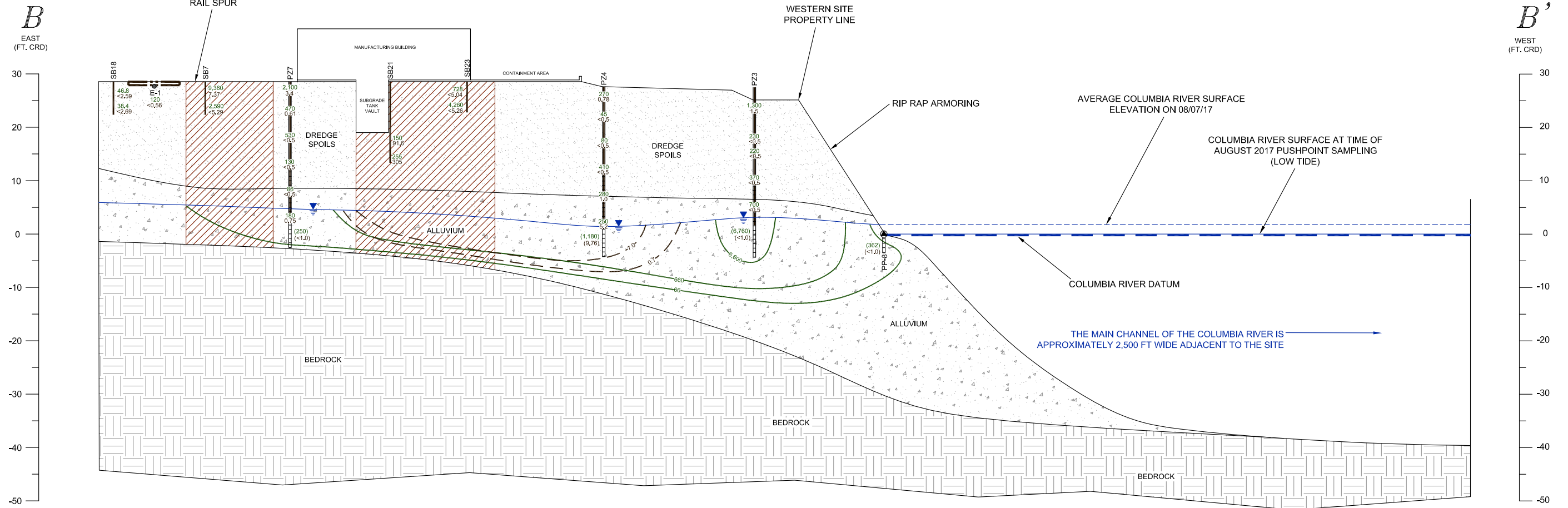
- AUGUST 2017 GROUNDWATER TABLE
- APPROXIMATE EXTENT OF SOIL EXCAVATION
- SOIL SAMPLE LOCATION (B11, B12, AND B13 OFF-SET FROM CROSS-SECTION TRANSECT LINE)
- PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
- 6,200 ZINC CONCENTRATION IN SOIL (mg/kg)
- <0.53 CADMIUM CONCENTRATION IN SOIL (mg/kg)
- (41,800) AUGUST 2017 ZINC CONCENTRATION IN GROUNDWATER (µg/L)
- (8,13) AUGUST 2017 CADMIUM CONCENTRATION IN GROUNDWATER (µg/L)
- 6,600 INFERRED GROUNDWATER ZINC ISOCONCENTRATION CONTOUR IN µg/L
- 7.0 INFERRED GROUNDWATER CADMIUM ISOCONCENTRATION CONTOUR IN µg/L
- AREA OF SATURATED AND UNSATURATED ZONE SOIL POTENTIALLY IMPACTED WITH ZINC CONCENTRATIONS WHICH MAY BE A SOURCE OF GROUNDWATER IMPACTS
- RIVER DREDGE SPOILS (FINE TO COARSE-GRAIN SANDS)
- ALLUVIUM (FINE TO COARSE-GRAIN SANDS WITH SILTS AND GRAVELS)
- BEDROCK (BASALTIC ANDESITE)
- MONITOR WELL
- SCREENED INTERVAL

NOTES

1. COLUMBIA RIVER IS TIDAL AT SITE LOCATION.
2. GROUNDWATER ELEVATIONS ARE FROM AUGUST 7, 2017.
3. EASTERN LIMIT OF 43 FT FEDERALLY MAINTAINED DEEP DRAFT NAVIGATION CHANNEL IS LOCATED APPROXIMATELY 900 FT FROM WESTERN SITE PROPERTY BOUNDARY.
4. µg/L = MICROGRAMS PER LITER; mg/kg = MILLIGRAMS PER KILOGRAM; CRD = COLUMBIA RIVER DATUM
5. CROSS-SECTION TRANSECT LINE SHOWN IN FIGURE 7.



TITLE CROSS-SECTION A-A'	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
2923 South Tryon Street-Suite 100 Charlotte, North Carolina 28203 704-586-0007(p) 704-586-0373(f) License # C-1269 / #C-245 Geology	
DATE: 09/25/19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 8A

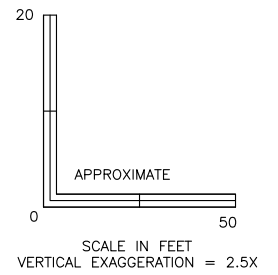


LEGEND

- AUGUST 2017 GROUNDWATER TABLE
- APPROXIMATE EXTENT OF SOIL EXCAVATION
- SOIL SAMPLE LOCATION (B11, B12, AND B13 OFF-SET FROM CROSS-SECTION TRANSECT LINE)
- PUSHPOINT (TRANSITIONAL ZONE GROUNDWATER SAMPLE LOCATION)
- 255 ZINC CONCENTRATION IN SOIL (mg/kg)
- 305 CADMIUM CONCENTRATION IN SOIL (mg/kg)
- (1,180) AUGUST 2017 ZINC CONCENTRATION IN GROUNDWATER (µg/L)
- (9.76) AUGUST 2017 CADMIUM CONCENTRATION IN GROUNDWATER (µg/L)
- 6,600 INFERRED ZINC ISOCONCENTRATION CONTOUR IN µg/L
- 7.0 INFERRED CADMIUM ISOCONCENTRATION CONTOUR IN µg/L
- AREA OF SATURATED AND UNSATURATED ZONE SOIL POTENTIALLY IMPACTED WITH ZINC AND/OR CADMIUM CONCENTRATIONS WHICH MAY BE A SOURCE OF GROUNDWATER IMPACTS
- RIVER DREDGE SPOILS (FINE TO COARSE-GRAIN SANDS)
- ALLUVIUM (FINE TO COARSE-GRAIN SANDS WITH SILTS AND GRAVELS)
- BEDROCK (BASALTIC ANDESITE)
- MONITOR WELL
- SOIL BORING
- SCREENED INTERVAL

NOTES

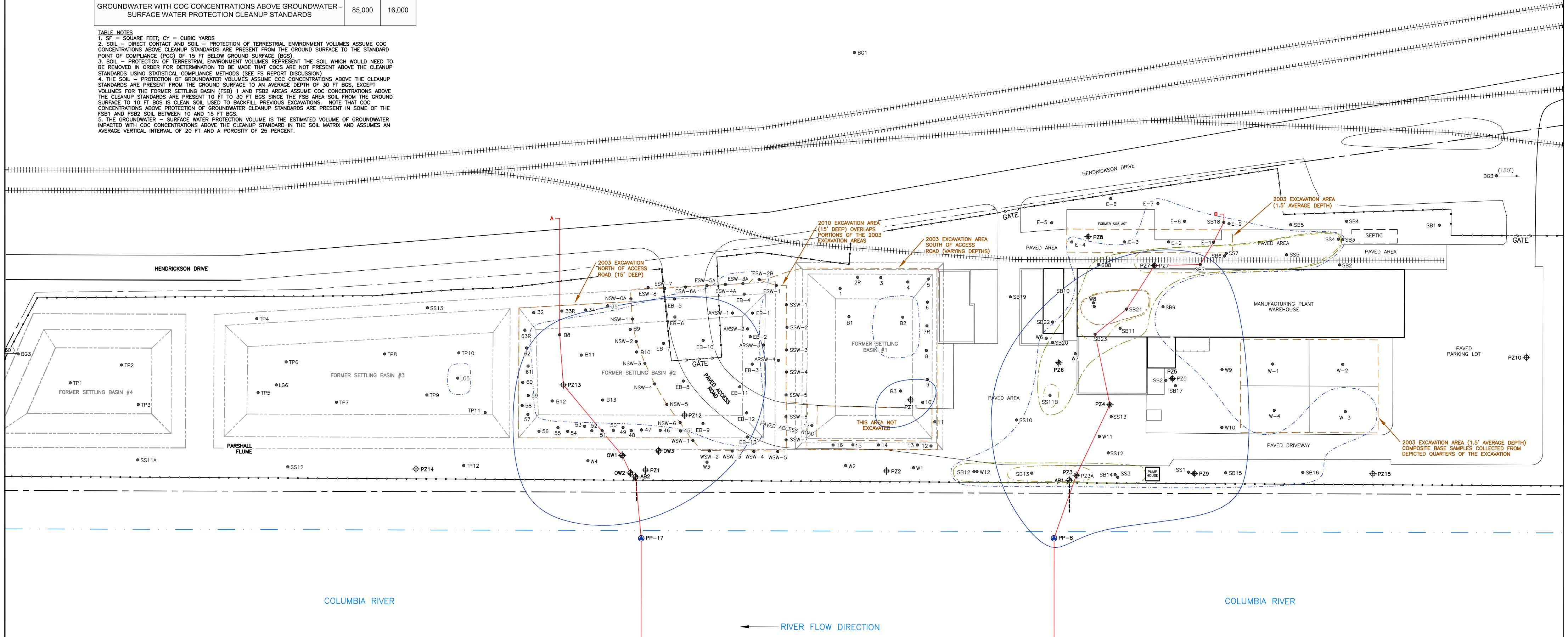
- COLUMBIA RIVER IS TIDAL AT SITE LOCATION.
- GROUNDWATER ELEVATIONS ARE FROM AUGUST 7, 2017.
- EASTERN LIMIT OF 43 FT IS FEDERALLY MAINTAINED DEEP DRAFT NAVIGATION CHANNEL LOCATED APPROXIMATELY 900 FT FROM WESTERN SITE PROPERTY BOUNDARY.
- µg/L = MICROGRAMS PER LITER; mg/kg = MILLIGRAMS PER KILOGRAM; CRD = COLUMBIA RIVER DATUM
- CROSS-SECTION TRANSECT LINE SHOWN IN FIGURE 7.



TITLE CROSS-SECTION B-B'	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
2923 South Tryon Street-Suite 100 Charlotte, North Carolina 28203 704-586-0007(p) 704-586-0373(f) License # C-1269 / #C-245 Geology	
DATE: 09/25/19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 8B

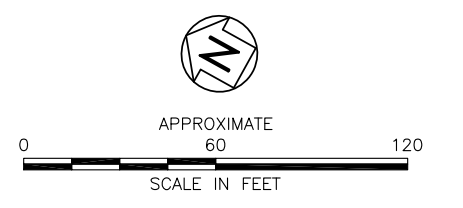
	AREA (SF)	VOLUME* (CY)
SOIL WITH COC CONCENTRATIONS ABOVE SOIL - DIRECT CONTACT CLEANUP STANDARDS	1,500	840
SOIL WITH COC CONCENTRATIONS ABOVE UNRESTRICTED LAND USE SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT CLEANUP STANDARDS (SEE NOTE 3)	15,000	8,300
SOIL WITH COC CONCENTRATIONS ABOVE INDUSTRIAL SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT CLEANUP STANDARDS	8,000	4,500
SOIL WITH COC CONCENTRATIONS ABOVE SOIL - PROTECTION OF GROUNDWATER CLEANUP STANDARDS	71,000	69,000
GROUNDWATER WITH COC CONCENTRATIONS ABOVE GROUNDWATER - SURFACE WATER PROTECTION CLEANUP STANDARDS	85,000	16,000

TABLE NOTES
1. SF = SQUARE FEET, CY = CUBIC YARDS
2. SOIL - DIRECT CONTACT AND SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT VOLUMES ASSUME COC CONCENTRATIONS ABOVE CLEANUP STANDARDS ARE PRESENT FROM THE GROUND SURFACE TO THE STANDARD POINT OF COMPLIANCE (POC) OF 15 FT BELOW GROUND SURFACE (BGS).
3. SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT VOLUMES REPRESENT THE SOIL WHICH WOULD NEED TO BE REMOVED IN ORDER FOR DETERMINATION TO BE MADE THAT COCS ARE NOT PRESENT ABOVE THE CLEANUP STANDARDS USING STATISTICAL COMPLIANCE METHODS (SEE FS REPORT DISCUSSION).
4. THE SOIL - PROTECTION OF GROUNDWATER VOLUMES ASSUME COC CONCENTRATIONS ABOVE THE CLEANUP STANDARDS ARE PRESENT FROM THE GROUND SURFACE TO AN AVERAGE DEPTH OF 30 FT BGS, EXCEPT VOLUMES FOR THE FORMER SETTLING BASIN (FSB) 1 AND FSB2 AREAS ASSUME COC CONCENTRATIONS ABOVE THE CLEANUP STANDARDS ARE PRESENT 10 FT TO 30 FT BGS SINCE THE FSB AREA SOIL FROM THE GROUND SURFACE TO 10 FT BGS IS CLEAN SOIL USED TO BACKFILL PREVIOUS EXCAVATIONS. NOTE THAT COC CONCENTRATIONS ABOVE PROTECTION OF GROUNDWATER CLEANUP STANDARDS ARE PRESENT IN SOME OF THE FSB1 AND FSB2 SOIL BETWEEN 10 AND 15 FT BGS.
5. THE GROUNDWATER - SURFACE WATER PROTECTION VOLUME IS THE ESTIMATED VOLUME OF GROUNDWATER IMPACTED WITH COC CONCENTRATIONS ABOVE THE CLEANUP STANDARD IN THE SOIL MATRIX AND ASSUMES AN AVERAGE VERTICAL INTERVAL OF 20 FT AND A POROSITY OF 25 PERCENT.



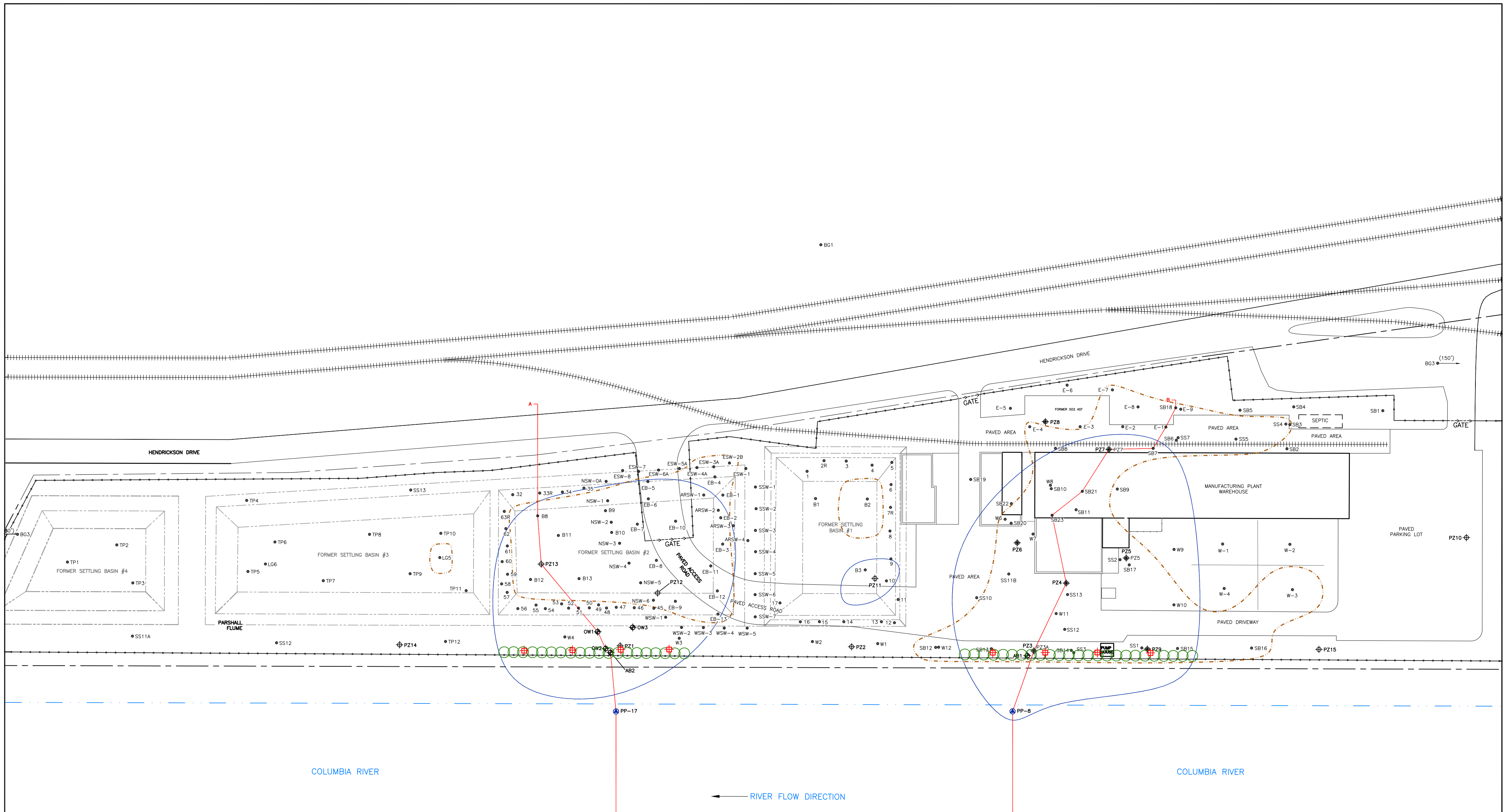
LEGEND

- PROPERTY LINE
- FENCE LINE
- APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- RAILROAD TRACK
- EXTENT OF FORMER SETTLING BASIN (FSB)
- PERIMETER OF FORMER SOIL EXCAVATION
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- ⊕ PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN SOIL ABOVE SOIL - DIRECT CONTACT CLEANUP STANDARDS
- ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN SOIL ABOVE INDUSTRIAL SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT CLEANUP STANDARDS
- ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN SOIL ABOVE UNRESTRICTED LAND USE SOIL - PROTECTION OF TERRESTRIAL ENVIRONMENT CLEANUP STANDARDS (SEE TABLE NOTE 3)
- ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN SOIL ABOVE SOIL - PROTECTION OF GROUNDWATER CLEANUP STANDARDS
- ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN GROUNDWATER ABOVE GROUNDWATER CLEANUP STANDARDS
- CROSS-SECTION TRANSECT LINE (CROSS-SECTIONS PRESENTED IN FIGURES 8A AND 8B)



NOTES
1. SOIL SAMPLE LOCATIONS ARE FROM SOIL WHICH REMAINS IN PLACE AT THE SITE AFTER COMPLETION OF EXCAVATION ACTIVITIES (REMAINING SOIL). SOIL SAMPLE LOCATIONS WHICH WERE REMOVED BY EXCAVATION ACTIVITIES ARE NOT DEPICTED.
2. IMPORTED COLUMBIA RIVER DREDGE SPOILS OBTAINED FROM ADJACENT PROPERTY SOUTH OF THE SITE WERE USED TO BACKFILL EXCAVATIONS.
3. SAMPLES OB1 THROUGH OB4, SB1-SURF-1/2/3/4, AND SB2-SURF-1/2/3/4 REPRESENT SOIL WITHIN THE EXTENTS OF FSB1 AND FSB2, BUT EXACT LOCATIONS ARE NOT KNOWN AND THE SAMPLES ARE NOT DEPICTED.
4. ESTIMATED EXTENTS OF COC IN GROUNDWATER ABOVE A GROUNDWATER CLEANUP STANDARD ARE BASED ON AUGUST 2017 SAMPLE DATA.
5. THE BOTTOM OF ANGLE WELLS AB1 AND AB2 LOCATED APPROXIMATELY 30 AND 20 FEET (RESPECTIVELY) SOUTHWEST OF THE WELL LOCATION DEPICTED ON THE MAP. THE DASHED LINES EXTENDING TOWARD THE COLUMBIA RIVER FROM THOSE WELLS INDICATES THE ESTIMATED LATERAL EXTENT OF EACH WELL IN THAT DIRECTION.

ESTIMATED EXTENTS AND VOLUMES OF COC CONCENTRATIONS ABOVE CLEANUP STANDARDS	
CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
	2923 South Tryon Street, Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f) License # C-1269 / #C-245 Geology
DATE: 09-25-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 9

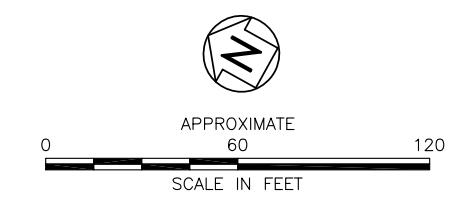


LEGEND

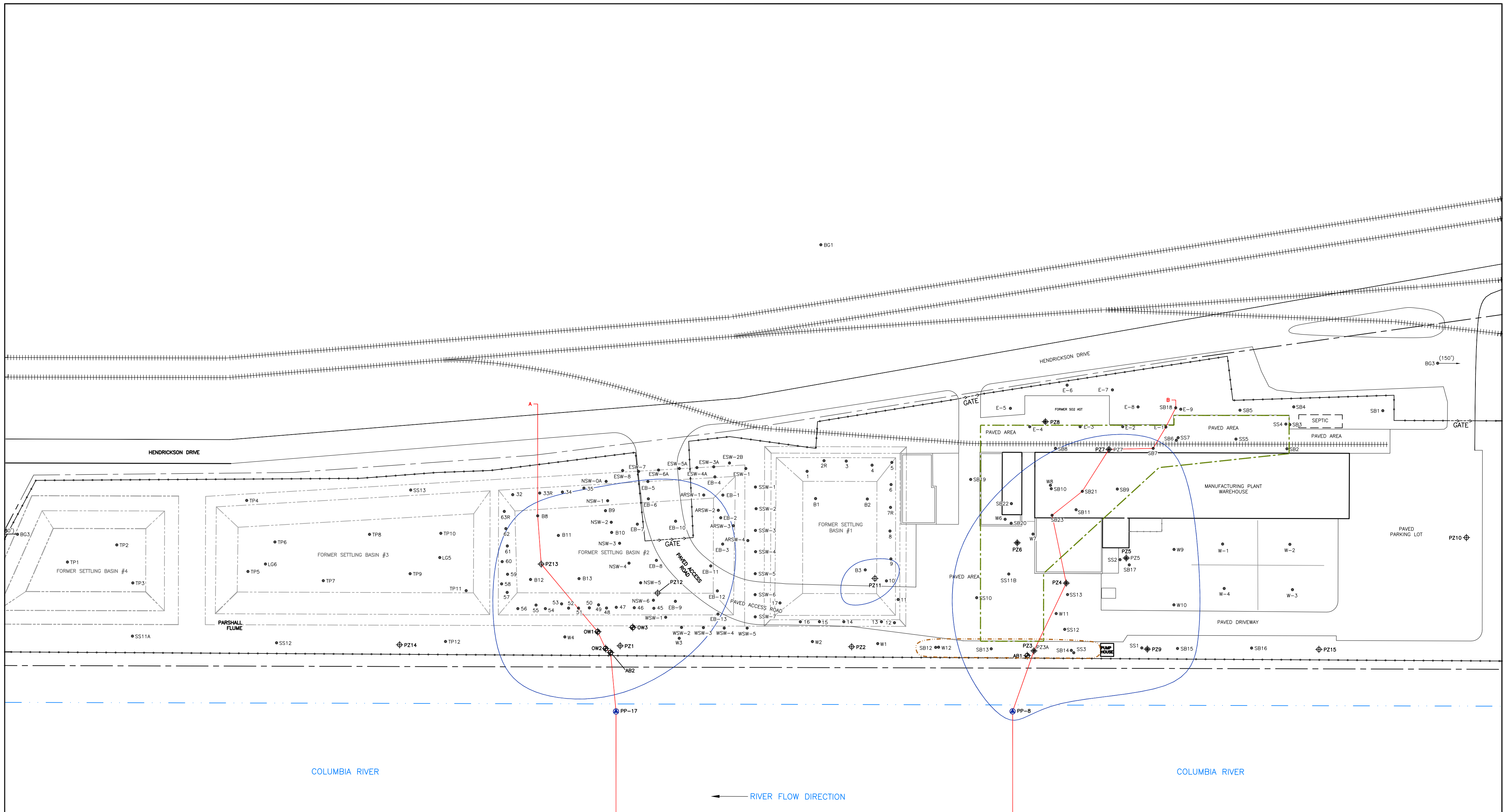
- — — — — PROPERTY LINE
- — — — — FENCE LINE
- — — — — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- ||||| RAILROAD TRACK
- EXTENT OF FORMER SETTLING BASIN (FSB)
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- ⊕ PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- — — — — ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN GROUNDWATER ABOVE GROUNDWATER CLEANUP STANDARDS
- — — — — CROSS-SECTION TRANSECT LINE (CROSS-SECTIONS PRESENTED IN FIGURES 8A AND 8B)
- — — — — APPROXIMATE HORIZONTAL EXTENT OF SOIL REMEDIATION AREA (SEE NOTE 3)
- ⊕ GROUNDWATER EXTRACTION WELL (ALTERNATIVE #1)
- ⊕ TEMPORARY INJECTION WELL LOCATION WITH 5 FT RADIUS OF INFLUENCE DEPICTED (ALTERNATIVES #2 AND #3)

NOTES

1. SOIL SAMPLE LOCATIONS ARE FROM SOIL WHICH REMAINS IN PLACE AT THE SITE AFTER COMPLETION OF EXCAVATION ACTIVITIES (REMAINING SOIL). SOIL SAMPLE LOCATIONS WHICH WERE REMOVED BY EXCAVATION ACTIVITIES ARE NOT DEPICTED.
2. ESTIMATED EXTENTS OF COC IN GROUNDWATER ABOVE A GROUNDWATER CLEANUP STANDARD ARE BASED ON AUGUST 2017 SAMPLE DATA.
3. SOIL REMEDIATION EXTENTS REPRESENT THE AREAS THAT WILL BE REMOVED TO AN AVERAGE DEPTH OF 30 FT BELOW GROUND SURFACE (BGS) FOR ALTERNATIVES #1 AND #2 AND THE AREAS THAT WILL BE REMOVED TO AN AVERAGE DEPTH OF 15 FT BGS FOR ALTERNATIVE #3. ALTERNATIVE #3 INCLUDES IN-SITU SOIL SOLIDIFICATION OF SOIL IN THESE AREAS FROM 15 TO 30 FT BGS. THE EXTENTS OF SOIL TO BE REMOVED FOR SIDEWALL SLOPE STABILIZATION ARE NOT DEPICTED.



FILE CLEANUP ALTERNATIVES #1, #2, AND #3 REMEDY MAP	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
2923 South Tryon Street, Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f) License # C-1269 / #C-245 Geology	
DATE: 09-25-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 10

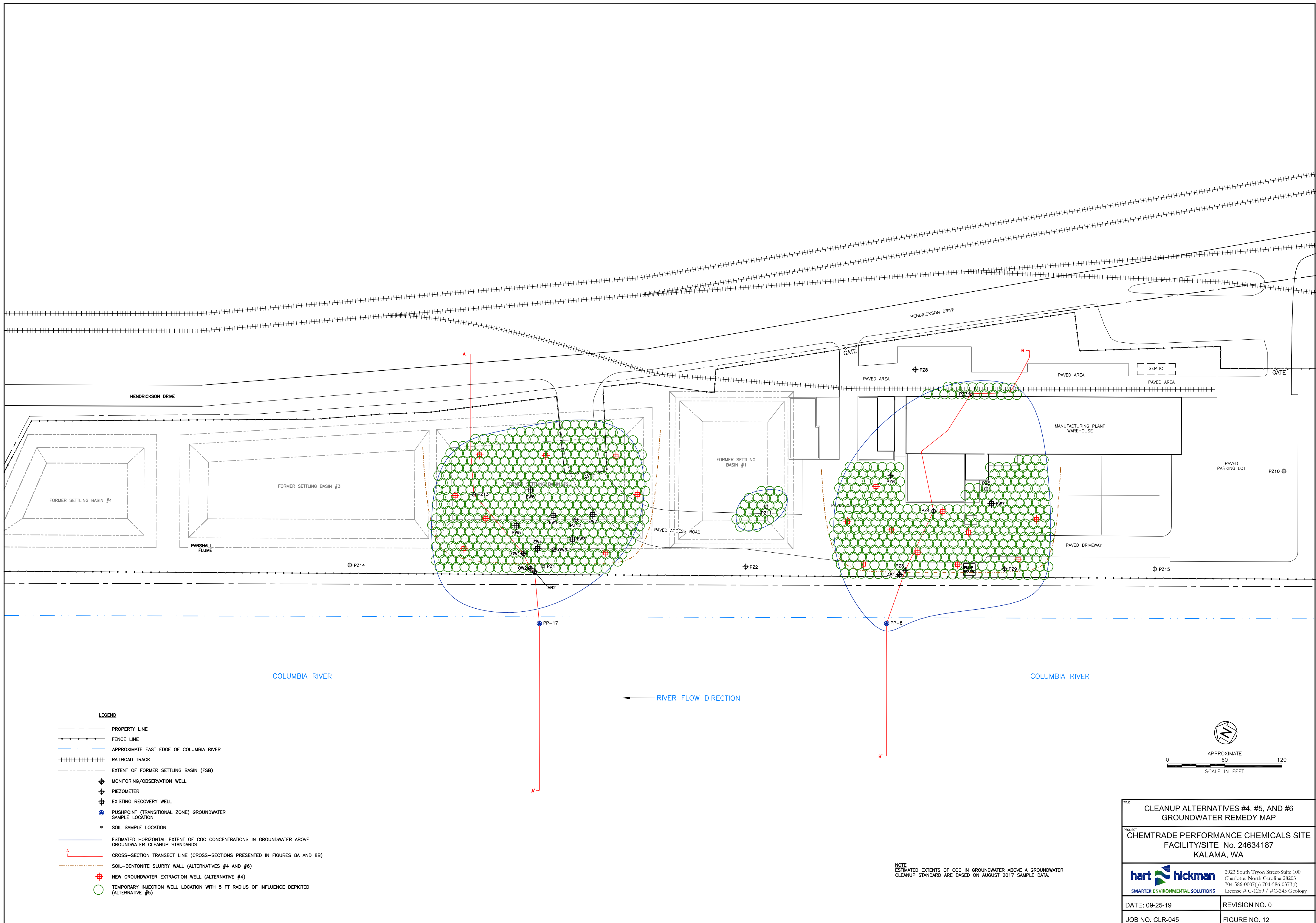


- LEGEND**
- PROPERTY LINE
 - - - FENCE LINE
 - - - - - APPROXIMATE EAST EDGE OF COLUMBIA RIVER
 - ||||| RAILROAD TRACK
 - - - - - EXTENT OF FORMER SETTLING BASIN (FSB)
 - ⊕ MONITORING/OBSERVATION WELL
 - ⊕ PIEZOMETER
 - ⊕ PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
 - SOIL SAMPLE LOCATION
 - ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN GROUNDWATER ABOVE GROUNDWATER CLEANUP STANDARDS
 - CROSS-SECTION TRANSECT LINE (CROSS-SECTIONS PRESENTED IN FIGURES 8A AND 8B)
 - APPROXIMATE HORIZONTAL EXTENT OF SOIL REMOVAL AREA (SEE NOTE 3)
 - APPROXIMATE HORIZONTAL EXTENTS OF CONCRETE SLABS AND PAVEMENT TO BE MAINTAINED UNDER AN INSTITUTIONAL CONTROL

NOTES

- SOIL SAMPLE LOCATIONS ARE FROM SOIL WHICH REMAINS IN PLACE AT THE SITE AFTER COMPLETION OF EXCAVATION ACTIVITIES (REMAINING SOIL). SOIL SAMPLE LOCATIONS WHICH WERE REMOVED BY EXCAVATION ACTIVITIES ARE NOT DEPICTED.
- ESTIMATED EXTENTS OF COC IN GROUNDWATER ABOVE A GROUNDWATER CLEANUP STANDARD ARE BASED ON AUGUST 2017 SAMPLE DATA.
- SOIL REMOVAL EXTENTS REPRESENT THE AREA THAT WILL BE REMOVED TO A DEPTH OF 6 FT BELOW GROUND SURFACE (BGS). THE EXTENT OF SOIL TO BE REMOVED FOR SIDEWALL SLOPE STABILIZATION IS NOT DEPICTED.

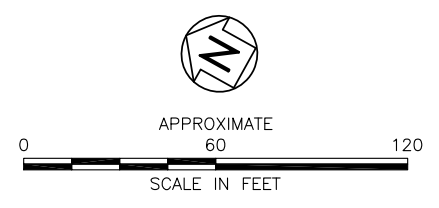
<p>THE CLEANUP ALTERNATIVES #4, #5, #6, AND #7 SOIL REMOVAL AND INSTITUTIONAL CONTROL MAP</p>	
<p>PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA</p>	
<p>hart hickman SMARTER ENVIRONMENTAL SOLUTIONS</p>	
<p>2923 South Tryon Street, Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f) License # C-1269 / #C-245 Geology</p>	
DATE: 09-25-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 11




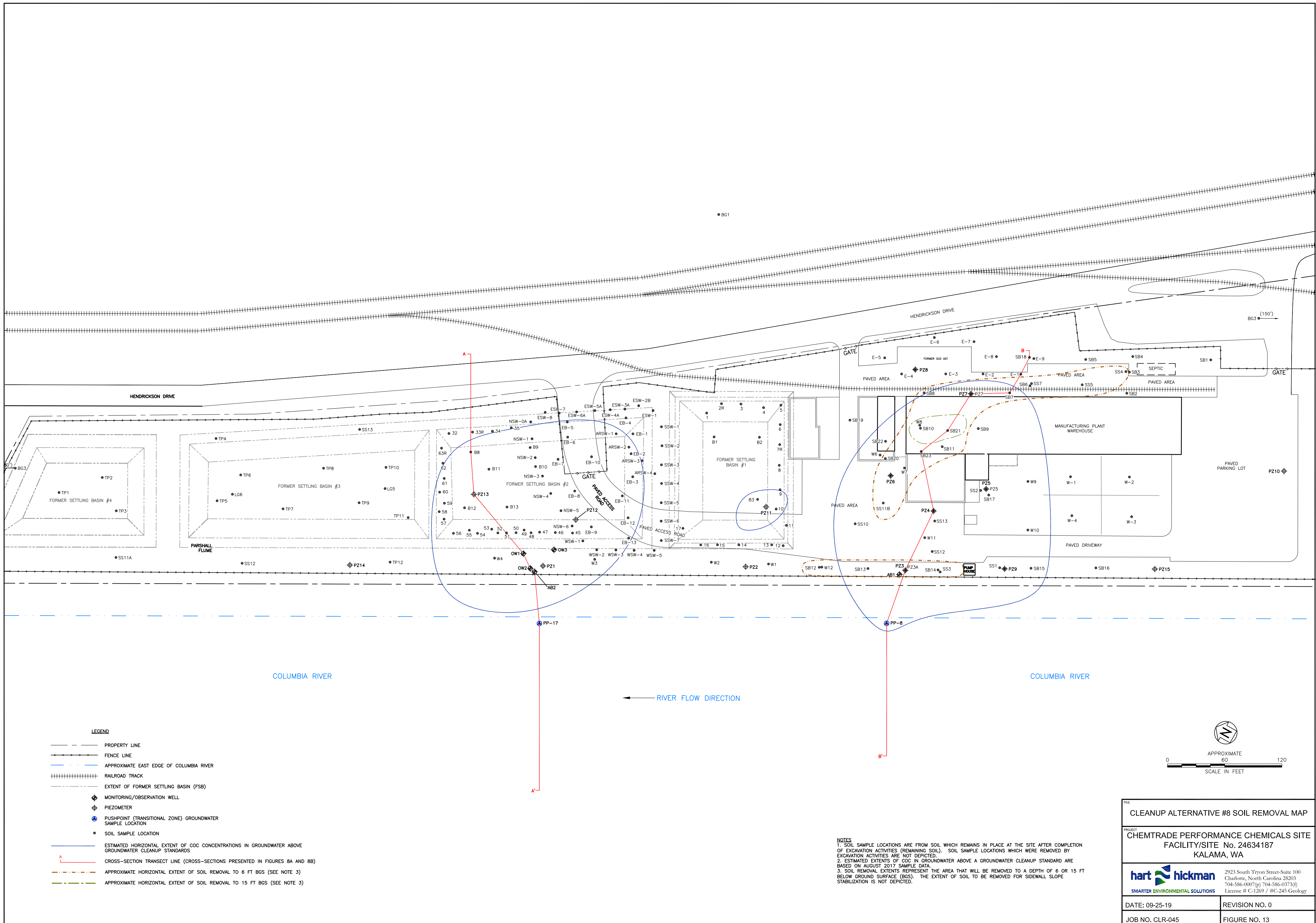
LEGEND

- — — — — PROPERTY LINE
- — — — — FENCE LINE
- — — — — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- ||||| RAILROAD TRACK
- - - - - EXTENT OF FORMER SETTLING BASIN (FSB)
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- ⊕ EXISTING RECOVERY WELL
- ⊕ PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- — — — — ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN GROUNDWATER ABOVE GROUNDWATER CLEANUP STANDARDS
- — — — — CROSS-SECTION TRANSECT LINE (CROSS-SECTIONS PRESENTED IN FIGURES 8A AND 8B)
- — — — — SOIL-BENTONITE SLURRY WALL (ALTERNATIVES #4 AND #6)
- ⊕ NEW GROUNDWATER EXTRACTION WELL (ALTERNATIVE #4)
- ⊕ TEMPORARY INJECTION WELL LOCATION WITH 5 FT RADIUS OF INFLUENCE DEPICTED (ALTERNATIVE #5)

NOTE
ESTIMATED EXTENTS OF COC IN GROUNDWATER ABOVE A GROUNDWATER CLEANUP STANDARD ARE BASED ON AUGUST 2017 SAMPLE DATA.

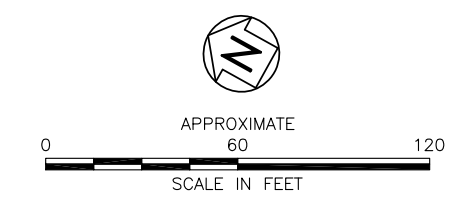


TITLE CLEANUP ALTERNATIVES #4, #5, AND #6 GROUNDWATER REMEDY MAP	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
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DATE: 09-25-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 12



LEGEND

- — — — — PROPERTY LINE
- — — — — FENCE LINE
- — — — — APPROXIMATE EAST EDGE OF COLUMBIA RIVER
- ||||| RAILROAD TRACK
- — — — — EXTENT OF FORMER SETTLING BASIN (FSB)
- ⊕ MONITORING/OBSERVATION WELL
- ⊕ PIEZOMETER
- ⊕ PUSHPOINT (TRANSITIONAL ZONE) GROUNDWATER SAMPLE LOCATION
- SOIL SAMPLE LOCATION
- — — — — ESTIMATED HORIZONTAL EXTENT OF COC CONCENTRATIONS IN GROUNDWATER ABOVE GROUNDWATER CLEANUP STANDARDS
- — — — — CROSS-SECTION TRANSECT LINE (CROSS-SECTIONS PRESENTED IN FIGURES 8A AND 8B)
- — — — — APPROXIMATE HORIZONTAL EXTENT OF SOIL REMOVAL TO 6 FT BGS (SEE NOTE 3)
- — — — — APPROXIMATE HORIZONTAL EXTENT OF SOIL REMOVAL TO 15 FT BGS (SEE NOTE 3)



NOTES

1. SOIL SAMPLE LOCATIONS ARE FROM SOIL WHICH REMAINS IN PLACE AT THE SITE AFTER COMPLETION OF EXCAVATION ACTIVITIES (REMAINING SOIL). SOIL SAMPLE LOCATIONS WHICH WERE REMOVED BY EXCAVATION ACTIVITIES ARE NOT DEPICTED.
2. ESTIMATED EXTENTS OF COC IN GROUNDWATER ABOVE A GROUNDWATER CLEANUP STANDARD ARE BASED ON AUGUST 2017 SAMPLE DATA.
3. SOIL REMOVAL EXTENTS REPRESENT THE AREA THAT WILL BE REMOVED TO A DEPTH OF 6 OR 15 FT BELOW GROUND SURFACE (BGS). THE EXTENT OF SOIL TO BE REMOVED FOR SIDEWALL SLOPE STABILIZATION IS NOT DEPICTED.

FILE CLEANUP ALTERNATIVE #8 SOIL REMOVAL MAP	
PROJECT CHEMTRADE PERFORMANCE CHEMICALS SITE FACILITY/SITE No. 24634187 KALAMA, WA	
2923 South Tryon Street, Suite 100 Charlotte, North Carolina 28203 704-586-0007 (p) 704-586-0373 (f) License # C-1269 / #C-245 Geology	
DATE: 09-25-19	REVISION NO. 0
JOB NO. CLR-045	FIGURE NO. 13

Appendix A
Statistical Analyses of COCs in Remaining Site Soil

Appendix A - Statistical Analyses of COCs in Remaining Site Soil

As discussed in Section 2.4.1.2 of the FS report, the simplified terrestrial ecological evaluation process presented in WAC 173-340-7492(2) includes analysis of contaminants as a screening step in evaluating ecological risk at a site, and indicates this analysis may be used to determine that no further evaluation is necessary to conclude that a site does not pose a substantial threat of significant adverse effects to terrestrial ecological receptors. The evaluation may be ended if a contaminant analysis indicates no hazardous substance listed in Table 749-2 of WAC 173-340-900 is, or will be, present in the soil at a depth not exceeding the POC at concentrations higher than the values provided in Table 749-2 of WAC 173-340-900, using the statistical compliance methods described in WAC 173-340-740(7).

Per WAC 173-340-740(7)(c), data analysis and evaluation procedures used to evaluate compliance with soil CULs shall be defined in a compliance monitoring plan prepared under WAC 173-340-410. Note that WAC 173-340-410(2) indicates that compliance monitoring shall be required for all cleanup actions and that a compliance monitoring plan shall be prepared unless otherwise directed by Ecology. Per WAC 173-340-740(7)(d)(i), when data analysis procedures for evaluating compliance are not specified in an applicable state or federal law, a confidence interval approach may be used where the upper one-sided ninety-five percent confidence limit on the true mean soil concentration (95% UCL) is less than the soil CUL. Finally, WAC 173-340-740(7)(e) indicates that for all data analysis methods used:

- (i) No single sample concentration shall be greater than two times the soil CUL; and,
- (ii) Less than 10 percent of the sample concentrations shall exceed the soil CUL.

The July 5, 2018 Opinion included a draft memorandum for a statistical analysis completed by Ecology on sample data for soil collected at the Site prior to 2017 which determined recommended 95% UCLs of 1.6 and 450 mg/kg for cadmium and zinc, respectively. Note that soil samples were collected at the site during August 2018 (after completion of this analysis by Ecology). Per the memorandum, the recommended results of the analysis were based off of calculations performed through the MTCASat 97 Site Module (MTCASat). As discussed in the

memorandum, both MTCASat (which meets the requirements of WAC 173-340-740(7)(d)(i)) and EPA's ProUCL software (which meets the requirements of WAC 173-340-740(7)(d)(iv)) were used in the analysis and the methods in MTCASat were preferred because of the ratio of detected versus non-detected values in the zinc sample set. Non-detected values were assigned a value at the laboratory method detection limit (MDL), or at the laboratory practical quantitation limit (PQL) for sample results not reported to the MDL, because of the number of non-detects in the sample set (less than 50%). The memorandum indicates that this is an alternate statistical procedure that appears appropriate per WAC 173-340-740(7)(f)(v). In addition, the memorandum notes that outliers were included in the data sets because there are no provisions in MTCA for excluding outliers that cannot be demonstrated to be in error.

The memorandum notes that the specific data set used to make statistical calculations may be amended if it is recommended by the Ecology Site Manager that specific pathways should be excluded with the use of an environmental covenant.

Updated 95% UCL concentrations for cadmium and zinc in remaining Site soil were calculated for multiple scenarios using MTCASat for comparison of remaining soil concentrations to soil – protection of terrestrial environment CULs in FS evaluations. For each calculation:

- Data for samples collected from 15 ft bgs or deeper were not included in the evaluations because they are below the standard POC.
- Non-detect values were assigned a value at the laboratory MDL, or at the laboratory PQL for sample results not reported to the MDL.
- Sample data for imported fill used to backfill the excavations was conservatively not used in the calculations despite the fact that excavation backfill accounts for a relatively large percentage of the volume of remaining soil at the site. Note that cadmium was not detected in backfill samples and zinc was detected at low levels (averaging 34 mg/kg).
- The 95% UCL concentrations are based on Z-statistic (which is consistent with the recommended 95% UCL concentrations previously determined by Ecology).

Soil sample data used in the 95% UCL concentrations calculations are presented in Table 1 of this appendix and MTCASat compliance calculations reports are also included in this appendix.

Sitewide Soil - Cadmium 95% UCL

The 95% UCL cadmium concentration was calculated for remaining Sitewide soil samples to the standard POC. A 95% UCL cadmium concentration of approximately 6.4 mg/kg was calculated using the data.

Sitewide Soil - Zinc 95% UCL

The 95% UCL zinc concentration was calculated for remaining Sitewide soil samples to the standard POC. A 95% UCL zinc concentration of approximately 544 mg/kg was calculated using the data.

Uncovered Soil - Cadmium 95% UCL

The 95% UCL cadmium concentration was calculated for remaining Sitewide soil samples that are not covered by existing structures or pavement to the standard POC at the site. A 95% UCL cadmium concentration of approximately 1.3 mg/kg was calculated using the data.

Uncovered Soil - Zinc 95% UCL

The 95% UCL zinc concentration was calculated for remaining Sitewide soil samples that are not covered by existing structures or pavement to the standard POC at the site. A 95% UCL zinc concentration of approximately 170 mg/kg was calculated using the data.

Appendix A - Table 1
95% UCL Calculation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Sample Depth (ft bgs)	Cadmium (mg/kg)	Zinc (mg/kg)
Former Settling Basin Areas				
1	09/05/2003	5	0.53	33
3	09/05/2003	3	0.52	33
4	09/05/2003	5	0.51	26
5	09/05/2003	1	0.51	33
6	09/05/2003	3	0.51	32
8	09/05/2003	1	0.56	280
9	09/09/2003	3	0.53	31
10	09/09/2003	5	0.54	33
11	09/09/2003	1	0.88	270
12	09/09/2003	3	0.54	28
13	09/09/2003	3	0.54	27
14	09/09/2003	5	0.54	31
15	09/09/2003	1	0.54	31
16	09/09/2003	3	0.54	31
17	09/09/2003	1	0.54	32
32	10/02/2003	1	0.52	34
34	10/02/2003	5	0.52	47
35	10/02/2003	7	0.52	40
45	10/08/2003	7	0.53	24
46	09/25/2003	5	0.53	27
47	09/16/2003	9	0.53	22
48	09/25/2003	3	0.53	29
49	09/16/2003	7	0.53	29
50	09/25/2003	1	0.53	35
51	09/16/2003	5	0.53	32
52	09/25/2003	3	0.53	29
53	09/16/2003	9	0.53	29
54	09/25/2003	1	0.53	33
55	09/16/2003	7	0.53	23
56	09/16/2003	5	0.53	24
57	09/16/2003	5	0.53	24
58	09/25/2003	1	0.53	34
59	09/16/2003	7	0.53	32
60	09/25/2003	3	0.53	32
61	09/16/2003	9	0.53	36
62	09/25/2003	5	0.53	33
2R	09/12/2003	1	--	210
33R	10/02/2003	3	0.52	36
63R	10/06/2003	7	0.53	34
7R	09/12/2003	5	--	100
ARSW-1	09/16/2010	7-8	2.2	91.5
ARSW-2	09/16/2010	7-8	2.2	283
ARSW-3	09/16/2010	7-8	2.1	141
ARSW-4	09/16/2010	7-8	2.1	146
B1	09/16/2003	7-8	5.3	32
B2	09/05/2003	9	0.5	410
B3	09/12/2003	5.5	0.52	27
ESW-1	08/17/2010	7-8	2.1	55.1
ESW-2B	08/23/2010	7-8	0.15	44
ESW-3A	08/20/2010	7-8	0.32	46.7
ESW-4A	08/20/2010	7-8	0.30	48.0
ESW-5A	08/27/2010	7-8	0.532	37
ESW-6A	08/27/2010	7-8	0.52	40.1
ESW-7	08/17/2010	7-8	2.1	43.3
ESW-8	08/27/2010	7-8	0.5	52.1
LG5	10/23/2002	5	0.2	376
LG6	10/23/2002	5	0.2	47.2
NSW-0A	08/31/2010	7-8	0.5	169
NSW-1	08/17/2010	7-8	2.1	48.8
NSW-2	08/17/2010	7-8	2.0	62.7
NSW-3	08/17/2010	7-8	2.0	126
NSW-4	08/17/2010	7-8	2.1	79
NSW-5	08/17/2010	7-8	2.2	48.7
NSW-6	08/17/2010	7-8	2.2	47.8
OB1	09/16/2003	10-15	0.52	390
OB2	09/16/2003	10-15	0.56	510
OB3	09/16/2003	10-15	0.52	120
OB4	09/16/2003	10-15	0.52	930
SB1-Surf-1	10/16/2003	0-0.5	0.55	35
SB1-Surf-2	10/16/2003	0-0.5	0.54	71
SB1-Surf-3	10/16/2003	0-0.5	0.56	98
SB1-Surf-4	10/16/2003	0-0.5	0.55	40
SB2-Surf-1	10/16/2003	0-0.5	0.56	99
SB2-Surf-2	10/16/2003	0-0.5	0.56	49
SB2-Surf-3	10/16/2003	0-0.5	0.56	38
SB2-Surf-4	10/16/2003	0-0.5	0.56	52
SS11A	03/11/2003	0-3	0.50	76
SSW-1	08/17/2010	7-8	2.1	84.9
SSW-2	08/17/2010	7-8	2.1	47.9
SSW-3	08/17/2010	7-8	2.1	53.5
SSW-4	08/17/2010	7-8	2.2	48.7
SSW-5	08/17/2010	7-8	2.1	50.4
SSW-6	08/30/2010	7-8	0.52	80.3
SSW-7	08/30/2010	7-8	0.5	44.2
TP1	03/11/2003	5	0.50	49
TP1	03/11/2003	1	0.50	34
TP1	03/11/2003	3	0.50	34
TP1	03/11/2003	7	0.50	30
TP10	03/11/2003	3	0.50	46
TP11	03/11/2003	3	0.50	62
TP11	03/11/2003	5	0.50	48
TP11	03/11/2003	1	0.50	38
TP11	03/11/2003	7	0.50	38
TP12	03/11/2003	3	0.50	65
TP2	03/11/2003	1	0.50	49
TP2	03/11/2003	5	0.50	28
TP2	03/11/2003	3	0.50	23
TP2	03/11/2003	7	0.50	22
TP3	03/11/2003	0-3	0.50	34
TP4	03/11/2003	3	0.50	26
TP5	03/11/2003	1	0.50	37
TP5	03/11/2003	3	0.50	37
TP5	03/11/2003	5	0.50	31
TP5	03/11/2003	7	0.50	27
TP7	03/11/2003	3	0.50	31
TP8	03/11/2003	5	0.50	42
TP8	03/11/2003	1	0.50	38
TP8	03/11/2003	3	0.50	31
TP8	03/11/2003	7	0.50	28
W1	10/15/2003	0-0.2	0.5	160
W2	10/15/2003	0-0.2	0.6	140
W3	10/15/2003	0-0.2	0.67	26
W4	10/15/2003	0-0.2	0.51	71
WSW-1	08/17/2010	7-8	2.2	45.6
WSW-2	08/17/2010	7-8	2.14	41.7
WSW-3	08/17/2010	7-8	2.1	44.4
WSW-4	08/17/2010	7-8	2.1	48.3
WSW-5	08/17/2010	7-8	2.1	61.0

Appendix A - Table 1
95% UCL Calculation Data
Chemtrade Performance Chemicals US LLC Site
Kalama, WA
H&H Project No. CLR-045

Sample ID	Sample Date	Sample Depth (ft bgs)	Cadmium (mg/kg)	Zinc (mg/kg)
Manufacturing Plant Area - Uncovered Soil Samples				
E-5	10/08/2003	0-0.25	0.56	63
E-6	10/08/2003	0-0.25	0.56	100
E-7	10/08/2003	0-0.25	0.65	120
E-8	10/08/2003	0-0.25	0.56	480
E-9	10/08/2003	0-0.25	0.56	390
PZ3A	04/15/2003	1	1.5	1,300
PZ3A	04/15/2003	8	0.50	230
PZ3A	04/15/2003	10	0.50	220
PZ5	04/15/2003	10	1.5	1,300
PZ5	04/15/2003	5	0.88	530
PZ5	04/15/2003	1	0.50	100
PZ9	05/06/2003	1	0.50	37
PZ9	05/06/2003	10	0.50	28
PZ9	05/06/2003	5	0.50	26
SB-1	08/10/2017	0-3	1.29	15.4
SB-1	08/10/2017	3-6	1.32	13.2
SB-3	08/10/2017	0-3	1.29	299
SB-3	08/10/2017	3-6	1.33	17.9
SB-4	08/10/2017	0-3	1.29	36.3
SB-4	08/10/2017	3-6	1.31	13.1
SB-5	08/10/2017	0-3	5.12	238
SB-5	08/10/2017	3-6	5.13	119
SB-12	08/10/2017	0-3	4.99	754
SB-12	08/10/2017	3-6	5.18	91.9
SB-13	08/10/2017	0-3	5.19	1,300
SB-13	08/10/2017	3-6	5.13	113
SB-14	08/10/2017	0-3	2.54	488
SB-14	08/10/2017	3-6	2.60	109
SB-15	08/10/2017	0-3	2.51	372
SB-15	08/10/2017	3-6	2.62	513
SB-16	08/10/2017	0-3	2.52	387
SB-16	08/10/2017	3-6	2.59	32.7
SB-17	08/10/2017	0-3	2.55	303
SB-17	08/10/2017	3-6	2.66	166
SB-18	08/10/2017	0-3	2.59	46.8
SB-18	08/10/2017	3-6	2.69	38.4
SS1	10/23/2002	0-0.5	0.60	400
SS2	10/23/2002	0.5-1	1.8	1,290
SS3	10/23/2002	0-0.5	1.7	868
W-1	10/02/2003	1.5	0.53	210
W10	04/16/2003	1	0.65	280
W10	04/16/2003	10	0.50	180
W10	04/16/2003	5	0.50	88
W-2	10/02/2003	1.5	0.53	26
W-3	10/02/2003	1.5	0.53	420
W-4	10/02/2003	1	0.53	60
W9	04/16/2003	10	0.50	45
W9	04/16/2003	1	0.50	37
W9	04/16/2003	5	0.50	36
Manufacturing Plant Area - Covered Soil Samples				
E-1	10/08/2003	1.4	0.56	120
E-2	10/08/2003	1.5	0.56	250
E-3	10/08/2003	1.5	0.56	140
E-4	10/08/2003	1	0.56	340
PZ4	04/15/2003	1	0.78	270
PZ4	04/15/2003	10	0.50	80
PZ4	04/15/2003	5	0.50	45
PZ6	04/15/2003	5	0.50	360
PZ6	04/15/2003	10	0.50	180
PZ6	04/15/2003	1	0.50	150
PZ7	04/15/2003	1	3.4	2,100
PZ7	04/15/2003	10	0.50	530
PZ7	04/15/2003	5	0.61	470
PZ8	04/15/2003	1	0.50	84
PZ8	04/15/2003	10	0.50	61
PZ8	04/15/2003	5	0.50	34
SB-2	08/09/2017	0-3	1.26	94.5
SB-2	08/09/2017	3-6	1.30	209
SB-6	08/09/2017	1-3	5.92	5,250
SB-6	08/09/2017	3-6	5.30	3,200
SB-7	08/09/2017	1-3	7.37	9,360
SB-7	08/09/2017	3-6	5.29	2,590
SB-8	08/10/2017	1-3	5.33	652
SB-8	08/10/2017	3-6	5.21	441
SB-9	08/10/2017	0-3	5.00	97.4
SB-9	08/10/2017	3-6	4.92	91.9
SB-10	08/10/2017	0-3	107	367
SB-10	08/10/2017	3-6	76.2	627
SB-11	08/10/2017	1-3	5.03	592
SB-11	08/10/2017	3-6	5.01	166
SB-19	08/11/2017	0-3	2.58	25.8
SB-19	08/11/2017	3-6	2.60	26.0
SB-20	08/11/2017	0-3	2.67	594
SB-20	08/11/2017	3-4	2.56	813
SB-21	08/11/2017	10-13	91.6	150
SB-21	08/11/2017	13-16	305	255
SB-22	08/11/2017	0-3	2.56	160
SB-23	08/10/2017	1-3	5.04	728
SB-23	08/10/2017	3-6	5.26	4,260
SS10	04/16/2003	0.5-1	0.50	170
SS11B	04/16/2003	0.5-1	0.78	1,200
SS4	10/24/2002	0-0.5	1.1	2,330
SS5	10/24/2002	0-0.5	0.2	116
SS7	10/24/2002	0-0.5	8.5	19,100
SS12	04/16/2003	0.5-1	0.50	27
SS13	04/16/2003	0.5-1	0.50	220
W11	04/16/2003	10	0.50	35
W11	04/16/2003	1	0.50	31
W11	04/16/2003	5	0.50	22
W12	04/16/2003	1	5.5	620
W12	04/16/2003	5	0.50	330
W12	04/16/2003	10	0.50	330
W6	04/16/2003	1	0.50	490
W6	04/16/2003	5	0.50	160
W6	04/16/2003	10	0.50	74
W7	04/16/2003	1	0.82	900
W7	04/16/2003	10	0.50	500
W7	04/16/2003	5	0.50	170
W8	04/16/2003	5	0.50	350
W8	04/16/2003	1	0.50	230
W8	04/16/2003	10	2.3	61

Notes:
bgs = below ground surface; mg/kg = milligrams per kilogram; -- indicates not analyzed
italicized gray value is the laboratory minimum detection limit (MDL) or practical quantitation limit (PQL)

Compliance calculations

0.53 1 Cadmium - Site Wide Soil

0.52 3
 0.51 4
 0.51 5
 0.51 6
 0.56 8
 0.53 9
 0.54 10
 0.88 11
 0.54 12
 0.54 13
 0.54 14
 0.54 15
 0.54 16
 0.54 17
 0.52 32
 0.52 34
 0.52 35
 0.53 45
 0.53 46
 0.53 47
 0.53 48
 0.53 49
 0.53 50
 0.53 51
 0.53 52
 0.53 53
 0.53 54
 0.53 55
 0.53 56
 0.53 57
 0.53 58
 0.53 59
 0.53 60
 0.53 61
 0.53 62
 0.52 33R
 0.53 63R
 2.16 ARSW-1
 2.16 ARSW-2
 2.07 ARSW-3
 2.08 ARSW-4
 5.3 B1
 0.53 B2
 0.52 B3
 2.1 ESW-1
 0.148 ESW-2B
 0.321 ESW-3A
 0.297 ESW-4A
 0.532 ESW-5A
 0.521 ESW-6A
 2.1 ESW-7
 0.532 ESW-8
 0.2 LG5
 0.2 LG6

Number of samples		Uncensored values	
Uncensored	226	Mean	3.90
Censored		Lognormal mean	1.71
Detection limit or PQL		Std. devn.	22.7213923
Method detection limit		Median	0.54
TOTAL	226	Min.	0.148
		Max.	305
Lognormal distribution?		Normal distribution?	
r-squared is:	0.729	r-squared is:	0.114
Recommendations:			
Reject BOTH lognormal and normal distributions. See Statistics Guidance.			
UCL (based on Z-statistic) is 6.386			

Compliance calculations

0.531 NSW-0A
2.11 NSW-1
2 NSW-2
2.04 NSW-3
2.08 NSW-4
2.15 NSW-5
2.15 NSW-6
0.52 OB1*
0.56 OB2*
0.52 OB3*
0.52 OB4*
0.55 SB1-Surf-1
0.54 SB1-Surf-2
0.56 SB1-Surf-3
0.55 SB1-Surf-4
0.56 SB2-Surf-1
0.56 SB2-Surf-2
0.56 SB2-Surf-3
0.56 SB2-Surf-4
0.5 SS11A
0.5 SS12
0.5 SS13
2.12 SSW-1
2.13 SSW-2
2.1 SSW-3
2.16 SSW-4
2.14 SSW-5
0.52 SSW-6
0.516 SSW-7
0.5 TP1
0.5 TP1
0.5 TP1
0.5 TP1
0.5 TP10
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP12
0.5 TP2
0.5 TP2
0.5 TP2
0.5 TP2
0.5 TP3
0.5 TP4
0.5 TP5
0.5 TP5
0.5 TP5
0.5 TP5
0.5 TP7
0.5 TP8
0.5 TP8
0.5 TP8
0.5 TP8
0.54 W1

Compliance calculations

0.56	W2
0.67	W3
0.51	W4
2.15	WSW-1
2.14	WSW-2
2.12	WSW-3
2.12	WSW-4
2.12	WSW-5
0.56	E-5
0.56	E-6
0.65	E-7
0.56	E-8
0.56	E-9
1.5	PZ3A
0.5	PZ3A
0.5	PZ3A
1.5	PZ5
0.88	PZ5
0.5	PZ5
1.29	SB-1
1.32	SB-1
1.29	SB-3
1.33	SB-3
1.29	SB-4
1.31	SB-4
5.12	SB-5
5.13	SB-5
4.99	SB-12
5.18	SB-12
5.19	SB-13
5.13	SB-13
2.54	SB-14
2.6	SB-14
2.51	SB-15
2.62	SB-15
2.52	SB-16
2.59	SB-16
2.55	SB-17
2.66	SB-17
2.59	SB-18
2.69	SB-18
0.6	SS1
1.8	SS2
1.7	SS3
0.53	W-1
0.65	W10
0.5	W10
0.5	W10
0.53	W-2
0.53	W-3
0.53	W-4
0.5	W9
0.5	W9
0.5	W9
0.56	E-1

Compliance calculations

0.56	E-2
0.56	E-3
0.56	E-4
0.78	PZ4
0.5	PZ4
0.5	PZ4
0.5	PZ6
0.5	PZ6
0.5	PZ6
3.4	PZ7
0.5	PZ7
0.61	PZ7
0.5	PZ8
0.5	PZ8
0.5	PZ8
0.5	PZ9
0.5	PZ9
0.5	PZ9
1.26	SB-2
1.3	SB-2
5.92	SB-6
5.3	SB-6
7.37	SB-7
5.29	SB-7
5.33	SB-8
5.21	SB-8
5	SB-9
4.92	SB-9
107	SB-10
76.2	SB-10
5.03	SB-11
5.01	SB-11
2.58	SB-19
2.6	SB-19
2.67	SB-20
2.56	SB-20
91.6	SB-21
305	SB-21
2.56	SB-22
5.04	SB-23
5.26	SB-23
0.5	SS10
0.78	SS11B
1.1	SS4
0.2	SS5
8.5	SS7
0.5	W11
0.5	W11
0.5	W11
5.5	W12
0.5	W12
0.5	W12
0.5	W6
0.5	W6
0.5	W6

Compliance calculations

0.82	W7
0.5	W7
0.5	W7
0.5	W8
0.5	W8
2.3	W8

Compliance calculations

33 1 Zinc - Site Wide Soil
 33 3
 26 4
 33 5
 32 6
 280 8
 31 9
 33 10
 270 11
 28 12
 27 13
 31 14
 31 15
 31 16
 32 17
 34 32
 47 34
 40 35
 24 45
 27 46
 22 47
 29 48
 29 49
 35 50
 32 51
 29 52
 29 53
 33 54
 23 55
 24 56
 24 57
 34 58
 32 59
 32 60
 36 61
 33 62
 210 2R
 36 33R
 34 63R
 100 7R
 91.5 ARSW-1
 283 ARSW-2
 141 ARSW-3
 146 ARSW-4
 32 B1
 410 B2
 27 B3
 55.1 ESW-1
 43.5 ESW-2B
 46.7 ESW-3A
 48 ESW-4A
 37 ESW-5A
 40.1 ESW-6A
 43.3 ESW-7
 52.1 ESW-8

Number of samples		Uncensored values		
Uncensored	228	Mean	380.37	
Censored		Lognormal mean	240.50	
Detection limit or PQL		Std. devn.	1502.6397	
Method detection limit		Median	61	
TOTAL	228	Min.	13.1	
		Max.	19100	
Lognormal distribution?		Normal distribution?		
r-squared is:	0.897	r-squared is:	0.200	
Recommendations:				
Reject BOTH lognormal and normal distributions. See Statistics Guidance.				
UCL (based on Z-statistic) is 544.073				

Compliance calculations

376	LG5
47.2	LG6
169	NSW-0A
48.8	NSW-1
62.7	NSW-2
126	NSW-3
79	NSW-4
48.7	NSW-5
47.8	NSW-6
390	OB1*
510	OB2*
120	OB3*
930	OB4*
35	SB1-Surf-1
71	SB1-Surf-2
98	SB1-Surf-3
40	SB1-Surf-4
99	SB2-Surf-1
49	SB2-Surf-2
38	SB2-Surf-3
52	SB2-Surf-4
76	SS11A
27	SS12
220	SS13
84.9	SSW-1
47.9	SSW-2
53.5	SSW-3
48.7	SSW-4
50.4	SSW-5
80.3	SSW-6
44.2	SSW-7
49	TP1
34	TP1
34	TP1
30	TP1
46	TP10
62	TP11
48	TP11
38	TP11
38	TP11
65	TP12
49	TP2
28	TP2
23	TP2
22	TP2
34	TP3
26	TP4
37	TP5
37	TP5
31	TP5
27	TP5
31	TP7
42	TP8
38	TP8
31	TP8

Compliance calculations

28	TP8
160	W1
140	W2
26	W3
71	W4
45.6	WSW-1
41.7	WSW-2
44.4	WSW-3
48.3	WSW-4
61	WSW-5
63	E-5
100	E-6
120	E-7
480	E-8
390	E-9
1300	PZ3A
230	PZ3A
220	PZ3A
1300	PZ5
530	PZ5
100	PZ5
15.4	SB-1
13.2	SB-1
299	SB-3
17.9	SB-3
36.3	SB-4
13.1	SB-4
238	SB-5
119	SB-5
754	SB-12
91.9	SB-12
1300	SB-13
113	SB-13
488	SB-14
109	SB-14
372	SB-15
513	SB-15
387	SB-16
32.7	SB-16
303	SB-17
166	SB-17
46.8	SB-18
38.4	SB-18
400	SS1
1290	SS2
868	SS3
210	W-1
280	W10
180	W10
88	W10
26	W-2
420	W-3
60	W-4
45	W9
37	W9

Compliance calculations

36	W9
120	E-1
250	E-2
140	E-3
340	E-4
270	PZ4
80	PZ4
45	PZ4
360	PZ6
180	PZ6
150	PZ6
2100	PZ7
530	PZ7
470	PZ7
84	PZ8
61	PZ8
34	PZ8
37	PZ9
28	PZ9
26	PZ9
94.5	SB-2
209	SB-2
5250	SB-6
3200	SB-6
9360	SB-7
2590	SB-7
652	SB-8
441	SB-8
97.4	SB-9
91.9	SB-9
367	SB-10
627	SB-10
592	SB-11
166	SB-11
25.8	SB-19
26	SB-19
594	SB-20
813	SB-20
150	SB-21
255	SB-21
160	SB-22
728	SB-23
4260	SB-23
170	SS10
1200	SS11B
2330	SS4
116	SS5
19100	SS7
35	W11
31	W11
22	W11
620	W12
330	W12
330	W12
490	W6

Compliance calculations

160	W6
74	W6
900	W7
500	W7
170	W7
350	W8
230	W8
61	W8

Compliance calculations

0.53 1 Cadmium - Uncovered Soil

0.52 3
 0.51 4
 0.51 5
 0.51 6
 0.56 8
 0.53 9
 0.54 10
 0.88 11
 0.54 12
 0.54 13
 0.54 14
 0.54 15
 0.54 16
 0.54 17
 0.52 32
 0.52 34
 0.52 35
 0.53 45
 0.53 46
 0.53 47
 0.53 48
 0.53 49
 0.53 50
 0.53 51
 0.53 52
 0.53 53
 0.53 54
 0.53 55
 0.53 56
 0.53 57
 0.53 58
 0.53 59
 0.53 60
 0.53 61
 0.53 62
 0.52 33R
 0.53 63R
 2.16 ARSW-1
 2.16 ARSW-2
 2.07 ARSW-3
 2.08 ARSW-4
 5.3 B1
 0.53 B2
 0.52 B3
 2.1 ESW-1
 0.148 ESW-2B
 0.321 ESW-3A
 0.297 ESW-4A
 0.532 ESW-5A
 0.521 ESW-6A
 2.1 ESW-7
 0.532 ESW-8
 0.2 LG5
 0.2 LG6

Number of samples		Uncensored values	
Uncensored	165	Mean	1.11
Censored		Lognormal mean	1.05
Detection limit or PQL		Std. devn.	1.10649485
Method detection limit		Median	0.53
TOTAL	165	Min.	0.148
		Max.	5.3
Lognormal distribution?		Normal distribution?	
r-squared is:		r-squared is:	
Recommendations:			
Reject lognormal distribution.			
Y value is -14.9474. This lies outside the tabled values of 1.4449 and -2.4337			
Reject normal distribution.			
Y value is -28.1304. This lies outside the tabled values of 1.4449 and -2.4337			
UCL (based on t-statistic) is 1.25232394180283			
UCL (based on Z-statistic) is 1.251			

Compliance calculations

0.531 NSW-0A
2.11 NSW-1
2 NSW-2
2.04 NSW-3
2.08 NSW-4
2.15 NSW-5
2.15 NSW-6
0.52 OB1
0.56 OB2
0.52 OB3
0.52 OB4
0.55 SB1-Surf-1
0.54 SB1-Surf-2
0.56 SB1-Surf-3
0.55 SB1-Surf-4
0.56 SB2-Surf-1
0.56 SB2-Surf-2
0.56 SB2-Surf-3
0.56 SB2-Surf-4
0.5 SS11A
2.12 SSW-1
2.13 SSW-2
2.1 SSW-3
2.16 SSW-4
2.14 SSW-5
0.52 SSW-6
0.516 SSW-7
0.5 TP1
0.5 TP1
0.5 TP1
0.5 TP1
0.5 TP10
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP11
0.5 TP12
0.5 TP2
0.5 TP2
0.5 TP2
0.5 TP2
0.5 TP3
0.5 TP4
0.5 TP5
0.5 TP5
0.5 TP5
0.5 TP5
0.5 TP7
0.5 TP8
0.5 TP8
0.5 TP8
0.5 TP8
0.54 W1
0.56 W2
0.67 W3

Compliance calculations

0.51	W4
2.15	WSW-1
2.14	WSW-2
2.12	WSW-3
2.12	WSW-4
2.12	WSW-5
0.56	E-5
0.56	E-6
0.65	E-7
0.56	E-8
0.56	E-9
1.5	PZ3A
0.5	PZ3A
0.5	PZ3A
1.5	PZ5
0.88	PZ5
0.5	PZ5
0.5	PZ9
0.5	PZ9
0.5	PZ9
1.29	SB-1
1.32	SB-1
1.29	SB-3
1.33	SB-3
1.29	SB-4
1.31	SB-4
5.12	SB-5
5.13	SB-5
4.99	SB-12
5.18	SB-12
5.19	SB-13
5.13	SB-13
2.54	SB-14
2.6	SB-14
2.51	SB-15
2.62	SB-15
2.52	SB-16
2.59	SB-16
2.55	SB-17
2.66	SB-17
2.59	SB-18
2.69	SB-18
0.6	SS1
1.8	SS2
1.7	SS3
0.53	W-1
0.65	W10
0.5	W10
0.5	W10
0.53	W-2
0.53	W-3
0.53	W-4
0.5	W9
0.5	W9
0.5	W9

Compliance calculations

33 1
 33 3
 26 4
 33 5
 32 6
 280 8
 31 9
 33 10
 270 11
 28 12
 27 13
 31 14
 31 15
 31 16
 32 17
 34 32
 47 34
 40 35
 24 45
 27 46
 22 47
 29 48
 29 49
 35 50
 32 51
 29 52
 29 53
 33 54
 23 55
 24 56
 24 57
 34 58
 32 59
 32 60
 36 61
 33 62
 210 2R
 36 33R
 34 63R
 100 7R
 91.5 ARSW-1
 283 ARSW-2
 141 ARSW-3
 146 ARSW-4
 32 B1
 410 B2
 27 B3
 55.1 ESW-1
 43.5 ESW-2B
 46.7 ESW-3A
 48 ESW-4A
 37 ESW-5A
 40.1 ESW-6A
 43.3 ESW-7
 52.1 ESW-8

Zinc - Uncovered Soil

Number of samples		Uncensored values	
Uncensored	167	Mean	139.49
Censored		Lognormal mean	117.36
Detection limit or PQL		Std. devn.	238.585417
Method detection limit		Median	46.7
TOTAL	167	Min.	13.1
		Max.	1300
Lognormal distribution?		Normal distribution?	
r-squared is:		r-squared is:	
Recommendations:			
UCL (based on Z-statistic) is 169.862			

Compliance calculations

376	LG5
47.2	LG6
169	NSW-0A
48.8	NSW-1
62.7	NSW-2
126	NSW-3
79	NSW-4
48.7	NSW-5
47.8	NSW-6
390	OB1
510	OB2
120	OB3
930	OB4
35	SB1-Surf-1
71	SB1-Surf-2
98	SB1-Surf-3
40	SB1-Surf-4
99	SB2-Surf-1
49	SB2-Surf-2
38	SB2-Surf-3
52	SB2-Surf-4
76	SS11A
84.9	SSW-1
47.9	SSW-2
53.5	SSW-3
48.7	SSW-4
50.4	SSW-5
80.3	SSW-6
44.2	SSW-7
49	TP1
34	TP1
34	TP1
30	TP1
46	TP10
62	TP11
48	TP11
38	TP11
38	TP11
65	TP12
49	TP2
28	TP2
23	TP2
22	TP2
34	TP3
26	TP4
37	TP5
37	TP5
31	TP5
27	TP5
31	TP7
42	TP8
38	TP8
31	TP8
28	TP8
160	W1

Compliance calculations

140	W2
26	W3
71	W4
45.6	WSW-1
41.7	WSW-2
44.4	WSW-3
48.3	WSW-4
61	WSW-5
63	E-5
100	E-6
120	E-7
480	E-8
390	E-9
1300	PZ3A
230	PZ3A
220	PZ3A
1300	PZ5
530	PZ5
100	PZ5
37	PZ9
28	PZ9
26	PZ9
15.4	SB-1
13.2	SB-1
299	SB-3
17.9	SB-3
36.3	SB-4
13.1	SB-4
238	SB-5
119	SB-5
754	SB-12
91.9	SB-12
1300	SB-13
113	SB-13
488	SB-14
109	SB-14
372	SB-15
513	SB-15
387	SB-16
32.7	SB-16
303	SB-17
166	SB-17
46.8	SB-18
38.4	SB-18
400	SS1
1290	SS2
868	SS3
210	W-1
280	W10
180	W10
88	W10
26	W-2
420	W-3
60	W-4
45	W9

Compliance calculations

37 W9
36 W9