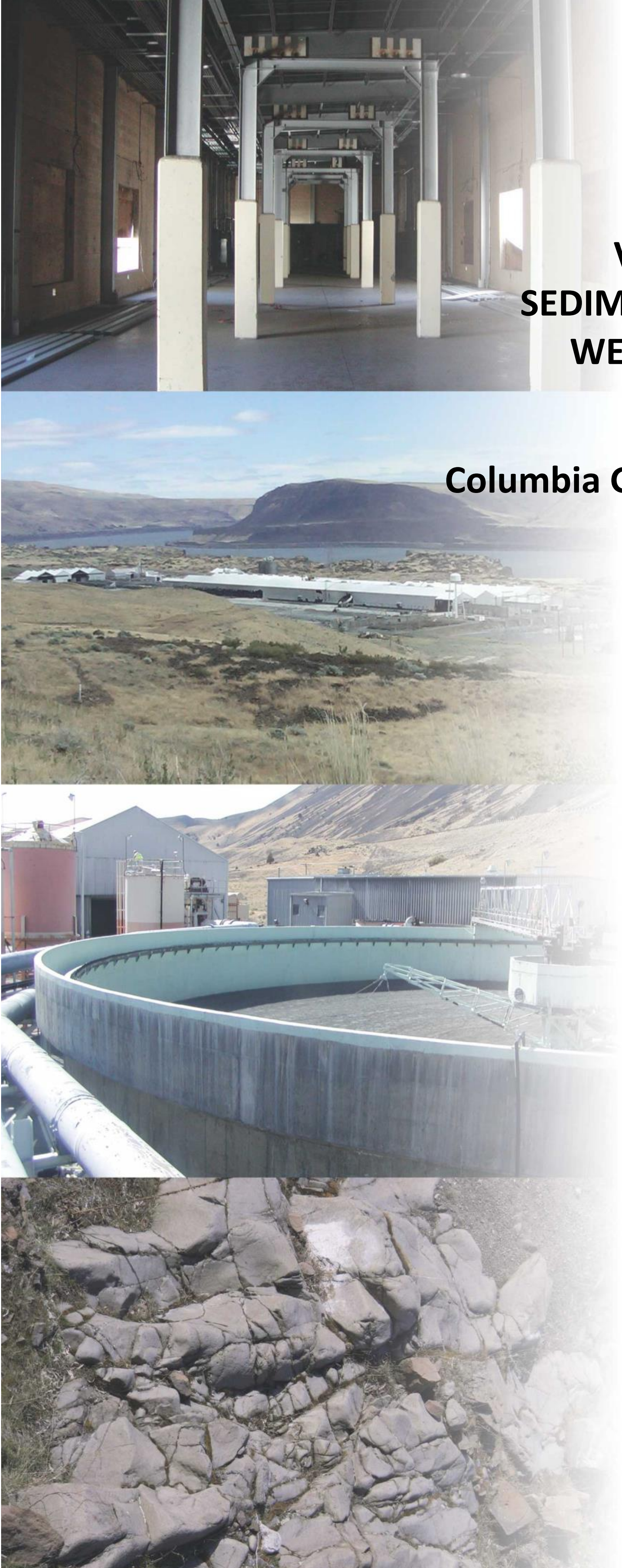


FINAL DRAFT REMEDIAL INVESTIGATION REPORT

VOLUME 4: COLUMBIA RIVER SEDIMENTS, GROUNDWATER, AND WETLANDS AREAS OF CONCERN RESULTS AND SUMMARY

Columbia Gorge Aluminum Smelter Site

Revision 0
Goldendale, WA
Facility Site ID #95415874

Agreed Order DE 10483

June 14, 2022

On behalf of:

Lockheed Martin Corporation
6801 Rockledge Drive
Bethesda MD 20817

NSC Smelter LLC
85 John Day Dam Road
Goldendale WA 98620

Prepared by:

Tetra Tech, Inc.
19803 North Creek Parkway
Bothell WA 98011

Blue Mountain Environmental Consulting Inc.
125 Main Street
Waitsburg WA 99361

Plateau Geoscience Group LLC
P. O. Box 1020
Battle Ground WA 98604

FINAL DRAFT REMEDIAL INVESTIGATION REPORT

VOLUME 4: COLUMBIA RIVER SEDIMENTS, GROUNDWATER, AND WETLANDS AREAS OF CONCERN RESULTS AND SUMMARY

Columbia Gorge Aluminum Smelter Site

Revision 0

Goldendale, WA

Facility Site ID #95415874

Agreed Order DE 10483

June 14, 2022

On behalf of:

Lockheed Martin Corporation
6801 Rockledge Drive
Bethesda MD 20817

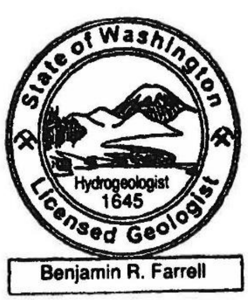
NSC Smelter LLC
85 John Day Dam Road
Goldendale WA 98620

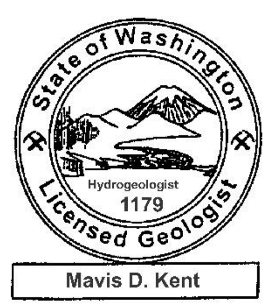
Prepared by:

Tetra Tech, Inc.
19803 North Creek Parkway
Bothell WA 98011

Blue Mountain Environmental Consulting Inc.
125 Main Street
Waitsburg WA 99361

Plateau Geoscience Group LLC
P. O. Box 1020
Battle Ground WA 98604





Ben Farrell
Licensed Geologist, Tetra Tech

Dr. Mavis Kent
Licensed Geologist, Plateau Geosciences

Table of Contents

Figures

Page

Tables

Page

Acronyms

AOC	Area of Concern
BAL	Basalt Aquifer – Lower Zone
BAU	Basalt Aquifer – Upper Zone
BMEC	Blue Mountain Environmental Consulting, Inc.
BPA	Bonneville Power Administration
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CB	Catch Basin
cfs	Cubic feet per second
CLARC	Cleanup Level and Risk Calculation database
COPCs	Chemicals of Potential Concern
cPAHs	Carcinogenic Polycyclic Aromatic Hydrocarbons
CSL	Cleanup Screening Level
DO	Dissolved oxygen
Ecology	Washington Department of Ecology
EELF	East End Landfill
EESH	Lockheed Martin Energy, Environment, Safety, & Health
EIMS	Environmental Information Management System
EPA	U.S. Environmental Protection Agency
ESI	East Surface Impoundment
FS	Feasibility Study
ft bgs	Feet below ground surface
ft msl	Feet mean sea level
gpm	Gallons per minute
GPS	Global Positioning System
GWAOC	Groundwater in Uppermost Aquifer AOC
HEAF	High Efficiency Air Filtration
IDW	Investigation-Derived Waste
I&M	Industrial and Monitoring
Lockheed Martin	Lockheed Martin Corporation
MCLs	Maximum Contaminant Levels
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MTCA	Model Toxics Control Act
NESI	North of the East Surface Impoundment
NPDES	National Pollutant Discharge Elimination System
NSC	NSC Smelter, LLC

PAAOC	Plant Area AOC
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PGG	Plateau Geoscience Group, LLC
RI	Remedial Investigation
RYAOC	Rectifier Yard Area of Concern
SAP	Sampling and Analysis Plan
SCO	Sediment Cleanup Objectives
SCUM II	Sediment Cleanup User's Manual
SE	Scrubber Effluent
SMS	Washington State Sediment Management Standards
SPL	Spent Pot Liner
SWMU	Solid Waste Management Unit
SVOCs	Semivolatile Organic Compounds
TCE	Trichloroethene
Tetra Tech	Tetra Tech, Inc.
TFAS	Treaty Fishing Access Site
TICs	Tentatively Identified Compounds
TPH	Total Petroleum Hydrocarbons
TPH-Dx	Total Petroleum Hydrocarbons – Diesel-extended range
TPH-Gx	Total Petroleum Hydrocarbons – Gasoline-extended range
TTEC	Total Toxicity Equivalent Concentrations
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
UA	Unconsolidated Aquifer
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
UST	Underground Storage Tank
UTL	Upper Threshold Limit
VOC	Volatile Organic Compound
WA ELAP	Washington State Laboratory Accreditation Program
WAC	Washington Administrative Code
WAD	Weak Acid Dissociable
WELF	West End Landfill
WESP	Wet Electrostatic Precipitator
WLAOC	Wetlands Area of Concern
WSI	West Surface Impoundment

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs)
(Agreed Order No. DE 10483)

Solid Waste Management Units (SWMUs)

NPDES Ponds (SWMU #1)
East Surface Impoundment (ESI) (SWMU #2)
Intermittent Sludge Disposal Ponds (SWMU #3)
West Surface Impoundment (SWMU #4)
Line A Secondary Scrubber Recycle Station (SWMU #5)
Line B, C, D Secondary Scrubber Recycle Stations (SWMU #6)
Decommissioned Air Pollution Control Equipment (SWMU #7)
Tertiary Treatment Plant (SWMU #8)
Paste Plant Recycle Water System (SWMU #9)
North Pot Liner Soaking Station (SWMU #10)
South Pot Liner Soaking Station (SWMU #11)
East SPL Storage Area (SWMU #12)
West SPL Storage Area (SWMU #13)
North SPL Storage Containment Building (SWMU #14)
South SPL Storage Building (SWMU #15)
SPL Handling Containment Building (SWMU #16)
East End Landfill (SWMU #17)
West End Landfill (SWMU #18)
Plant Construction Landfill (SWMU #19)
Drum Storage Area (SWMU #20)
Construction Rubble Storage Area (SWMU #21)
Wood Pallet Storage Area (SWMU #22)
Reduction Cell Skirt Storage Area (SWMU #23)
Carbon Waste Roll-off Area (SWMU #24)
Solid Waste Collection Bin and Dumpsters (SWMU #25)
HEAF Filter Roll-Off Bin (SWMU #26)
Tire and Wheel Storage Area (SWMU #27)
90-Day Drum Storage Area (SWMU #28)
Caustic Spill (SWMU #29)
Paste Plant Spill (SWMU #30)

Smelter Sign Area (SWMU #31)
Stormwater pond and appurtenant facilities (SWMU #32)

Areas of Concern (AOCs)

Columbia River Sediments
Groundwater in the Uppermost Aquifer at the Facility
Wetlands
Rectifier Yard
Plant Area

Preface

This Volume (Volume 4 of the RI Report) summarizes the RI results for each of the 32 SWMUs at the site. An additional area of investigation was identified to include the southern surface drainage ditch near the West Spent Pot Liner (SPL) Storage Area (SWMU 13). Results for each SWMU are presented in numerical order followed by a summary and recommendation section. The RI report consists of the following additional Volumes:

- **Volume 1, Introduction and Project Framework**, presents background information about the site identified data need the site conceptual model, the regulatory framework including screening levels and risk pathway evaluation and calculation approach, and data quality assessment. References for the entire RI report are also included in Volume 1.
- **Volume 2, SWMU Results and Summary**, presents the RI results for the 32 SWMUs at the site as well as three additional investigation areas that were investigated during the course of the RI and WPA. A summary and recommendation section is included at the end of the Volume.
- **Volume 3, Rectifier Yard and Plant Area – Area of Concern (AOC) Results and Summary** presents the results for the for main footprint of the former plant and includes summarization of RI results for the Rectifier Yard and Plant Area AOCs. This section also includes relevant data from SWMUs and underground conveyance lines within the footprint of the former plant courtyards and south plant area.
- **Volume 5, Appendices,** includes all Appendices for the RI report including: Appendix A, Derived Screening Levels and Background Concentrations; Appendix B, SWMU Field Logs; Appendix C, Columbia River Sediments AOC; Appendix D, Groundwater in the Uppermost Aquifer AOC; Appendix E, Wetlands AOC; Appendix F, Rectifier Yard AOC; Appendix G, Plant Area AOC; Appendix H, Analytical Results; and Appendix I Data Validation Reports.

Background information regarding the SWMUs and associated RI data needs is briefly summarized in Volume 1 of the RI with further details summarized in the Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b) and the WPA. Analytical results and data validation reports for the SWMUs are provided in Volume 5, Appendices H and I. Field logs for the SWMUs are provided in Volume 5, Appendix B and are organized by SWMU number and the initial RI and WPA data sets.

Figure P-1 and P-2 show the locations of the SWMUs and other plant features and property ownership in the site vicinity.

R:\projects_2011\LockheedMartin_GoldendaleSiteInvestig\maps\2019_Reporting\Figure_1-1_Site_Features.mxd

Legend

Wetlands

N
W E
S

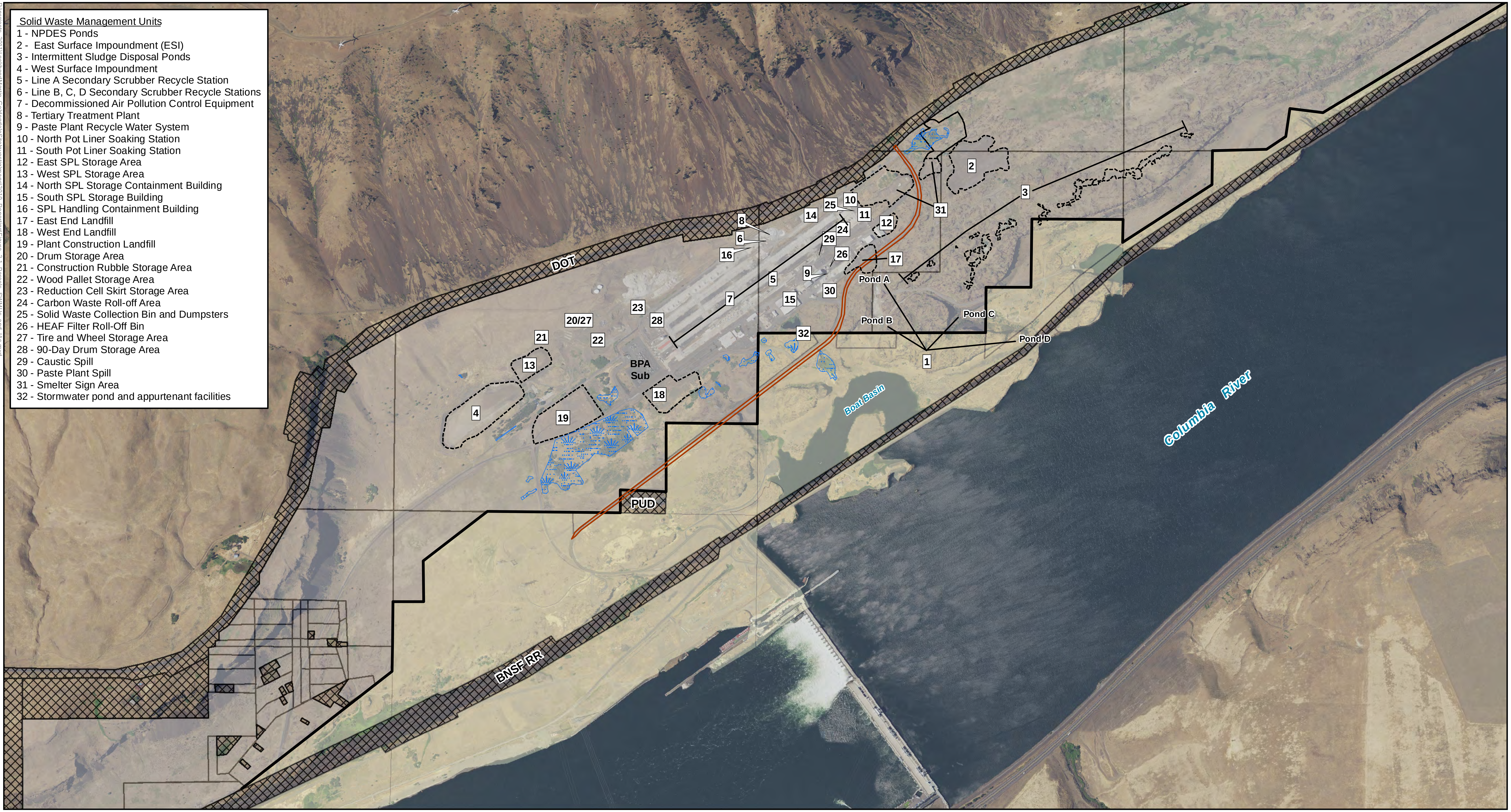
0 500 1,000 2,000

Feet

Imagery Data Sources: USDA NAIP 1-m Imagery, 2006.

Figure P-1
Primary Site and Vicinity
Features Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

NSC Smelter LLC Parcels

USACE

Other Ownership

Klickitat County Road Right-of-Way (John Day Dam Road)

Property Boundary

1 Solid Waste Management Unit

SWMU Investigation Areas

Wetlands

N W E S

0 500 1,000 2,000 Feet

Imagery Source: NAIP 2017

Figure P-2
Parcel Ownership and Solid Waste Management Units and Investigation Areas

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Section 1
Columbia River Sediments

This section summarizes the Remedial Investigation (RI) results for the Columbia River Sediments Area of Concern (AOC). Investigation of Columbia River sediments was included in the Agreed Order (Ecology 2014) to determine if "the NPDES outfall, sheet flow from the property near the river, and two intermittent streams have the potential to contaminate sediments in the Columbia River adjacent to the smelter." The scope of work, provided as Exhibit E in the Agreed Order, also specified evaluation of select pathways for their potential to contaminate sediments (Ecology 2014).

1.1 BACKGROUND SUMMARY

The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) includes a detailed summary of background information about the Columbia River Sediments AOC, including Columbia River site setting, primary site features [e.g., John Day Dam, Boat Basin and associated drainages, National Pollutant Discharge Elimination System (NPDES) Outfall], and past environmental sediment studies and investigations. Figure P-1 shows the primary site features adjacent to the Columbia River.

The Columbia River Sediments AOC field investigation was conducted in April 2016 in accordance with the Ecology-approved Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b), as summarized in Section 1.2 below. On August 4, 2017, a presentation of the Columbia River AOC RI sediment sampling results was given to Ecology and Yakama Nation Tribe at the project site in Goldendale, Washington. Comments regarding the presentation and associated materials were provided via e-mail correspondence by Ecology on September 6, 2017, including comments from the Yakama Nation Tribe. Ecology comments included the following key items:

- **Background Sample Designations and Comparisons.** Sediment sample results were initially compared against maximum background sample concentrations. Ecology requested the term background sample be changed to "reference" sample moving forward, and that reference sample results used for comparative review include assessment for outliers. Ecology also requested that instead of using the maximum reference concentrations, statistically representative values should be developed.
- **Freshwater Bioassays.** Ecology indicated that freshwater bioassays would be required at stations where the Washington State Sediment Management Standards (SMS),

freshwater sediment cleanup objectives (SCO) criteria was exceeded. Although none of the project data exceeded established freshwater SCO for total polycyclic aromatic hydrocarbons (PAHs), Ecology required additional consideration of carcinogenic PAHs (cPAHs) based on potential human health concerns. For cPAHs, sample station concentrations exceeding upstream (reference station) values were considered for freshwater bioassay testing.

A meeting was held at Ecology Headquarters in Lacey, Washington on May 24, 2018 between Ecology, Yakama Nation Tribe, and the client group to discuss the basis and requirements for sediment bioassay sampling. The client group agreed to conduct the sediment bioassay sampling and testing based on Ecology's agreement that the associated findings would address remaining concerns regarding the project site and associated Columbia River sediments.

A Final Columbia River Sediments AOC Bioassay Sampling and Analysis Plan (SAP) was prepared on July 9, 2018 (Tetra Tech 2018a). The bioassay sediment sampling was completed in early August 2018 in accordance with the Ecology-approved SAP. A summary of the Columbia River Sediments AOC field investigation and analytical program is provided in Section 1.2, remedial investigation results are summarized in Section 1.3, and associated conclusions and recommendations are summarized in Section 1.4 below.

1.2 FIELD INVESTIGATION AND ANALYTICAL PROGRAM SUMMARY

The field investigation and analytical programs for Columbia River Sediments AOC RI work effort, including the 2016 sediment sampling activity and subsequent 2018 bioassay sampling and testing activities are summarized in the following sections.

1.2.1 2016 Columbia River Sediment Sampling and Analysis Activity

The Columbia River Sediments AOC field investigation was conducted in April 2016 in accordance with the Ecology-approved Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Surface sediment samples were collected using a clean, stainless steel 0.1-square meter (meter^2) van Veen grab sampling device. Sediment from the intake pond (i.e., sample station SD05) was collected using a smaller stainless-steel, petite Ponar grab sampler. The full penetration depth of the 0.1-meter^2 van Veen grab sampler is 21 centimeters (about 8 inches). Sediment samples were collected from the top 15 centimeters (0-6 inches below the mud line) as this represents the biologically active zone as specified in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Field observations, including sediment characteristics, presence of debris and biota were recorded on station-specific field forms at the time of collection of each grab sample (Volume 5, Appendix C-1).

Sampling was conducted using a tiered approach, with 36 priority (Tier 1) samples collected for a full suite of analyses, including total cyanide, fluoride, sulfate, PAHs, polychlorinated biphenyls (PCBs), total petroleum hydrocarbons – diesel extended range (TPH-Dx), metals, total organic carbon, and grain size as shown in Table 1-1. Additionally, 12 supplemental (Tier 2) samples were also collected and archived pending review of Tier 1 sample results (with exception of total cyanide, fluoride, and sulfate which were analyzed from each of the 12 locations along with the initial Tier 1 sample set due to holding time restrictions). Figure 1-1 shows the RI sediment sample station locations. Figure 1-2 identifies the upstream reference station locations, including those along the Columbia River and along the John Day River near its confluence.

A total of 24 Tier 1 stations were sampled based on proximity to areas of historical plant operation, potential transport pathways between the site and the Columbia River, and areas of current use and potential exposures including: the NPDES discharge point and associated mixing zone, potential discharge areas for intermittent drainages leading to the Columbia River, and the Boat Basin including the public boat launch area (refer to Figure 1-1). Areas of potential overland flow and runoff, as well as potential groundwater discharge are also addressed by the Tier 1 sampling program.

Twelve upstream Tier 1 reference sample stations, including three from the John Day River at the confluence with the Columbia River and nine from the Columbia River approximately 1 to 2 miles above the John Day River, were sampled in support of the RI work effort (refer to Figure 1-2). The reference station locations were sampled to provide information regarding contaminant levels associated with watershed-wide sources from both the Columbia River and John Day River systems immediately upstream of the project site.

A summary of the 2016 Columbia River RI sampling results is provided in Section 1.3.1 below.

1.2.2 2018 Columbia River Bioassay Sampling and Testing Activity

The Columbia River Sediments AOC bioassay sampling activity was completed in early August 2018 in accordance with the Ecology-approved SAP (Tetra Tech 2018a). Sediment bioassay samples were collected from the biologically active zone (0- to 6-inches below mudline) using a clean, 0.1-meter^2, stainless-steel van Veen grab sampling device A total of ten sediment bioassay sample station locations were sampled, including seven study area samples (SD05, SD14, SD15, SD17, SD18, SD20, and SD22) and three reference station locations (BKG04, BKG05, and

Table 1-1
Columbia River Sediments AOC – Sampling Program
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Area of Investigation	Type and Number of Samples [a]	Analytical Suite [b]	Sample Area Description and Sample Rationale
Boat Basin and Adjacent Columbia River Frontage	12 – Tier 1 (SD13, SD14, SD15, SD16, SD17, SD18, SD19, SD20, SD21, SD22, SD23, SD24) 4 – Tier 2 [c] (SD25, SD26, SD27, SD28)	COPC: -- Total Cyanide [c] -- Fluoride [c] -- Sulfate [c] -- PAHs -- PCBs [d] -- TPH-Dx -- Metals Other Constituents: -- TOC -- Grain Size	The Boat Basin is separated from the Columbia River by a railroad dike. A large culvert provides access to the Columbia River for boaters and is the only direct connection between the Boat Basin and the River. The Boat Basin includes a public boat launch and is located about 0.25 miles from the North Shore Treaty Fishing Access Site (TFAS). Intermittent drainage from the former aluminum smelter facility periodically discharges to The Boat Basin during storm events. Sample station locations were positioned in areas most likely to receive site runoff and in areas of high use (e.g., drainage paths, Boat Basin entrance and launch areas). Additional Columbia River station locations are positioned to provide coverage across the reach of The Boat Basin and to address areas where sediment is likely to accumulate. An additional upland site (the John Day Dam Burn Pile, FSID, 16820) [U.S. Army Corps of Engineers (USACE) 1994] that represents a potential source of sediment contamination is located on the southern side of the island that forms the southern shore of the Boat Basin. Operations at the John Day Lock and Dam are independent and are unrelated to the former smelter, as well as operation of the Burlington Northern Railroad which extends along the northern side of the Boat Basin and Columbia River. Refer to the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015b) for further description. Three stations in this investigation area (SD15, SD21, and SD22) were analyzed for PCB congeners (in addition to the standard analytical suite) including a location adjacent to the boat ramp, and two stations outside the Boat Basin in suspected sediment accumulation areas.
Columbia River at NPDES Outfall and Mixing Zone	6 – Tier 1 (SD07, SD08, SD09, SD10, SD11, SD12) 2 – Tier 2 [c] (SD29, SD30)		Sample station locations were positioned to capture discharge from the NPDES outfall diffuser, and primary mixing zone area associated with the NPDES outfall. Three stations (SD7, SD9, and SD11) were analyzed for PCB congeners (in addition to the standard analytical suite) near the NPDES Outfall.
Columbia River Upstream of NPDES Outfall to Eastern Boundary Below John Day River	6 – Tier 1 (SD01, SD02, SD03, SD04, SD05, SD06) 6 – Tier 2 [c] (SD31, SD32, SD33, SD34, SD35, SD36)		Sample station locations were positioned along the shoreline in the vicinity of potential drainage and groundwater discharge pathways, as well as in areas where sediment is likely to accumulate. One station location (SD05) was analyzed for PCB congeners (in addition to the standard analytical suite) in an assumed backwater depositional area near the surface water intake for the former plant and down slope from the eastern portion of the former smelter.
Columbia River and John Day River Reference Station Locations	12 – Tier 1 (BKG01-BKG12)		Nine reference sample station locations were positioned in the Columbia River between 1-2 miles upstream of the John Day River confluence for the purpose of evaluating baseline background conditions and potential upstream contributions. Three reference sample station locations were positioned along the John Day River adjacent to confluence with the Columbia River. The purpose of these samples is to assess contribution from the John Day watershed. All 12 reference stations were analyzed for PCB congener (in addition to the standard analytical suite) to provide an adequate data set for comparison.

Notes:

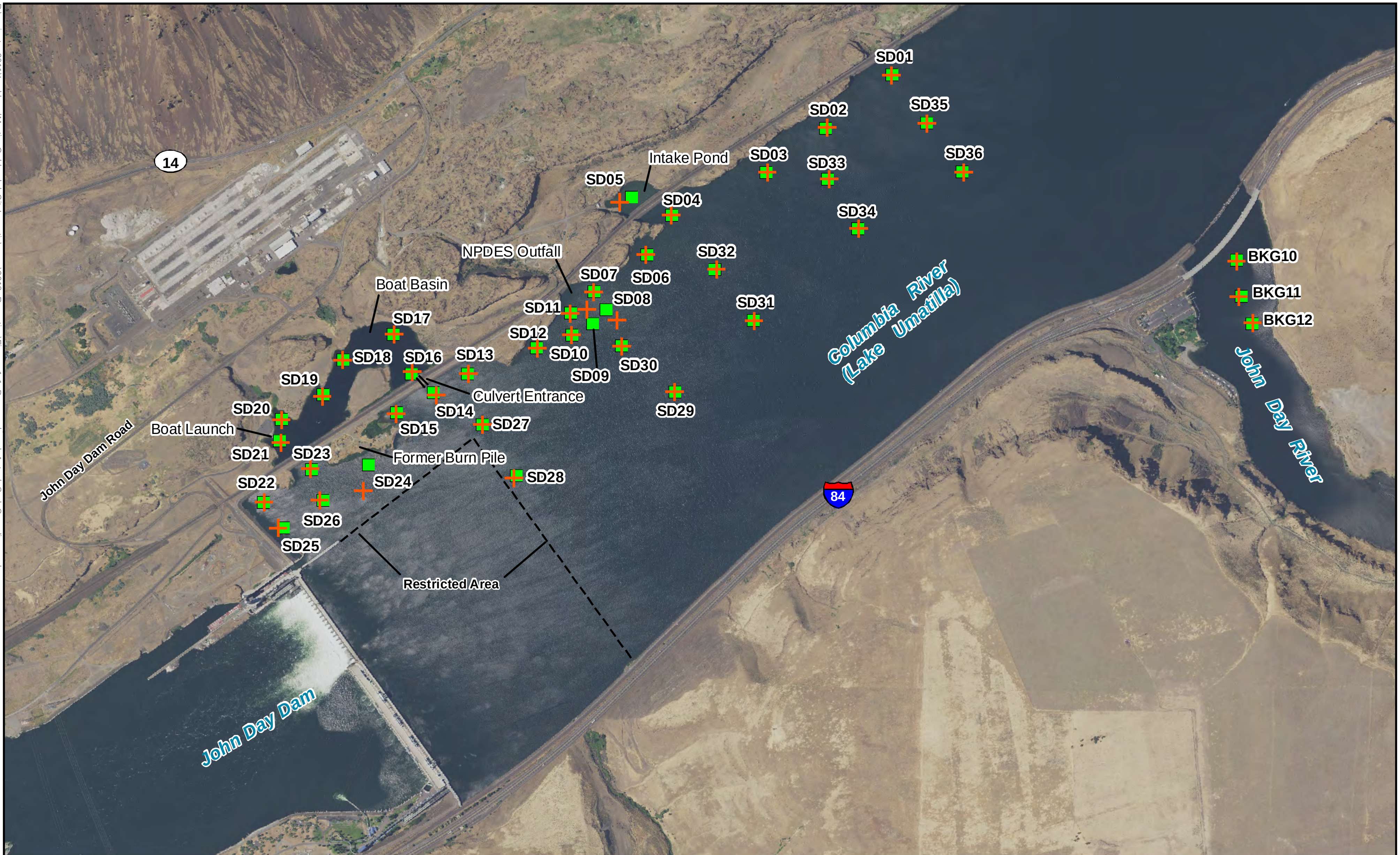
a All samples were collected from the biologically active zone (0- to 6-inches) as discrete grab samples. The sediment sampling program includes collection and full (comprehensive) laboratory analysis of thirty-six (36) Tier 1 samples. In addition, twelve (12) Tier 2 samples were collected and archived for select laboratory analysis (if required) based on results of the Tier 1 sample group.

b The full analytical suite was collected and analyzed for all Tier 1 samples. Tier 1 sample results determined the need for Tier 2 sample analysis.

c Tier 2 samples for total cyanide, fluoride, and sulfate were analyzed with the Tier 1 samples due to holding time limits for these analyses.

d All samples were analyzed for PCB Aroclors by EPA method 8082. Select samples were analyzed for PCB congeners (list of 209 congeners), including all background locations and select samples from each investigation area (refer to Figures 1-1 and 1-2).

AOC = Area of Concern
COPCs = Chemicals of Potential Concern
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TOC = Total Organic Carbon
TPH-Dx = Total Petroleum Hydrocarbons (Diesel- and Oil-Range)
Metals = Includes Aluminum, Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Selenium, and Zinc. The select list of metals represents those associated with the Washington State Sediment Management Standards, as well as those common to the aluminum reduction and smelter operations.



Legend

Proposed Sample Location

Grab Sample Location (May 2016)

NPDES - National Pollutant Discharge Elimination System

N W E S

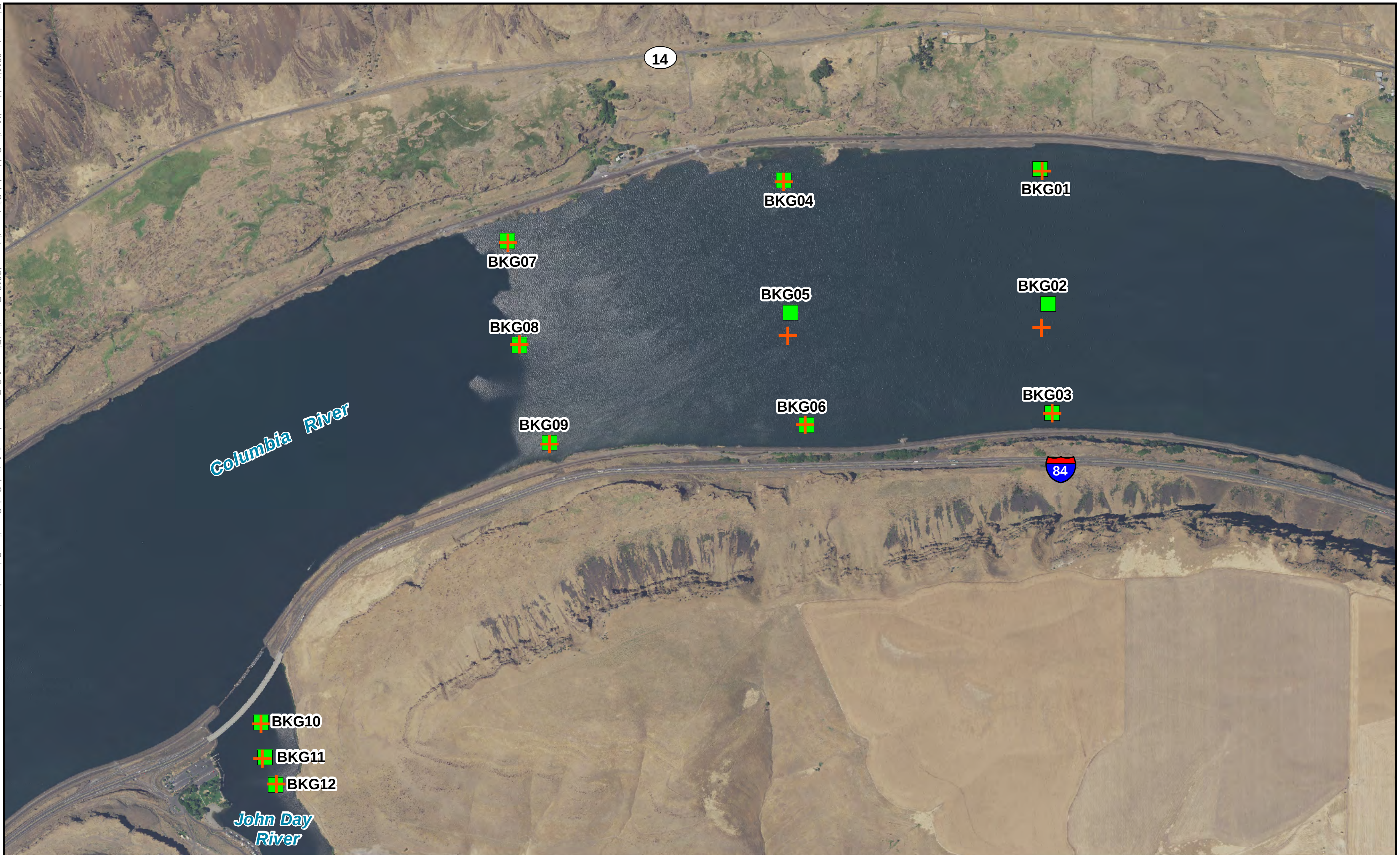
0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 1-1
Columbia River Sediment AOC
Sediment Sampling Location Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

- Proposed Sediment Sample Location
- Grab Sample Location (May 2016)

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 1-2
Columbia River Sediment AOC
Background Sediment Station Location Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

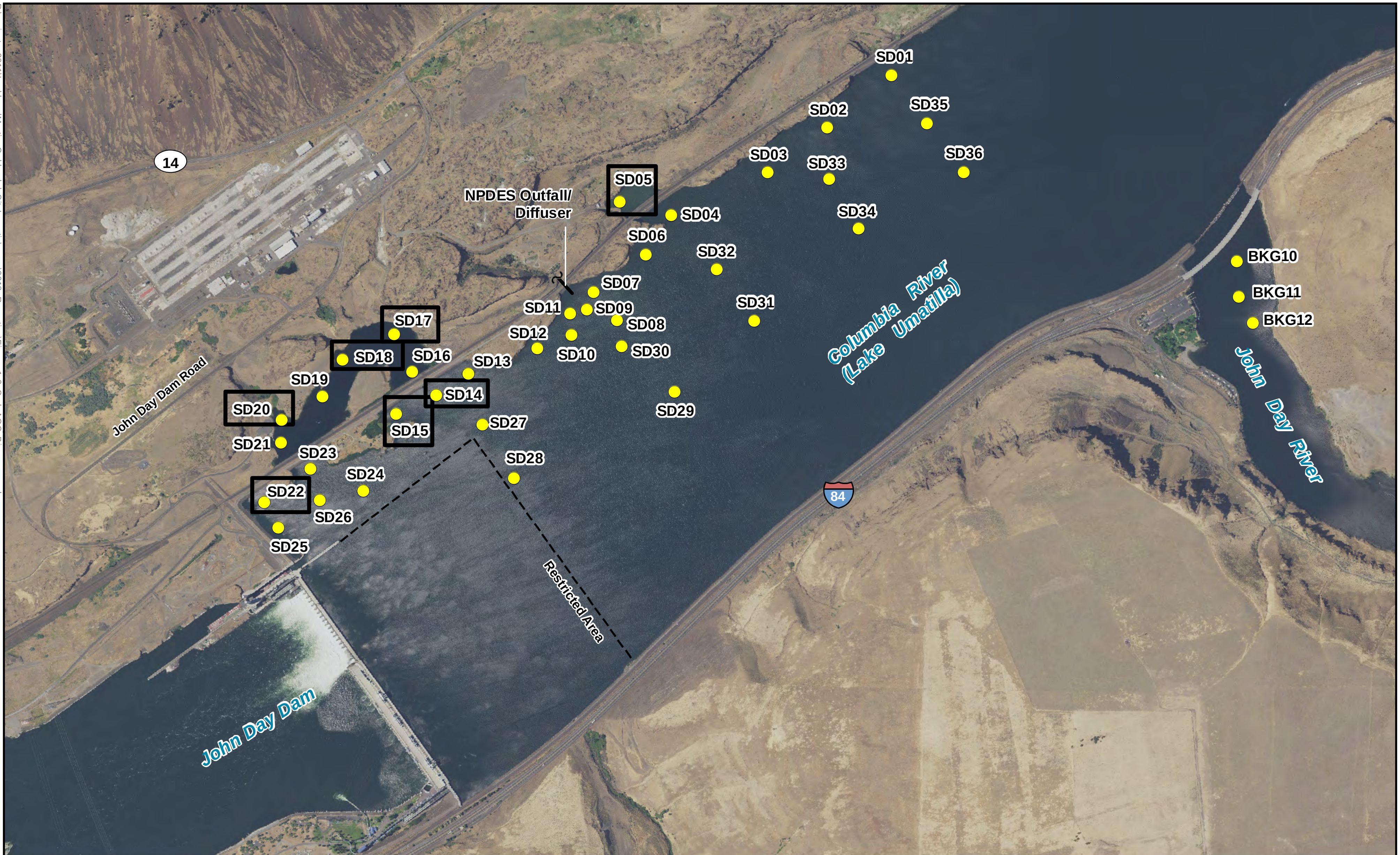
R:\projects_2011\LockheedMartin_GoldendaleSiteInvestig\maps\2018_Reporting\Figure_1-2_Proposed_and_Actual_Sed_Sampling_Bckgrnd.mxd

BKG10), for bioassay testing. Figure 1-3 shows the location of the seven-selected study area bioassay sample stations. Figure 1-4 shows the location of the three reference station locations. The rationale for selected bioassay sediment sample station locations is provided in the SAP (Tetra Tech 2018a). The testing program included three reference sediment locations (i.e., BKG04, BKG05, and BKG10) for use in comparing the biological responses of the project areas. The reference sediment represents sediment with similar physical characteristics as the project area sediment, but free of site-related influences. The reference sediments provide an indication of any physical effects of the sediments to test organism performance.

The collected project samples were submitted under standard chain-of-custody procedures to EcoAnalysts, Inc. of Port Gamble, Washington for bioassay testing. Bioassay testing included: 10-day Amphipod (*Hyalella azteca*) Survival Endpoint and 20-day Midge (*Chironomus dilutus*) Survival and Growth End Points. The two bioassays, amphipod mortality, and midge survival and growth conducted in support of this program are based on guidance found in the Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates (EPA 2000), United States Army Corps Seattle District Dredged Material Management Program updates, and interpretive guidance in Ecology's Sediment Cleanup User's Manual (SCUM II) (Ecology 2017a). These tests included the following:

- **10-Day Amphipod Mortality Bioassay.** This test involves exposing the amphipod *Hyalella azteca* to test sediment for 10 days and counting the surviving animals at the end of the exposure period. The control sediment has a performance standard of less than 20 percent mortality. The reference sediment has a performance standard of less than 25 percent mortality.
- **20-Day Midge Mortality and Growth Bioassay.** This test involves exposing *Chironomus dilutus* larvae to test sediment for 20 days and counting the surviving animals at the end of the exposure period. Growth (ash-free dry weight) is also assessed on the surviving organisms. The control and reference sediments have performance standards of less than or equal to 32 and 35 percent mortality, respectively.

Sediment from each of the samples was also collected and analyzed for total organic carbon and grain size. In addition, sediment samples were collected and archived (frozen) for potential future chemical analysis, if needed, based on the bioassay test results. General biological testing procedures are summarized in Table 1-2. The solid phase bioassay test interpretation and performance standards are presented in Table 1-3. A summary of the 2018 Columbia River RI bioassay sampling results is provided in Section 1.3.2 below.



Legend

SD20 Sediment Bioassay Sample Location

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 1-3
Columbia River Sediment AOC
Study Area Bioassay Sediment Sampling Locations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Legend

BKG04 Sediment Bioassay Sample Location

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 1-4
Columbia River Sediment AOC
Bioassay Reference Sediment Station
Location Map

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

R:\projects_2011\LockheedMartin_GoldendaleSiteInvestig\maps\2018_Reporting\Figure_1-4_Bioassay_Ref_Sed_Sampling.mxd

Table 1-2
Columbia River Sediments AOC – Summary of Testing Conditions for Bioassays
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Test Organism:	*Chironomus dilutus*	*Hyalella azteca*
Test Type:	20-day Solid Phase	10-day Solid Phase
Duration:	20 days	10 days
Test Chamber:	1-pint glass jar screened overflow ports and Zumwalt renewal apparatus	1-pint glass jar screened overflow ports and Zumwalt renewal apparatus
Age of Organism:	< 24-h-old larvae	7-8 days old
Organisms/Chamber:	12	10
Test Volumes:	100 mL sediment: 175 mL water	100 mL sediment: 175 mL water
Treatments:	9 + 2 controls (DI rinsed silica sand control and field collected control)	
Replicates:	8 + 2 surrogate chambers	8 + 2 surrogate chambers
Flow Regime:	2 volume additions/day	2 volume additions/day
Water Quality:	Hardness, alkalinity, conductivity, and ammonia at Day 0, 10, or 20 Temperature daily (ideally continuously) Dissolved oxygen (DO) and pH monitored daily. Conductivity weekly. Concentrations of DO should be measured more often if DO has declined by more than 1 mg/L since previous measurement	
Temperature:	23 ± 1°C Testing should be conducted as low within the acceptable range as possible 21.5-22.0°C to limit pupation The daily mean test temperature must be within ±1°C of 23°C. The instantaneous temperature must always be within ±3°C of 23°C.	23 ± 1°C The daily mean test temperature must be within ±1°C of 23°C. The instantaneous temperature must always be within ±3°C of 23°C.
Conductivity:	Unspecified test limits. Dilution water targets are: Hardness 90 to 100 mg/L, as CaCO3, alkalinity 50 to 70 mg/L as CaCO3, conductivity 330 to 360 mS/cm	
pH:	Unspecified test limits. Dilution water targets are: pH 7.8 to 8.2	
DO:	>2.5 mg/L	>2.5 mg/L
Reference Toxicant Test:	NH_3	NH_3
Photoperiod:	100-1000 lux 10 – 100 ft-candles 16 hours light/8 hours dark	100-1000 lux 10 – 100 ft-candles 16 hours light/8 hours dark
Aeration:	None, unless dissolved oxygen in overlying water drops below 2.5 mg/L	None, unless dissolved oxygen in overlying water drops below 2.5 mg/L
Feeding:	Tetrafin® goldfish food, fed 1.5 mL daily to each test chamber starting Day -1 (1.0 mL contains 4.0 mg of dry solids)	YCT food, fed 1.0 mL (1,800 mg/L stock) daily to each test chamber Wheat Grass food, 0.25 g/100 mL, fed 1.0 mL slurry
Endpoints:	Survival, Emergence Dry Weight Ash Free Dry Weight	Survival

Table 1-3
Columbia River Sediments AOC – Performance Standards and Bioassay Test Interpretation
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Toxicity Test	Negative Control Performance Standard	Reference Sediment Performance Standard	SCO[a]	CSL[a]
Hyalella azteca 10-day mortality	$M_C \leq 20\%$	M_R-$M_C \leq 25\%$	$M_T - M_C > 15\%$	$M_T - M_C > 25\%$
Chironomus dilutus 20-day mortality	$M_C \leq 32\%$	$M_R \leq 35\%$	$M_T - M_C > 15\%$	$M_T - M_C > 25\%$
Chironomus dilutus 20-day growth	$MIG_C \geq 0.48$ mg/Individual	$MIG_R / MIG_C \geq 0.8$	$MIG_T / MIG_C < 0.75$	$MIG_T / MIG_C < 0.6$

Source: Ecology (2019c) Table 8-4. Sediment Cleanup User's Manual (SCUM), December 2019.

a A statistical significance is set at $\alpha = 0.05$ (i.e., an exceedance of the criteria occurs when $p < 0.05$).

M = Mortality
mg = milligrams
MIG = Mean individual growth rate (mg/individual/day)
Subscripts: C = Control; R = Reference; T = Test sediment

1.3 REMEDIAL INVESTIGATION RESULTS

The Columbia River Sediments AOC RI results, including the 2016 sediment sampling activity and subsequent 2018 bioassay sampling and testing activities, are summarized in the following sections.

1.3.1 2016 Columbia River Sediment Sampling Results

The Columbia River Sediments AOC investigation was completed in April 2016, in accordance with the Ecology-approved RI Phase 2 Work Plan (Tetra Tech et al. 2015b). All sediment samples were shipped to TestAmerica Laboratories of Tacoma, Washington, a Washington State accredited (WA ELAP) laboratory, for specified sediment analysis (refer to Table 1-1). All samples were received by the laboratory in reported good condition and under standard chain-of-custody protocol. Sample results were validated by an independent, third-party data validation contractor, Laboratory Data Consultants of Carlsbad, California. Completed field sampling forms for the Columbia River Sediments AOC are included in Volume 5, Appendix C-1. Laboratory analytical data reports are provided in Volume 5, Appendix H-1 and data validation reports are provided in

Volume 5, Appendix I-1. The sediment sample results and associated information have been uploaded to Ecology's Environmental Information Management System (EIMS) under Study Identification Number (AODE10483).

No impacts to data usability were identified for the Columbia River sediment data beyond the rejected results for cyanide. Sufficient data for cyanide in sediments was found to be usable such that the rejected results in some samples did not impact the overall assessment of Columbia River sediment quality.

The 2016 Columbia River sediment sampling results are summarized for reference station locations in Table 1-4 and for the project (study area) locations in Table 1-5. The sediment sample results include totals for both PCB Aroclors and Congeners, as well as for PAHs (including total PAHs and total cPAHs). No PCB Aroclors were detected in the project sediment samples; the detailed results of the individual PCB congeners (i.e., 206 congeners) are fully summarized in Volume 5, Appendix C-2 of this report.

Table 1-4 provides a summary of reference station sediment sample results which include Freshwater Sediment Management Standards [Sediment Cleanup Objective (SCO) and Cleanup Screening Level (CSL)] for comparative review. For reference station locations, two metals including nickel in five samples (BKG03, BKG04, BKG05, BKG10, and BKG12) and arsenic in sample BKG03 were detected at concentrations slightly above their associated SCO screening levels of 26 milligrams per kilogram (mg/kg) and 14 mg/kg, respectively.

Based on Ecology's request, reference station sediment data (refer to Table 1-4) have been evaluated for outliers using ProUCL™, and statistical representative reference values have been developed for comparative review using the 90/90 Upper Threshold Limit (UTL) consistent with the SCUM II recommendations (Ecology 2017a). Reference station outlier evaluation and 90/90 UTL statistics for the project reference station locations are provided in RI Report Volume 5, Appendix C-3.

Table 1-5 provides a summary of project (study area) sediment sample results, which include SMS Freshwater SCO and CSL screening levels, as well as the 90/90 UTL reference concentrations (as derived from reference station samples collected as part of this RI work effort) for comparative review. Maximum detected reference station concentrations are also provided in Table 1-5 for general information. Based on this initial screening, three additional Tier 2 sample locations (SED25, SED26, and SED27) were analyzed for cadmium based on the results in the Tier 1

Table 1-4
Columbia River Sediments AOC - Reference Station Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter Name	Units	Freshwater SMS Screening Levels		Analytical Results												
		SCO	CSL	CRSAOC-BKG01 4/27/2016	CRSAOC-BKG02 4/27/2016	CRSAOC-BKG03 4/27/2016	CRSAOC-BKG04 4/27/2016	CRSAOC-BKG05 4/27/2016	CRSAOC-BKG06 4/27/2016	CRSAOC-BKG07 4/27/2016	CRSAOC-BKG08 4/27/2016	CRSAOC-BKG09 4/27/2016	CRSAOC-BKG10 4/25/2016	CRSAOC-BKG11 4/25/2016	CRSAOC-BKG12 4/27/2016	CRSAOC-BKG40 (Dup of BKG05) 4/27/2016
Grain Size/Total Organic Carbon																
Particle/Grain Size, Clay	%	NA	NA	12.1	24.5	5.1	7.4	28.8	23.8	4.5	27.1	12.1	28.4	25.8	21.2	28.6
Particle/Grain Size, Gravel	%	NA	NA	0.7	37.2	7.5	0	0	0	0	3.5	0	0	0	0	0
Particle/Grain Size, Sand	%	NA	NA	36.3	6.8	65.4	65.6	6.4	1.9	83.4	9.9	39.5	1.5	0.1	1.2	6.5
Particle/Grain Size, Silt	%	NA	NA	50.9	31.5	22	27.1	64.8	74.3	12.1	59.5	48.4	70.1	74.1	77.6	64.9
Total Organic Carbon	%	NA	NA	1.1	2	0.63	0.66	2	2.1	0.29	1.8	0.95	1.9	1.2	0.99	1.8
Metals																
Aluminum	mg/Kg	NA	NA	9,000	8,900	16,000	17,000	19,000 J	13,000	7,100	15,000	10,000	20,000	16,000	21,000	15,000 J
Arsenic	mg/Kg	14	120	4.4	4.1	**20**	9.6	10	6.9	4	6.5	5.7	7.7	4.7	4.5	8.2
Cadmium	mg/Kg	2.1	5.54	0.64	0.72	1.2	1	1.5 J	1.3	0.36	1.3	0.8	1.1	0.47	0.41	1.2 J
Chromium	mg/Kg	72	88	16 J	13 J	31 J	32 J	29 J	21 J	15 J	22 J	19 J	29 J	23 J	27	23 J
Copper	mg/Kg	400	1,200	17 J	16 J	31 J	27 J	37 J	29 J	14 J	27 J	19 J	54 J	45 J	50	29 J
Lead	mg/Kg	360	1,300	13	12	26	22	28 J	21	13	21	14	19	10	8.7	22 J
Mercury	mg/Kg	1	1	0.044	0.058	0.067	0.073	0.11 J	0.099	0.026 J	0.096	0.065	0.093	0.037 J	0.039	0.15 J
Nickel	mg/Kg	26	110	15	13	**29**	**29**	**28 J**	21	13	22	18	**31 J**	25 J	**28**	22 J
Selenium	mg/Kg	NA	NA	1.1	1.1	2.4	2	2.2	1.6	0.78	1.8	1.2	2.1	1.6	1.3	1.9
Zinc	mg/Kg	3,200	4,200	130	120	280	230	250 J	190	140	200	140	170	90	85	190 J
Inorganics																
Total Cyanide	mg/Kg	NA	NA	3.2 UJ	3.2 UJ	6 UJ	5.8 UJ	5.7 UJ	4.3 UJ	2.6 UJ	5.6 UJ	4.1 UJ	6.1 U	3.7 U	3.7 U	4.9 UJ
Fluoride	mg/Kg	NA	NA	3.2 J	7.3 J	5.9 J	4.6 J	6.6 J	3.4	0.84 B	6	2.9	5.3	2.4 B	2.7	7.8 J
Sulfate	mg/Kg	NA	NA	28	62	41	62	110	130	25 B	230	71	290	220	110	110
Polychlorinated Biphenyls (PCBs)																
Total PCB Aroclor	µg/Kg	110	2,500	0.84 U	0.81 U	1.4 U	1.4 U	1.5 U	0.99 U	0.66 U	1.4 U	0.93 U	1.3 U	0.77 U	0.91 U	1.3 U
Total PCB Congener	µg/Kg	110	2,500	1.36	1.45	1.40	5.16	2.64	2.26	0.349	3.22	2.31	2.11	0.923	0.619	2.04
Polycyclic Aromatic Hydrocarbons (PAHs)																
1-Methylnaphthalene	µg/Kg	NA	NA	7	8.7 J	2 U	3.3 J	13 J	9.3 J	0.85 U	1.7 U	1.2 U	9 J	1.7 J	1.1 U	28 J
2-Methylnaphthalene	µg/Kg	NA	NA	7.6	15	3.1 J	4.3 J	13 J	5.7 J	0.61 U	3.1 J	3.9 J	12 J	5 J	0.76 U	30 J
Acenaphthene	µg/Kg	NA	NA	3.1 J	7.3 J	4.5 J	3 J	3.5 J	1.2 U	1.9 J	1.6 U	1.2 J	1.5 U	1.1 U	1 U	24 J
Acenaphthylene	µg/Kg	NA	NA	0.68 U	0.88 U	22	1.5 U	1.3 UJ	1 U	0.68 U	1.3 U	0.96 U	1.3 U	0.91 U	0.84 U	28 J
Anthracene	µg/Kg	NA	NA	8.1	4.2 J	11 J	5.1 J	7.1 J	2.9 J	1.7 J	1.6 U	2.1 J	3.1 J	1.2 J	1 U	29 J
Benz[a]anthracene	µg/Kg	NA	NA	32	3.7 J	83	34	11 J	3.8 J	16	4.6 J	8.4 J	8.9 J	4.6 J	4.7 J	38 J
Benzo(a)pyrene	µg/Kg	NA	NA	35	3.8 J	140	41	11 J	0.82 U	21	5.1 J	8.2 J	8.2 J	4.5 J	4.9 J	30 J
Benzo(b)fluoranthene	µg/Kg	NA	NA	46	7.3 J	150	59	19 J	8.7 J	29	12 J	14	16	9.7	7.7 J	40 J
Benzo(ghi)perylene	µg/Kg	NA	NA	27	4.4 J	190	37	10 J	4.5 J	16	6.4 J	7 J	8.7 J	5.4 J	3.8 J	31 J
Benzo(k)fluoranthene	µg/Kg	NA	NA	14	2.2 J	43	17	6.2 J	2.4 J	13	4.6 J	4 J	4.6 J	2.6 J	3 J	32 J
Chrysene	µg/Kg	NA	NA	44	6.6 J	120	46	19 J	8 J	21	12 J	11	14	9 J	6.3 J	49 J
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	5.7 J	1.3 U	16	7.1 J	3.2 J	1.5 U	3 J	1.9 U	2.1 J	1.9 U	1.3 U	1.2 U	26 J
Fluoranthene	µg/Kg	NA	NA	55	15	210	57	30 J	14	23	16	17	24	14	9	46 J
Fluorene	µg/Kg	NA	NA	2.9 J	7.6 J	5.6 J	3.4 J	8.8 J	4.7 J	0.68 U	1.3 U	2.5 J	7.4 J	6.5 J	0.84 U	27 J
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	30	4.6 J	150	39	11 J	3.7 J	17	4.7 J	7.9 J	8 J	4.6 J	4.2 J	32 J
Naphthalene	µg/Kg	NA	NA	11	100	7.4 J	5.4 J	11 J	6.9 J	1.1 U	5.6 J	4.2 J	15	6.6 J	2 J	30 J
Phenanthrene	µg/Kg	NA	NA	33	20	100	27	21 J	9.3 J	11	9.9 J	9.5 J	15	8.9 J	3.2 J	34 J
Pyrene	µg/Kg	NA	NA	50	9.8	260	46	21 J	9.5 J	21	12 J	13	17	9.9	8.4	40 J
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	48.2	5.71	185	57.1	16.2	2.43	29.0	7.91	12.0	12.2	6.81	6.98	47.3
Total PAHs	µg/Kg	17,000	30,000	411	220	1,516	435	219	93	195	96	116	171	94	57	594
Petroleum Range Organics																
#2 Diesel	mg/Kg	NA	NA	18 U	19 U	31 U	31 U	29 U	24 U	15 U	33 U	22 U	29 U	22 U	19 U	27 U
Motor Oil	mg/Kg	NA	NA	15 U	16 U	26 U	26 U	24 U	29 J	13 U	27 U	18 U	35 J	26 J	61 J	61 J

Notes:
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.
Bold = Sample result > SCO screening level.

CSL = Cleanup Screening Level
J = Estimated concentration
NA = Not applicable
nc = Not calculated
SCO = Sediment Cleanup Objective
SMS = Sediment Management Standards
U = Chemical was not detected at or above the associated method detection limit.
UTL = Upper Threshold Limit

Table 1-5
Columbia River Sediments AOC - Project (Study Area) Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Parameter Name	Units	Sediment Screening Levels: Freshwater SMS Criteria SCO	Freshwater SMS Criteria CSL	Reference Concentrations [a] Maximum	Reference Concentrations [a] 90/90 UTL	CRSAOC-SED01 4/30/2016	CRSAOC-SED02 4/30/2016	CRSAOC-SED40 (Dup of SED02) 4/30/2016	CRSAOC-SED03 4/30/2016	CRSAOC-SED04 5/1/2016	CRSAOC-SED41 (Dup of SED04) 5/1/2016	CRSAOC-SED05 5/2/2016	CRSAOC-SED06 5/1/2016	CRSAOC-SED07 5/1/2016	CRSAOC-SED42 (Dup of SED07) 5/1/2016	CRSAOC-SED08 5/1/2016	CRSAOC-SED09 5/1/2016	CRSAOC-SED10 5/1/2016	CRSAOC-SED11 5/1/2016	CRSAOC-SED12 5/1/2016	CRSAOC-SED13 5/1/2016	CRSAOC-SED14 5/1/2016	CRSAOC-SED15 5/1/2016	CRSAOC-SED43 (Dup of SED15) 5/1/2016
Grain Size/Total Organic Carbon																								
Particle/Grain Size, Clay	%	NA	NA	NA	NA	8.9	15.8	24.4	20.4	27.9	28.4	3.6	7	10.5	8.2	24.4	3.1	4.8	3.1	6.4	26.5	23	14.8	14.3
Particle/Grain Size, Gravel	%	NA	NA	NA	NA	0	0	0	0	0	0	4	0	1.4	0	0	0	0	0	3.9	0	0	0	0
Particle/Grain Size, Sand	%	NA	NA	NA	NA	62.6	36	11.5	9.9	2.2	2.2	62.8	63.3	74.6	70.4	9.2	89.4	77	91.1	61	7.4	5.4	10	7.9
Particle/Grain Size, Silt	%	NA	NA	NA	NA	28.5	48.2	64.1	69.7	69.9	69.4	29.6	29.7	13.5	21.4	66.4	7.5	18.2	5.8	28.7	66.1	71.6	75.2	77.8
Total Organic Carbon	%	NA	NA	2.1	nc	0.74	1.6	1.5	1.7	2.1	2.2	1.1	0.7	0.62	0.65	1.7	0.27	0.43	0.23	0.52	1.6	1.7	3	3.1
Metals																								
Aluminum	mg/Kg	NA	NA	21,000	23000[b]	11,000	17,000	15,000	19,000	21,000	20,000	7,100	9,500	9,000	9,800	19,000	7,500	9,300	5,800	10,000	21,000	21,000	18,000	17,000
Arsenic	mg/Kg	14	120	20	11[c]	4.7	7.6	7.1	8.3	9.4	9.3	3	4.6	4.5	4.8	8.5	5.1	4.5	3.8	4.8	8.7	9.4	9.1	8.8
Cadmium	mg/Kg	2.1	5.54	1.5	1.7[b]	0.6	1.2	1	1.5	1.6	1.6	0.56	0.65	0.51	0.57	1.5	0.4	0.32	0.28	0.48	1.7	2.3	2.5	2.4
Chromium	mg/Kg	72	88	32	35[b]	18 J	25 J	23 J	27 J	29 J	29 J	11	15 J	14 J	15 J	27 J	13 J	17 J	10 J	17 J	29 J	29 J	27 J	26 J
Copper	mg/Kg	400	1,200	54	55[b]	16	28	26	31	38 J	37 J	16	14 J	13 J	15 J	32 J	8.8 J	12 J	7.5 J	14 J	36 J	37 J	39 J	36 J
Lead	mg/Kg	360	1,300	28	30[b]	11	20	18	23	27	27	6.7	10	9.2	10	23	8.1	7	6.4	8.6	23	26	24	25
Mercury	mg/Kg	1	1	0.15	0.14[b]	0.036	0.076	0.082	0.11	0.12	0.12	0.029 J	0.041	0.033	0.037	0.14	0.016 J	0.02 J	0.017 J	0.03	0.11	0.12	0.13	0.12
Nickel	mg/Kg	26	110	31	35b	16	24	22	26	29 J	28 J	10	14 J	13 J	14 J	26 J	11 J	14 J	9.1 J	14 J	26 J	27 J	26 J	25 J
Selenium	mg/Kg	NA	NA	2.4	2.6[b]	0.96	1.5	1.3	1.7	2.1	1.9	0.95	0.81	0.84	0.88	1.8	0.68	0.75	0.52	0.83	1.6	1.8	2	1.9
Zinc	mg/Kg	3,200	4,200	280	290[b]	120	190	170	210	240 J	230 J	83	110 J	96 J	100 J	210 J	95 J	75 J	67 J	95 J	220 J	250 J	270 J	260 J
Inorganics																								
Total Cyanide	mg/Kg	NA	NA	ND	nc	2.9 UJ	5.1 UJ	4.7 UJ	5.3 UJ	5.7 UJ	5.7 UJ	3.6 R	3 UJ	2.7 UJ	3 UJ	5.4 UJ	2.6 UJ	2.7 UJ	2.3 UJ	2.8 UJ	4.7 UJ	5.1 UJ	**11 J**	5.4 UJ
Fluoride	mg/Kg	NA	NA	7.8	7.7[b]	0.47 U	1.6 B	1.2 B	1.5 B	**9 J**	4.4 J	0.62 B	0.48 U	2.4 B	1.9 B	2.7 J	0.82 B	1.2 B	0.36 U	1.6 B	3.1	6.2	5 J	1.7 B
Sulfate	mg/Kg	NA	NA	290	278[b]	39	81 J	62 J	88	**380**	**410**	**380 J**	71	59	64	120	14 B	19 B	11 B	24 B	**390**	**430**	**460 J**	**670 J**
Polychlorinated Biphenyls (PCBs)																								
Total PCB Aroclor	µg/Kg	110	2,500	ND	nc	0.7 U	1.2 U	1.0 U	1.5 U	1.5 U	1.6 U	0.75 U	0.84 U	0.76 U	0.74 U	1.2 U	0.59 U	0.65 U	0.6 U	0.71 U	1.1 U	1.3 U	1.3 U	1.4 U
Total PCB Congener	µg/Kg	110	2,500	5.16	4.4[b]							1.08		1.03			0.196		0.136				2.41	2.79
Polycyclic Aromatic Hydrocarbons (PAHs)																								
1-Methylnaphthalene	µg/Kg	NA	NA	28	nc	2.7 J	9.9 J	8.2 J	2.4 J	1.9 U	1.9 U	2.2 J	0.95 U	0.96 U	0.83 U	1.7 U	0.69 U	0.69 U	0.68 U	0.8 UJ	4 J	8.3 J	3.7 J	9.2 J
2-Methylnaphthalene	µg/Kg	NA	NA	30	nc	5.1 J	12	14	3.5 J	1.4 U	1.3 U	5.8 J	0.68 U	0.69 U	2.4 J	1.2 U	0.49 U	0.49 U	1.2 J	0.57 J	4.7 J	18	9.4 J	12 J
Acenaphthene	µg/Kg	NA	NA	24	nc	2.3 J	1.4 U	12	1.8 U	1.8 U	1.8 U	30	3.4 J	1.4 J	1.6 J	1.6 U	2.3 J	0.65 U	11	5.7 J	5.7 J	60	9.3 J	11 J
Acenaphthylene	µg/Kg	NA	NA	28	nc	0.76 U	1.1 U	2.6 J	1.5 U	1.5 U	1.5 U	0.85 U	0.75 U	0.76 U	0.66 U	1.4 U	0.55 U	0.55 U	0.54 U	0.63 UJ	1.3 UJ	1.2 U	1.4 U	1.4 U
Anthracene	µg/Kg	NA	NA	29	nc	4.6 J	5.6 J	9.5 J	3.6 J	2.8 J	4 J	37	3.1 J	2.2 J	3.2 J	3 J	2.7 J	4.1 J	11	5.7 J	7.6 J	79	12 J	16
Benz[a]anthracene	µg/Kg	NA	NA	83	nc	21	24	36	9.3 J	20	14 J	280	32	14	16	11 J	24	44	90	51 J	52 J	800	72	98
Benzo(a)pyrene	µg/Kg	NA	NA	140	41[c]	20	22 J	38 J	9.3 J	19	18	**310**	36	21	23	12 J	32	**120**	**100**	**64 J**	**70 J**	**810**	**92**	**120**
Benzo(b)fluoranthene	µg/Kg	NA	NA	150	nc	34	42	57	17	30	29	470	50	40	36	18	47	230	140	84 J	100 J	1200	140	180
Benzo(ghi)perylene	µg/Kg	NA	NA	190	nc	18	23	26	8.9 J	14 J	15	280	30	37 J	22 J	9.2 J	28	140	83	52 J	59 J	710	77	95
Benzo(k)fluoranthene	µg/Kg	NA	NA	43	nc	12	16	21	5.9 J	8.6 J	9.2 J	190	19	12	12	5.4 J	16	67	45	33 J	39 J	410	49	63
Chrysene	µg/Kg	NA	NA	120	nc	37	38 J	59 J	14 J	24	25	400	39	21	25	13 J	35	250	100	63 J	86 J	1100	110	140
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	26	nc	3.2 J	3.5 J	5.1 J	2.1 U	2.2 U	3.6 J	41	5.3 J	5.4 J	3.8 J	2 U	4.9 J	21	13	8.6 J	9.9 J	130	15	17
Fluoranthene	µg/Kg	NA	NA	210	nc	36	49	66	24	36	37	410	48	27	29	21	39	20	130	75 J	93 J	1200	130	180
Fluorene	µg/Kg	NA	NA	27	nc	0.76 U	1.1 U	11	1.5 U	3.6 J	5.8 J	15	2.3 J	0.76 U	0.66 U	1.4 U	1.6 J	0.55 U	5.7	2.9 J	5.1 J	45	14	12 J
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	150	nc	19	24	28	12 J	15	17	300	32	38 J	24 J	10 J	30	130	88	51 J	62 J	720	83	100
Naphthalene	µg/Kg	NA	NA	100	nc	7 J	13 J	99 J	6.2 J	4.2 J	7.9 J	7.7 J	7.2 J	1.2 U	2.6 J	3 J	1.1 J	0.87 U	2.9 J	2.3 J	6.6 J	16	8.6 J	13 J
Phenanthrene	µg/Kg	NA	NA	100	nc	26	26 J	44 J	12 J	16	20	180	21	10	13	9.4 J	16	10	61	33 J	39 J	400	57	81
Pyrene	µg/Kg	NA	NA	260	nc	35	38	51	17	31	29	360	44	23	25	19	34	17	120	64 J	81 J	950	110	150
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	185	57.1[d]	29.3	33.3	53.3	14.0	26.7	25.5	**442.1**	50.2	32.2	32.4	16.7	44.5	**171.7**	**138.6**	**87.4**	**97.2**	**1147.0**	**129.0**	**167.2**
Total PAHs	µg/Kg	17,000	30,000	1,516	nc	283	346	587	145	224	235	3,319	372	252	239	134	314	1,053	1,002	596	725	8,656	992	1,297
Petroleum Range Organics																								
#2 Diesel	mg/Kg	NA	NA	ND	nc	16 J	27 U	24 U	32 U	30 U	33 U	19 U	18 U	17 U	17 U	29 U	13 U	15 U	13 U	15 U	25 U	24 U	29 U	29 J
Motor Oil	mg/Kg	NA	NA	61	nc	36 J	30 J	20 U	140 J	25 U	30 J	43 J	15 U	14 U	14 U	24 U	11 U	12 U	10 U	12 U	100 J	73 J	33 J	55 J

Notes:

a) Reference concentrations developed from the collected samples BKG01 - BKG12
b) 90/90 UTL - normal distribution value
c) 90/90 UTL - normal distribution value with outlier removed
d) 90/90 UTL - nonparametric distribution value with outlier removed
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.
Yellow shading = Sample result > SCO screening level and > 90/90 UTL.

Bold = Sample result > 90/90 UTL of the reference sample results where no SCO criteria available.
BaPeq = Benzo(a)pyrene equivalent
CSL = Cleanup Screening Level
J = Estimated concentration
NA = Not applicable

nc = Not calculated
R = rejected result
SCO = Sediment Cleanup Objective
SMS = Sediment Management Standards
U = Chemical was not detected at or above the associated method detection limit.
UTL = Upper Threshold Limit

Table 1-5
Columbia River Sediments AOC - Project (Study Area) Sample Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Parameter Name	Units	Sediment Screening Levels				Analytical Results																			
		Freshwater SMS Criteria		Reference Concentrations [a]		CRSAOC-SED16	CRSAOC-SED17	CRSAOC-SED18	CRSAOC-SED19	CRSAOC-SED20	CRSAOC-SED21	CRSAOC-SED22	CRSAOC-SED23	CRSAOC-SED24	CRSAOC-SED25	CRSAOC-SED26	CRSAOC-SED27	CRSAOC-SED28	CRSAOC-SED29	CRSAOC-SED30	CRSAOC-SED31	CRSAOC-SED32	CRSAOC-SED33	CRSAOC-SED34	CRSAOC-SED35
		SCO	CSL	Maximum	90/90 UTL	5/2/2016	5/2/2016	5/2/2016	4/29/2016	4/29/2016	5/2/2016	4/26/2016	4/26/2016	4/26/2016	4/26/2016	4/26/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016	4/30/2016
Grain Size/Total Organic Carbon																									
Particle/Grain Size, Clay	%	NA	NA	NA	NA	1.5	40	37.3	1.2	2	0.2	42	22.3	23.6											
Particle/Grain Size, Gravel	%	NA	NA	NA	NA	0.4	0	0	6.3	0	4.5	0	0	0											
Particle/Grain Size, Sand	%	NA	NA	NA	NA	93.2	5.7	9.7	85.5	68.4	89.9	7.1	3.6	4											
Particle/Grain Size, Silt	%	NA	NA	NA	NA	4.9	54.3	53	6.9	29.6	5.3	50.9	74.1	72.4											
Total Organic Carbon	%	NA	NA	2.1	nc	0.24	3.9	3.7	0.22	0.67	1	1.7	2	1.7											
Metals																									
Aluminum	mg/Kg	NA	NA	21,000	23000[b]	6,000	19,000	16,000	6,300	1,500	4,500	23,000	21,000	20,000											
Arsenic	mg/Kg	14	120	20	11[c]	2.7	9.9	8.2	2.9	0.52	3.3	13	10	9.3											
Cadmium	mg/Kg	2.1	5.54	1.5	1.7[b]	0.21	1.2	1.3	0.23	0.081	0.16	3.3	2	1.9	1.3	1.9	1.4								
Chromium	mg/Kg	72	88	32	35[b]	9.5	24	20	11	2.9	5.4	31 J	30 J	28 J											
Copper	mg/Kg	400	1,200	54	55[b]	7.8	45	42	8.7	2.3	11	43 J	40 J	36 J											
Lead	mg/Kg	360	1,300	28	30[b]	5.4	22	19	5.1	1.2	3.9	51	28	26											
Mercury	mg/Kg	1	1	0.15	0.14[b]	0.012 J	0.085 J	0.079 J	0.013 J	0.022 J	0.0082 J	0.2	0.11	0.13											
Nickel	mg/Kg	26	110	31	35b	9.4	21	19	9.9	2.5	7	29 J	29 J	27 J											
Selenium	mg/Kg	NA	NA	2.4	2.6[b]	0.66 J	2.6 J	2	0.68	0.15	0.82	2.2	2.5	2.2											
Zinc	mg/Kg	3,200	4,200	280	290[b]	74	180	170	74	17	51	410	260	240											
Inorganics																									
Total Cyanide	mg/Kg	NA	NA	ND	nc	2.6 R	12 R	9.2 R	2.4 U	3.1 U	2.5 R	4.5 U	6.2 U	5.8 U	4.6 U	6.0 U	5.4 U	5.1 U	5.9 U	5.3 U	5.4 U	5.1 U	5.3 U	6.1 U	4.6 U
Fluoride	mg/Kg	NA	NA	7.8	7.7[b]	0.44 U	1.9 U	**12**	0.41 J	0.5 U	0.38 U	**8.4**	**8.9**	**9.1**	5.2	**8.1**	1.1 J	**8.9**	2.0 J	1.5 J	1.6 J	1.7 J	1.5 J	1.6 J	1.3 J
Sulfate	mg/Kg	NA	NA	290	278[b]	23 B	**4,700 J**	**1,900 J**	20	32	12 B	220	**300**	**350**	260	220	**320**	240	77	110	**290**	96	110	130	120
Polychlorinated Biphenyls (PCBs)																									
Total PCB Aroclor	µg/Kg	110	2,500	ND	nc	0.56 U	3.1 U	2.2 U	0.58 U	0.7 U	0.62 U	1.2 U	1.3 U	1.4 U											
Total PCB Congener	µg/Kg	110	2,500	5.16	4.4[b]						0.057	15.8													
Polycyclic Aromatic Hydrocarbons (PAHs)																									
1-Methylnaphthalene	µg/Kg	NA	NA	28	nc	2 J	4 UJ	11 J	4 J	0.85 U	0.73 U	3.4 J	6.1 J	3.2 J											
2-Methylnaphthalene	µg/Kg	NA	NA	30	nc	2.5 J	2.9 UJ	16 J	7.5	2.4 J	0.52 U	3.8 J	4.3 J	9 J											
Acenaphthene	µg/Kg	NA	NA	24	nc	21	59 J	63	21	15	0.69 U	5.1 J	2.1 J	1.9 J											
Acenaphthylene	µg/Kg	NA	NA	28	nc	0.73 U	3.2 UJ	2.3 U	0.65 U	0.68 U	0.58 U	1.1 U	1.5 U	1.5 U											
Anthracene	µg/Kg	NA	NA	29	nc	20	70 J	65	20	17	0.69 U	38	5.1 J	5.5 J											
Benz[a]anthracene	µg/Kg	NA	NA	83	nc	200	520 J	450	170	160	2.2 J	240	22	20											
Benzo(a)pyrene	µg/Kg	NA	NA	140	41[c]	**250**	**620 J**	**560**	**180**	**180**	3.1 J	**190**	24	22											
Benzo(b)fluoranthene	µg/Kg	NA	NA	150	nc	360	990 J	830	250	240	5.9	410	40	36											
Benzo(ghi)perylene	µg/Kg	NA	NA	190	nc	220	550 J	460	150	150	3.1 J	130	22	20											
Benzo(k)fluoranthene	µg/Kg	NA	NA	43	nc	140	350 J	280	86	82	2.2 J	110	11 J	10 J											
Chrysene	µg/Kg	NA	NA	120	nc	250	890 J	710	200	190	3.9 J	220	33	30											
Dibenzo(a,h)anthracene	µg/Kg	NA	NA	26	nc	33	77 J	72	23	24	0.83 U	26	4.7 J	4.4 J											
Fluoranthene	µg/Kg	NA	NA	210	nc	300	1000 J	870	260	240	4.5 J	130	47	41											
Fluorene	µg/Kg	NA	NA	27	nc	10	39 J	38	12	9.5	0.58 U	8.9 J	5.8 J	6.1 J											
Indeno(1,2,3-cd)pyrene	µg/Kg	NA	NA	150	nc	230	550 J	480	150	170	3.7 J	130	22	21											
Naphthalene	µg/Kg	NA	NA	100	nc	5 J	18 J	21 J	5.3 J	4 J	0.93 U	7.5 J	6.7 J	6.6 J											
Phenanthrene	µg/Kg	NA	NA	100	nc	120	370 J	350	110	88	1.6 J	44	20	18											
Pyrene	µg/Kg	NA	NA	260	nc	270	880 J	730	230	210	4 J	250	36	33											
Total cPAH BaPeq (calc)	µg/Kg	NA	NA	185	57.1[d]	**348.8**	**877.6**	**778.3**	**249.9**	**249.5**	4.6	**283.8**	34.3	31.4											
Total PAHs	µg/Kg	17,000	30,000	1,516	nc	2,434	6,983	6,006	1,879	1,782	34	1,947	312	288											
Petroleum Range Organics																									
#2 Diesel	mg/Kg	NA	NA	ND	nc	13 U	68 U	51 U	14 J	22 J	12 U	24 U	33 U	29 U											
Motor Oil	mg/Kg	NA	NA	61	nc	18 J	64 J	76 J	32 J	80 J	10 J	20 U	29 J	24 U											

Notes:

a) Reference concentrations developed from the collected samples BKG01 - BKG12

b) 90/90 UTL - normal distribution value

c) 90/90 UTL - normal distribution value with outlier removed

d) 90/90 UTL - nonparametric distribution value with outlier removed

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample because cross-contamination is suspected.

Yellow shading = Sample result > SCO screening level and > 90/90 UTL.

Bold = Sample result > 90/90 UTL of the reference sample results where no SCO criteria available.

BaPeq = Benzo(a)pyrene equivalent

CSL = Cleanup Screening Level

J = Estimated concentration

NA = Not applicable

nc = Not calculated

R = rejected result

SCO = Sediment Cleanup Objective

SMS = Sediment Management Standards

U = Chemical was not detected at or above the associated method detection limit.

UTL = Upper Threshold Limit

samples SED14, SED15, and SED22 having exceedances of the SCO for cadmium to delineate areas of exceedances. Those results are also included in Table 1-5.

A summary of sample station location information and associated physical characteristics (i.e., station location coordinates, water depths, sediment grain size, and total organic carbon content) is provided in Table 1-6. The distribution and range of grain size (percent fines) appears similar between the study area and Columbia River reference station locations indicating appropriateness for comparative review. Total organic carbon percent generally correlates with grain size distribution (e.g., higher percent fines result in higher percentage of total organic carbon). The John Day River reference stations (BKG10, BKG11, and BKG12) exhibit both high percent fines and associated high total organic carbon content (refer to Table 1-5).

Table 1-7 includes a summary of applicable sediment screening level exceedances. Sediment sample results were first screened against available SMS freshwater criteria and then compared against associated 90/90 UTL reference concentrations. In those cases where no SMS freshwater criteria are available, results were compared directly against associated 90/90 UTL reference concentrations.

Figure 1-5 shows SMS freshwater criteria exceedances in those cases where the associated 90/90 UTL reference level is also exceeded. Figure 1-6 shows all sediment concentrations exceeding their associated 90/90 UTL reference levels, including total cPAHs as requested by Ecology. A summary of the RI sediment sample results and associated key findings include the following:

- No organics, including total PAHs, total PCBs, or total petroleum hydrocarbons were detected in sediments above available SMS screening levels.
- Although no SMS freshwater criteria are available specifically for cPAHs, Ecology requested additional consideration of these compounds to better assess potential human health concerns. As such, total cPAH concentrations were screened directly against associated 90/90 UTL reference values (see Table 1-7 and Figure 1-6).
- No detections of any chemicals above the SMS CSL screening level were reported.
- Only cadmium at three locations slightly exceeded the SMS SCO screening level and associated 90/90 UTL reference concentration. It is noted that cadmium is not uniquely related to smelter plant operations. Tier 2 sampling locations successfully bounded the area potentially related to the exceedances.
- Cyanide was detected in one sample, SED 15, at 11 mg/kg. Cyanide was not detected in any of the reference sample locations or any of the other sediment sampling locations.

Table 1-6
Columbia River Sediments AOC – Sample Station Location and Physical Characteristics Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Sample Station Identification	Sample Collection Date	Sample Station Coordinates [a]		Water Depth (feet)	Percent Fine (percent)	Sediment Total Organic Carbon (percent)
		Latitude	Longitude			
CRSAOC-BKG01	4/27/2016	45.75101369	-120.6073699	87	63	1.1
CRSAOC-BKG02	4/27/2016	45.74526519	-120.607395	149	56	2
CRSAOC-BKG03	4/27/2016	45.74212517	-120.6068194	19	27.1	0.63
CRSAOC-BKG04	4/27/2016	45.75059294	-120.620913	92	34.5	0.66
CRSAOC-BKG05	4/27/2016	45.74495584	-120.6206934	116	93.6	2
CRSAOC-BKG06	4/27/2016	45.741681	-120.6197727	61	98.1	2.1
CRSAOC-BKG07	4/27/2016	45.74834381	-120.6353705	88	16.6	0.29
CRSAOC-BKG08	4/27/2016	45.74461204	-120.6347694	130	86.6	1.8
CRSAOC-BKG09	4/27/2016	45.74094848	-120.6331611	42	60.5	0.95
CRSAOC-BKG10	4/25/2016	45.73068453	-120.6482716	65	98.5	1.9
CRSAOC-BKG11	4/25/2016	45.72940125	-120.6481652	72	99.9	1.2
CRSAOC-BKG12	4/27/2016	45.72846942	-120.6474408	11	98.8	0.99
CRSAOC-SED01	4/30/2016	45.73232411	-120.6774569	79	37.4	0.74
CRSAOC-SED02	4/30/2016	45.73280404	-120.6800998	90	64	1.6
CRSAOC-SED03	4/30/2016	45.73088073	-120.6787473	121	90.1	1.7
CRSAOC-SED04	5/1/2016	45.72951805	-120.681447	88	97.8	2.1
CRSAOC-SED05	5/2/2016	45.72850552	-120.6802283	18	33.2	1.1
CRSAOC-SED06	5/1/2016	45.72888678	-120.6817995	70	36.7	0.7
CRSAOC-SED07	5/1/2016	45.72798373	-120.6825759	38	24	0.62
CRSAOC-SED08	5/1/2016	45.7287575	-120.6826371	130	90.8	1.7
CRSAOC-SED09	5/1/2016	45.72749461	-120.68433	35	10.6	0.27
CRSAOC-SED10	5/1/2016	45.72657012	-120.6878892	45	23	0.43
CRSAOC-SED11	5/1/2016	45.72578639	-120.689548	30	8.9	0.23
CRSAOC-SED12	5/1/2016	45.72511998	-120.6915972	33	35.1	0.52
CRSAOC-SED13	5/1/2016	45.72663398	-120.6907959	53	92.6	1.16
CRSAOC-SED14	5/1/2016	45.72799331	-120.6917272	49	94.6	1.17
CRSAOC-SED15	5/1/2016	45.72705841	-120.6943646	30	90	3
CRSAOC-SED16	5/2/2016	45.72573166	-120.6954013	30	6.4	0.24
CRSAOC-SED17	5/2/2016	45.72487434	-120.6975071	66	94.3	3.9
CRSAOC-SED18	5/2/2016	45.72406769	-120.6975293	55	90.3	3.7
CRSAOC-SED19	4/29/2016	45.72191125	-120.6983829	38	8.1	0.22
CRSAOC-SED20	4/29/2016	45.72312871	-120.6960334	18	31.6	0.67
CRSAOC-SED21	5/2/2016	45.72233891	-120.6932841	19	5.5	0.1
CRSAOC-SED22	4/26/2016	45.72098334	-120.6976675	40	92.9	1.7
CRSAOC-SED23	4/26/2016	45.72198909	-120.6955369	40	96.4	2
CRSAOC-SED24	4/26/2016	45.72472819	-120.6871611	71	96	1.7
CRSAOC-SED25	4/26/2016	45.72279543	-120.6855209	NR	NA	NA
CRSAOC-SED26	4/26/2016	45.72594163	-120.6772388	66	NA	NA
CRSAOC-SED27	4/30/2016	45.72757924	-120.6799706	98	65.1	1.7
CRSAOC-SED28	4/26/2016	45.72850376	-120.6731522	125	NA	NA
CRSAOC-SED29	4/30/2016	45.7303637	-120.6750979	101	92.3	1.9
CRSAOC-SED30	4/30/2016	45.73362248	-120.6692921	133	93.8	1.7
CRSAOC-SED31	4/30/2016	45.73183454	-120.6677729	117	89	1.6
CRSAOC-SED32	4/30/2016	45.73564613	-120.6642682	108	91.2	1.7
CRSAOC-SED33	4/30/2016	45.733622	-120.669292	114	91.7	1.8
CRSAOC-SED34	4/30/2016	45.731835	-120.667773	99	93.9	2
CRSAOC-SED35	4/30/2016	45.735646	-120.664268	115	81.4	1.4
CRSAOC-SED36	Sample not collected due to lack of available sediment					

Notes:

a Washington State Plane, South (NAD 83) converted to latitude and longitude (WGS 84).

Sediment samples collected from the top 15 centimeters (biological active zone).

Table 1-7
Columbia River Sediments AOC – Screening Level Exceedance Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter (Units)	Sample Number	Sample Result	Screening Levels: Freshwater SMS SCO	Screening Levels: Reference (Maximum)	Screening Levels: Reference (90/90 UTL)
Cadmium (mg/kg)	CRSAOC-SED14	2.3	2.1	1.5	1.3
	CRSAOC-SED15	2.5			
	CRSAOC-SED22	3.3			
Total Cyanide (mg/kg)	CRSAOC-SED15	11 J	NA	ND	ND
Fluoride (mg/kg)	CRSAOC-SED18	12	NA	7.8	7.7
	CRSAOC-SED22	8.4			
	CRSAOC-SED23	8.9			
	CRSAOC-SED24	9.1			
	CRSAOC-SED26	8.1			
	CRSAOC-SED28	8.9			
Sulfate (mg/kg)	CRSAOC-SED04	380	NA	290	278
	CRSAOC-SED05	380 J			
	CRSAOC-SED13	390			
	CRSAOC-SED14	430			
	CRSAOC-SED15	460 J			
	CRSAOC-SED17	4,700 J			
	CRSAOC-SED18	1,900 J			
	CRSAOC-SED23	300			
	CRSAOC-SED24	350			
	CRSAOC-SED27	320			
Total cPAH (µg/kg)	CRSAOC-SED05	442.1	NA (17,000) [a]	185	57
	CRSAOC-SED10	171.1			
	CRSAOC-SED11	138.6			
	CRSAOC-SED12	87.4			
	CRSAOC-SED13	97.2			
	CRSAOC-SED14	1,147			
	CRSAOC-SED15	129			
	CRSAOC-SED16	348.8			
	CRSAOC-SED17	877.6			
	CRSAOC-SED18	778.3			
	CRSAOC-SED19	249.9			
	CRSAOC-SED20	249.5			
	CRSAOC-SED22	283.8			

Notes:

a The SMS SCO value of 17,000 µg/kg is for total PAHs.

mg/kg = Milligrams per kilogram

µg/kg = Micrograms per kilogram

NA = Not applicable
ND = Not detected
J = Data flag indicating reported concentration is an estimated value
cPAH = Carcinogenic polycyclic aromatic hydrocarbons
SMS = Sediment Management Standards
SCO = Sediment Cleanup Objective
UTL = Upper Tolerance Limit

R:\projects_2011\LockheedMartin_GoldendaleSiteInvestig\maps\2018_Reporting\Figure_1-5_Sed_AOC_SMS_Exceedance.mxd

Legend

● Sediment Sample Location

Cadmium = 2.1 mg/kg (SMS Sediment Cleanup Objective)
Cadmium = 1.3 mg/kg (Reference [90/90 UTL] Concentration)

Notes:

mg/kg	milligrams per kilogram
J	Data flag indicating estimated concentration

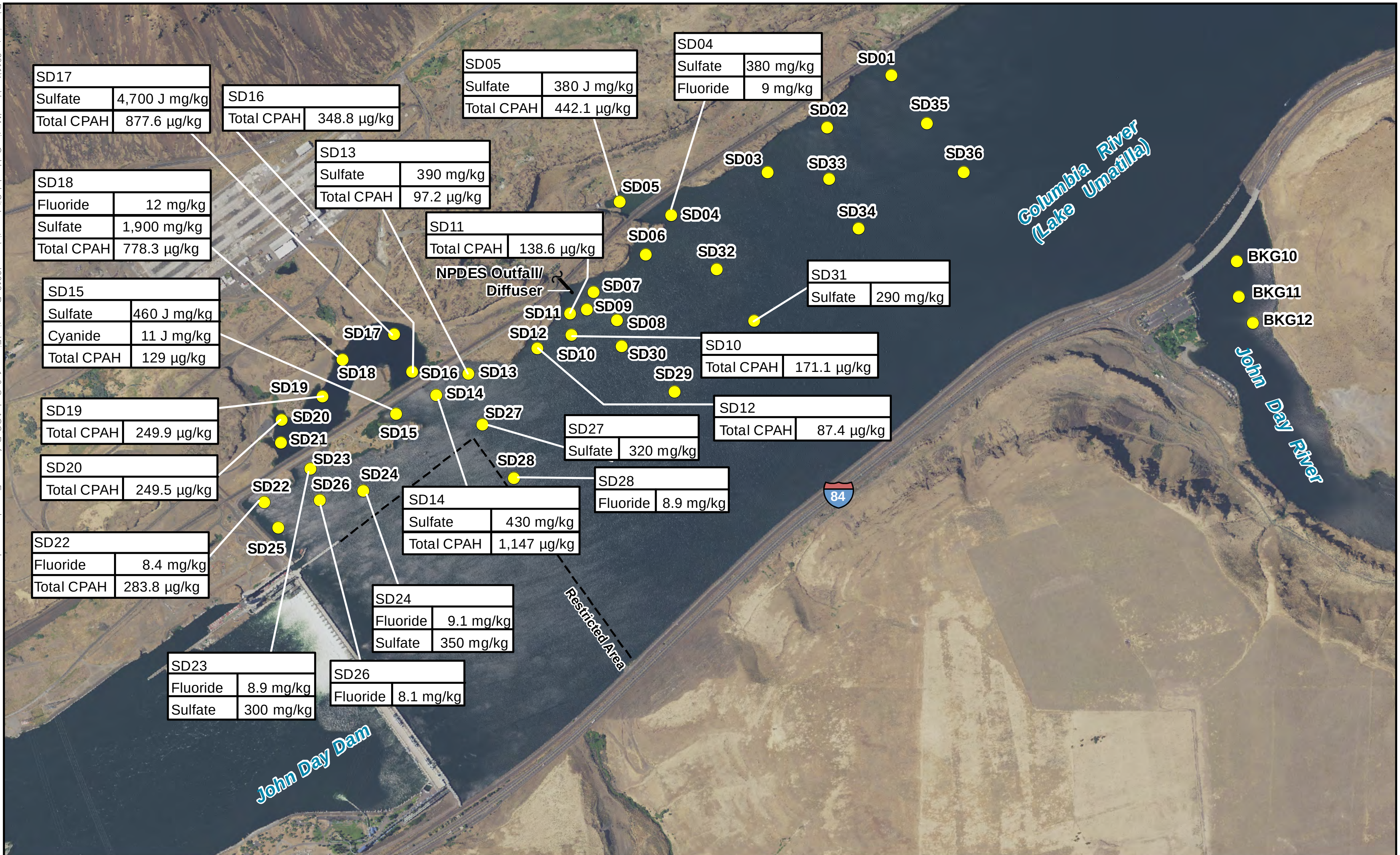
N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 1-5
Columbia River Sediment AOC
Freshwater SMS (SCO) and Reference
(90/90 UTL) Criteria Exceedance

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend
Sediment Sample Location

Reference (90/90 UTL) Concentration
Fluoride = 7.7 mg/kg
Sulfate = 278 mg/kg
Total cPAH = 57 µg/kg

Notes:

µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
J	Data flag indicating estimated concentration
SMS	Washington State Sediment Management Standards

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 1-6
Columbia River Sediment AOC
Reference (90/90 UTL) Concentration Exceedance
Where No SMS Criteria Available

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

- Fluoride was detected above the 90/90 UTL reference concentration of 7.7 mg/kg at six locations, with the highest concentration of 12 mg/kg at SED18.

- Sulfate was detected above the 90/90 UTL reference concentration of 278 mg/kg at 10 locations with the highest concentrations of 4,700 and 1,900 mg/kg at SED17 and SED18.

- Many detections above screening criteria are adjacent to or within the Boat Basin. Also, many of these detections were from stations characterized by finer grained silty sands and elevated total organic carbon percentages.

- The area surrounding the NPDES outfall and associated diffuser showed limited impacts to sediment, with only a few relatively low-level detections of cPAHs above the associated 90/90 UTL reference concentration.

1.3.2 2018 Columbia River Bioassay Sampling and Testing Results

The Columbia River Sediments AOC bioassay sampling activity was completed in early August 2018 in accordance with the Ecology-approved SAP (Tetra Tech 2018a). All sediment samples were shipped to EcoAnalysts, Port Gamble, Washington, for the sediment bioassay testing. In addition, subsamples of the sediment were shipped to TestAmerica Laboratories of Tacoma, Washington, a WA ELAP laboratory, for grain size and total organic carbon analysis, and to archive for potential additional chemical analysis. All samples were received by the laboratory in reported good condition and under standard chain-of-custody protocol. Completed field sampling forms for the Columbia River Sediments AOC are included in Volume 5, Appendix C-1. Laboratory analytical data reports for the grain size and total organic carbon analyses are provided in Volume 5, Appendix H-1. A summary of sample station location information and associated physical characteristics (i.e., station location water depths, sediment grain size, and total organic carbon content) is provided in Table 1-8. Note that because the bioassay samples were collected in 2018 separately from the original sediment samples which were collected in 2016, there is some variability and the values shown in Table 1-8 will not match the values in Tables 1-4 and 1-5.

The 2018 Columbia River sediment bioassay testing results are summarized in Tables 1-9, 1-10, and 1-11. Table 1-9 presents the results for the *Hyalella azteca* 10-day survival tests. Table 1-10 presents the results of the *Chironomus dilutus* survival tests and Table 1-11 presents the results of the *Chironomus dilutus* growth tests. A summary of the bioassay testing results includes:

Table 1-8
Columbia River Sediments AOC – Sediment Bioassay Grain Size and Total Organic Carbon Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Sample Location	Sample Collection Date	Sample Station Coordinates [a]		Water Depth (feet)	TOC (mg/kg)/%	% Fines	Silt (%)	Clay (%)	Gravel (%)	Sand (%)
		Latitude	Longitude							
CRSAOC-BKG10-BA	7/31/18	45.73065813	-120.6482438	65	23,000 / 2.3	93.9	70.2	23.7	0	6
CRSAOC-SED22-BA	7/31/18	45.72192434	-120.6983260	60	19,000 / 1.9	91.4	56.6	34.8	0	8.6
CRSAOC-SED15-BA	7/31/18	45.72514414	-120.6916078	30	42,000 / 4.2	78.5	63.7	14.8	0	21.4
CRSAOC-SED14-BA	7/31/18	45.72546928	-120.6890055	53	19,000 / 1.9	91.9	68.4	23.5	0	8.2
CRSAOC-BKG05-BA	8/1/18	45.748355	-120.6205696	95	3,800 / 0.38	21	13.4	7.6	0	79
CRSAOC-BKG04-BA	8/1/18	45.75049322	-120.6212229	120	5,500 / 0.55	20.1	14.3	5.8	0	80
CRSAOC-SED20-BA	8/1/18	45.72488722	-120.6975436	20	6,600 / 0.66	23.7	18.5	5.2	0	76.3
CRSAOC-SED18-BA	8/1/18	45.72706986	-120.6943516	75	62,000 / 6.2	90.3	53.5	36.8	0	9.6
CRSAOC-SED17-BA	8/1/18	45.72798312	-120.6916818	47	45,000 / 4.5	88.7	50.7	38	0	11.2
CRSAOC-SED05-BA	8/1/18	45.73308	-120.6793989	65	26,000 / 2.6	75.8	60.9	14.9	0	24.2
CRSAOC-SED100-BA (Duplicate of SED22-BA)	7/31/18	45.72192439	-120.6983260	60	20,000 / 2.0	89.7	52.9	36.8	0	10.3

Notes:

a Washington State Plane, South (NAD 83) converted to latitude and longitude (WGS 84).

mg/kg = Milligrams per kilogram

TOC = Total organic carbon

Table 1-9
Columbia River Sediments AOC – Survival Evaluation for *Hyalella azteca*
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Sample ID	Mean Mortality (%)	Std Dev	Control Performance Standard C ≤20%	Reference Performance Standard R ≤25%	Comparison to Reference Samples	
					SCO T - R >15% And T vs. R SS	CSL T - R >25% And T vs. R SS
Sand Control	8.7	8.3	Acceptable			
BKG04	3.8	5.2		Acceptable		
SED20	2.5	4.6			-1.3%; Not SS	-1.3%; Not SS
BKG05	1.3	3.5		Acceptable		
SED20	2.5	4.6			1.3%; Not SS	1.3%; Not SS
BKG10	5.0	5.3		Acceptable		
SED05	3.8	7.4			-1.3%; Not SS	-1.3%; Not SS
SED14	2.5	4.6			-2.5%; Not SS	-2.5%; Not SS
SED15	3.8	5.2			-1.3%; Not SS	-1.3%; Not SS
SED17	3.8	7.4			-1.3%; Not SS	-1.3%; Not SS
SED18	5.0	5.3			0.0%; Not SS	0.0%; Not SS
SED22	12.5	10.4			7.5%; Not SS	7.5%; Not SS

Notes:

Bioassay test results for samples SED05, SED14, SED15, SED17, SED18 and SED22 are compared to BKG10; SED20 is compared to BKG04 and BKG05 based on similarity in grain size.

[green] Pass; Sample test to reference test comparison result less than criteria
[gray] Not applicable

C = Control
CSL = Cleanup Screening Level
R = Reference (BKG## Samples)
SCO = Sediment Cleanup Objective
SS = Statistically Significant (p <0.05)
T = Treatment (SED## Samples)

Table 1-10
Columbia River Sediments AOC – Survival Evaluation for *Chironomus dilutus*
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Sample ID	Mean Mortality (%)	Std Dev	Control Performance Standard C ≤32%	Reference Performance Standard R ≤35%	Comparison to Reference Samples	
					SCO T - R >15% And T vs. R SS	CSL T - R >25% And T vs. R SS
Sand Control	3.1	8.8	Acceptable			
BKG04	9.4	11.3		Acceptable		
SED20	20.8	16.1			11.4%; Not SS	11.4%; Not SS
BKG05	8.3	10.9		Acceptable		
SED20	20.8	16.1			12.5%; Not SS	12.5%; Not SS
BKG10	12.5	8.9		Acceptable		
SED05	28.1	15.4			15.6%; Not SS	15.6%; Not SS
SED14	13.5	10.9			1.0%; Not SS	1.0%; Not SS
SED15	13.5	4.3			1.0%; Not SS	1.0%; Not SS
SED17	5.2	7.6			-7.3%; Not SS	-7.3%; Not SS
SED18	14.3	14.2			1.8%; Not SS	1.8%; Not SS
SED22	17.7	18.1			5.2%; Not SS	5.2%; Not SS

Notes:

Bioassay test results for samples SED05, SED14, SED15, SED17, SED18 and SED22 are compared to BKG10; SED20 is compared to BKG04 and BKG05.

(Green) Pass; Sample test to reference test comparison result less than criteria

(Gray) Not applicable

C = Control
CSL = Cleanup Screening Level
R = Reference (BKG## Samples)
SCO = Sediment Cleanup Objective
SS = Statistically Significant ($p < 0.05$)
T = Treatment (SED## Samples)

Table 1-11
Columbia River Sediments AOC – Growth Evaluation for *Chironomus dilutus* [AFDW per survivor (mg)]
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Sample ID	MIG (mg/ind)	Std dev	Control Performance Standard MIG_C ≥0.48 mg/ind	Reference Performance Standard MIG_R/MIG_C ≥0.8	Comparison to Reference Samples	
					SCO MIG_T/MIG_R <0.75; And T vs. R SS	CSL MIG_T/MIG_R <0.6; And T vs. R SS
Sand Control	1.899	0.565	Acceptable			
BKG04	2.329	0.455		>1.0; Acceptable		
SED20	2.278	0.331			0.98; Not SS	0.98; Not SS
BKG05	2.210	0.490		>1.0; Acceptable		
SED20	2.278	0.331			1.03; Not SS	1.03; Not SS
BKG10	2.290	0.318		>1.0; Acceptable		
SED05	1.898	0.245			0.83; Not SS	0.83; Not SS
SED14	2.057	0.361			0.90; Not SS	0.90; Not SS
SED15	2.170	0.224			0.95; Not SS	0.95; Not SS
SED17	2.135	0.242			0.93; Not SS	0.93; Not SS
SED18	2.656	0.672			1.16; Not SS	1.16; Not SS
SED22	2.358	0.397			1.03; Not SS	1.03; Not SS

Notes:

Bioassay test results for samples SED05, SED14, SED15, SED17, SED18 and SED22 are compared to BKG10; SED20 is compared to BKG04 and BKG05.

Pass; Sample test to reference test comparison result greater than criteria

Not applicable

AFDW = Ash free dry weight
C = Control
CSL = Cleanup Screening Level
Ind = Individual
mg = Milligrams
MIGR = Mean Individual Growth Reference sample
MIGT = Mean Individual Growth Test sample
R = Reference (BKG## Samples)
SCO = Sediment Cleanup Objective
SS = Statistically Significant ($p < 0.05$)
T = Treatment (SED## Samples)

- Overall, for all three tests, the laboratory sand control samples met the control performance standards for each of the tests and end-point measurements (mortality and growth).

- The reference sediment samples submitted for testing met the reference performance standard for each of the tests and end-point measurements.

- All the sediment samples submitted for the three bioassay tests passed their respective criteria for each endpoint compared to the reference samples.

The sediment bioassay testing results show that no samples exhibited toxicity to benthic organisms based on the results of the 10-day Amphipod (*Hyalella azteca*) Survival endpoint, the 20-day Midge (*Chironomus dilutus*) Survival endpoint, and 20-day Midge (*Chironomus dilutus*) Growth endpoint tests. The complete bioassay laboratory report detailing these results is presented in Volume 5, Appendix C-4 of this report.

1.3.3 Sediment Transport and Deposition

The reach of the Columbia River in the site vicinity was suspected to be a depositional area due to the presence of the John Day Dam downstream of the site and the confluence of the John Day River on the Oregon shoreline southeast of the site. However, sediment deposition is considered relatively low throughout the John Day Reservoir system (extending from John Day Dam upstream to McNary Dam) based on a U.S. Geological Survey (USGS) bathymetric study over this 76-mile reach of the Columbia River [USGS open-file report (2004-1014)]. The USGS study suggests much of the reservoir floor includes exposed bedrock with a thin cover of fine-grained sediment (i.e., study assumed thickness of 50 centimeters was less than the resolution of the seismic-reflection system). The limited amount of sediment observed throughout this reservoir is presumably because there were several dams that already existed upstream of the John Day Dam prior to its construction. A relatively high percent of fine-grained material was observed during the RI sediment sampling activities with 19 of the 37 samples collected from the Columbia River upstream of the John Day Dam having greater than 70% fines while 10 locations had less than 50% fines, and some locations required multiple grab sample attempts (deployments) in order to collect enough sediment for required laboratory analysis (refer to Table 1-5).

The pool elevation of the Columbia River (Lake Umatilla) above the dam ranges from 257 to 268 feet mean seal level (ft msl), with center-channel water depths ranging between 115 and 149 ft through the study area based on RI field measurements (refer to Table 1-6). No maintenance dredging has been required on the upstream side of the John Day Dam since construction based on recent communication with the U.S. Army Corps of Engineers (USACE) (Tetra Tech, personal communication, October 25, 2018). Future disturbance of the surface sediments is unlikely given the lack of maintenance dredging and net depositional environment in the investigation area.

The John Day River flows into the Columbia River on the Oregon side, on the opposite riverbank about one mile upstream of the former smelter site. The John Day River is free flowing and drains a large area of central Oregon high desert (5,090 square miles) and contributes sediment to the Columbia River, particularly during high water periods. The average discharge for the John Day River in the Lower John Day sub-basin (Service Creek Gauging station) is 1,937 cubic feet per second (cfs) (USGS 2013). No sediment loading rates were identified for the John Day River at its confluence with the Columbia River at the time of this report. The dam gate operations (discharge) and lock operations on the northern side of the dam (as observed in Figure 1-3) may influence sediment transport from the John Day River confluence to the north side of the reservoir.

The boat launch area and Boat Basin are located about 0.5 miles from the former smelter and upstream from the John Day Dam (refer to Figure P-1). The Boat Basin does not appear to represent a naturally formed basin and wetland feature, rather it was extensively filled and graded during the construction of the John Day Dam. It also appears the Boat Basin was constructed during the final phase of dam construction and was formed as river levels behind the dam were raised. The Boat Basin is separated from the Columbia River by a railroad dike. A large culvert provides access to the Columbia River for boaters and is the only direct connection between the Boat Basin and the Columbia River. Water depth within the Boat Basin ranged from 18 ft (Station SD20) to 66 ft (Station SD17) based on RI field measurements at the time of sediment sampling (refer to Table 1-6). Circulation within the Boat Basin is considered low due to its limited direct access with the Columbia River and assumed restricted communication between the railroad dike and Columbia River. Significant variability in fine-grained sediments, 5.5% fines (SED21) to 94.3% fines (SED17), was observed within the Boat Basin based on results from the RI sediment sampling work effort (refer to Table 1-6).

1.4 CONCLUSIONS AND RECOMMENDATIONS

The RI results for the Columbia River Sediments AOC suggests that sediment quality has not been significantly impacted above relevant screening levels from past aluminum smelter operations, or from other potential non-site related historical or ongoing sources. These findings are generally consistent with results from past investigations of sediments in the Columbia River and Boat Basin near the subject site (Tetra Tech et al. 2015a).

Some of the chemicals that formed the basis for bioassay testing, such as cadmium, are not uniquely related to plant operations, which suggests that there are other potential contaminant sources. A review of historical aerial photographs from the 1960's to early 1970's indicates significant disturbance and stockpiled construction materials in the vicinity of the Boat Basin. The Boat Basin represents a man-made feature that was constructed during the final phase of dam construction. Other potential sources of contamination (including PAHs) were identified in the Preliminary Assessment/Site Investigation of the John Day Dam including a burn pile on Rail Road Island and service roads that were reportedly sprayed with oils (USACE 1994). Other ongoing uses of the Boat Basin include vehicle access and parking, vessel launch and storage, and railroad operations. These historical and ongoing operations could have potentially contributed to sediment contamination in the Boat Basin and adjacent Columbia River. The Burlington Northern railroad extends along the northern (Washington) side of the Boat Basin and Columbia River. The associated railroad track is constructed using creosote-treated railroad ties that represent a commonly known source of PAH contamination. For example, a PAH Chemical Action Plan, prepared by Washington State Departments of Ecology and Health, cites railroad ties as a major source for PAH contamination (Ecology 2012b).

As discussed above in Section 1.1, the results of the sediment chemistry testing combined with the results of the bioassay testing, address the ecological and human health concerns regarding the project site and associated Columbia River sediments. Based on discussions with Ecology, freshwater bioassays were performed at stations where the Washington SMS, freshwater SCO criteria was exceeded. In addition, although none of the project data exceeded established freshwater SCO for total PAHs, Ecology also required the inclusion of stations with elevated concentrations of cPAHs. The bioassay test results indicate that the Columbia river sediments adjacent to the site met the SMS SCO and CSL criteria for acute and chronic survival and chronic sub-lethal biological assessments and do not exhibit a toxic response for fresh water benthic organisms.

The results of the sediment chemistry testing combined with the results of the bioassay testing for the Columbia River Sediments AOC indicate that no further investigation or remedial action is warranted at the project site.

Section 2
Groundwater in the Uppermost Aquifer

This section summarizes the RI and WPA findings for the Groundwater in Uppermost Aquifer Area of Concern (GWAOC). The Agreed Order (Ecology 2014) states that there is historical groundwater data associated with a few Solid Waste Management Units (SWMUs), but that the full extent of groundwater contamination in the uppermost aquifer is unknown.

The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) includes a detailed summary of background information about the GWAOC. Specific objectives and work elements for the GWAOC are summarized in detail in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Figure P-1 shows the primary site and vicinity features. The Final WPA (Tetra Tech et al. 2020b) addresses groundwater data needs identified during review of Draft RI Report.

2.1 GEOLOGY AND AQUIFER ZONE NOMENCLATURE

To provide introductory context for this GWAOC section, a brief discussion of site geology and aquifer zone nomenclature is provided. Note that an overview of site hydrogeology is also provided in Volume 1, Section 2.2.3 and 2.2.4. Conceptually, the hydrostratigraphy at the site consists of an unconsolidated aquifer zone that is underlain by a series of water-bearing zones within the basalt bedrock. The groundwater gradient is toward the Columbia River to the southwest in upland and former plant operational areas and is described in more detail in the following sections. A downward vertical gradient has been documented between the aquifer zones. Note that at this site, gradients do not necessarily imply the amount of physical groundwater flow. The following aquifer zones have been defined at the site and this terminology is used in the RI report:

- **Unconsolidated Aquifer (UA)**. The UA Zone includes the shallow water-bearing zone in the colluvium, alluvium, and fill that overlies the basalt bedrock in most upland areas associated with former plant operational areas. This unit is thicker and more laterally extensive on the western side of the site than in the eastern portion. At some locations, shallow groundwater occurs within the first 2-3 ft of weathered and fractured basalt bedrock and is considered part of the UA zone. A French-drain groundwater collection system is present in the vicinity of the former plant and discharges shallow groundwater to the stormwater pond. Other underground line system (e.g., the SE line-system) also interact with the shallow groundwater and affect migration of shallow groundwater in the plant are footprint. The SE line system discharges water to the head of NPDES Pond A during high water periods in the winter and spring.

- **Basalt Aquifer Upper Zone (BAU)**. The BAU Zone is consistently present within the basalt flow sequence. Most commonly this unit occurs within a flow top beneath unconsolidated materials and a zone of less permeable basalt. At some locations, there is a second deeper water-bearing zone that most commonly developed in a fracture zone. In some cases (e.g., BAMW-1) the fractures are related to a fault zone. In other cases, RI-MW1-BAL, a fault zone was not identified. Water-levels in both BAU zones are relatively similar. This flow sequence is truncated by erosion south of the main plant where the basalt flows can be seen in cliff outcrops above the Columbia River.

- **Basalt Aquifer-Lower Zone (BAL)**. In the Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015b), the BAL Zone was defined to include the saturated zones beneath the BAU. The BAL includes water-bearing zones near the Columbia River pool elevation and extending downward to the approximate elevation of the reservoir bottom. Based on the RI findings, the BAL zone consists of two distinct water-bearing zones near and below the Lake Umatilla reservoir pool elevation of the Columbia River.

2.2 GROUNDWATER RI AND WPA FIELD ACTIVITIES SUMMARY

The GWAOC remedial field investigation included a site-wide drilling and monitoring well installation, groundwater sampling, and aquifer testing program to complete RI groundwater site characterization activities.

2.2.1 RI Data Needs

Data needs identified in the Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b) included the following:

- Existing well inspection and assessment to verify the suitability of the wells for inclusion in the RI program.

- Hydrostratigraphic characterization including identification and hydraulic testing of fracture zones and flow interiors, characterization and confirmation of water-bearing zones, and characterization of groundwater flow direction and gradients.

- Aquifer characteristics including hydraulic conductivity characterization and aquifer zone interconnection.

- Evaluation of groundwater flow pathways.
- Groundwater quality and geochemistry to define the nature and extent of groundwater contamination at the site with geochemistry also used to help distinguish hydrostratigraphic zones.
- Characterization of potential releases to groundwater at the Plant Area AOC, selected SWMUs, and other areas lacking historical groundwater chemical data.
- Characterization of the lateral (downgradient) and vertical extent of contamination.
- Characterization of groundwater background concentrations.

The GWAOC investigation scope includes the following work elements to address site-wide hydrostratigraphic and aquifer characterization:

- Inspection and assessment of existing well network.
- Geologic site reconnaissance.
- Continuous coring and packer testing at three locations.
- Drilling and installation of 22 monitoring wells.
- Well development at all newly constructed wells and a subset of six pre-existing monitoring wells.
- Well surveying of existing and newly constructed monitoring wells.
- Collection of four quarterly comprehensive rounds of water-levels and groundwater geochemical and chemical data collection from all available existing and newly constructed monitoring wells.
- Aquifer testing including: slug tests at all well locations, two constant rate pumping tests at different areas of the site, a stormwater pond drawdown test, an industrial well test, and a long-term (one year) groundwater level transducer study.

2.2.2 WPA Data Needs Summary and Investigation

Based on the finding of the Draft RI Report, the following data needs were identified for groundwater in the final WPA.

- Characterize spring water quality (including the spring in western area of Site that was discovered during the initial RI field investigation, NESI area wetland spring, Wetland D spring, Wetland K spring, and Wetland F spring).

- If possible, using hand-driven well points characterize shallow groundwater chemical concentrations at the Western Intermittent Drainage near the Boat Basin and between Wetland K and the Boat Basin.

- Characterize groundwater concentration in new and existing wells in the UA and BAU zones in the Former Plant Area Footprint.

- Groundwater flux and water-balance evaluation to assess amount of discharge to site drainages and to the Columbia River.

- Supplemental TPH groundwater and spring sampling to address elevated petroleum hydrocarbon concentrations in soil as appropriate.

The WPA scope of work included the following groundwater investigation work elements:

- Collect water samples from each of the five existing wetland springs, including the newly discovered spring in western area, NESI area wetland spring, Wetland D spring, Wetland K spring, and Wetland F spring.

- Collection of one round of groundwater samples from existing and new UA and BAU zone wells in the Former Plant Area Footprint to determine current conditions and better document TPH groundwater concentrations.

- Attempted Installation and sampling of two temporary hand-driven well points, one at the Western Intermittent Drainage near the Boat Basin and one between Wetland K and the Boat Basin. Collect 1 groundwater sample from each well point (if water is present). Three attempts will be made at sub-locations for each temporary well point stations to successfully complete sampling.

- Installation and sampling of 11 new temporary monitoring wells and 8 groundwater borings in the Plant Area AOC to address subsurface hotspot areas in Plant Area AOC and to assess shallow groundwater impacts for TPH and other chemicals of potential concern. Characterize water-level elevations at new well locations (see Plant Area AOC below).

- Analysis of stage ratio and time lag for shoreline wells and Columbia River to estimate transmissivity and groundwater flux.

- Evaluation of hydrogeologic water balance in the vicinity of the stormwater pond and the NPDES ponds.

- Further Evaluation of risk-based concentrations for development of fluoride and sulfate screening levels.

2.2.3 Well Network Summary

Fifty-three pre-existing monitoring wells were identified at the site at the beginning of the RI planning process. Three facility industrial wells are also present at the site, although only one of the industrial wells is currently operational and was operational during the majority of the RI field program. Thirty monitoring wells were installed as part of the initial RI field investigation. There are currently 94 monitoring wells at the site including: 48 wells completed in the UA aquifer zone, 35 completed in the BAU aquifer zone, and 11 wells completed in the BAL aquifer zone.

Figure 2-1 shows the pre-existing and RI and WPA well locations and Figure 2-2 shows these same well locations by aquifer unit designations. Local fault zones are also shown on Figures 2-1 and 2-2.

2.2.3.1 Existing Well Network Verification Inspection

The existing well network was inspected as an initial field task of the RI during September 2015 (Tetra Tech 2016). The purpose of the inspection was to: 1) field verify the condition and locations of existing wells, 2) confirm the suitability of the wells for RI data collection purposes, and 3) identifying wells that needed maintenance, repair, or decommissioning.

All fifty-three existing site wells were found to be suitable for RI monitoring. A subset of the existing monitoring well network (including prospective background wells MW-1, MW-2A, MW-2B), and the wells near the West Spent Pot Liner (SPL) Storage Area (MW-16A, MW-17A, and MW-6B) that had not been sampled for several years were recommended for development. Simple maintenance problems noted during inspection (e.g., lock and well cap replacement and vegetation clearing) were performed during and following the field inspection. Based on the results of the inspection, all pre-existing and new monitoring wells were surveyed by a Washington State-licensed surveyor to the same control points and datum to ensure accurate and consistent reporting of water-level elevations. Monitoring well installation and well network surveying is discussed in detail below.

2.2.3.2 RI and WPA Well Installation and Well Development

Thirty new monitoring wells were installed during the RI including 8 shallow temporary-designated wells that were constructed similarly to the RI monitoring wells. As specified in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b), these temporary-designated wells were

Legend

- Pre-existing Monitoring Well
- Recently Constructed Remedial Investigation Monitoring Well
- WPA Well
- Production Well
- Spring
- Thrust Fault
- Strike Slip Fault
- Fault Displacement and Location Uncertain

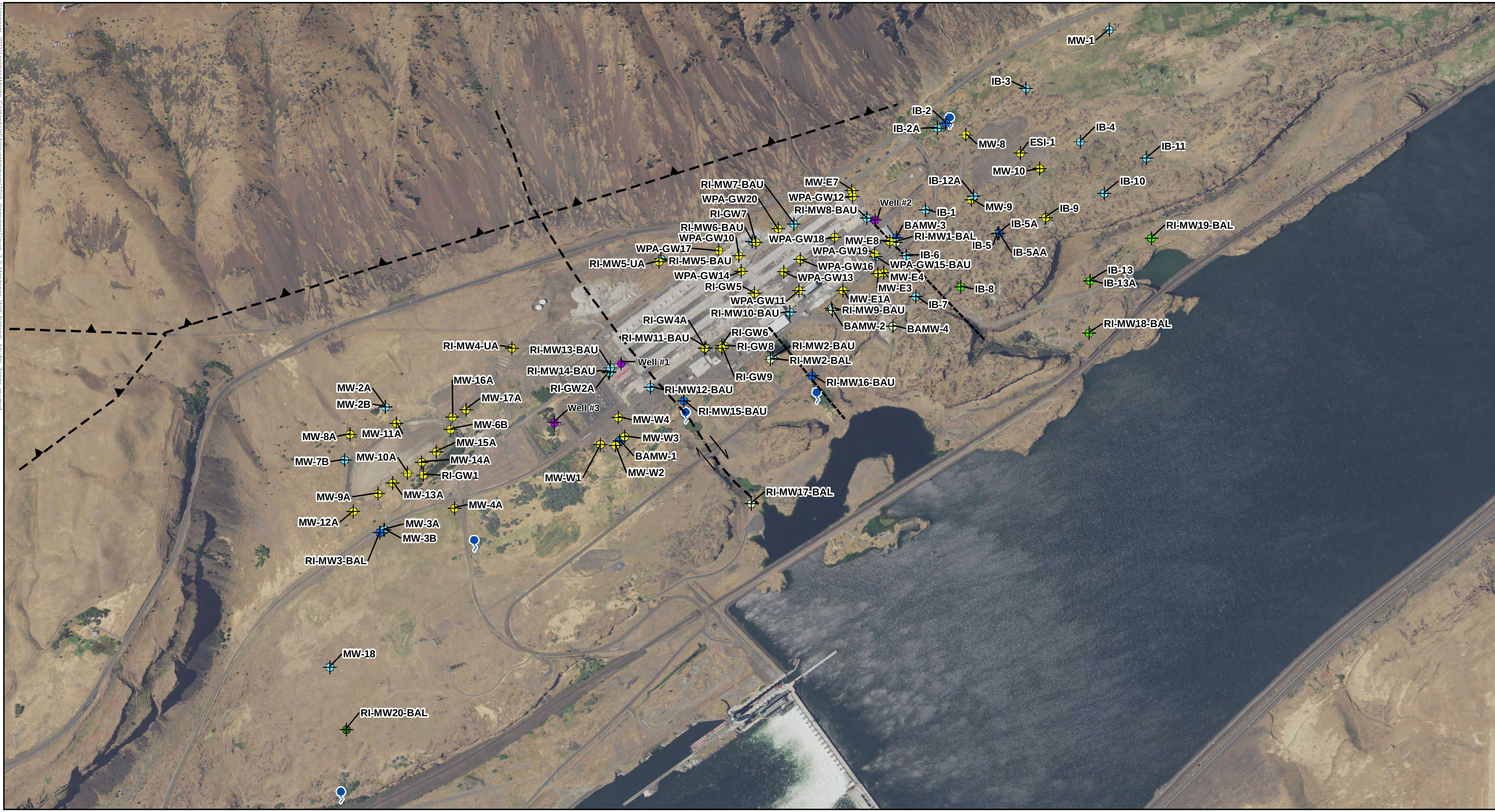
N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-1
Monitoring Well Network

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Production Well

Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

BAU_1 - Shallower Water-bearing Zone

BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

BAL_1 - Shallower Water-bearing Zone

BAL_2 - Deeper Water-bearing Zone

BAL_3 - Deepest Water-bearing Zone

Spring

Thrust Fault

Strike Slip Fault

Fault Displacement and Location Uncertain

N W E S

0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 2-2
Monitoring Well Network
by Aquifer Zone

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

planned to be sampled only once unless chemical concentrations were detected above associated groundwater screening levels. The temporary wells (e.g., designated as RI-GW7) were installed to evaluate if releases to groundwater have occurred as specific SWMUs and Plant Area AOC features. The baseline groundwater monitoring results for the 8 temporary wells were compared against screening levels as specified in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). All eight temporary wells were retained in the RI monitoring program because of exceedances of groundwater screening levels. Monitoring wells installed as part of the RI at the site include: 10 UA-aquifer zone wells (including the 8 temporary wells), 14 BAU-aquifer zone wells, and 6 BAL-aquifer zone wells.

All 30 RI monitoring wells were installed consistent with the scope and procedures detailed in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Well RI-MW20-BAL was originally planned to be a well screened in the BAU Zone; however, the BAU zone was not present at this location, so the well was screened in the first water-bearing zone encountered in the basalt aquifer system. at a depth of about 170 feet below ground surface (ft bgs). This zone was interpreted to represent the BAL-zone, and the well was accordingly named as RI-MW20-BAL.

Eleven wells were installed as part of WPA investigation consistent with the scope and procedures in the WPA and Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). One of the wells was installed in the BAU zone with remainder representing temporary wells installed in the UA zone. During the WPA field investigation, eight borings within the plant area were also sampled for groundwater using temporary well screens consistent with the procedures specified in the WPA.

All wells and borings were constructed consistent with the requirements and specifications in Washington Administrative Code (WAC) Chapter 173, Division 360, Minimum Standards for Construction and Maintenance of Wells. All well boring logs and well construction logs are included in Volume 5, Appendix D-1.

Wells completed in the basalt bedrock were drilled using a combination of air-rotary and sonic drilling techniques. During the initial RI field investigation, wells drilled in the UA aquifer zone were completed using a combination of sonic and hollow-stem auger drilling methods. During the WPA field investigation, all wells were installed using air-rotary drilling methods. The rock cores were drilled using a combination auger and coring rig equipped with HQ core barrels. Well drilling and installation during the initial RI field investigation was performed by Cascade Drilling, Inc., a Washington State-licensed drilling and well construction contractor. Well drilling and installation during the WPA field investigation was performed by Environmental West Explorations, Inc., a Washington State-licensed drilling and well construction contractor.

During drilling and well installation in the basalt aquifer system using the sonic drill rig, water was added to the boring to cool the bit, which complicated identification of water-bearing zones. In this case, informal bail down tests were performed of prospective water-bearing zones using a decontaminated sand bailer to confirm the presence of the water-bearing zones.

Installation of eight of the monitoring wells including: RI-MW2-BAU, RI-MW2-BAL, RI-MW9-BAU, RI-MW16-BAU, RI-MW17-BAL, RI-MW18-BAL, RI-MW19-BAL, and RI-MW20-BAL required land use agreements/permits from the USACE and/or Bonneville Power Administration (BPA). This permitting process took several months and extended the schedule of the monitoring well drilling program.

RI well logs and construction diagrams are provided in Volume 5, Appendix D-1. Well logs and well construction diagrams for pre-existing wells are provided in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). Tables 2-1 and 2-2 summarize the construction information for the RI and WPA wells and groundwater borings, and pre-existing wells, respectively.

All of the wells installed during the RI were developed using a decontaminated pump, bailer, and/or surge block. Six existing monitoring wells (including the pre-existing background wells, and the three wells near the West SPL Storage Area) were included for development. Well development forms for all of the wells developed during the RI and WPA are included in Volume 5, Appendix D-2.

A purple-pink material was found during development of pre-existing well MW-1, which is located east of the East Surface Impoundment (ESI) and is upgradient of all suspected source areas at the site (refer to Figure 2-1). Well development activities at this well were halted. The development water from this well was containerized separately, profiled, and disposed of at Columbia Ridge Landfill. Refer to Section 2.3.8.9 for a summary of characterization results for well MW-1.

Table 2-1
Groundwater AOC - RI and WPA Monitoring Well and Groundwater Boring Construction Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Well ID	Date of Construction	Well or Boring Diameter	Total Depth (ft-bgs)	Screen Interval (ft-bgs)	Screen Interval (ft-TOC)	Static Water Level at Construction (ft-TOC)	Well Location		Type of Surface Completion
							Site Proximity	Aquifer Zone Designation	
Temporary Wells									
RI-GW1	12/1/2015	2-inch	26.9	16.7-26.7	16.1-26.1	18.71	Research & Development lab drainfield	UA	flush-mount
RI-GW2A	10/28/2016	2-inch	43.5	33.3-43.3	32.8-42.8	34.13	Rectifier Yard Oil House	UA	flush-mount
RI-GW4A	10/26/2016	2-inch	30.0	19.8-29.8	19.4-29.4	21.21	Casting Pits	UA	flush-mount
RI-GW5	10/28/2016	2-inch	18.0	7.8-17.8	7.4-17.4	12.32	Line A Scubber Recycle System	UA	flush-mount
RI-GW6	12/10/2015	2-inch	21.7	11.5-21.5	10.9-20.9	13.88	Compressor Building UST	UA	flush-mount
RI-GW7	10/26/2016	2-inch	15.0	4.7-14.7	4.4-14.4	3.45	Tertiary Treatment Plant	UA	flush-mount
RI-GW8	10/31/2016	2-inch	35.0	19.8-34.8	19.4-34.4	21.44	Compressor Building UST	UA	flush-mount
RI-GW9	11/1/2016	2-inch	31.0	15.8-30.8	15.4-30.4	21.62	Compressor Building UST	UA	flush-mount
WPA-GW10	11/3/2020	2-inch	25.0	15.0-25.0	14.58-24.58	21.37	Crucible Cleaning Room IA	UA	flush-mount
WPA-GW11	10/29/2020	2-inch	30.0	20.0-30.0	20.33-30.33	20.67	Coke & Pitch Unloading IA	UA	flush-mount
WPA-GW12	11/30/2020	2-inch	25.0	14.7-24.7	14.9-25.9	19.35	North Potliner Soaking Station	UA	flush-mount
WPA-GW13	10/27/2020	2-inch	20.0	10.0-20.0	12.7-22.7	12.93	SE08 IA	UA	above-ground with boillards
WPA-GW14	11/3/2020	2-inch	20.0	10.0-20.0	10.4-20.4	11.4	Crucible Cleaning Room IA	UA	flush-mount
WPA-GW15-BAU	12/2/2020	2-inch	48.1	37.9-47.9	38..3-48.4	36.18	SE17 Area/ EELF	BAU_1	flush-mount
WPA-GW16	10/27/2020	2-inch	20.0	10.0-20.0	10.2-20.2	14	VS01 IA	UA	flush-mount
WPA-GW17	10/29/2020	2-inch	30.0	15.0-30.0	15.1-30.1	20.63	Crucible Cleaning Room IA	UA	flush-mount
WPA-GW18	11/3/2020	2-inch	25.0	15.0-25.0	15.3-25.3	17.2	SE Line MH17L4	UA	flush-mount
WPA-GW19	12/2/2020	2-inch	32.7	22.5-32.5	22.8-32.8	Dry	SE17 Area/ EELF	UA	flush-mount
WPA-GW20	4/5/2021	2-inch	25.0	15.0-25.0	15.0-25.0	20.55	SE18 IA	UA	flush-mount
WPA-CCR-SB05	10/25/2020	2-inch	25.3	15.3-25.3	18.4-28.4	18.25	Crucible Cleaning Room IA	UA	temporary well screen
WPA-FWB-SB05	10/28/2020	2-inch	27.5	17.5-27.5	20.25-30.25	20.47	FWB IA	UA	temporary well screen
WPA-SE08-SB02	10/27/2020	2-inch	20.0	15.0-20.0	17.8-22.8	13.12	SE08 IA	UA	temporary well screen
WPA-SE08-SB03	10/27/2020	2-inch	22.0	12.0-22.0	12.0-22.0	12.63	SE08 IA	UA	temporary well screen
WPA-SE18-SB01	11/2/2020	2-inch	15.0	10.0-15.0	10.3-15.3	10.81	SE18 IA	UA	temporary well screen
WPA-SE18-SB04	11/2/2020	2-inch	20.0	10.0-20.0	10.2-20.2	10.51	SE18 IA	UA	temporary well screen
WPA-SE18-SB05	4/7/2021	2-inch	25.0	15.0-25.0	15.0-25.0	13.58	SE18 IA	UA	temporary well screen
WPA-SE18-SB06	4/6/2021	2-inch	25.0	15.0-25.0	15.4-25.4	23.47	SE18 IA	UA	temporary well screen

Table 2-1
Groundwater AOC - RI and WPA Monitoring Well and Groundwater Boring Construction Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Well ID	Date of Construction	Well or Boring Diameter	Total Depth (ft-bgs)	Screen Interval (ft-bgs)	Screen Interval (ft-TOC)	Static Water Level at Construction (ft-TOC)	Well Location		Type of Surface Completion
							Site Proximity	Aquifer Zone Designation	
Permanent Wells									
RI-MW1-BAL	11/24/2015	4-inch	210.2	190.0-210.0	192.1-212.1	184.06	East SPL Storage Building	BAL_1	above-ground with bollards
RI-MW2-BAU	10/28/2016	4-inch	40.0	24.8-39.8	26.8-41.8	7.81	Stormwater Pond	BAU_1	above-ground with bollards
RI-MW2-BAL	11/9/2016	2-inch	200.0	179.8-199.8	181.8-201.8	172.01	Stormwater Pond	BAL_1	above-ground with bollards
RI-MW3-BAL	11/13/2015	2-inch	153.2	128.0-153.0	130.4-155.4	39.56	Southwest of West Surface Impoundment near MW-3A and MW-3B	BAU_2	above-ground with bollards
RI-MW4-UA	11/17/2015	2-inch	86.0	70.8-85.8	72.6-87.6	70.67	Northeast of West SPL Storage and West Surface Impoundment (upgradient)	UA	above-ground with bollards
RI-MW5-UA	11/19/2015	2-inch	71.8	51.6-71.6	52.9-72.9	41.69	North of main plant (upgradient)	UA	above-ground with bollards
RI-MW5-BAU	12/3/2015	2-inch	115.5	95.3-115.3	96.9-116.9	54.31	North of main plant (upgradient)	BAU_1	above-ground with bollards
RI-MW6-BAU	12/18/2015	2-inch	63.0	42.0-62.0	41.6-61.6	15.8	Tertiary Treatment Plant	BAU_1	flush-mount
RI-MW7 BAU	11/23/2015	2-inch	51.0	30.0-50.0	29.5-49.5	25.02	North SPL Storage Building	BAU_1	flush-mount
RI-MW8-BAU	12/17/2015	2-inch	60.0	38.8-58.8	38.5-58.5	42.53	South of North and South Potliner Soaking Stations	BAU_1	flush-mount
RI-MW9-BAU	10/20/2016	2-inch	36.0	15.8-35.8	17.3-37.3	9.02	Paste Plant Spill	BAU_1	above-ground with bollards
RI-MW10-BAU	12/9/2015	2-inch	54.0	33.0-53.0	32.6-52.6	17.98	Industrial Sump	BAU_1	flush-mount
RI-MW11-BAU	12/16/2015	2-inch	77.1	56.6-76.6	55.9-75.9	17.84	Casting Pits	BAU_1	flush-mount
RI-MW12-BAU	12/15/2015	2-inch	80.5	60.3-80.3	59.8-79.8	59.78	Cast House oil water seperator/sump	BAU_1	flush-mount
RI-MW13-BAU	12/10/2015	2-inch	65.1	44.9-64.9	44.5-64.5	30.03	Rectifier Yard Oil House	BAU_1	flush-mount
RI-MW14-BAU	12/11/2015	2-inch	70.2	50.0-70.0	49.6-69.6	30.73	Rectifiier Yard Oil House	BAU_1	flush-mount
RI-MW15-BAU	11/2/2016	2-inch	72.0	61.8-71.8	63.4-73.4	61.28	West End Landfill access road	BAU_2	above-ground with bollards
RI-MW16-BAU	11/15/2016	2-inch	120.0	99.8-119.8	99.3-99.3	83.65	John Day Dam Road south of Stormwater Pond	BAU_2	flush-mount
RI-MW17-BAL	10/25/2016	2-inch	26.0	10.8-25.8	12.3-27.3	12.78	Boat Basin	BAL_1	above-ground with bollards
RI-MW18-BAL	10/14/2016	2-inch	125.7	105.5-125.5	107.1-127.1	57.25	NDPES Pond D	BAL_2	above-ground with bollards
RI-MW19-BAL	10/19/2016	2-inch	126.0	115.8-125.8	117.3-127.3	69.74	Plant surface water intake	BAL_2	above-ground with bollards
RI-MW20 -BAL	11/18/2016	2-inch	190.0	169.8-189-8	171.8-191.8	169.71	Southwest of MW-18 and WSI	BAL_3	above-ground with bollards

Notes:
BAL = Basalt Aquifer Lower Zone subdivided into BAL_1 (shallowest), BAL_2 (deeper), and BAL_3 (deepest) zones
BAU = Basalt Aquifer Upper Zone subdivided into BAU_1 (shallower) and BAU_2 (deeper) zones
ft-bgs = Feet below ground surface
ft-TOC = Feet below top of well casing
SPL = Spent pot liner
UA = Upper (Unconsolidated) Aquifer Zone
WPA = Work Plan Addendum

Table 2-2
Groundwater AOC - Existing Monitoring Well Construction Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

	Reported Well Construction Detail [a]						Well Location		
Well Identification	Date of Construction	Total Well Depth (ft-bgs)	Screen Interval (ft-bgs)	Screen Interval (ft-TOC)	Static Water Level at Construction (ft-bgs)	Well Diameter (Inches)	Site Proximity	Aquifer Zone Designation	Type of Surface Completion
ESI-1	12/22/1992	14	6 - 14	9.1-17.1	12	2	East Surface Impoundment	UA	Above-ground, no bollards
IB-1	11/6/1985	63	40 - 50	41.5-51.5	33	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-2	10/10/1985	59	44 - 54	44.7-54.7	51.6	2	East Surface Impoundment	BAU	Above- ground, no bollards
IB-2A	10/11/1985	23	16 - 21	17.2-22.2	5.1	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-3	10/17/1985	35	20 - 30	21.4-31.4	12	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-4	10/22/1985	42	12 - 22	13.4-23.4	15.7	2	East Surface Impoundment	BAU_1	Above ground, no bollards
IB-5	10/17/1985	25	10 - 20	11.4-21.4	16	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-5A	10/16/1985	145	135 - 145	136.3-146.3	58.44	2	East Surface Impoundment	BAU_2	Above-ground, no bollards
IB-5AA	10/16/1985	68	58 - 68	59.1-69.1	59.3	2	East Surface Impoundment	BAU_2	Above-ground, no bollards
IB-6	10/30/1985	62	18 - 58	18.9-58.9	DRY	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-7	11/28/1985	25	10 -20	11.0-21.0	DRY	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-8	11/13/1985	306	281 - 291	282.6-292.6	193	2	East Surface Impoundment	BAL_2	Above-ground, no bollards
IB-9	10/18/1985	15	5 - 10	5.5-10.5	5.3	2	East Surface Impoundment	UA	Above-ground, no bollards
IB-10	10/21/1985	31	17 - 27	18.1-28.1	12.5	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-11	10/18/1985	29	14 - 24	15.5-25.5	10	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-12A	11/6/1985	64	49 - 59	51.1-61.1	13.5	2	East Surface Impoundment	BAU_1	Above-ground, no bollards
IB-13	11/11/1985	153	135 - 140	136.4-141.4	66.07	2	East Surface Impoundment	BAL_2	Above-ground, no bollards
IB-13A	11/11/1985	99	89 - 94	90.2-95.2	65	2	East Surface Impoundment	BAL_2	Above-ground, no bollards
MW-1	4/4/1984	27	22 - 27	23.7-28.7	8	4	East Surface Impoundment	BAU_1	Above-ground, no bollards
MW-8	4/23/1984	14	9- 14	10.5-15.5	4	4	East Surface Impoundment	UA	Above-ground, no bollards
MW-9	4/23/1984	16	11 - 16	12.9-17.9	6	4	East Surface Impoundment	UA	Above-ground, no bollards
MW-10	4/27/1984	13	8 - 13	9.9-14.9	2	4	East Surface Impoundment	UA	Above-ground, no bollards
MW-2A	4/4/1984	55	50-55	51.5-56.5	31	2	West Surface Impoundment	UA	Above-ground, no bollards
MW-2B	4/5/1984	109	104-109	104.6-109.6	78	4	West Surface Impoundment	BAU_1	Above-ground, no bollards
MW-3A	4/13/1984	25	20-25	22.0-27.0	22	2	West Surface Impoundment	UA	Above-ground, no bollards
MW-3B**	4/9/1984	51	46-51	48.5-53.5	22	4	West Surface Impoundment	BAU_1	Above-ground, no bollards
MW-4A	4/17/1984	21	16-21	17.6-22.6	4	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-6B	4/20/1984	50	35-40	36.7-41.7	15	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-7B	4/25/1984	109	104-109	106.2-111.2	82	2	West Surface Impoundment	BAU_1	Above-ground, no bollards
MW-8A	5/7/1989	32	21.5 - 31.5	23.2-33.2	26	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-9A	4/18/1989	35	30.5 - 35.5	32.5-37.5	32.5	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-10A	4/20/1989	26	13 - 26	14.5-27.5	15	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-11A	4/28/1989	29	19 - 29	21.1-31.1	20	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-12A	5/2/1989	55	40 - 55	42.0-57.0	32.5	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-13A	5/4/1989	31	18.5 - 30.6	20.6-32.7	21	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-14A	5/6/1989	30	8.5 - 29.5	10.6-31.6	7.5	4	West Surface Impoundment	UA	Above-ground, no bollards
MW-15A	5/6/1989	29	12.5 - 28	14.6-30.1	10.5	4	West Surface Impoundment	UA	Above-ground, no bollards

Table 2-2
Groundwater AOC - Existing Monitoring Well Construction Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Well Identification	Reported Well Construction Detail [a] Date of Construction	Total Well Depth (ft-bgs)	Screen Interval (ft-bgs)	Screen Interval (ft-TOC)	Static Water Level at Construction (ft-bgs)	Well Diameter (Inches)	Well Location Site Proximity	Aquifer Zone Designation	Type of Surface Completion
MW-18	10/18/2004	51	35 - 50	36.6-51.6	23.25	4	West Surface Impoundment	BAU_1	Above-ground, no bollards
MW-16A	1/10/1990	42	22 - 42	23.3-43.3	30	4	West Spent Potliner	UA	Above-ground, no bollards
MW-17A	1/10/1990	35	15 - 35	15.6-35.6	22	4	West Spent Potliner	UA	Above-ground, no bollards
MW-E1A	6/23/2008	15	8 - 15	10.4-17.4	10	2	East End Landfill	UA	Above ground with bollards
MW-E3	6/23/2008	25	20 - 25	22.9-27.9	DRY	2	East End Landfill	UA	Above-ground with bollards
MW-E4	6/24/2008	38	22 - 36	24.1-38.1	DRY	2	East End Landfill	UA	Above-ground with bollards
MW-E7	6/21/2008	28	18 - 28	17.5-27.5	18.5	2	East End Landfill	UA	flush-mount
MW-E8	6/24/2008	23	13 - 23	12.7-22.7	17	2	East End Landfill	UA	flush-mount
MW-W1	6/22/2008	30	20 - 30	22.5-32.5	20	2	West End Landfill	UA	Above-ground with bollards
MW-W2	6/22/2008	30	20 - 30	22.0-32.0	22	2	West End Landfill	UA	Above-ground with bollards
MW-W3	6/22/2008	30	18 - 30	20.3-32.3	20	2	West End Landfill	UA	Above-ground with bollards
MW-W4	6/22/2008	65	50 - 65	49.5-64.5	53.5	2	West End Landfill	UA	flush-mount
BAMW-1	10/14/2009	162	142 - 162	144.3-164.3	134	2	BAMW- Designated Wells	BAU_2	Above-ground with bollards
BAMW-2	10/12/2009	240	220 - 240	222.9-242.9	219	2	BAMW- Designated Wells	BAL_1	Above-ground with bollards
BAMW-3	10/8/2009	131	111 - 131	113.4-133.4	116	2	BAMW- Designated Wells	BAU_2	Above-ground with bollards
BAMW-4	10/19/2009	220	200 - 220	202.8-222.8	199	2	BAMW- Designated Wells	BAL_1	Above-ground with bollards

Notes:

a Existing well construction detail as compiled and referenced in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a).

BAL = Basalt Aquifer Lower Zone subdivided into BAL_1 (shallower) and BAL_2 (deeper) zones

BAU = Basalt Aquifer Upper Zone subdivided into BAU_1 (shallower) and BAU_2 (deeper) zones

EELF = East End Landfill

ESI = East Surface Impoundment

ft-BGS = Feet below ground surface

ft TOC = Feet below top of casing

NA = Not Available

2.2.3.3 *Well Network Survey*

All existing and newly installed monitoring well locations and elevations were surveyed by a state licensed surveyor as part of the RI work effort during January and March 2017. A few additional features (e.g., stilling well measurement-point elevations at stormwater pond and surface water intake, Spring 01 elevation, and Boat Basin Dock measurement-point elevation) were surveyed on May 10, 2017. The WPA wells were surveyed on during December 2020 and May 2021. Survey results are provided in Volume 5, Appendix D-3. All wells were surveyed using real-time kinematic Global Positioning System (GPS) equipment (Trimble R8 GPS receivers with Trimble Model TSC3 electronic data collection units). The horizontal coordinates are referenced the Washington State Plane Coordinate System South Zone Grid, NAD 83. Vertical elevations reference North American Vertical Datum of 1988. All coordinates were established utilizing the Oregon Real Time GPS network.

2.2.4 Geologic Site Reconnaissance

During November 2015, a geologic reconnaissance of the site was performed. An expert on Columbia River Basalts stratigraphy (Terry Tolan) participated and helped refine the understanding of site geology. The rock cores previously collected and catalogued during RI coring and packer testing (see Section 2.2.3 below) were also inspected by the project team and a memorandum about the site reconnaissance and notes on the cores were prepared (Intera 2015). Volume 5, Appendix D-4 includes the Intera (2015) field reconnaissance memorandum.

2.2.5 Coring and Packer Tests

Packer tests were performed in conjunction with continuous rock coring activities in Fall 2015 at three borings located in the eastern, central, and western portion of the site (RI-MW1 core, RI-MW2 core, and RI-MW3 core) (Figure 2-3). The location of the RI-MW2 core was initially planned in the immediate vicinity of the planned RI-MW2 well cluster. However, due to delays in getting necessary authorization to drill in this area, the RI-MW2 core was drilled about 300 ft north near the southwest corner of the canopy area (refer to Figure 2-3). The geology in the two locations was found to be similar, so the change in the coring location did not significantly affect the RI findings.

Legend

- Unconsolidated Aquifer Well (UA)
- Uppermost Basalt Aquifer Well (BAU)
- Lower Basalt Aquifer Well (BAL)
- Continuous Coring Location

N W E S

0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 2-3
Coring and Packer Test Locations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

A CME 75 drill rig was used to drill the core holes. The drill rig was capable of mud-rotary drilling up to 7 7/8-inch borehole diameter (used in unconsolidated upper interval of core holes), casing advancement, HQ3 wire-line coring, and hollow-stem auger drilling. The HQ3 wire-line core represents a triple-tube coring set-up.

Each boring was continuously cored, and all of the core sections were logged and processed by the field geologist consistent with the procedures specified in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Lithology, texture, fracture characteristics, recovery, and rock quality designation were included on the core logs as provided in Volume 5, Appendix D-5 of this report.

The objectives of the packer tests were to characterize hydraulic characteristics of the water-bearing zones as well as low permeability flow interiors in the fractured bedrock. Packer test field logs are included in Volume 5, Appendix D-6 of this report. A total of 18 packer tests were completed in the test borings: 1) RI-MW3 core included five test intervals; 2) RI-MW1 core included six test intervals; and 3) RI-MW2 core included seven open intervals. Where possible (i.e., RI-MW1 core and RI-MW3 core locations), water levels in nearby monitoring wells constructed with similar screened intervals to the core testing intervals were monitored to evaluate potential response from injections. In each test boring, a series of constant head injection tests were performed using a single pneumatic packer inflated to isolate each test interval. The source of the water for the injection water was the facility water supply, which at the time of the coring investigation was Industrial Well 1. Selection of the intervals to be tested was based upon the characteristics of the rock cores and the presence of formation fractures determined at the time of drilling.

Once a test interval was selected, the packer assembly was lowered into place and the pneumatic packer was inflated to isolate the zone. For the most part each packer test was completed in a series of 5- to 10-minute constant pressure (constant head) steps. The maximum planned injection pressure for each test interval was based upon the depth of the test interval and the ability of test equipment to achieve planned injection pressures and injection rates. The tests employed the placement of a single packer above the test interval. Packer seal verification was indirectly determined by flow and pressure measurements during the initial pressure steps.

At the RI-MW1 core and RI-MW3 core locations, nearby monitoring wells were gauged during the packer tests to determine potential response to the injections. For the RI-MW1 core location wells MW-E8 and BAMW-1 were gauged, and at the RI-MW3 core location wells MW-3A and MW-3B were gauged. No monitoring wells were present in the vicinity of the RI-MW2 core location at the time the tests were implemented during fall 2015.

Four packer test analysis procedures were attempted for each of the tests including Lugeon (1933) packer test analysis, Theim (1906) equation analysis, Theis (1935) analysis of pumping and recovery, and Theis (1935) analysis of recovery. The complete analyses for each packer test are included in Volume 5, Appendix D-6.

Each core hole was abandoned and backfilled in 10-ft lifts using a bentonite-grout slurry. Monitoring wells were later installed in the vicinity of the core holes based on the coring and packer test results, and pump tests were subsequently performed at RI MW2-BAU and RI-MW1-BAL to characterize potential aquifer zone interconnection as well as aquifer zone properties.

2.2.6 Slug Tests

Slug testing was performed in all existing and newly installed monitoring wells in May-June 2017. The tests consisted of monitoring water-level displacements caused by the insertion and removal of a solid slug from the well. Water-level displacement was measured using In-Situ Level TROLL 500 and 700 pressure transducers, which were programmed to collect data at up to one-quarter second time intervals. When the rate of well recovery was sufficient to allow for multiple tests, additional tests were performed at each well. The size of the slug was selected to be consistent with the diameter of the well, the saturated interval in the well, and the expected recovery rate. Use of pneumatic slug test methodology was considered, but due to the variety of surface completions in the existing and RI well network, adequate seal placement appeared to be problematic, and standard slug test techniques were adopted.

The slug test data were downloaded from the transducer and the drawdown was calculated from the downloaded data. Two slug tests were selected for analysis from each well and typically included one slug-in test and one slug-out test. In cases where static water levels were below the top of the filter pack, only slug-out test results were used in the curve match analyses. Slug test analysis was performed using the commercially-available AQTESOLV software (HydroSOLVE

2007). The Bouwer and Rice (1976) and Springer and Gelhar (1991) methods for analyzing slug tests in confined and unconfined aquifer were used as appropriate to estimate hydraulic conductivity. The Bouwer and Rice method was used to analyze wells with a straight-line response and the Springer-Gelhar method was used to analyze wells with an inertial response. The AQTESOLV interpretation plots are provided as Volume 5, Appendix D-7. Slug test results are presented and discussed in Section 2.3.4 of this report.

2.2.7 Aquifer Pumping Tests

This section summarizes the RI field program for aquifer pump tests including the RI-MW2-BAU and RI-MW1-BAL constant rate tests, the industrial well pumping well test, and the stormwater pond drawdown test.

2.2.7.1 RI-MW2-BAU Pumping Test

The RI-MW2-BAU pumping test was performed during July 2017 to evaluate aquifer properties and aquifer zone interconnection in the main plant area near the stormwater pond. Continuous coring and packer testing were also previously performed in this area as part of the RI to aid in hydrogeologic characterization as discussed previously. Consistent with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b), the following wells were fitted with transducers and used monitoring locations for the test: RI-MW2-BAU, RI-MW2-BAL, RI-MW9-BAU, RI-MW10-BAU, RI-MW15-BAU, RI-MW16-BAU, and the stormwater pond stilling well. The RI-MW2-BAU pump test layout is shown in Figure 2-4.

A Grundfos Ready Flow 3, 10/100, 115V pump was used for pumping during the step-drawdown and constant rate tests. The pump was equipped with a check-ball valve and was placed near the base of the screen interval of the well. The pump unit and dedicated pump tubing was secured to a bollard at wellhead with steel cable. Discharge water was temporarily stored in a 300-gallon capacity plastic tote located near the well head. A trash pump was placed was used to pump the water from the tote to the 20,000-gallon FRAC tank located northwest of the stormwater pond along the fence line. Insitu Troll™ pressure transducers were used to monitor each of monitoring wells included in the tests.

Insitu Level Troll™ 500 and 700 pressure transducers were used to monitor each of monitoring wells included in the tests. These pressure transducers were used in the slug tests, aquifer tests, and water-level characterization study. All pressure transducers used in the RI were vented. The

Legend

- Unconsolidated Aquifer Well (UA)
- Uppermost Basalt Aquifer Well (BAU)
- Lower Basalt Aquifer Well (BAL)
- Production Well
- Surface Water or Storm Water Gauging Station
- Transducer with Data Logger
- Pumping Well

N / W / E / S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-4
RI-MW2-BAU
Aquifer Test Layout

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

pressure ratings for the transducers were rating 5 and 15 PSI. A variety of lengths of vented interchangeable poly cable were used with the transducers. A Barotroll was set up in a covered area near the Compressor Building and used to record barometric pressure changes during the entire period of the water-level characterization study, and aquifer tests. A step-drawdown test and a constant rate pumping test were conducted at monitoring well RI-MW2-BAU. Well construction details for the pumping test and selected observation wells are included in Table 2-1.

A three-step drawdown test was conducted on July 12, 2017. The first step ran for 83 minutes and was measured at an approximate rate of 5 gallons per minute (gpm). For the second step the pump was turned up to approximately 10 gpm and ran for 60 minutes. The final step was run at approximately 15 gpm for 74 minutes. At the completion of the test, all the transducers were left recording overnight to evaluate aquifer recovery and conditions.

A constant rate pumping test was conducted during July 12-13, 2017. The pump was set to a rate of 15 gpm for the entirety of the test. Manual gauging and continuous transducer measurements were routinely performed and evaluated throughout the duration of the test.

The test was concluded after 21.7 hours of pumping due to lack of observed response in any of the observation wells or stormwater pond stilling well. The RI-MW2-BAU step drawdown and constant rate pump test data and associated analysis is provided in Volume 5, Appendix D-8. Pump test results are summarized in Section 2.3.5 of the report.

2.2.7.2 RI-MW1-BAL Pumping Tests

The RI-MW1-BAL pumping tests were performed between July 26-28, 2017 to evaluate aquifer interconnection and aquifer properties in eastern area of the main plant. Well RI-MW1-BAL was selected for the pumping test because it represents one location with continuous core that was previously packer tested and is located near suspected source areas. A two-step drawdown test was performed on July 26, 2017 and a constant rate pump test was performed on July 27-28, 2017 at the monitoring well.

Prior to both pumping tests, pressure transducers were installed in the pumping well RI-MW1-BAL and in six nearby observation wells (RI-MW8-BAU, BAMW-2, BAMW-3, IB-1, MW-E1A, and RI-MW7-BAU). Figure 2-5 shows the layout for the RI-MW1-BAL pumping tests. Well construction details for the pumping and observation wells are included in Tables 2-1 and 2-2 and Volume 5, Appendix D-1. Well RI-MW7-BAU was selected as an upgradient well to monitor potential site-wide trends. A Grundfos Ready Flow 3, 22/210, 230 V pump was used for the pumping test at RI-MW1-BAL. The pump was equipped with a check-ball valve and was placed near the base of the screen interval of the well. Water management at the well head was similar to the RI-MW2-BAU aquifer tests.

Two-Step Draw Down Test

The first step ran for 64 minutes and the pumping rate was set at approximately 9 gpm. For the second step, turned up to an approximate rate of 12 gpm the pump was turned up to an approximate rate of 12 gpm (i.e., full capacity). At the completion of the test, all transducers were left recording overnight to evaluate aquifer recovery and conditions.

Constant Rate Pumping Test

During the constant rate pumping test, the pump was set to full capacity at a rate of 12 gpm for the entirety of the test. Manual gauging and continuous transducer measurements were routinely performed and evaluated throughout the duration of the test. The test was concluded after just over 24 hours of pumping and monitoring of all wells continued during the recovery phase. The RI-MW1-BAL step-drawdown and constant rate pump test data and analyses are provided in Volume 5, Appendix D-8. Pump test results are summarized in Section 2.3.5 of this report.

2.2.7.3 Industrial Well Pumping Test

The industrial well pumping test was conducted to evaluate potential interconnection between monitoring wells completed in the BAU and/or BAL aquifer zones. A historical industrial well pumping test (URS 2011) was previously conducted that included continuous pumping of all three industrial wells over a 56-hour period with transducer water-level monitoring of existing basalt aquifer wells. Results of that test included a drawdown response in well BAMW-1, which is located near the West End Landfill (WELF) (refer to Figure P-1), and at a distance of 1,000 and 795 ft from Industrial Wells 1 and 3, respectively. The 2011 industrial well pump test findings are summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). Limitations and

Legend

- Unconsolidated Aquifer Well (UA)
- Uppermost Basalt Aquifer Well (BAU)
- Lower Basalt Aquifer Well (BAL)
- Production Well
- Surface Water or Storm Water Gauging Station
- Transducer with Data Logger
- Pumping Well

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-5
RI-MW1-BAL
Aquifer Test Layout

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

uncertainties with the historical tests include: a general lack of basalt aquifer zone monitoring coverage at the time of the test and uncertainty regarding which specific industrial well caused the observed response at BAMW-1.

The Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b) specified two industrial well pumping tests that included: 1) pumping of Industrial Well 2 with monitoring of new wells RI-MW1-BAL, RI-MW8-BAU, and pre-existing well BAMW-3, and 2) pumping of Industrial Well 1 with monitoring of new well RI-MW13-BAU. However, Industrial Well 2 was non-operational due to plant demolition activities, and Industrial Well 1 had a problem with caving and became non-operational during winter 2017. Industrial Well 3 was the only operational well at the plant during August 2017 when the test was completed. For this reason, the transducer monitoring was modified to include bedrock wells near Industrial Well 3.

Industrial Well 3 is 1,128 ft deep and the well is cased from ground surface with a 12-inch casing extending to 400 ft bgs and an open borehole construction from 400 ft bgs to the bottom of the hole. The pump was originally set in the well between 380 and 400 ft bgs at the time the well was constructed. During winter 2017, the non-operational pump was replaced, and the new pump was set at approximately 50 ft bgs. Water-level measurements at the industrial well were not possible due to its wellhead construction.

Prior to the start of the test, pressure transducers were installed in eight nearby monitoring wells. The industrial pumping well was unable to be monitored with a transducer. The following wells were fitted with transducers and used as observation wells: RI-MW2-BAL, RI-MW2-BAU, RI-MW3-BAL, BAMW-1, RI-MW13-BAU, MW-7B, MW-6B, RI-MW15-BAU. The test layout for the industrial well pumping test is shown in Figure 2-6.

The industrial well (well 3) constant rate test was performed between August 2-4, 2017. The rate of pumping from the Industrial Well 3 could not be adjusted but was estimated at about 50 gpm based on facility-provided information. The test was run for a total of 40.4 hours. The Industrial Well 3 Pump test data and analysis is provided in Volume 5, Appendix D-9. Pump test results are discussed in Section 2.3.5 of this report.

Legend

- Unconsolidated Aquifer Well (UA)
- Uppermost Basalt Aquifer Well (BAU)
- Lower Basalt Aquifer Well (BAL)
- Production Well
- Surface Water or Storm Water Gauging Station
- Transducer with Data Logger
- Pumping Well
- Manual Gauging Station

N
W E
S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-6
Industrial Well
Pumping Test Layout

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

2.2.8 Stormwater Pond Drawdown Test

The stormwater pond is a constructed feature that is part of the facility's permitted NPDES stormwater system (refer to Figure P-1). Stormwater and collected shallow groundwater drain to the stormwater pond. During the wet season, water accumulating in the stormwater pond is periodically pumped to the industrial sump, and subsequently discharged though a pipeline to the Columbia River under an existing NPDES permit. The stormwater pond, which is a primary feature of SWMU 32, is unlined and constructed within the basalt bedrock. Refer to Volume 2, Section 32, for the complete stormwater system (SWMU 32) results.

The objective of the stormwater pond drawdown test was to evaluate whether the stormwater pond is hydraulically interconnected with or is a source of recharge for the basalt aquifer system in this area of the site.

The investigation consisted of transducer monitoring of the stormwater pond and nearby wells RI-MW2-BAU and RI-MW2-BAL during a routine stormwater discharge event in May 2017. The pumping rate of the pond for this test was about 350 to 400 gpm over a period of about 5 days. The stormwater pond drawdown test transducer data is included in Volume 5, Appendix D-10. The results of the tests are summarized in Section 2.3.7 of this report.

2.2.9 Water-Level Characterization Study

As specified in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b), the objective of the water-level characterization study was to evaluate seasonal variability and potential aquifer interconnection at two well clusters: 1) one well cluster located near the East SPL Storage Building and North and South Pot Liner Storage Areas (with planned transducer monitoring at wells RI-MW1-BAL, BAMW-3, and RI-MW8-BAU), and a second well cluster near the stormwater pond (with planned transducer monitoring of wells RI-MW2-BAU, RI-MW2-BAL, and the stormwater pond).

During drilling of the monitoring wells near the Columbia River (i.e., wells RI-MW18-BAL and RI-MW19-BAL), groundwater was unexpectedly not encountered until an elevation of about 40 ft below the elevation of the river and the water-level in the boring rose in elevation significantly, which indicated confined conditions. Based on this preliminary finding, it was hypothesized that there may be more than one permeable zone within the BAL, and it became clear that the hydrologic relationship between the BAL-zone wells along the shoreline and the Columbia River could not be characterized with the stations included in the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Additional monitoring stations were added to the water-level characterization study, so that water-level elevations in wells along the shoreline and the Columbia River (i.e., surface water intake pond and Boat Basin dock stations) could be compared.

The layout of the monitoring stations for the water-level characterization study is shown in Figure 2-7. Eight monitoring wells (RI-MW1-BAL, RI-MW2-BAU, RI-MW2-BAL, RI-MW8-BAU, BAMW-3, RI-MW17-BAL, RI-MW18-BAL, and RI-MW19-BAL) and two water gauging locations (stormwater pond and surface water intake pond). Stilling wells were constructed at the stormwater pond and the surface water intake pond and the stilling wells were surveyed. In addition, water-levels were collected at the Boat Basin dock by hand with each groundwater sampling round. Hydrograph data for the Lake Umatilla pool at John Day Dam was also obtained from USACE and used in the data evaluation. Data collection for the water-level study was for a period of about one-year (April 2017 to April 2018). Data and field documentation for the water-level characterization study is included in Volume 5, Appendix D-10. The results for the water-level characterization study are summarized in Section 2.3.7.

2.2.10 Groundwater Sampling Program

Four quarters of groundwater sampling were performed including: Initial baseline round (Winter – January to February 2017), 2nd Quarter (Spring – May 2017), 3rd Quarter (Summer – August 2017), and 4th Quarter (Fall – November 2017) in accordance with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b).

The wells were sampled using low-flow sampling techniques and included use of a bladder pump to sample the deep BAL zone wells and a submersible pump (GeoSub™) to sample BAU zone wells and deeper UA zone wells. Shallow UA zone wells and surface water stations were sampled using a peristaltic pump. Dedicated pump tubing was used at each well and all non-dedicated equipment (e.g., pumps, water-level electronic tapes) was decontaminated after sampling at each station using an Alconox-water wash, and a de-ionized water rinse consistent with the work plan procedures. Groundwater sampling forms for each quarterly sampling round are provided in Volume 5, Appendix D-11.

The chemical groundwater monitoring program is summarized in Table 2-3 and briefly summarized in the following subsections.

Legend

- Unconsolidated Aquifer Well (UA)
- Uppermost Basalt Aquifer Well (BAU)
- Lower Basalt Aquifer Well (BAL)
- Production Well
- Surface Water or Storm Water Gauging Station
- Transducer with Data Logger
- Hand-gauging

N / E / S / W

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-7
Water-level Characterization Study
Monitoring Locations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Table 2-3
Groundwater AOC – RI Groundwater Analytical Program Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

<table>
<tr><th colspan="2" rowspan="2">Well / Sample Type</th><th rowspan="2">Initial (Q1/Baseline) Sampling Round</th><th rowspan="2">Initial Sampling Round Analytical Program</th><th colspan="3">Quarterly Sampling Rounds</th><th rowspan="2">Quarterly Sampling Round Analytical Program</th></tr>
<tr><th>Q2 (Spring)</th><th>Q3 (Summer)</th><th>Q4 (Fall)</th></tr>
<tr><td colspan="2">Existing Monitoring Wells</td><td>37</td><td rowspan="8">All Wells
Total cyanide
WAD cyanide
Free Cyanide
Fluoride
Sulfate
Metals [a]
Filtered Metals [a]
Polycyclic Aromatic Hydrocarbons
Polychlorinated Biphenyls

Geochemistry [b]

Additional Analyses at 10 Selected Wells
Volatile Organic Compound [c]
Total Petroleum Hydrocarbons[c]
[TPH-GX (gasoline range) and TPH-Dx (diesel range) organics] [c]</td><td>37</td><td>39</td><td>38</td><td rowspan="8">Total cyanide
WAD cyanide
Fluoride
Sulfate

Other chemicals that exceed screening levels in one or more wells during the initial sampling round were included in subsequent sampling rounds</td></tr>
<tr><td colspan="2">Production Wells</td><td>2</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="2">New Permanent Monitoring Wells</td><td>22</td><td>22</td><td>22</td><td>22</td></tr>
<tr><td colspan="2">New Temporary Monitoring Wells</td><td>8</td><td>8</td><td>7</td><td>8</td></tr>
<tr><td rowspan="3">Water Features</td><td>Spring-01</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Stormwater Pond</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>NESI Wetland</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="2">Total Samples</td><td>70</td><td>69</td><td>72</td><td>71</td></tr>
</table>

a For metals, both field-filtered and unfiltered samples were collected. Metals analytical suite to include: Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, and Zn. ESI wells to include Fe.

b Geochemistry suite to include major ions (Ca, Mg, Na, K, and Cl) and conventional parameters (hardness, TDS, and total alkalinity).

c A subset of 10 locations were sampled for VOCs, TPH-Dx, and TPH-Gx including wells: RI-MW2-BAU, RI-MW10-BAU, RI-GW-4, RI-GW-6, RI-MW11-BAU, RI-MW12-BAU, RI-MW13-BAU, RI-MW14-BAU, RI-MW15-BAU, and RI-GW1.

Note: Eleven monitoring wells including 2 (BAU)- and 9 (UA)-designated wells were either dry or had too little water to sample during the baseline (Q1) monitoring event (all newly installed wells were successfully sampled).

2.2.10.1 Baseline Sampling Round (Q1) Analytical Program

The initial (baseline) quarterly groundwater sampling round included a comprehensive analytical suite for COPC including: total cyanide, weak-acid dissociable (WAD) cyanide, free cyanide, fluoride, sulfate, selected metals (Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, and Zn), PAHs, PCBs, as well as major ion geochemistry (Ca, Na, Mg, Cl, HCO_3, and CO_3). Both unfiltered and field-filtered samples were collected for metals analyses. A subset of 10 wells were analyzed during the baseline round for volatile organic compounds (VOCs), total petroleum hydrocarbons – gasoline extended range (TPH-Gx), and TPH-Dx (refer to Table 2-3).

Iron was included in the analytical program for wells near the ESI during the baseline round and quarterly at all four of the ESI wells included in the ESI long-term monitoring program.

2.2.10.2 Subsequent RI Sampling Rounds (Q2 through Q4) Analytical Program

During subsequent quarterly rounds of groundwater sampling, all monitoring wells were analyzed for total cyanide, WAD cyanide, fluoride, and sulfate. The 8 temporary wells installed during the RI and sampled during the baseline sampling round were retained in the RI sampling program because of exceedances of groundwater screening levels and sampled using the same approach to the analytical program as all of the other monitoring wells included in the RI program. Consistent with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b), groundwater sampling was also continued in specific wells for all chemicals that exceeded groundwater screening levels during the baseline round. Based on the results of the baseline round of sampling, free cyanide was continued in the monitoring program for those wells with positive detections of any form of cyanide during the baseline round.

Arsenic was retained in the analytical program for all wells based on its widespread low-level occurrence. A few additional metals (Al, Cr, Fe, Pb, and Ni) were included for the small subset of wells that exceeded groundwater screening levels during the baseline round. All samples collected for metals included both total (unfiltered) and dissolved (field-filtered) samples. The eight background-designated well locations (IB-3, MW-2A, MW-2B, MW-8A, MW-11A, RI-MW4-UA, RI-MW5-UA, and RI-MW5-BAU) were also routinely sampled during each quarter for this list of metals. PCB monitoring was continued in the one well (RI-MW17-BAL) with baseline results above Model Toxics Control Act (MTCA) groundwater screening levels.

Based on the baseline round sample results, VOCs were routinely analyzed for at RI-GW1 (at the R & D laboratory) and wells at the Former Compressor Building UST wells (RI-GW6, RI-GW8, and RI-GW9). The UST wells were also analyzed for TPH-Dx, TPH-Gx, and PAHs based on baseline round exceedances for these chemicals or elevated subsurface soil concentrations for these chemicals.

2.2.10.3 Well MW-1 Analytical Program

Well MW-1, a pre-existing monitoring well located east of the ESI and upgradient of all suspected source areas., was found to contain a purple-pink material during well development prior to the initial baseline groundwater sampling round (refer to Figure 2-1). A grab sample of the purple-pink material was collected with a disposable bailer during the initial baseline (Q1) quarterly sampling event for waste profiling purposes with following analytical program: VOCs [including tentatively identified compounds (TICs)], semivolatile organic compounds [(SVOCs) including TICs], TPH-Dx, TPH-Gx, metals (As, Cd, Cr, Hg, Pb, Ni, Se), and glycols.

During the spring quarter (Q2), groundwater was sampled from MW-1 using low-flow sampling techniques for the baseline round analytical program including: total cyanide, WAD cyanide, free cyanide, fluoride, sulfate, PAHs, PCBs as well as previously sampled chemicals that were elevated above screening levels in the purple-pink material including metals (As, Fe, and Pb), VOCs, and TPH-Dx.

During the summer quarter (Q3) sampling event, well MW-1 was sampled using low-flow sampling techniques for aluminum smelter-related chemicals (total cyanide, WAD cyanide, fluoride, and sulfate) as well as those chemicals that had previously exceeded screening levels including TPH-Dx, metals (As, Fe, Pb), and VOCs. In addition, chlorinated herbicides and chlorinated pesticides were also analyzed at the request of Ecology.

During the fall quarter (Q4) sampling round, well MW-1 was sampled using low-flow sampling techniques for aluminum smelter-related chemicals (total cyanide, WAD cyanide, fluoride, and sulfate) as well as chemicals that had previously exceeded screening levels including total and dissolved metals (As, Fe, and Pb), TPH-Dx, VOCs, and chlorinated pesticides. Groundwater sampling results for well MW-1 are summarized in Section 2.3.8 of this report.

2.2.11 WPA Groundwater Analytical Program

The analytical suite for single round of groundwater samples for existing wells collected during December 2020 in the Former Plant Area Footprint included: total and free cyanide (North and South Pot Liner Soaking Station and East SPL Storage Area wells only: MW-E7, MW-E8, RI-MW8-BAU, and BAMW-3), fluoride, sulfate, diesel and residual-range organics, gasoline range hydrocarbons (Former Compressor Building UST and East End Landfill (EELF) area wells only: RI-GW6, RI-GW8, RI-GW9, MW-E1A, MW-E3, and MW-E4) and VOCs (EELF area wells only: MW-E1A, MW-E3). New wells constructed near the North SPL Storage Area (WPA-GW12) and the EELF (WPA-GW18-BAU) were sampled for the same analytical program as the existing wells in these areas. The analytical suite for water samples from wetland springs included: total and free cyanide, fluoride, sulfate, PAHs, PCBs, selected metals (As, Cd, Cr, Hg, Pb.

The analytical suite for groundwater samples collected from borings and newly constructed monitoring wells at individual Plant Area WPA investigation areas included: cyanide (free and total), fluoride, sulfate, PAHs, and total petroleum hydrocarbons. A few locations also included VOC and metals analyses (Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn).

2.2.12 Water IDW Management

Water investigation-derived waste (IDW) was generated during several phases of investigation including: drilling, well development, aquifer testing groundwater sampling, and equipment decontamination. All water IDW was initially containerized at the location it was generated and subsequently transported and transferred into larger containers (either a FRAC tank or 55-gallon drums). Ecology agreed to allow the water IDW to be discharged to the stormwater pond under the NPDES permit based on analytical results. This process is described as follows for the various groundwater-related field activities:

- Water generated during drilling operations was contained at each drilling site in 300-gallon capacity totes. The full totes were then transported to the drilling equipment and IDW staging area that was located at the canopy area in the central portion of the former plant area (near the stormwater pond). Water in the totes was then transferred to a 20,000-gallon capacity FRAC tank with secondary containment. Pressure washer water associated with drilling rig decontamination was also transferred and stored in the FRAC tanks.

- Water generated during well development water was initially contained in a 300-gallon tote at the well site and then transported and transferred to the FRAC tank located at the staging area. Development water from the Compressor Building UST wells and MW-1 was contained separately in 55-gallon drums due to the suspected presence of TPH and the purple-pink material in the development water.

- During the RI-MW2-BAU aquifer test, water was pumped from the well to a 300-gallon tote, and then from the tote up to a 20,000-gallon FRAC tank located north of the stormwater pond along the fence line. For the RI-MW1-BAL aquifer test, water was pumped from the well to a 300-gallon plastic tote, and then to a 20,000-gallon FRAC tank located beside the well.

- Purge water generated during well sampling was initially contained in 5-gallon buckets at each well site, and then transported and transferred into the FRAC tank or 300-gallon tote. Purge water from the monitoring wells associated with the Compressor Building UST and MW-1 was contained separately in 55-gallon drums.

- Water stored in the FRAC tanks and tote was discharged to the stormwater pond following chemical testing. IDW water planned to be discharged to the stormwater pond was sampled for the analytical parameters specified in the facility NPDES permit [Al, total suspended solids, fluoride, oil and grease, benzo(a)pyrene, Sb, Ni, As, WAD cyanide, hardness, pH, and temperature], and reported under the NPDES permit. In addition, the quarterly groundwater sample results were evaluated to determine the suitability for discharge to the stormwater pond. FRAC tanks were discharged to the stormwater pond four times during the course of the RI field investigation and the 300-gallon tote was discharged once.

- Development water and purge water generated from the monitoring wells at the Compressor Building former USTs and MW-1 was chemically profiled and sent to Columbia Ridge Landfill for disposal.

- During the WPA, water IDW generated during drilling, well development water, decontamination fluids was contained in a FRAC tank. Based on testing results, that showed elevated fluoride concentration, the project team, elected to have the FRAC tank water transported and disposed of at the Columbia Ridge Landfill evaporation ponds. IDW soils included a roll-off box of soil cuttings disposed of as non-hazardous waste at the Columbia Ridge Landfill, and a single 55-gallon drum of K088-listed waste from the footprint of the EELF that was disposed of at the Chemical Waste Management, hazardous waste facility in Arlington, Oregon.

2.3 GROUNDWATER RI RESULTS AND FINDINGS

This section describes the geology, hydrostratigraphy, groundwater flow, aquifer characteristics, as well as groundwater quality, geochemistry, based on the results of the RI work effort.

2.3.1 Geology and Hydrostratigraphy

The site is located on the Columbia River Plateau where the bedrock is composed of the Miocene Columbia River Basalt Group. Specifically, the lower to Middle Miocene Grande Ronde Basalt Formation underlies the topographic bench in the former smelter vicinity. The Grande Ronde Basalts are generally fine grained and petrographically non-distinctive (Bela 1982). Individual flows range in thickness from less than 3 ft to more than 160 ft but are generally between 50 and 80 ft (Bela 1982). The Grande Ronde Basalts are estimated to be greater than 1,500 ft thick along the lower John Day River (Bela 1982).

The Columbia Hills form a ridge north of the site with about 3,000 ft of relief. The geologic structure of the Columbia Hills consists of a series of east-west trending anticlines and synclines that are cut by or overlie north-dipping thrust faults (Bela 1982, USGS 2014). A second series of northwest/southeast trending high-angle faults (with associated folds) divide the east west trending folds and faults into a series of segments (Bela 1982, USGS 2014). Most of these high-angle faults represent right-lateral strike-slip faults (Anderson et al. 2015). There is suspected Quaternary movement along some of the northwest/southeast trending fault sections (USGS 2014). An east-west trending thrust fault is present near the base of the Columbia Hills to the north of the site based upon a repeated section within the Grande Ronde Basalt (Bela 1982).

Two generally northwest-southeast trending faults, one named the Goldendale strike-slip fault and the other a combination strike-slip and normal fault, intersect the thrust fault in the site vicinity (KPUD 2014) (refer to Figures 2-1 and 2-2 that show the site vicinity faults and the monitoring well network). The Goldendale Fault is mapped west of the West Surface Impoundment (WSI), and about one mile downstream of John Day Dam. The second fault passes under the former location of the aluminum plant with the fault trace coinciding with the western gulley/intermittent drainage that leads from the western end of the Boat Basin up to the western end of the former plant area (KPUD 2014). A recent geologic map including the fault features was included in the KPUD (2014) report and has been included in Volume 5, Appendix D-12. According to the John

Day Pool pumped storage pre-application document, it is unlikely that the faults in the immediate site vicinity are active or have the potential to produce earthquakes (KPUD 2014). In general, within the Columbia River Basalt Aquifer system, there is limited or impeded groundwater flow across faults due to fault gouge and weathering within the fault zone (PNNL 2002, Reidel and Tolan 2013), and there are commonly confined aquifer conditions in the vicinity of most faults. Faults may also represent a groundwater flow pathway along the fault, particularly where erosion along the fault has resulted in a topographic low or the fault is aligned parallel to groundwater flow.

The topographic bench on which the plant is located represents an erosional feature formed by erosional scour during the Pleistocene Missoula Floods. In the vicinity of the site, the basalt bedrock and topographic bench is partially covered by unconsolidated deposits consisting predominately of: colluvium shed from the ridge to the north; man-made fill associated with highway construction, dam construction, and smelter construction and operations; glacial fluvial sediments (Missoula Flood deposits), loess and other aeolian deposits; and minor amounts of alluvium. These unconsolidated deposits are present as either a discrete stratigraphic unit ranging from a few feet to about 50 ft thick or as localized areas within flood-scoured depressions on the basalt bench surface.

The occurrence and distribution of these units were confirmed during this RI work effort by outcrop reconnaissance, core drilling, and lithologic logging of rock chips from air-rotary drilling activities and partial rock cores generated by sonic drilling activities.

2.3.1.1 Coring and Drilling Observation Findings

Prior to the RI, the basalt bedrock at the site had previously been logged based upon cuttings and drilling behavior. The coring activity provided more detailed geologic characterization than had been previously documented. For example, some zones historically logged based on cuttings as gravel or ash, actually represent basalt bedrock zones with coarser gravel cuttings representing more fractured and permeable zones and finer cuttings representing harder and less permeable basalt. The core logs and the Intera (2015) core log notes are provided in Volume 5, Appendix D-4 and lithologic logs and well construction diagrams are included in Volume 5, Appendix D-1.

There appear to be three basalt flows represented in the RI cores and well borings that comprise the basalt aquifer system at the site. In general, the more fractured and permeable zones represent flow tops and overlying flow bottoms that are about 10-20 ft thick. The basalt flow interiors consist of dense, moderately fractured, columnar basalt of low permeability.

Evidence of tectonic fracturing was observed in the RI-MW1 and RI-MW2 cores, but not in the RI-MW3 cores. The tectonic fracturing in the vicinity of the RI-MW1 and RI-MW2, suggests the presence of a fault(s) in the vicinity. It had been previously hypothesized that there may be additional northwest-southeast trending faults present at the site in addition to the mapped fault at the western end of the Boat Basin. The evidence of faulting in cores corroborates the presence of north-south trending faults including: 1) at the eastern end of the site near the East SPL Storage Area and extending down the gully of the NPDES ponds, and 2) near the stormwater pond and extending southward toward Spring 01 (refer to Figure P-1). Other lines of evidence include: 1) the presence of other mapped northwest-southeast trending strike-slip faults at the site and the surrounding area, 2) the presence of north-south trending gullies and associated springs in the site vicinity, and 3) groundwater and spring chemical results. However, these findings are uncertain because of the lack of clear vertical displacement or other evidence of faulting observed at site outcrops.

In the RI-MW1 core, evidence of tectonic fracturing was observed between 47.3 ft bgs and 153.5 ft bgs and included shatter breccias, potential slickensides, and multiple parting planes in some intervals (Intera 2015). No evidence of displacement was noted in the RI-MW1 core.

In the RI-MW2 core, tectonic fracturing was also noted. A well-developed tectonic gouge zone was present between approximately 158 to 159 ft bgs and based on comparison to the MW-1 core the maximum apparent vertical offset is potentially on the order of 10 to 20 ft (Intera 2015). Also, during abandonment of the MW-2 core hole, it took an anomalously large amount of benzonite grout slurry to backfill the interval at around 140 ft bgs. indicating a highly fractured zone at this depth, for which there was no recovery in the core.

In comparison, the RI-MW3 core was largely intact with comparatively fewer fractures. Photographs of all the core intervals are available upon request and the rock cores are in storage at the site.

2.3.1.2 Geologic Reconnaissance Findings

This section summarizes the findings based on the geologic reconnaissance performed during November 2015 and supplemented by other site reconnaissance efforts, including investigation of the Wetlands AOC during April 2016, quarterly groundwater sampling activities, and the drilling of RI-MW20-BAL during November 2016. The November 2015 site visit summary report (Intera 2015) is provided in Volume 5, Appendix D-4.

<u>Outcrop Observations</u>

Basalt outcrops east of the East SPL Storage Building that were observed during RI field reconnaissance are characterized by a complex interflow structure and heterogenous appearance: some zones were highly weathered to glass and clay, some zones were vesicular, and others consisted of dense, non-vesicular basalt. Some basalt zones were observed to have a dip in outcrop, but the apparent dip was not consistent at a given outcrop or between outcrops. At some locations, potential volcanic bombs in a clay matrix were found. These outcrops were interpreted to represent vesicular flow-top breccia that was produced by lava fountaining at the flow's vent and was subsequently rafted away and eventually emplaced (Intera 2015; Reidel and Tolan 2013; Tolan et al. 2009). During and after emplacement the flow-top breccia was intruded by still molten lava forming the complex interflow structure observed in outcrop.

The basalt flows observed in outcrop are part of the Sentinel Bluffs Member of the Grande Ronde Basalt Formation (Intera 2015; Reidel 2005). The Sentinel Bluffs Member represent the topmost (youngest) member of the Grand Ronde Basalts. More specifically, the outcrops observed at the plant area appear to represent the Basalt of Museum, which represent the youngest designated unit within the Sentinel Bluffs Member (Intera 2015). Based on texture and flow appearance, the basalt flows at the base of the site section near the NPDES ponds may potentially represent the lowest portion of the Basalt of Museum, which is termed the Rocky Coulee basalt. These sub-member designations are tentative, since they are in part based on basalt flow chemical composition that has not been determined at this locality.

No evidence of faulting or vertical displacement was observed in outcrop and it's been hypothesized that the fault zones were eroded by the Missoula floods with gullies marking the fault zones in the area. This hypothesis is supported by the mapping of the fault that trends up the gully that leads from the west end of the Boat Basin and the evidence of tectonic fracturing in rock cores that align with other gullies and springs at the site.

The Sentinel Bluffs unit designation is consistent with the presence of silicified wood fragments occurring as “float” within the colluvium and/or alluvium overlying the basalts and located near the Drum Storage Area in the western portion of the site. These silicified fragments are likely to have been locally derived from a sedimentary interbed that correlates with the basal Vantage Horizon Member of the overlying Wanapum Basalt Formation.

Localized gravel and sand deposits were observed by the field team along the Columbia River shoreline and in the lower portion of gullies that drain from the site to the Columbia River. These sediments contain granitic clasts and appear to represent Missoula Flood Deposits. The deposits mantle the basalt bedrock and range up to maximum thickness of about 20 ft. These deposits may locally perch shallow groundwater, but no springs or seepage were observed along the Columbia River shoreline.

Occurrence of Springs

The occurrence of springs is relevant to the site hydrogeologic conceptual model. Three perennial springs that appear to drain from the basalt aquifer system were assessed or discovered during the course of the RI and are described below.

A spring that emanated from the basalt bedrock south of John Day Dam Road and the stormwater pond was found during the November 2015 geologic reconnaissance effort. The spring appears to be perennial and was added to the groundwater sampling program (identified as Spring 01, and informally named Rattlesnake Spring by the field teams). The spring is at a similar elevation and interconnected with the BAU aquifer zone. Water was observed to flow in two narrow channels (rills) within the Wetland K area (refer to Figure 2-1). The amount of discharge in each of the channels was estimated to be up to around 1 to 2 gpm at the time of inspection. The surface drainage did not extend downstream of Wetland K and no springs or seepage was found along the Columbia River in this area. This spring was previously documented and sampled [Plateau Geoscience Group, LLC (PGG) 2013a], although at the time of the investigation, it was not known the spring drained from the basalts and that it is perennial. This spring is further discussed in the Wetlands AOC in Section 3 of this report.

A perennial spring was also found south of well RI-MW20-BAL at the top of basalt cliffs near the former Cliffs community during installation of nearby well RI-MW20-BAL during November of 2016. Figure 2-8 shows the lines of cross-section (as discussed in the following section) and includes the locations of the springs that appear to discharge from basalt bedrock. A shallow-dug well and associated drainpipe is also located at the spring location. The spring currently appears to be used for livestock watering. The spring appears to be recharged from a shallow interval within the basalts that appears to correlate in elevation with the BAU zone. However, this water-bearing zone was not present at well RI-MW20-BAL, which was originally planned as a BAU-zone well. The reason for the absence of this water-bearing zone at the RI-MW20 BAL location is unclear. It appears that the impermeable flow interior is particularly thick at the RI-MW20-BAL location, and the nearby spring is an area where a more permeable zone is present, such as a fault or fracture system. This spring was not included in the initial RI sampling program because its large distance from the site (about one mile southwest of the WSI). The spring was subsequently sampled as part of the WPA sampling program.

A third perennial spring was observed in Wetland F and is located near the head of the gulley that drains to the western end of the Boat Basin (refer to Figure 2-8). Water emanating from this spring travels in a channel for a short distance and then seeps into the unconsolidated soils. Based on reconnaissance of the gulley, no additional springs or seepage was observed in the gully south of John Day Dam Road and upstream of the Boat Basin. This spring was previously documented and sampled (PGG 2013a), though at that time it was not known that the spring drained from the basalts and that it is perennial. These springs are further discussed in the Wetlands AOC in Section 3 of this volume.

Two springs were also found that drained from the UA aquifer zone:

- A modified spring is present at the southwestern margin of Wetland D, which discharges from the UA Zone into a small pond, and then flows westward through a roadway culvert that pools in an open area to the west where it infiltrates into the ground. This modified spring appears to be perennial and used for cattle watering. It is further described in the Wetlands AOC, Section 3 of this volume.

- A seasonal seep/spring was found in the North of the East Surface Impoundment (NESI) wetland. This spring was sampled as part of the RI and the results are included in the groundwater data summary tables and figures for comparison purposes. The wetland spring drains to the west and infiltrates into the ground east of John Day Dam road. The NESI wetland is further discussed in the Smelter Sign Area (SWMU 31) investigation summary in Volume 2, Section 31 of the RI report.

Legend

- Production Well
- Unconsolidated Aquifer Well (UA)

Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone

Lower Basalt Aquifer Well (BAL)

- BAL_1 - Shallower Water-bearing Zone
- BAL_2 - Deeper Water-bearing Zone
- BAL_3 - Deepest Water-bearing Zone

A A' Cross-Section

Spring

N
W E
S

0 500 1,000 2,000
Feet

1:15,000 1 inch = 1,250 feet

Figure 2-8
Lines of Cross-Section

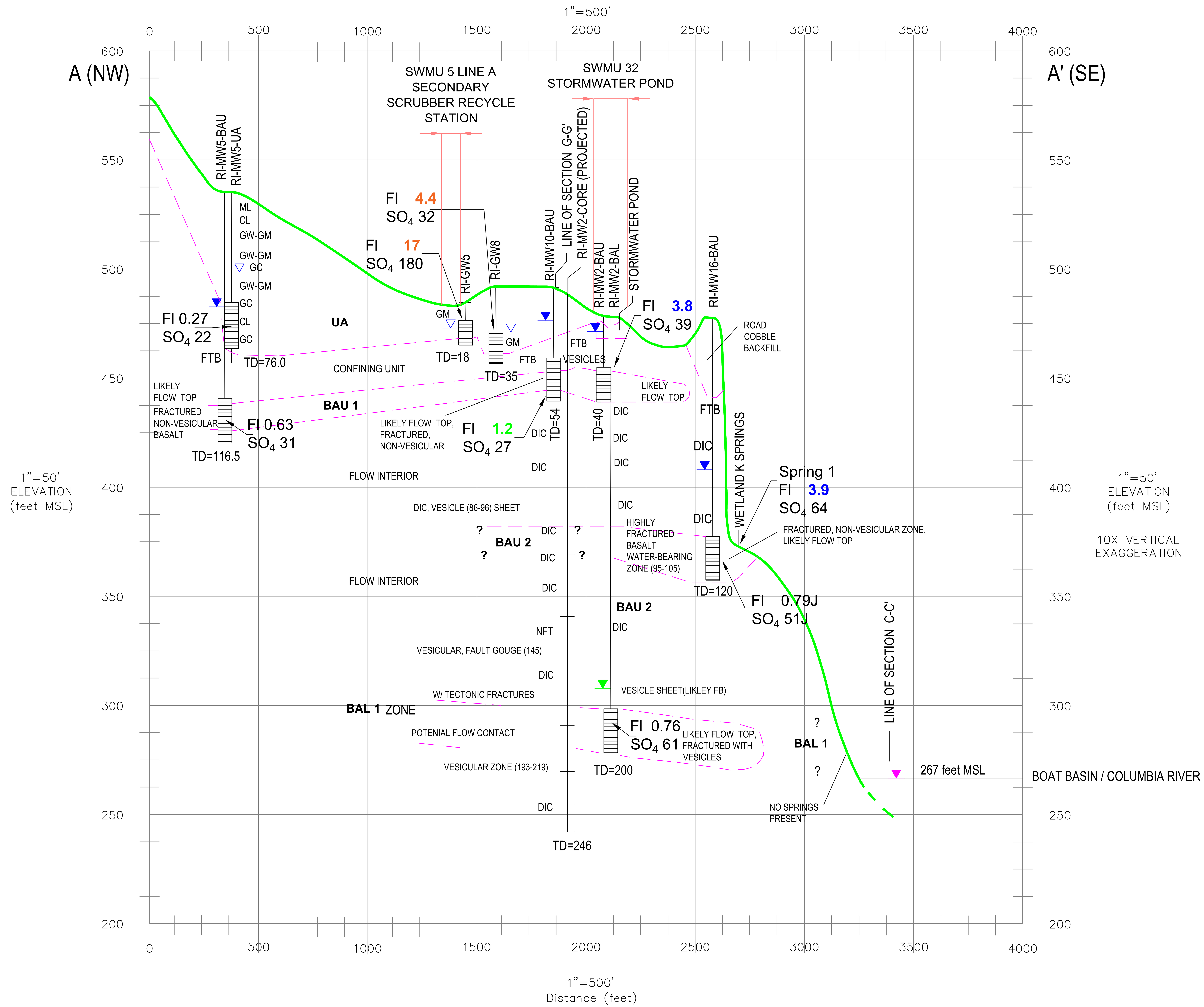
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

2.3.1.3 Cross-Sections

The RI drilling program has provided substantially more information regarding the geology and hydrostratigraphy, particularly for the basalt bedrock aquifer system in the area of the main plant and in outlying areas near the Columbia River where few borings had been previously drilled. The geology and hydrostratigraphy of the site are presented in a series of RI cross-sections. Figure 2-8 shows the lines of cross-section, and the seven cross-sections are shown in Figures 2-9 through 2-15. The cross-sections have been updated to include wells installed during the WPA along the lines of section as appropriate. Detailed cross-section of the underground line and soil borings as investigated during the WPA are presented and summarized in Volume 3, Section 2.5. The cross-sections include fluoride and sulfate results from the first quarter (Q1) of the RI sampling program. In addition, fluoride and sulfate concentrations for wells constructed during the WPA and the WPA spring sampling are included for locations on the lines of cross-section.

The lines of section shown in Figure 2-8 were selected to provide geologic and hydrogeologic interpretations across the entire site. Five of the lines of cross-section were selected to be generally parallel to groundwater flow (Sections A-A', B-B', D-D', E-E' and F-F'), and also show the relationship between water-bearing zones and the Columbia River. Two lines of cross-section were prepared perpendicular to groundwater flow including: 1) line of cross-section C-C' that shows the geology and hydrogeology along the Columbia River shoreline, and 2) line of cross-section G-G' that shows geology and hydrogeology along the central portion of the site and includes several SWMUs and other features of interest.

The cross-sections were developed to: 1) show the thickness, occurrence and water-level elevations for the UA aquifer zone, 2) show the hydraulic relationship between the UA and underlying BAU aquifer zone, 3) determine whether individual basalt flow tops could be identified and correlated across the site because they represent the main water-bearing zones within the basalt aquifer system, 4) correlate water-bearing zones and characterize and evaluate the water-level elevations for specific aquifer zones across the site, 5) compare water-level elevations for specific aquifer zones to the Columbia River and other water features such as springs and the stormwater pond, 6) show the locations and thickness of impermeable basalt flow interiors across the site, and 7) show hydrogeology in the vicinity of mapped and suspected faults and fracture zones.



Abbreviations for cross-sections:

Aquifer Zones

UA Unconsolidated Aquifer
BAU Basalt Aquifer Upper
BAL Basalt Aquifer Lower

Rock Cores

DIC Dense Interior Columnar
FB Flow Bottom
FTB Flow-top breccia
IVZ Internal vesicular zone
NFT Normal Flow Top
Wx Weathered

Unified Soil Classification System

CL Clay
ML Silt
GC Clayey Gravel
GM Silty Gravel
GP Poorly Graded Gravel
GW Well Graded Gravel
SC Clayey Sand
SM Silty Sand
SP Poorly graded Sand
SW Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level
Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI 4.5 Exceeds MCL of 4.0 mg/L
FI 3.0 Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI 1.2 Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4 300 Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

25 0 25 50 (Vertical feet)
250 0 250 500 (Horizontal feet)

Figure 2-9
Cross-Section A (NW) - A' (SE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

25 0 25 50 (Vertical feet)

250 0 250 500 (Horizontal feet)

Figure 2-10
Cross-Section B (N) - B'(S)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
FTB	Flow-top breccia
IVZ	Internal vesicular zone
NFT	Normal Flow Top
Wx	Weathered

Unified Soil Classification System

CL	Clay
ML	Silt
GC	Clayey Gravel
GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

50 0 50 100 (Vertical feet)

500 0 500 1000 (Horizontal feet)

Figure 2-11
Cross-Section C (SW) - C' (NE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

25 0 25 50 (Vertical feet)

250 0 250 500 (Horizontal feet)

Figure 2-12
Cross-Section D (NW) - D'(SE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

FI	4.5	Exceeds MCL of 4.0 mg/L
FI	3.0	Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI	1.2	Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4	300	Exceeds Secondary MCL of 250 mg/L

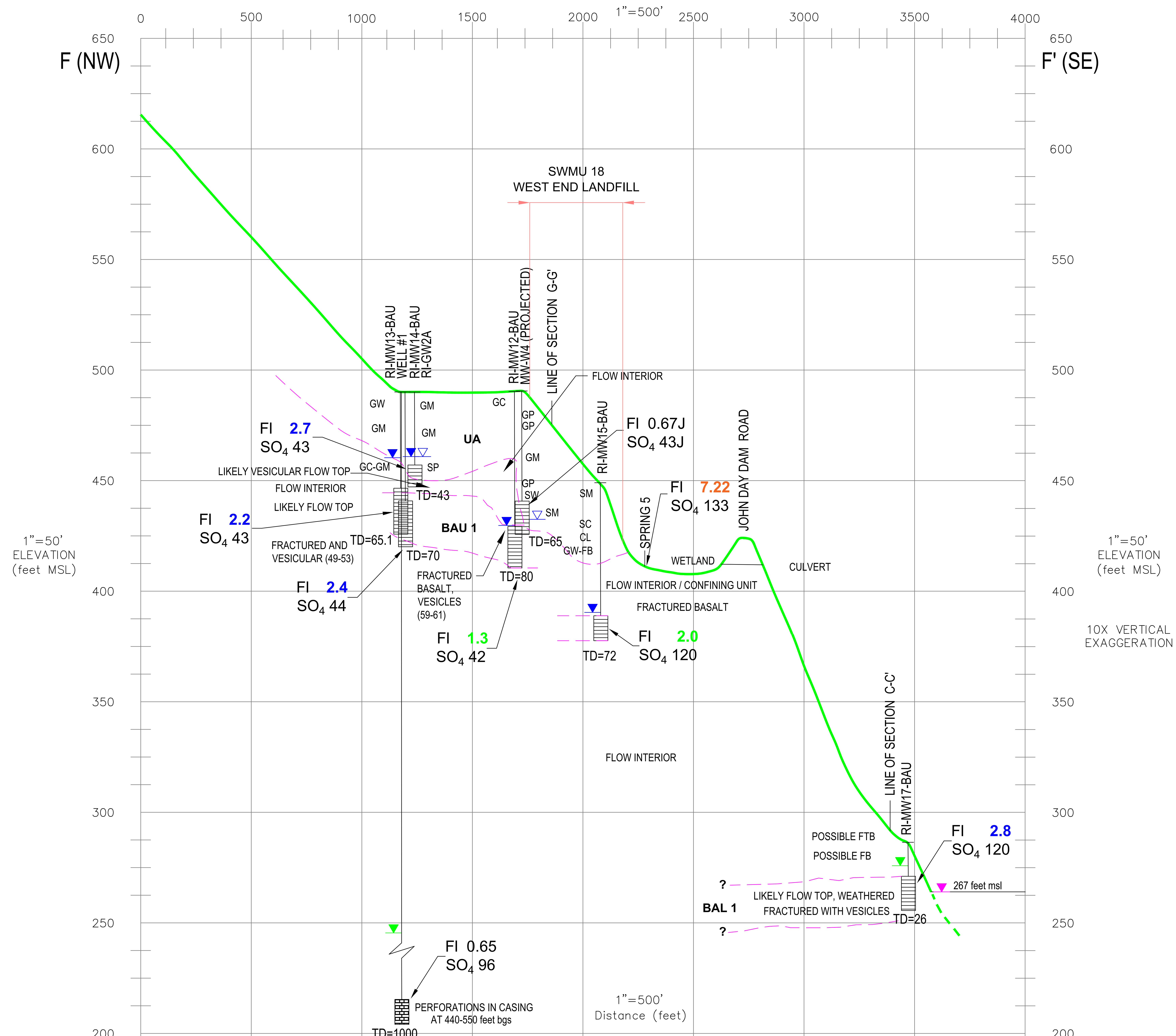
FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

25 0 25 50
(Vertical feet)

250 0 250 500
(Horizontal feet)

Figure 2-13
Cross-Section E (NW) - E'(SE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Abbreviations for cross-sections:

Aquifer Zones

UA Unconsolidated Aquifer
BAU Basalt Aquifer Upper
BAL Basalt Aquifer Lower

Rock Cores

DIC Dense Interior Columnar
FB Flow Bottom
FTB Flow-top breccia
IVZ Internal vesicular zone
NFT Normal Flow Top
Wx Weathered

Unified Soil Classification System

CL Clay
ML Silt
GC Clayey Gravel
GM Silty Gravel
GP Poorly Graded Gravel
GW Well Graded Gravel
SC Clayey Sand
SM Silty Sand
SP Poorly graded Sand
SW Well graded sand

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level

Well Screen interval

Legend

- Surface Water-Level Elevation, During Baseline Round
- UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
- Lithologic Contact

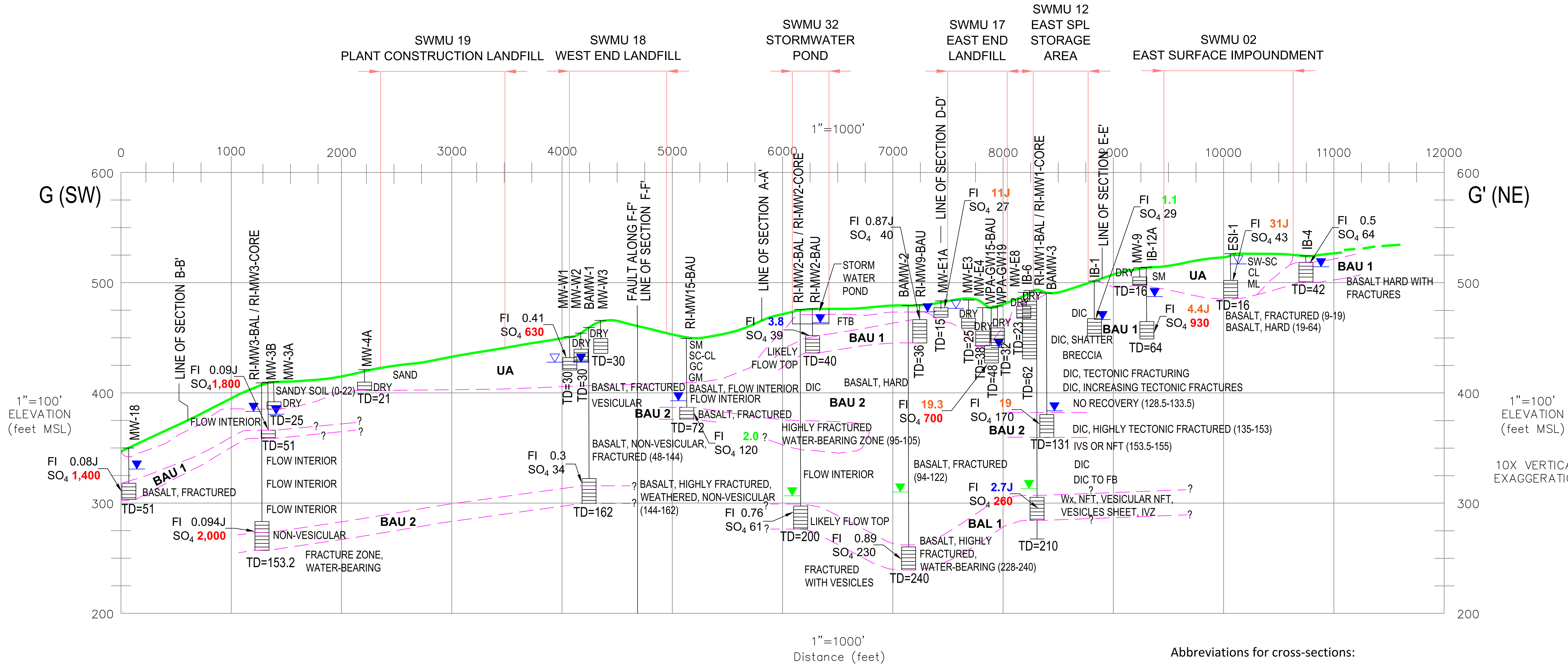
FI 4.5 Exceeds MCL of 4.0 mg/L
FI 3.0 Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI 1.2 Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4 300 Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

25 0 25 50 (Vertical feet)
250 0 250 500 (Horizontal feet)

Figure 2-14
Cross-Section F (NW) - F'(SE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Abbreviations for cross-sections:

Aquifer Zones

UA	Unconsolidated Aquifer
BAU	Basalt Aquifer Upper
BAL	Basalt Aquifer Lower

Rock Cores

DIC	Dense Interior Columnar
FB	Flow Bottom
FTB	Flow-top breccia
IVZ	Internal vesicular zone
NFT	Normal Flow Top
Wx	Weathered

Unified Soil Classification System

CL	Clay
ML	Silt
GC	Clayey Gravel
GM	Silty Gravel
GP	Poorly Graded Gravel
GW	Well Graded Gravel
SC	Clayey Sand
SM	Silty Sand
SP	Poorly graded Sand
SW	Well graded sand

ESI - East Surface Impoundment
WELF - West End Landfill

TD - Total Depth (feet bgs)
bgs - Below Ground Surface
msl - Mean Sea Level
Well Screen interval

Legend

Surface Water-Level Elevation, During Baseline Round
UA Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
BAU Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
BAL Water-Level Elevation, Static Water Level Elevation During Baseline Sampling Round (winter 2017)
Lithologic Contact

FI 4.5 Exceeds MCL of 4.0 mg/L
FI 3.0 Exceeds MTCA Method C Screening Level of 2.1 mg/L
FI 1.2 Exceeds MTCA Method B Screening Level of 0.96 mg/L
SO_4 300 Exceeds Secondary MCL of 250 mg/L

FI and SO_4 concentration data is from the Q1 (Winter 2017) round of RI sampling for all locations where RI data is available or from the WPA Sampling Events in December 2020 and April 2021.

50 0 50 100 (Vertical feet)
500 0 500 1000 (Horizontal feet)

Figure 2-15
Cross-Section G (SW) - G' (NE)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Several different types of available information have been incorporated into the cross-sections, including both historical and RI-specific well boring and core logs. For unconsolidated materials the Unified Soil Classification System (USCS) symbols were used and are explained in the individual cross-sections. Basalt-specific flow terminology from the rock cores was also included in the cross-sections and explained accordingly. For historical borings, the lithologic descriptions included in the original logs were used. Different water-level elevation symbols were used for each of the main aquifer zones and surface water to help distinguish between them.

The main basalt aquifer zones (BAU and BAL) have been subdivided on the cross-sections to support correlation of specific water-bearing zones across the site. For example, the BAU aquifer zone has been divided into two water-bearing zones, including $BAU_{1,}$ which represents the shallower zone and BAU_2, which represents the deeper BAU water-bearing zone. The BAU_1 zone appears to generally represent a vesicular flow top, while the deeper BAU_2 zone appears to generally represent a fracture zone(s) that is locally developed within the underlying flow interior. Note that the water-level elevation in these two zones are relatively similar, but with a downward gradient between zones. Relatively impermeable flow interiors separate the BAU1 and BAU2 zones that tend to limit interconnection between the subzones. The BAL aquifer zone has been subdivided into the BAL_1, BAL_2, and BAL_3 water-bearing zones. These zones appear to all represent flow tops that are separated by low-permeability flow interiors.

The site hydrostratigraphy remains conceptually similar to that previously described in the Final RI Phase 1 and Phase 2 Work Plans (Tetra Tech et al. 2015a,b). Refined description of the hydrostratigraphic zones based on drilling observations and cross-sections are summarized by aquifer zone in the following subsections. Major geologic and hydrostratigraphic findings that can be seen in the cross-sections are summarized in the following sections.

UA Zone

The UA zone is limited to those areas where surficial deposits and fill occur. In areas where basalt outcrops occur close to the ground surface, the UA zone is not present. The lithology of the UA zone commonly consists of clayey gravel (GC) or silty gravel (GM) with cobbles in areas around the former smelter plant. These materials commonly represent fill emplaced as part of the plant foundation or colluvium. At a few locations, a thin sand (SP) layer found near the basalt contact represents the UA water-bearing zone. In areas west of the main plant, the UA zone typically consists of silty sand (SP) and poorly graded sand (SM).

Confined conditions were observed based on the water-level changes during and following drilling, particularly UA wells on the north side of the site at the base of the colluvial apron leading down from the ridge line (e.g., wells RI-MW4-UA, RI-MW5UA, RI-GW7) or within the weathered, basalt flow top contact zone between the basalt and overlying surficial materials (e.g., wells RI-GW2A, RI-GW9). At these locations, water-level elevations rose significantly after the well was constructed. The lithologic interval above the water-bearing zone was dry to moist during drilling and the soils overlying the water-bearing zone typically included intervals of clay that may serve as the confining unit.

The saturated thickness of the UA zone is generally thin and ranges from about 2-10 ft. About 11 of the pre-existing monitoring wells completed in the UA are seasonally and/or consistently dry.

BAU Zone

The BAU zone appears to be interconnected with the uppermost UA zone and is characterized by generally similar water-levels as UA zone. In areas where there are no unconsolidated materials, the BAU represents the uppermost aquifer zone at the site. In general, the thickness of the BAU water-bearing zone is around 15 ft bgs. Confined conditions were observed during drilling of some wells including: BAMW-3 and RI-MW3-BAL (which was reassigned to the BAU zone based on water-level elevations and water-bearing zone elevations after initial field work was completed).

In some areas, more than one water-bearing zone makes up the BAU zone (BAU_1 and BAU_2). At locations where more than one water-bearing zone with the BAU occurs, the hydraulic degree of interconnection between the BAU_1 and BAU_2 zone appears variable. However, a low-permeability flow interior separates BAU zone from the underlying BAL-zone and the water-level elevations between the zones are significantly different.

Examples of well clusters with more than one BAU- water-bearing zones include the following:

- **MW-3B/RI-MW3-BAL (Figure 2-10, Cross-Section B-B').** Well RI-MW3-BAL is screened in a significantly deeper water-bearing zone than MW-3B; however, the water-level at the two wells are similar due to confined conditions observed at RI-MW3-BAL. A dense flow interior was noted in the lithologic interval between RI-

MW3B and RI-MW3-BAL. RI-MW3-BAL appears to be completed in a fractured basalt (as opposed to a laterally extensive flow top, which typically form the main basalt water-bearing zones at the site). Based on the similarity in water-levels, this water-bearing fracture system appears to be interconnected with the shallower BAU_1 zone at this location. The water bearing zone at RI-MW3-BAL is at similar elevation to BAMW-3 and the wells have a similar confined water-level elevation pattern, which suggest that this deeper BAU_2 zone may be correlated and continuous in the western portion of the site.

- **RI-MW2-BAU, RI-MW2-BAL, RI-MW16-BAU, and Spring 01 (Figure 2-9, Cross-Section A-A').** A complete groundwater flow path appears to exist between the stormwater pond and Spring 01. This flow path may be located along the alignment of a north-south trending fault zone in this area. Evidence of faulting and tectonic fracturing was noted in the RI-MW2 core. In the vicinity of the stormwater pond a second (deeper) highly conductive water-bearing zone (this zone produced about 70 gpm during air-rotary drilling operations) and was encountered during drilling of the boring for RI-MW2-BAL at a depth of 95-105 ft bgs. Although a well was not completed in this interval, water-levels observed in the boring during drilling suggest that the zone was characterized by water-level elevations a few feet lower than in nearby RI-MW2-BAU. The elevation of this water-bearing zone is similar to well RI-MW16-BAU and Spring 01.

- **IB-2/IB-2A (Figure 2-13, Cross-Section E-E').** Well IB-2A is completed in the top of the BAU zone, while IB-2 is deeper. There is a downward vertical gradient between the wells. Well IB-2 is characterized by low hydraulic conductivity based on the large amount of drawdown observed during low-flow sampling and slug test findings.

- **Wells IB-5, IB-5A, IB-5AA (not shown in Cross-sections).** Well IB-5 was characterized by low hydraulic conductivity based on the slug test results. Also, well IB-5A did not exhibit recovery during the slug tests and was quick to drawdown and slow to recover during groundwater sampling, which suggest very low permeability. Water-level elevations at these three wells are significantly different with head differences between sequentially deeper wells in the cluster of 23.65 and 37.32 ft (refer to Section 2.3.2 below) and exhibit a large downward vertical gradient with depth. The head differences and vertical gradients suggest limited connection between water-bearing zones at this location. Water-levels in these wells are significantly higher in elevation than BAL-zone wells.

BAL Zone

The BAL zone is defined by water-level elevations within about 40 ft of the Columbia River surface elevation. The BAL zone appears to occur within a series of vesicular and fractured flow tops.

Based on review of lithology, coring results and water-level elevation information, the BAL aquifer zone appears to consist of two or three water-bearing zones that may be interconnected. These are summarized by depth sequence as follows:

- **Wells RI-MW1-BAL, RI-MW2-BAL, BAMW-2, BAMW-4, and RI-MW17-BAL (Figures 2-9 and 2-12).** These wells represent the shallow BAL_1 zone, in which the water-bearing zone occurs above or slightly below the Lake Umatilla Pool elevation.
- **Wells IB-8, IB-13, IB-13A, RI-MW18-BAL, and RI MW-19-BAL (Figures 2-11 and 2-12).** These wells represent the deeper BAL zone (BAL_2) in which the water-bearing zone is encountered at up to 40 ft below the Lake Umatilla Pool elevation. Confined conditions occur with water-level elevations rising to within a few feet of the elevation of the Columbia River during drilling.
- **Well RI-MW20-BAL (Figures 2-12).** This well is screened in a flow top at a significantly lower elevation (about 100 ft) than the BAL_2 zone and for this reason has been designated as the BAL_3 zone. Water-level elevations in this well are within a few feet of the Columbia River tail-out elevation downstream of John Day Dam. It is unclear whether the RI-MW20-BAL water-bearing zone represents the same stratigraphic zone as the BAL_2 zone wells that has been displaced through faulting, or if it represents a distinct zone, separate from the other BAL Zones.

2.3.2 Groundwater Gradients

Comprehensive rounds of groundwater measurements were collected during each round of quarterly groundwater sampling consistent with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Water-level elevations for the quarterly monitoring well gauging program are summarized in Table 2-4. Water-levels were measured during each sampling round. Water-level elevation trends for each aquifer zone and area of the site are presented in Volume 5, Appendix D-13 and summarized in Section 2.3.2.4.

Figures 2-16, 2-17, and 2-18 show water-level elevations for the UA, BAU, and BAL aquifer zones, respectively, during the baseline (winter 2017, Q1) groundwater sampling round. Seasonal fluctuation of groundwater elevations does not significantly affect the groundwater elevation contours as discussed in Section 2.3.2.4. For this reason, data from the baseline (winter 2017, Q1) sampling round was selected for the water-level elevation contour maps and the calculations of gradients in following subsections. Additional wells were installed in the plant area footprint during fall 2020 and water-level elevations were collected as part of the WPA investigation and the water-level elevation results for the WPA sampling program are presented in Section 2.4.

Table 2-4
Groundwater AOC - Static Water Level Elevations
RI Quarterly Groundwater Monitoring Program
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Well Identification	Aquifer Zone Designation	Baseline Round (Q1) January-February 2017 Static Water Level Elev (feet MSL)	Spring Quarter (Q2) May 2017 Static Water Level Elev (feet MSL)	Summer Quarter (Q3) August 2017 Static Water Level Elev (feet MSL)	Fall Quarter (Q4) November 2017 Static Water Level Elev (feet MSL)
ESI-1	UA	520.19	518.27	515.67	514.16
IB-1	BAU	488.03	488.79	485.44	480.97
IB-2	BAU	514.12	494.19	492.37	479.51
IB-2A	BAU	515.86	515.31	510.51	511.96
IB-3	BAU	529.41	530.39	525.75	524.80
IB-4	BAU	515.59	517.31	515.22	514.58
IB-5	BAU	497.78	496.88	495.29	494.62
IB-5A	BAU	436.61	437.14	431.92	429.22
IB-5AA	BAU	460.15	452.94	446.59	445.29
IB-6	BAU	DRY	DRY	DRY	DRY
IB-7	BAU	DRY	DRY	DRY	DRY
IB-8	BAL	269.06	269.00	267.82	267.70
IB-9	UA	503.50	506.45	505.35	501.36
IB-10	BAU	510.39	513.71	511.74	510.80
IB-11	BAU	513.87	515.58	513.30	512.26
IB-12A	BAU	479.04	489.82	478.74	468.35
IB-13	BAL	267.15	266.67	266.42	268.08
IB-13A	BAL	267.22	266.66	266.46	268.13
MW-1	BAU	533.68	534.11	531.35	531.27
MW-8	UA	518.08	517.68	513.92	514.26
MW-9	UA	DRY	DRY	DRY	DRY
MW-10	UA	514.48	513.77	508.40	506.96
MW-2A	UA	451.99	451.81	452.30	452.92
MW-2B	BAU	429.68	429.54	428.47	428.63
MW-3A	UA	388.89	389.01	389.30	389.23
MW-3B	BAU	380.33	380.27	381.44	381.38
MW-4A	UA	DRY	409.29	409.09	DRY
MW-6B	UA	430.64	431.76	431.10	432.06
MW-7B	BAU	374.77	376.79	375.37	375.50
MW-8A	UA	467.39	467.38	467.36	467.42
MW-9A	UA	DRY	DRY	DRY	DRY
MW-10A	UA	409.30	410.36	409.79	409.63
MW-11A	UA	431.11	431.15	431.16	431.14
MW-12A	UA	393.05	394.82	394.27	394.32
MW-13A	UA	DRY	DRY	401.63	401.25
MW-14A	UA	416.17	417.57	415.63	416.05
MW-15A	UA	420.06	421.15	419.11	419.76
MW-18	BAU	331.21	330.08	329.09	328.88
MW-16A	UA	435.29	436.38	436.43	436.41
MW-17A	UA	440.71	441.50	441.51	441.14
MW-E1A	UA	474.66	475.51	472.49	472.27
MW-E3	UA	461.77	464.90	461.77	DRY
MW-E4	UA	441.30	442.99	441.43	DRY
MW-E7	UA	478.54	481.99	479.34	478.77
MW-E8	UA	468.71	DRY	DRY	DRY
MW-W1	UA	429.88	435.57	430.21	429.23
MW-W2	UA	430.53	436.81	431.58	DRY
MW-W3	UA	DRY	444.08	DRY	DRY
MW-W4	UA	433.44	440.37	435.01	433.07
BAMW-1	BAU	433.91	438.45	433.61	432.13
BAMW-2	BAL	310.63	311.17	311.73	311.63
BAMW-3	BAU	383.73	416.20	408.80	403.35
BAMW-4	BAL	278.45	281.40	278.81	278.27

Table 2-4
Groundwater AOC - Static Water Level Elevations
RI Quarterly Groundwater Monitoring Program
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Well Identification	Aquifer Zone Designation	Baseline Round (Q1) January-February 2017	Spring Quarter (Q2) May 2017	Summer Quarter (Q3) August 2017	Fall Quarter (Q4) November 2017
		Static Water Level Elev (feet MSL)	Static Water Level Elev (feet MSL)	Static Water Level Elev (feet MSL)	Static Water Level Elev (feet MSL)
RI-GW1	UA	410.95	414.72	409.91	410.65
RI-GW2A	UA	461.40	464.70	461.10	460.16
RI-GW4A	UA	470.31	471.58	470.30	470.85
RI-GW5	UA	472.80	473.18	472.64	472.89
RI-GW6	UA	477.13	477.48	DRY	472.99
RI-GW7	UA	490.40	488.56	483.56	489.54
RI-GW8	UA	470.44	471.20	470.60	471.20
RI-GW9	UA	470.39	471.64	470.62	471.18
RI-MW1-BAL	BAL	310.05	311.13	311.63	311.36
RI-MW2-BAU	BAU	471.38	470.46	472.17	472.17
RI-MW2-BAL	BAL	306.74	307.54	307.50	307.16
RI-MW3-BAL	BAU	383.90	374.83	374.30	374.06
RI-MW4-UA	UA	492.53	491.83	491.17	491.03
RI-MW5-UA	UA	498.91	497.31	496.38	496.12
RI-MW5-BAU	BAU	482.25	481.22	479.69	479.38
RI-MW6-BAU	BAU	478.50	478.48	477.86	478.45
RI-MW7- BAU	BAU	475.34	476.10	474.58	474.66
RI-MW8-BAU	BAU	451.13	462.63	458.50	456.91
RI-MW9-BAU	BAU	474.88	474.51	472.45	472.58
RI-MW10-BAU	BAU	473.43	472.84	472.73	473.21
RI-MW11-BAU	BAU	470.24	470.94	470.08	470.74
RI-MW12-BAU	BAU	433.09	438.14	434.08	432.80
RI-MW13-BAU	BAU	461.31	463.86	460.72	460.21
RI-MW14-BAU	BAU	461.11	463.56	460.56	460.07
RI-MW15-BAU	BAU	392.26	392.36	390.65	392.37
RI-MW16-BAU	BAU	392.73	394.42	392.90	392.60
RI-MW17-BAL	BAL	277.09	278.09	276.92	277.13
RI-MW18-BAL	BAL	267.20	266.83	266.68	267.54
RI-MW19-BAL	BAL	267.02	266.64	266.63	267.23
RI-MW20 -BAL	BAL	165.77	168.78	165.12	164.29

Notes:

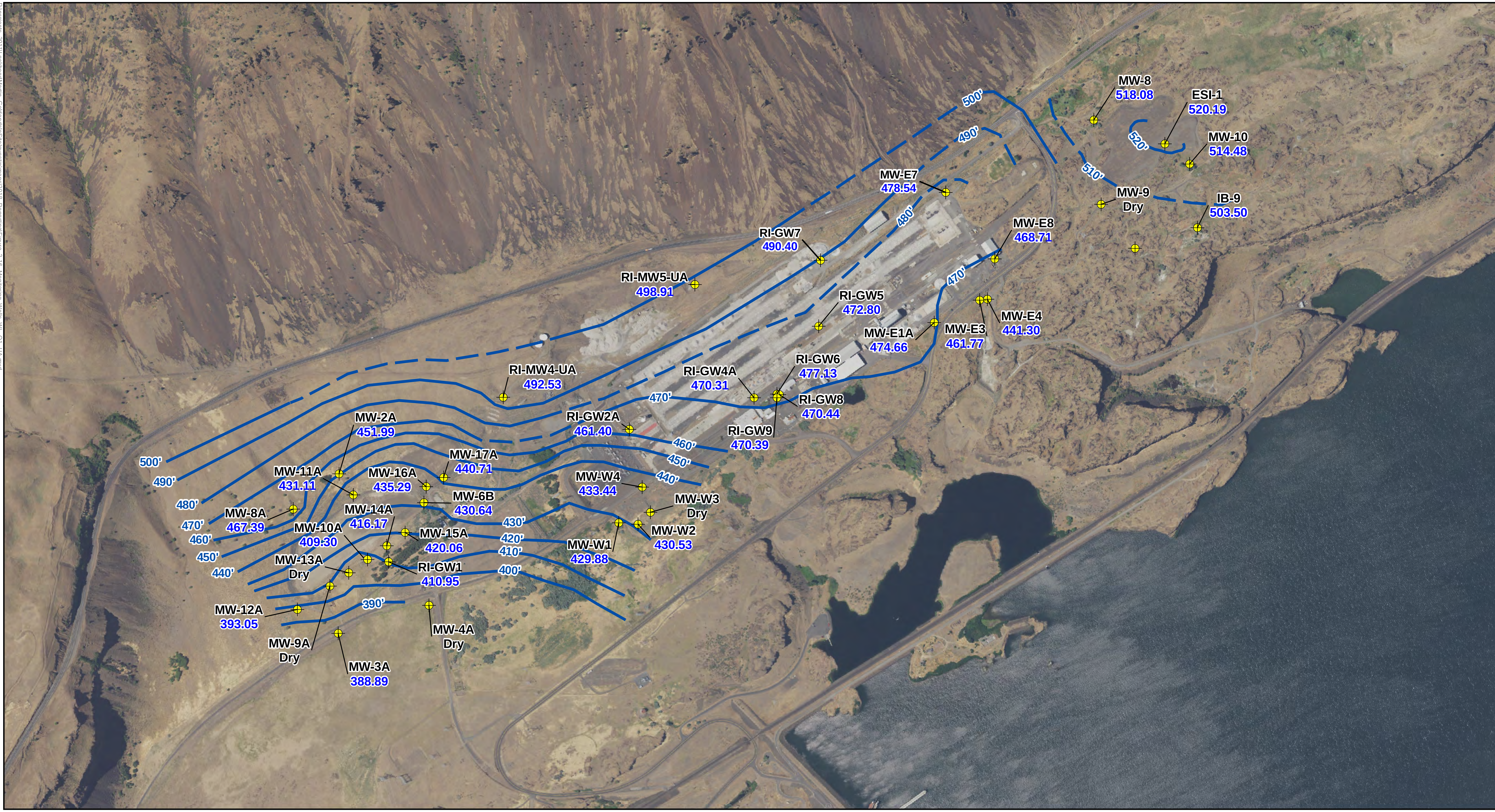
BAL = Basalt Aquifer-Lower

BAU = Basalt Aquifer-Upper

ESI = East Surface Impoundment

ft-MSL = Feet mean sea level

UA = Upper (Unconsolidated) Aquifer Zone



Legend

Unconsolidated Aquifer (UA) Well

388.89 Round 1 (Winter 2017) Static Water Level Elevation

300' 10' Water-Level Elevation Contour

N
W E
S

0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 2-16
Water-Level Elevations
Unconsolidated Aquifer Wells (UA)
Quarter 1 (Winter 2017)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Legend

Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone

331.21 Round 1 (Winter 2017) Water-Level Elevation

515' 30' Water-Level Elevation Contour

Spring

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-17
Water-Level Elevations
Uppermost Basalt Aquifer Wells (BAU)
Quarter 1 (Winter 2017)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Legend

Lower Basalt Aquifer Well (BAL)

- BAL_1 - Shallower Water-bearing Zone
- BAL_2 - Deeper Water-bearing Zone
- BAL_3 - Deepest Water-bearing Zone

165.77 Round 1 (Winter 2017) Water-Level Elevation

275' 10' Water-Level Elevation Contour BAL_1

265' 10' Water-Level Elevation Contour BAL_2

N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-18
Water-Level Elevations
Lower Basalt Aquifer (BAL) Wells
Quarter 1 (Winter 2017)

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

2.3.2.1 UA Zone Gradients

The horizontal gradient in the UA zone (where present) is generally to the west-southwest and the flow directions generally reflect site topography (refer to Figure 2-16). The UA zone is most extensive and thickest in areas of greatest accumulation of unconsolidated materials and in areas with depressions in the basalt bedrock surface.

The horizontal gradient across the site for the UA zone ranges between 0.003 foot/foot in the Plant Area and 0.053 foot/foot near the WSI (refer to Figure 2-17). An area of groundwater mounding in the UA zone is present in the central part of the plant area (refer to Section 2.4 of this volume). Overall, significantly flatter horizontal gradient is present in the vicinity of the former plant area and corresponding to the existing groundwater French drain system and scrubber effluent line piping systems. These systems collect and convey shallow groundwater to the stormwater pond and head of the NPDES Ponds. The flattening of the gradient in this area may be related to the collection systems as well as the modified flat topography of the plant area that was created during construction of the former aluminum smelter. The vertical gradient between the UA and BAU zone is downward and ranges between 0.016 foot/foot at WELF wells MW-W2/BAMW-1 and 0.413 foot/foot at WSI wells MW-2A/2B.

2.3.2.2 BAU Zone Gradients

The overall horizontal gradient in the BAU zone is generally to the west-southwest. This general direction is impacted by localized recharge and presence of plant drainage structures. Similar to the UA zone, the flow pattern generally reflects surface topography (refer to Figure 2-17) and is consistent with the UA and BAU aquifer zones being interconnected. The horizontal gradient for the BAU zone across the site ranges between 0.012-0.202 foot/foot, which is generally similar to the UA zone. An area of significantly flatter horizontal gradient is present in the BAU zone as well as in the UA zone in the vicinity of the former plant area and corresponding to the existing groundwater French drain system and scrubber effluent line piping systems. These systems collect and convey shallow groundwater to the stormwater pond and head of the NPDES Ponds. The flattening of the gradient in this area may be related to the groundwater collection and other piping systems as well as the flat topography of the plant area that was created during construction of the former aluminum smelter. Groundwater mounding is also present within the BAU zone in the central portion of the plant area and extending southward toward the stormwater pond (refer to Section 2.4 of this volume).

Among the steepest horizonal gradient for the BAU zone is between RI-MW8-BAU and BAMW-3, which is along the trend of the inferred fault zone at the east end of the plant. Based on the water-level elevation contour map, groundwater flow appears to converge on this feature, which is consistent with the presence of a more permeable pathway along this trend. A similar convergent pattern can be seen in the BAU zone along the strike-slip fault zone that extends down the Western Intermittent drainage near well RI-MW15-BAU and the Wetland F (Spring 05). A steep horizontal gradient within the BAU zone is also seen between the stormwater pond and the Wetland K spring near well RI-MW16-BAU.

The vertical gradient between the BAU zone and BAL zone is generally large and downward and ranges between 0.80-3.12 foot/foot. For areas where there is multiple water-bearing zones within the BAU, the gradient is generally downward and ranges from 0.19-0.78 foot/foot. For example, at the IB-5, IB-5AA, and IB-5A well cluster, the vertical gradient is strongly downward with head differences between sequentially deeper wells in the cluster of 23.65 and 37.32 ft (refer to Figure 2-17 and Volume 5, Appendix D-13). These older wells are characterized by low hydraulic conductivity and the deeper wells in the cluster (IB-5AA and IB-5A) appear to be completed in fracture systems that are isolated from one another. At the MW-3B/RI-MW3-BAL well pair, the vertical gradient was upward (-0.054 foot/foot) during the first quarter sampling event. This is due to the confined conditions at RI-MW3-BAL (refer to Figure 2-17).

2.3.2.3 BAL Zone Gradients

The horizontal gradient for the BAL zone appears is to be the southeast for the area east of the dam (refer to Figure 2-18). Horizontal gradient is influenced in part by water-levels elevations in RI-MW17-BAL, which has anomalously high water-level elevations for the BAL wells along the Columbia River. The overall horizontal gradient is 0.020 foot/foot for the BAL zone.

The RI-MW17-BAL water-bearing zone appears significantly higher in elevation than the water-bearing zone for wells RI-MW18-BAL and RI-MW19-BAL (refer to Figure 2-11, Cross-Section C-C’). It is most likely that the RI-MW17-BAL zone represents a shallower zone within the BAL than is observed in shoreline wells RI-MW18-BAL, RI-MW19-BAL, IB-13A, and IB-13.

Note that the horizontal gradient for the shallower BAL-zone wells is significantly steeper than the deeper BAL-zone wells located closer to the Columbia River. The horizontal gradient for the shallower BAL-zone wells is 0.060 foot/foot, in contrast with the deeper BAL-zone with a horizontal gradient of 0.001 foot/foot.

BAL-zone water-levels downstream (west) of the dam in well RI-MW20-BAL are about 100 ft lower in elevations than on the upstream side of the dam and appear to approximately correspond to Columbia River water-level elevations at the John Day Dam spillway (refer Figure 2-11). RI-MW-20 BAL water-level elevations were not contoured because of the large elevation difference and uncertain stratigraphic correlation between RI-MW20-BAL and the other BAL-zone well locations.

2.3.2.4 Seasonal Fluctuations

Seasonal fluctuations are observed in in the UA and BAU aquifer zones with the highest water-levels in the winter and/or spring and the lowest level in the fall (refer to Table 2-4). Recharge to the shallow UA and BAU zones is expected to occur primarily during the late fall (November) through early spring (April) that corresponds to the period of greatest precipitation and runoff. The amount of water level fluctuation for the UA zone is a median of 1.99 ft and a maximum of 10.52 ft. The amount of fluctuation for the BAU zone and is a median of 3.16 ft and a maximum of 32.47 ft. Due to the relatively large distances between wells and the relatively steep gradients, the fluctuations do not affect the water-elevation contour pattern for these zones (refer to Figures 2-16 and 2-17).

In the UA and BAU wells there were water-level fluctuations for individual wells greater than 10 ft. For the UA zone, well RI-GW7 fluctuated by 10.52 ft. Four wells completed in the BAU zone had water-level fluctuation greater than 10 ft including: IB-2 (34.61 ft), BAMW-3 (32.47 ft), IB-5AA (14.86 ft), and IB-12A (21.47 ft). Three of these wells (IB-2, IB-5AA and IB-12A) were characterized by low hydraulic conductivity during slug testing as well as significant draw down and slow recharge during low-flow groundwater sampling. The water-level elevation pattern at BAMW-3 was anomalous in that the lowest water-level elevation was observed during the winter sampling round, which is inconsistent with the water-level elevation pattern of the other BAU wells.

For the BAL zone, the water-level elevations do not fluctuate as much (less than 5-ft of fluctuation) with a median of 1.375 ft. Deeper BAL wells near the Columbia River showed an increase in water-levels during the fall (Q4) sampling event that generally coincides with an increase in the pool elevation of the Columbia River in the fall. Trends in water-levels for each aquifer zone for the four quarters of groundwater sampling are provided in Volume 5, Appendix D-13.

2.3.3 Packer Test Results

The results of the packer test analysis are summarized in Table 2-5. The packer test analyses are provided in Volume 5, Appendix D-6. The analysis of packer tests using the Theis (1935) solution for radial flow to a well consistently yielded the highest quality results for the zones tested. This is due to the solutions ability to utilize all data collected during the tests (injection through recovery), and to take into account data collected at observation wells some distance from the packer test wells.

The results generally show that the flow interiors are of low hydraulic conductivity (5.39E-4 – 75E-1 ft/day) and the water-bearing zones are of moderate hydraulic conductivity (1.1-1.97 ft/day). The packer test results include hydraulic conductivity values for the BAU zone and the BAL zone. For flow interiors, packer tests data was collected within low permeability zones between the BAU and BAL zones, and below the BAL zone.

The hydraulic conductivity of the BAU zone was characterized by the following packer tests (refer to Table 2-5):

- In the RW-MW1 core, the BAU zone is represented by packer test 9 (104.1–119.7 ft-bgs, 1.61 ft/day) that overlaps with the completion interval of nearby well BAMW-3. This permeable zone is separated by approximately 55 ft of rock from the deeper permeable zone [test 4 (110.8–128.5 ft bgs, 0.18 ft/day)] that overlaps with the screen interval for RI-MW3-BAL (deeper BAU_2 water-bearing zone with confined conditions).
- In the RI-MW2 core, a shallow permeable zone was characterized in the 13th test (36.1-47.8 ft bgs, 1.3 ft/day) that appears to correspond to the shallow BAU Zone at nearby wells RI-MW10-BAU and RI-MW2-BAU. The 14th test interval is also relatively permeable (71.3–84.2 ft bgs, 0.86 ft/day) is also relatively permeable and may correlate with the highly permeable basalt zone encountered in the boring for RI-MW2-BAL (95-105 ft bgs) and with the completion interval for RI-MW-16-BAU.
- A relatively permeable shallow zone was encountered in the second (45.3–53.5 ft bgs, 0.031 ft/day) and third (40.0–53.5 ft bgs, 1.1 ft/day) tests from the RI-MW3 core that corresponds to the shallow BAU zone at nearby well MW-3B (refer to Table 2-5).

Table 2-5
Groundwater AOC - Summary of Packer Test Results and Analyses
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

					Injection Data		Hydraulic Conductivity (ft/day)				
Test Well	Test Sequence	Test Interval (ft BGS)	Observation Well	Rock Type	Total Volume Injected (gal)	Time (mins)	Lugeon Analysis Method	Theim Steady State Analysis	Theis Analysis of Pumping and Recovery	Theis Analysis of Recovery	Field Rationale and Notes
RI-MW1	6	17.5 - 25.0	MW-E8 (13.0-23.0 ft bgs)	DENSE Basalt Moderately fractured	11.6	55	4.10E-02	3.71E-02	**6.20E-02**	5.27E-02	Test top of bedrock, immediately below conductor casing. Use MW-E8 as an observation well. Normal test.
RI-MW1	7	36.5 - 65.0	MW-E8; BAMW-3 (111-131 ft bgs)	DENSE Basalt Intensely fractured	457	70	5.53E-01	4.94E-01	**6.45E-01**	NA	Test conductivity of intensely fractured rock in zone of increased water loss during drilling. Competent packer seal rock not available in preferred nominal 10-ft test interval. Normal test; full recovery in 2 sec.
RI-MW1	8	89.3 - 99.7	BAMW-3 (111-131 ft bgs)	DENSE Basalt Intensely fractured	6.2	50	4.33E-02	1.16E-02	**7.20E-03**	5.40E-03	Test interval directly above observation well screen at BAMW-3. No change in water loss during drilling indicated a potential tight zone. Low volume of injection during ramp-up (increasing pressure) precluded need for ramp-down phase of injections.
RI-MW1	9	104.1 - 119.7	BAMW-3 (111-131 ft bgs)	DENSE Basalt Intensely fractured	361	90	1.92E-01	1.79E-01	**1.61E+01**	NA	Test fractures at the screen interval of observation well BAMW-3 (no hydraulic communication noted during drilling). Normal test; recovery within 18 sec (data not recorded).
RI-MW1	10	165.5 - 175.7	BAMW-3 (111-131 ft bgs)	DENSE Basalt Intensely fractured	341	90	1.48E-01	1.65E-01	**1.75E-01**	1.09E-01	Test the first section of rock in dense lava below conductive zones directly above. Solid rock for packer seal in intensely fractured formation. Normal test; recovery within 7 sec.
RI-MW1	11	220.0 - 230.0	None	DENSE Basalt Moderately fractured	8.8	30	<7.6E-03	8.52E-03	**6.04E-03**	5.72E-03	Test the first section of rock in potentially confining moderately fractured dense lava below inferred conductive zones. Note 230-240 ft bgs zone had similar rock core. Low volume of injection during ramp-up (increasing pressure) precluded need for ramp-down phase of injections. Some evidence of quick pressure release at start of recovery.
RI-MW2	12	22.2 - 33.8	None	VESICULAR Basalt Intensely fractured	NA	NA	NA	NA	**NA**	NA	Test top of bedrock, immediately below conductor casing. Tests suspended due to apparent fracture blow-by (packer ineffective).
RI-MW2	13	36.1 - 47.8	None	DENSE Basalt Moderately fractured	470	63	9.85E-01	1.06E+00	**1.30E+00**	NA	Tested highest bedrock zone practicable (good RQD for packer seal). Normal test, recovery in 3 sec.
RI-MW2	14	71.3 - 84.2	None	DENSE Basalt Moderately fractured	687	88	2.97E-01	3.11E-01	**8.63E-01**	1.95E+00	Tested next zone with good RQD (for packer seal). Normal test, recovery in 26 min.
RI-MW2	15	175.0 - 185.0	None	DENSE Basalt Moderately fractured	7.8	31	9.85E-03	1.10E-02	**5.39E-04**	4.23E-04	Test the first potential confining zone below the transmissive zones above. Low volume of injection during ramp-up (increasing pressure) precluded need for ramp-down phase of injections. Substantial recovery (60%) monitored for 92 min.
RI-MW2	16	189.6 - 205.0	None	VESICULAR Basalt Intensely fractured	835	28	2.91E+00	2.07E+00	**1.54E+00**	NA	Test 5-ft thick vesicular basalt zone with intensely fractured zone above and gradational zone below to dense basalt with moderate fracturing. Transmissivity very high compared to other zones. Used highest injection rates possible with test equipment. Full Recovery in 1 sec.
RI-MW2	17	207.2 - 225.0	None	VESICULAR Basalt Moderately fractured	1317	49	1.74E+00	1.71E+00	**1.97E+00**	NA	Test 15-ft thick vesicular basalt zone bordered by dense basalt with moderate fracturing (low transmissive-appearing bottom). Transmissivity very high compared to other zones. Used highest injection rates possible with test equipment. Full Recovery in 2 sec.
RI-MW2	18	230.3 - 240.0	None	DENSE Basalt Moderately fractured	38	67	1.40E-02	1.58E-02	**1.22E-02**	2.07E-02	Test bottom interval of boring. Chose upper interval where most competent rock was available to provide an approximately 10-ft test interval. Normal test.
RI-MW3	1	24.9 - 37.5	RI-MW3A (19.5-24.0 ft bgs)	VESICULAR Basalt & Breccia Mod. fractured	0.1	16	NA	NA	**NA**	3.46E-04	Test top of bedrock, immediately below conductor casing. Use RI-MW3A as an observation well. Ability to inject water limited by low formation permeability and shallowness. Recovery data used to estimate permeability.
RI-MW3	2	45.3 - 53.5	RI-MW3A; RI-MW3B (46.0-51.0 ft bgs)	VESICULAR Basalt Intensely fractured	11	54	4.20E-02	4.94E-02	**3.11E-02**	5.90E-02	Test fractures at the screen interval of observation well RI-MW3B (hydraulic communication noted during drilling). Normal test.
RI-MW3	3	40.0 - 53.5	RI-MW3A; RI-MW3B (46.0-51.0 ft bgs)	VESICULAR Basalt Intensely fractured	187.2	70	4.69E-01	4.88E-01	**1.11E+00**	NA	Test 2 was unexpectedly tight (intense fractures and hydraulic communication with MW-3B during coring). Test 3 raised upper packer 5.3 ft to locate conductive zone. Top packer elevated 5.3 ft from Test 2. The upper 5.3 ft of test 3 provides the vast majority of interval permeability.
RI-MW3	4	110.8 - 128.5	None	DENSE Basalt Moderately fractured	47.7	70	5.95E-02	5.84E-02	**1.80E-01**	2.67E-01	Weekend water level equalization inside corehole showed unexpected high head indicative of possible confining layer. Test to quantify this observation. Normal test.
RI-MW3	5	138.5 - 150.0	RI-MW3B	DENSE Basalt Intensely fractured	7.3	41	<1.44E-02	1.40E-02	**7.78E-03**	8.17E-03	Test bottom interval of boring. Chose upper interval where most competent rock was available to provide an approximately 10-ft test interval. Low volume of injection during ramp-up (increasing pressure) precluded ramp-down phase of injections.

Notes:
a Radius of influence for Theim analysis of 5 meters was used.
Bolding indicates highest quality solution.

ft bgs = feet below ground surface
ft/day = feet per day

gal = gallons
mins = minutes

The hydraulic conductivity of the BAL zone was characterized in the RI-MW2 core and represented by the 16th and 17th tests (189.6–225 ft bgs). The BAL zone in the 16th and 17th tests showed the highest observed hydraulic conductivity ranging between 1.5 to 2 ft/day and corresponding to the well screen interval of RI-MW2-BAL (refer to Table 2-5).

The hydraulic conductivity of the flow interior between the BAU and BAL zone is summarized as follows (refer to Table 2-5):

- In the RI-MW1 core, the flow interior was characterized by test 10 (165.5–175.7 ft-bgs, 1.75E-01 ft/day).
- In the RI-MW2 core, the flow interior was characterized by test 15 (175–185 ft-bgs, 5.39E-04 ft/day).
- In the RI-MW3 core, the flow interior was characterized by test 5 (138.5–150 ft-bgs, 7.78E-03 ft/day).

The hydraulic conductivity of the flow interior below the BAL zone at the RI-MW1 core was characterized by test 11 (220-230 ft-bgs, 6.04E-03 ft/day).

The degree of interconnection in the fracture system within the aquifer zones appears highly variable. For example, the second (45.3-53.5 ft bgs) and third (40.0-53.5 ft bgs) test interval in the RI-MW3 core appeared to be similarly fractured and the tests were completed over approximately the same test interval, with the exception that during the third test the top of the test interval was 5.3 ft higher. During the second test noted above, there was no observed water-level response in nearby observation well MW-3B completed in this same BAU zone. However, during the third test, water-levels increased in observation well MW-3B in direct response to water injection in the core hole. The difference in hydraulic conductivity between the second (0.031 ft/day) and third tests (1.1 ft/day) is due to fractures found in the top 5.3 ft of the third test interval and the degree of interconnection within the fracture system. For this reason, longer screen intervals (15-20 ft) were selected for use in the construction of monitoring wells in the basalt aquifer system.

2.3.4 Slug Tests Results

This section summarizes the slug tests results conducted at all monitoring wells during May 2016. The objective of the aquifer slug testing was to estimate aquifer hydraulic conductivity (K) for each well and hydraulic conductivity ranges for the various aquifer zones.

Table 2-6 summarizes the results of the slug test analysis by aquifer zone designation and includes the calculated mean and median result for each aquifer zone. For the majority of wells that were characterized by fully saturated screen and sand pack intervals, the hydraulic conductivity (K) values represent the mean of the K estimates obtained from individual slug-in and slug-out tests at that well.

For cases where the well is screened across the water table (i.e., the screen and sand-pack intervals were not fully saturated), the slug-in test data was not included in the results consistent with the Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Wells representing this condition include the following UA zone wells: RI-GW1, RI-GW4A, RI-GW5, RI-GW7, RI-GW8, RI-GW9, ESI-1, MW-8A, MW-10A, MW-12A, MW-14A, MW-15A, MW-16A, MW-17A, MW-E1A, and MW-W4. Also, the water-level in wells MW-E7 and RI-MW17-BAL was below the top of the filter pack, which creates potential for filter pack effects. In these cases, the reported result typically represents an average of the slug-out tests for those wells where two sets of slug tests were performed. In a few cases where only one set of tests was performed, and the screen and sand pack interval were not fully saturated, the result represents a single slug-out test. The selected portion of the recovery curves for these wells were adjusted to account for re-saturation of the sand pack during the early portion of the recovery curve. The AQTESOLV curve-match plots, field forms, and other documentation are provided as Volume 5, Appendix D-7 of this report.

The range of hydraulic conductivity values for each aquifer zone is highly variable and is summarized as follows:

- **UA zone**. Hydraulic conductivity values range from 0.06–922.00 ft/day. The calculated median and mean hydraulic conductivities for this zone are 0.98 and 73.79 ft/day, respectively.

- **BAU zone.** Hydraulic conductivity values range from 0.003–609.15 ft/day. The calculated median and mean hydraulic conductivities for this zone are 28.11 and 58.75 ft/day, respectively.

- **BAL zone.** Hydraulic conductivity values range from 1.29–466.10 ft/day. The calculated median hydraulic conductivity for this zone is 23.07 and 115.91 ft/day, respectively.

Table 2-6
Groundwater AOC - Summary of Slug Test Results
Average Hydraulic Conductivity (K)
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Well Number	Aquifer Zone	Well Screen Interval (ft-bgs)	Estimated Hydraulic Conductivity (K) [a] (ft/day)
UA Zone			
R1-GW1	UA	16.7-26.7	0.93
RI-GW2A	UA	33.3-43.3	0.47
RI-GW4A	UA	19.8-29.8	18.58
RI-GW5	UA	7.8-17.8	46.99
RI-GW7	UA	4.7-14.7	0.06
RI-GW8	UA	19.8-34.8	0.30
RI-GW9	UA	15.8-30.8	0.85
RI-MW4-UA	UA	70.8-85.8	0.39
RI-MW5-UA	UA	51.6-71.6	1.79
ESI-1	UA	6-16	0.08
IB-9	UA	5-10	23.18
MW-2A	UA	50-55	272.60
MW-6B	UA	35-40	8.97
MW-8	UA	9-14	922.00
MW-8A	UA	21.5-31.5	0.27
MW-10	UA	8-13	589.85
MW-10A	UA	13-26	0.27
MW-12A	UA	40-55	0.47
MW-14A	UA	8.5-29.5	2.20
MW-15A	UA	12.5-28	0.14
MW-16A	UA	22-42	0.36
MW-17A	UA	15-35	1.03
MW-E1A	UA	8-15	0.37
MW-E7	UA	18-28	7.10
MW-W1	UA	20-30	18.19
MW-W4	UA	50-65	1.08
Mean Hydraulic Conductivity			**73.79**
Median Hydraulic Conductivity			**0.98**
BAU Zone			
RI-MW2-BAU	BAU	24.8-39.8	31.53
RI-MW3-BAL	BAU	128.0-153.0	30.45
RI-MW5-BAU	BAU	95.3-115.3	0.20
RI-MW6-BAU	BAU	42.0-62.0	5.99
RI-MW7- BAU	BAU	30.0-50.0	0.31
RI-MW8-BAU	BAU	38.8-58.8	34.27
RI-MW9-BAU	BAU	15.8-35.8	47.63
RI-MW10-BAU	BAU	33.0-53.0	27.20
RI-MW11-BAU	BAU	56.6-76.6	29.01
RI-MW12-BAU	BAU	60.3-80.3	0.65
RI-MW13-BAU	BAU	44.9-64.9	8.46
RI-MW14-BAU	BAU	50.0-70.0	63.22
RI-MW15-BAU	BAU	61.8-71.8	112.85
RI-MW16-BAU	BAU	99.8-119.8	73.06
BAMW-1	BAU	142-162	2.67
BAMW-3	BAU	111-131	44.80
IB-1	BAU	40-50	47.25
IB-2A	BAU	16-21	30.44
IB-3	BAU	20-30	31.26
IB-4	BAU	12-22	7.11
IB-5	BAU	10-20	0.003
IB-5AA	BAU	58-68	0.06

Table 2-6
Groundwater AOC - Summary of Slug Test Results
Average Hydraulic Conductivity (K)
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Well Number	Aquifer Zone	Well Screen Interval (ft-bgs)	Estimated Hydraulic Conductivity (K) [a] (ft/day)
BAU Zone (Continued)			
IB-10	BAU	17-27	386.90
IB-11	BAU	14-24	6.87
IB-12A	BAU	49-59	0.01
MW-1	BAU	22-27	609.15
MW-2B	BAU	104-109	19.18
MW-3B	BAU	46-51	2.96
MW-7B	BAU	104-109	83.46
MW-18	BAU	35-50	25.72
Mean Hydraulic Conductivity			**58.75**
Median Hydraulic Conductivity			**28.11**
BAL Zone			
RI-MW1-BAL	BAL	190.0-210.0	5.28
RI-MW2-BAL	BAL	179.8-199.8	311.30
RI-MW17-BAL	BAL	10.8-25.8	1.54
RI-MW18-BAL	BAL	105.5-125.5	2.07
RI-MW19-BAL	BAL	115.8-125.8	3.55
RI-MW20-BAL	BAL	169.8-189.8	65.46
BAMW-2	BAL	220-240	1.29
BAMW-4	BAL	200-220	205.35
IB-8	BAL	281-291	190.00
IB-13	BAL	135-140	466.10
IB-13A	BAL	89-94	23.07
Mean Hydraulic Conductivity			**115.91**
Median Hydraulic Conductivity			**23.07**

Notes:

a Hydraulic conductivity values include generally include average estimates derived from both slug-in and slug-out tests. For wells with partial saturation of the filter pack, only results for slug-out tests were included in the reported results consistent with the Final RI Phase 2 Work Plan.

BAL = Basalt Aquifer-Lower

BAU = Basalt Aquifer-Upper

ft/day = Feet per day

ft-bgs = Feet below ground surface

UA = Unconsolidated Aquifer

Based on the median results, it appears the UA zone is characterized by generally lower hydraulic conductivities than the underlying basalt aquifer zones. Due to the variability and overlapping ranges in the slug test hydraulic conductivity results, no clear differences in the hydraulic conductivity values for the basalt aquifer zones could be identified.

The hydraulic conductivity values estimated from slug tests are strongly influenced by local conditions near the screen interval such as the amount and configuration of fractures in the bedrock screen interval, fully or partially saturated screens, the quality of well development, drilling-induced disturbances, and highly anisotropic formations (Butler 1998; Hyder and Butler 1995).

2.3.5 Aquifer Pumping Test Results

This section summarizes the results of various aquifer tests at the site including: constant rate pumping tests at monitoring wells RI-MW2-BAU and RI-MW1-BAL, and the industrial well pumping test. The main objective of the aquifer pumping test was evaluate potential aquifer zone interconnection in specific areas of the site. Aquifer zone interconnection is important for evaluation of groundwater flow pathways.

A limiting factor in the design of the aquifer tests was the small number and locations of available monitoring (observation) wells particularly in deeper zones within the basalt bedrock. For this reason, estimation of aquifer characteristics (e.g., hydraulic conductivity) was a secondary objective that was for the most part limited to the pumping well and those few observation wells that showed a response to pumping.

2.3.5.1 RI-MW2-BAU Pumping Test Results

Figure 2-4 shows the well RI-MW2-BAU pump test layout, including selected observation well locations. Of the six instrumented observation wells, there were no observed responses during pumping of well RI-MW2-BAU at a constant rate of 15 gpm over a 21.7-hour period. Although no pond response was observed during pumping, the results of the Stormwater Pond Drawdown Test show that the stormwater pond and well RI-MW2-BAU are hydraulically interconnected (refer to Section 2.3.6). The response curve for RI-MW2-BAU (refer to Volume 5, Appendix D-8) does not suggest a boundary condition caused induced recharge from the stormwater pond.

The drawdown data from pumping well RI-MW2-BAU for both the step-drawdown and the constant rate pumping tests were used to calculate hydraulic parameters. The curve-match solution for the RI-MW2-BAU aquifer pumping test data was the confined model (Theis 1935; Hantush 1961a,b). The AQTESOLV analyses for the pumping well data are presented in Volume 5, Appendix D-8. The hydraulic conductivity estimates made from RI-MW2-BAU drawdown data for the step test and the constant rate pumping test were 42.7 and 39.4 ft/day, respectively. The estimated K values are similar to the average K calculated from slug testing performed in well RI-MW2-BAU, which was 31.5 ft/day.

2.3.5.2 RI-MW1-BAL Pumping Test

Figure 2-5 shows the well RI-MW1-BAL pump test layout, including observation well locations. Of the six instrumented observation wells, there was an apparent response of about 0.2 ft in only one observation well (BAMW-2) that is also screened in the BAL zone. No responses were observed in any of the other observation wells during pumping of well RI-MW1-BAL at a constant rate of 12 gpm over a 24-hour period (refer to Figure 2-5).

Although observation well BAMW-2 is located a significant distance (about 1,100 ft) from the RI-MW1-BAL pump test well, water levels were observed to quickly decrease during pumping and rebound suddenly at cessation of pumping. Therefore, the transducer data from both the pumped well and from observation well BAMW-2 were used to calculate drawdown data for analysis. The curve-match solution for the RI-MW1-BAL aquifer test data was a leaky confined model without aquitard storage (Hantush and Jacob 1955; Hantush 1964). The analysis for the pumping well data are presented in Volume 5, Appendix D-8.

Pumped Well RI-MW1-BAL

Drawdown data for both the step-drawdown and the constant rate pumping tests were used to calculate hydraulic parameters. The hydraulic conductivity estimates made from well RI-MW1-BAL drawdown data for the step test, the constant rate test, and for the recovery phase were 6.4, 12.2, and 3.2 ft/day, respectively. For constant rate tests, the recovery data from the pumping well is often less noisy than the pumping phase data, and typically provides a more representative curve match. Overall, these K values are quite similar to the average K calculated from slug testing performed in well RI-MW1-BAL, which was 5.3 ft/day (refer to Table 2-6).

Observation Well BAMW-2

Drawdown data for both the step-drawdown and the constant rate pumping tests were used to calculate hydraulic parameters. The hydraulic conductivity estimates were 218.7 ft/day from the step-drawdown test, and 162.91 ft/day from the constant rate test, respectively. In contrast, an average K of 1.3 ft/day was calculated from the slug tests performed at well BAMW-2. Given the fractured bedrock environment, it seems likely that there is an enhanced permeability zone (such as a fracture or fault,) near the well, and evidence of tectonic fracturing was noted in the RI-MW1 core. Such a feature would provide the high-K preferential pathway needed allow drawdown generated by pumping well RI-MW1-BAL to transmit across the approximately 1,100 ft to generate a response at well BAMW-2.

Taking the slug test and pumping test results together, these hydraulic conductivity estimates indicate that the BAL zone is relatively well-fractured, producing slug test K values similar to those expected for fine sand. However, there appears to be unexpected connections that are laterally extensive, but of low storage, which have apparently resulted in drawdown propagating long distances in a short amount of time. These connections could be fault- or fracture-related, or to well-connected higher-permeability zones near the top of the basalt flow.

2.3.5.3 Industrial Well Pumping Test Results

Figure 2-6 shows the Industrial Well 3 pumping test layout including selected observation well locations. It was not feasible to instrument the Industrial Well 3 with a transducer due to its construction and seal. Of the eight instrumented observation wells, there was a suspected response in only well BAMW-1, located about 795 ft from Industrial Well 3. No responses were observed in any of the other observation wells during the 40.4-hour pump test. The pump test data analysis is provided in Volume 5, Appendix D-9.

Well BAMW-1 exhibited drawdown simultaneous to the start of pumping in the Industrial Well 3, but it did not show recovery when pumping ceased. The apparent response may not be due to the pumping from the Industrial Well 3 and may be due to some other unexplained local cause. Well BAMW-1 is completed in the BAU_2 zone and is characterized by confined conditions with water-levels elevations near the top of the basalt units at this location. The well is relatively near the mapped fault that is located in the gulley to the east. Faults can create confined conditions and/or represent a preferential pathway that would potentially allow for drawdown over a large distance of 795 ft. However, there is uncertainty regarding the location of the fault and its relationship to the wells. Another uncertainty is that the apparent water-level at the industrial well is significantly higher in elevation than other BAL zone wells based on the reported pump placement depth of 50 ft bgs. The Industrial Well 3 construction details are not sufficiently clear to identify which aquifer zones are currently supplying water in Industrial Well 3. Given the lack of recovery at BAMW-1 and other uncertainties, the cause of the apparent response is unclear.

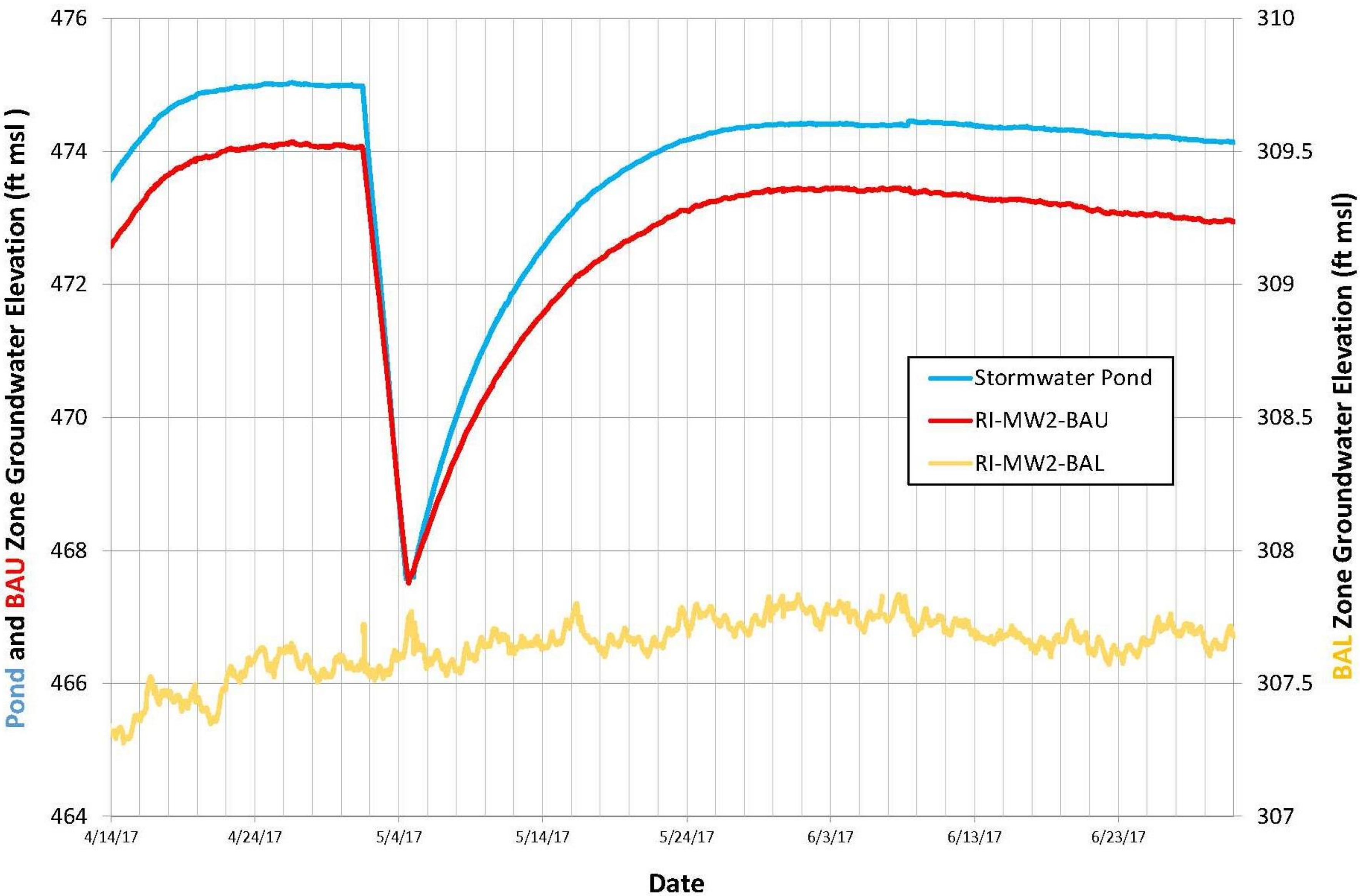
2.3.6 Stormwater Pond Drawdown Test Results

The objective of the stormwater pond drawdown test was to evaluate whether the stormwater pond is hydraulically interconnected with (or is a source of recharge for) the basalt aquifer system in this area of the site. The field investigation consisted of transducer monitoring of the stormwater pond and nearby wells RI-MW2-BAU and RI-MW2-BAL during a routine stormwater discharge event in May 2017 (refer to Figure 2-2). The pumping rate of the pond industrial pump for this event was about 350-400 gpm over a period of about 5 days.

Figure 2-19 shows the results for the pond drawdown test and the results are summarized as follows:

- Immediate response was noted in RI-MW2-BAU, which confirms that the stormwater pond recharges the BAU aquifer zone in this area.
- Water-levels in the stormwater pond are slighter higher than nearby well RI-MW2-BAU, which also suggests potential recharge and interconnection.
- The stormwater pond level recovered quickly after pumping and there was little to no rainfall or stormwater runoff during the test, which suggests potential recharge of the pond from the BAU zone during low water conditions.

No response was observed in well RI-MW2-BAL which indicates that the deep BAL zone is not hydraulically connected with the pond. The lack of response in well RI-MW2-BAL also indicates a lack of interconnection between the BAU and BAL aquifer zones. Water-level elevations were also routinely recorded at the stormwater pond, and in wells RI-MW2-BAU and RI-MW2-BAL as part of the water-level characterization study (see Section 2.3.7). Results for the year-long study for these same stations are included in Figure 2-20. The stormwater pond was pumped out 5 times



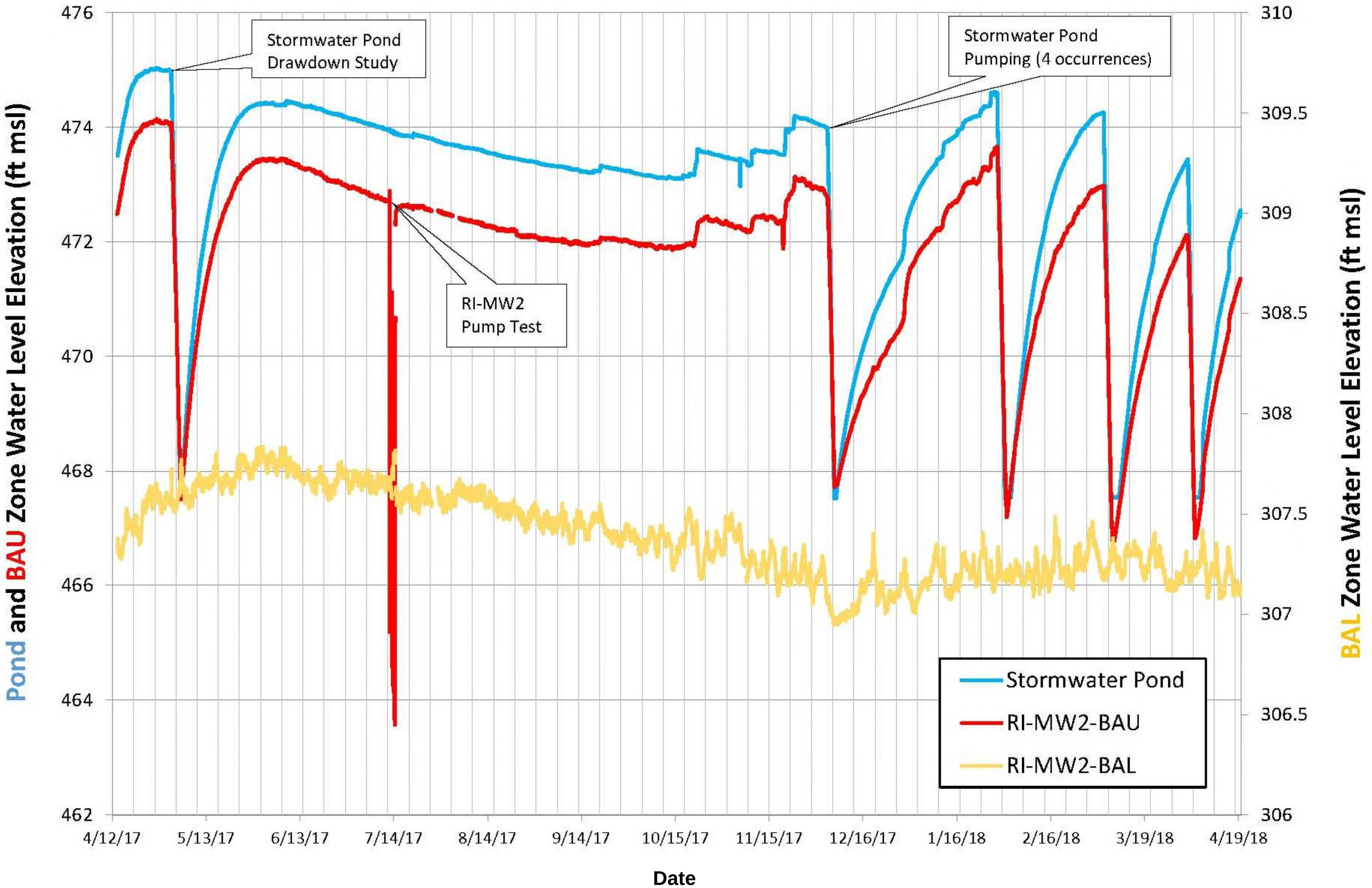
Legend

ft msl	=	Feet mean sea level
BAL	=	Basalt Aquifer Lower
BAU	=	Basalt Aquifer Upper

Figure 2-19

Stormwater Pond Drawdown Test Results

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

ft msl	=	Feet mean sea level
BAL	=	Basalt Aquifer Lower
BAU	=	Basalt Aquifer Upper

Figure 2-20

Water-level Characterization Study Results for Stormwater Pond Area

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

during the year-long water-level study as part of the ongoing stormwater management activities conducted under the NPDES permit, and a similar pattern of response was noted. Stormwater pond drawdown and water-level characterization study data is provided in Volume 5, Appendix D-10.

Other evidence supporting stormwater pond recharge interconnection with the BAU aquifer zone includes the following:

- Presence of a perennial spring (Spring 01) downgradient (south) of the stormwater pond. Based on review of historical aerial photographs from the 1960s and 1970s, this spring was not present prior to construction of the stormwater pond (refer to Volume 5, Appendix E-3).
- Similarity in geochemistry and water quality between the stormwater pond, nearby BAU zone wells, and Spring 01, which originates in basalt bedrock at an intermediate elevation between and the Columbia River and the stormwater pond (refer to Sections 2.3.8.1 and 2.3.8.2).

2.3.7 Water-Level Characterization Study Results

Figure 2-7 shows the water-level characterization study monitoring station locations. The study included continuous water-level measurement at select stations of a year-long period from April 2017 to April 2018. Transducer hydrograph data for the water-level characterization study is included in Volume 5, Appendix D-10. This work was performed as part of the initial RI field mobilization and this section summarizes the initial findings and results.

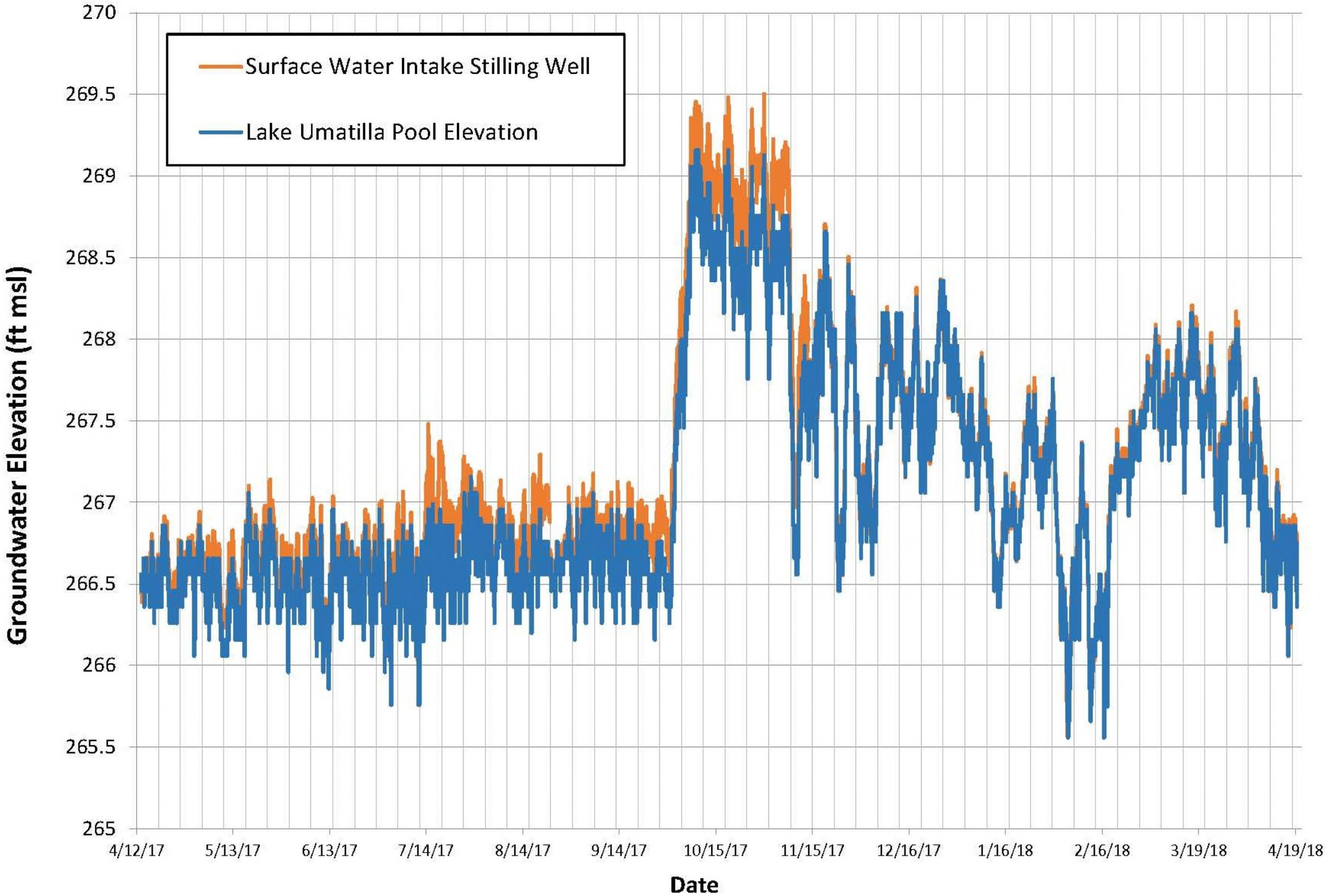
The results of additional data analyses performed as part of the WPA effort including: 1) evaluation of the various line groups and shallow groundwater, 2) the water balance assessment for the stormwater pond and various potential flow pathways toward the Columbia River, and 3) lag and dampening evaluation for shoreline wells is included in Section 2.4.

The results of the water-level characterization study have been evaluated through a series of hydrographs to characterize the water-level pattern for various aquifer zones and surface and stormwater features. In particular, the water-level patterns for the Columbia River and the basalt aquifer zones near the river have been compared to help evaluate potential groundwater flow paths. The hydrograph sequence is presented from the lowest elevation (Columbia River) to water-bearing zones of successively higher elevations (BAL zone along river, BAL zone in plant area, and BAU zone). In this way, the head differences between zones can be readily distinguished.

The results for the surface water intake pond and the Columbia River (Lake Umatilla Pool) gauging station are shown in Figure 2-21. While it is suspected that there is culvert that directly connects the surface water intake pond to the Columbia River, the location and type of connection has not been documented. The hydrographs patterns are similar for the study period and suggest that the surface water intake pond and the Columbia River are in connection. The surface water intake pond elevation appears slightly higher (about 0.2 ft) than the Lake Umatilla Pool measurement station for the majority of the study period. Both stations show a rapid increase in water levels (about 3 ft) during October 2017 that is likely associated with John Day Dam operations relating to cessation of agricultural irrigation and/or seasonal effects.

The hydrograph results for BAL wells near the Columbia River (i.e., wells RI-MW17-BAL, RI-MW18-BAL, and RI-MW19-BAL) show that the water elevation pattern at RI MW18-BAL and RI-MW-19-BAL are very similar and distinct from well RI-MW17-BAL (Figure 2-22). This hydrograph pattern also supports the finding that RI-MW17-BAL represents a separate shallower water-bearing zone within the BAL (shown as BAL_1 on cross-section figures) than the other shoreline wells (shown as BAL_2 on cross-section figures). The reason the Columbia River station(s) are not shown on this figure is because of the differences in scale that obscure the observed pattern.

A comparison of hydrographs for the surface water intake pond and Lake Umatilla Pool station with well RI-MW18-BAL shows that the river water-level elevations were higher than the well water-level elevations during much of the summer and fall months (Figure 2-23). This pattern suggests that the amount of discharge from the deeper BAL zone to the river is limited because the gradient is from the Columbia River toward the shoreline wells for significant portions of the year. The period where the gradient is toward the Columbia River was mainly during mid-April to mid-June 2017 when Columbia River elevations were generally at their lowest and most stable. Qualitative comparison of the hydrograph data (refer to Volume 5, Appendix D-10, Figures D-10.1 through D-10.7) also shows that well RI-MW18-BAL is characterized by a dampened and lagged response with respect to the Surface Water Intake Pond. The amount of lag ranges from 5 hours to 27 hours for selected corresponding lows and a range of 16 hours to 38 hours for selected corresponding highs based on inspection of non-barometrically corrected data (Volume 5, Appendix D, Figures D-10.1 through D-10.7).



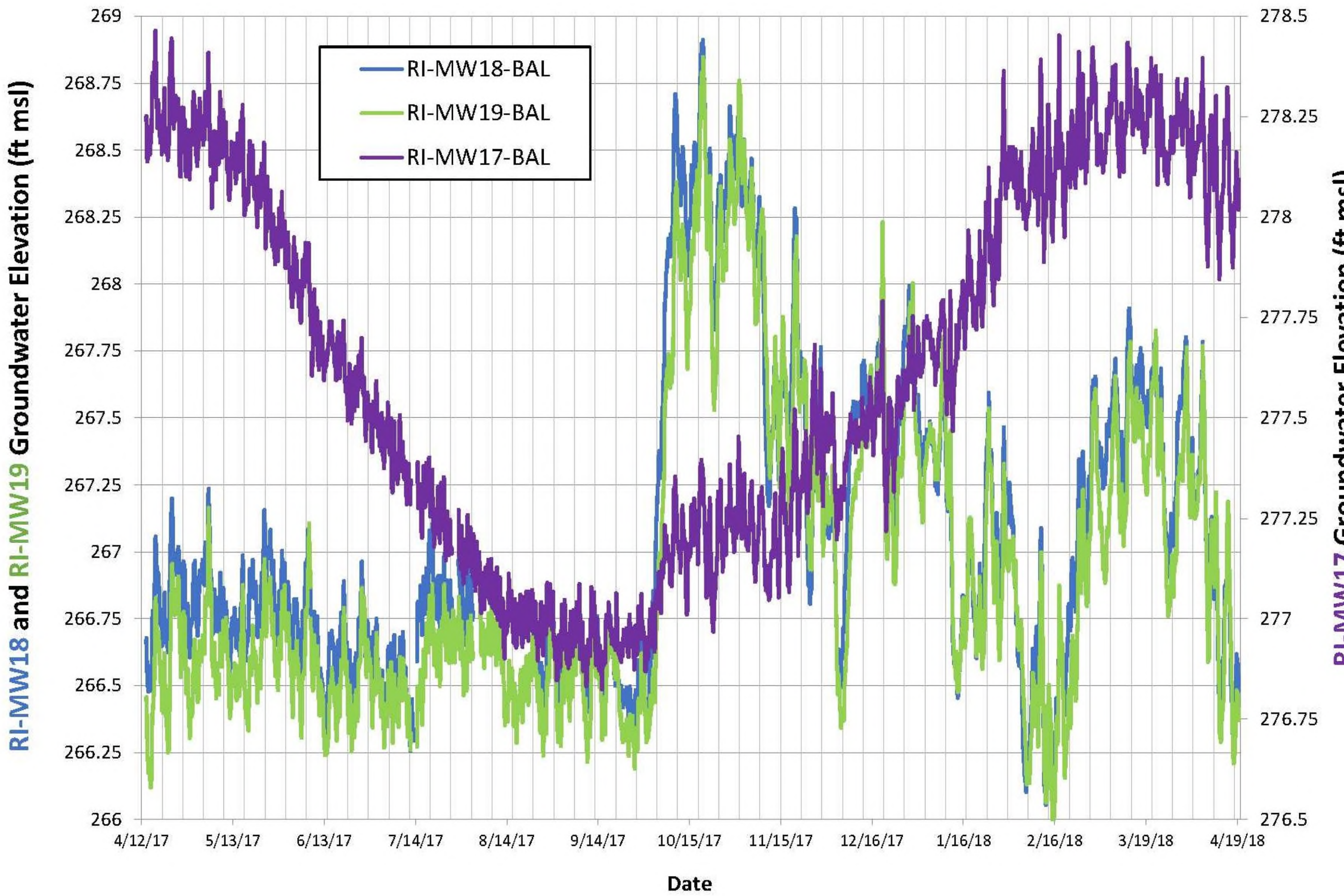
Legend

ft msl = Feet mean sea level

Figure 2-21

Surface Water Intake and Lake Umatilla Pool Water-Level Elevations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



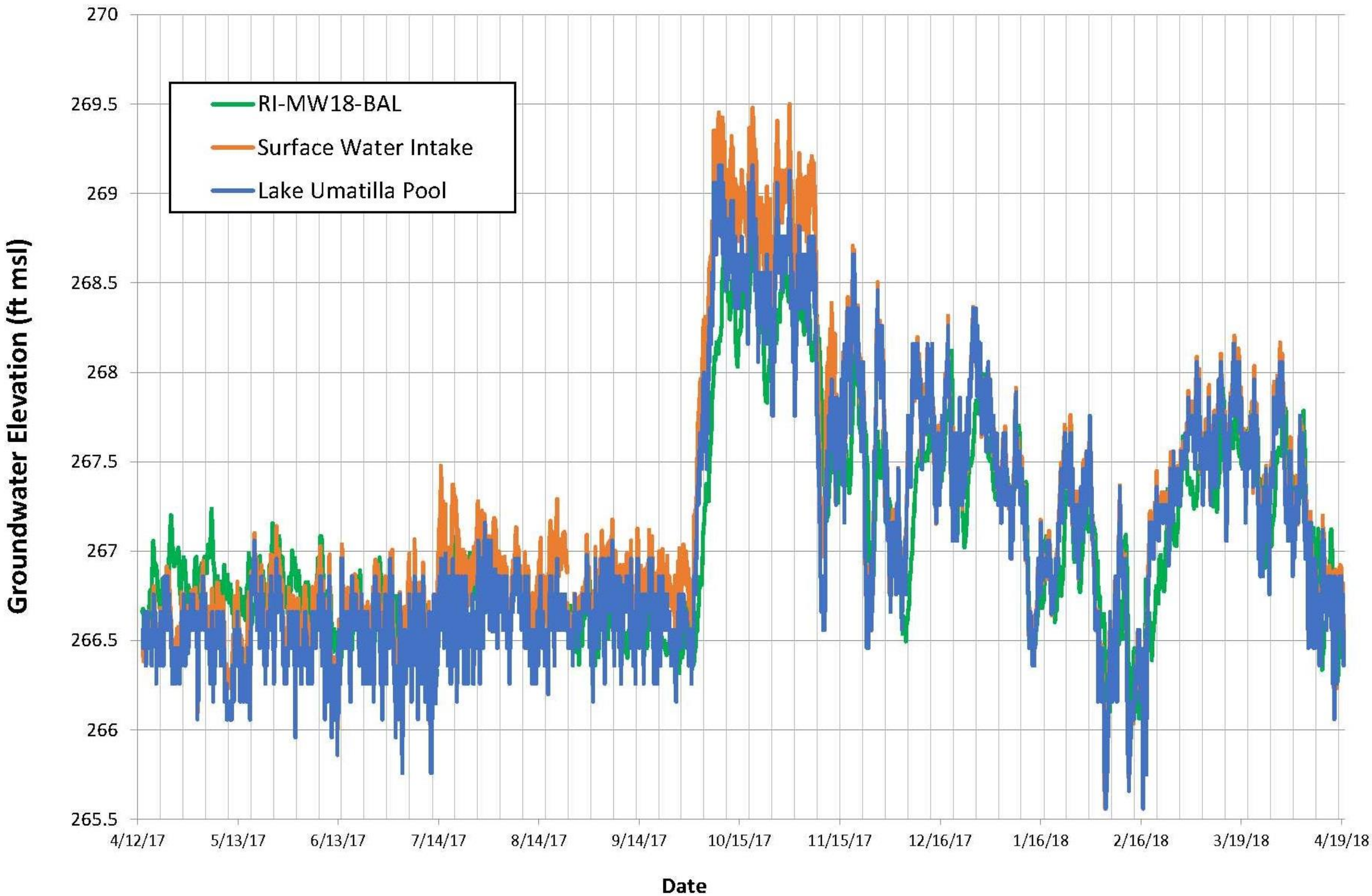
Legend

ft msl = Feet mean sea level
BAL = Basalt Aquifer Lower

Figure 2-22

BAL Aquifer Zone Water-Level Elevations near the Columbia River

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

ft msl = Feet mean sea level
BAL = Basalt Aquifer Lower

Figure 2-23

BAL Aquifer Zone Water-Level Elevations and Nearby Surface Water Water-Level Elevations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

This conclusion of limited groundwater discharge to the Columbia River is also supported by the fact that the deeper BAL_2 water-bearing zone is about 40 ft below the water-level elevation of the Columbia River. The water depth of the surface water intake pond is about 18 ft (refer to Table 1-5), and the water depth of the Boat Basin ranges from about 18 to 66 ft with the majority of the Boat Basin stations less than 40 ft. This finding suggests that there is an intervening thickness of impermeable flow interior that may be present below the base of the surface water intake pond and in areas of the Boat Basin that would limit groundwater discharge. The depth of the Lake Umatilla (Columbia River) channel is typically greater than 40 ft and the BAL_2 zone may sub-crop in the main channel. Based on the elevation of the deeper BAL water-bearing zone relative to the Columbia River surface water-elevations and channel depths as well as the hydrographs, it does not appear there is significant discharge from the BAL_2 zone to nearby areas of the Columbia River.

The amount of discharge to Columbia River from the shallower BAL zone (shown as BAL1 on cross-section figures) near RI-MW17-BAL also appears to be small. RI-MW17-BAL (screened in the BAL2 zone) has a distinctly different hydrograph pattern than the other wells along the shoreline (RI-MW18 and RI-MW19-BAL completed in the BAL2) that show a lagged and dampened response to the Columbia River (Figure 2-22). RI MW-17-BAL shows a hydrographic pattern that is distinctly different from the Columbia River (and most similar to other BAL1 zone wells, Figure 2-23), which suggests that the BAL1 zone is not hydraulically connected to the river at this location, even though RI-MW17-BAL is completed in the BAL1 zone only slightly below the elevation of the Columbia River surface.

Locally, it is not uncommon for basalt aquifer systems to have limited or no connection to the Columbia River. For example, The Dalles Groundwater Reservoir is not recharged by the Columbia River (OSE 1959), even though recharge from the Columbia River would be expected. More locally, the wells at John Day Dam have been historically characterized by declining yield (Beesom 2003). A lack of connection with the Columbia River was concluded to be a contributing factor. It’s been hypothesized that weathering of the near-surface basalt may reduce permeability, and/or that deposition of clay associated with the Missoula Floods or later deposition in the reservoirs may also have reduced the permeability of the fracture systems exposed along the river (Beesom 2003).

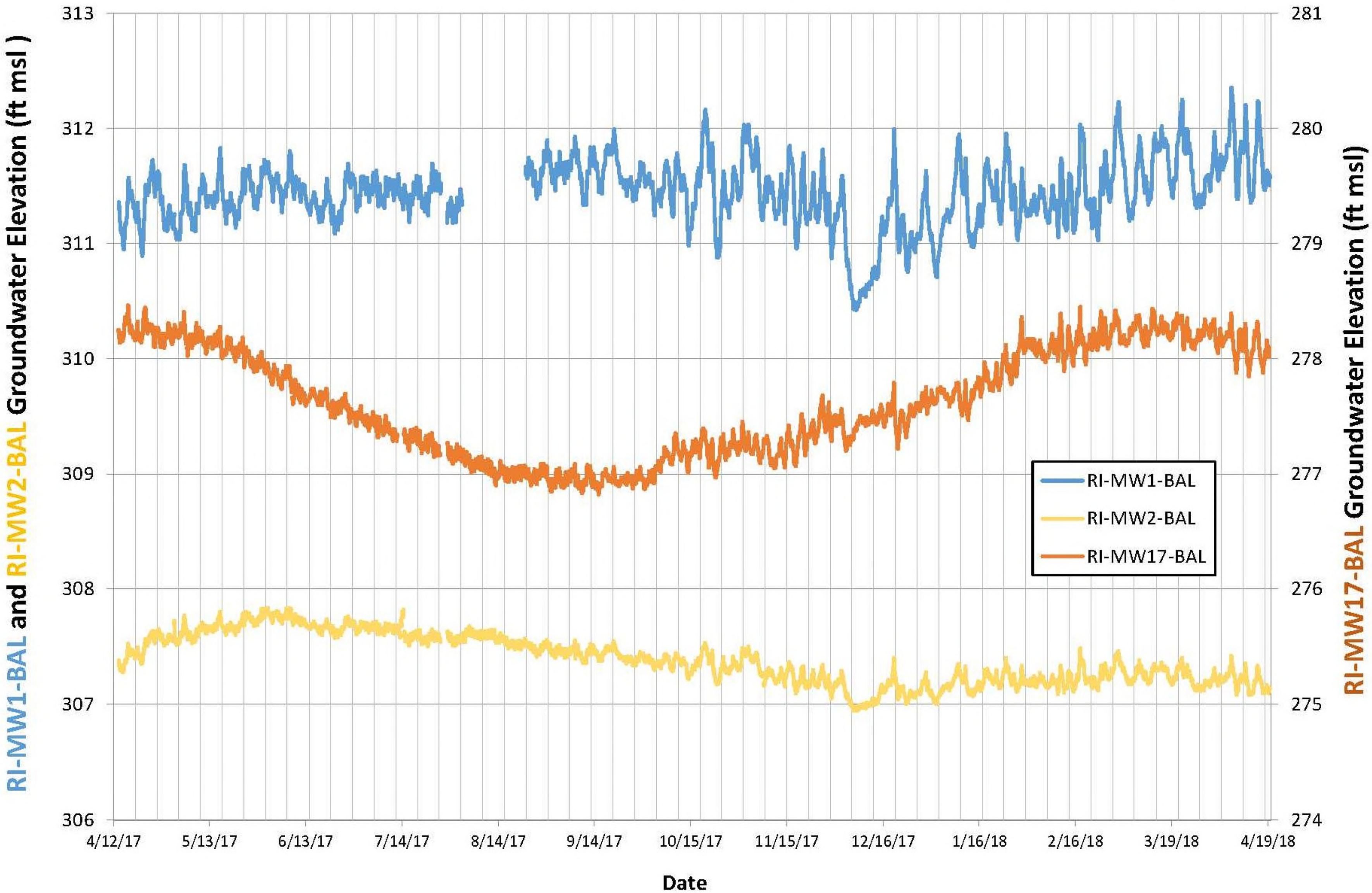
Well RI-MW17-BAL exhibits a water-level elevation pattern more similar to the shallower BAL-zone wells RI-MW1-BAL and RI-MW2-BAL than the deeper BAL zone wells (Figure 2-24). This pattern of water-level similarity shows that these well do not respond similarly to the wells along the River and exhibit a fluctuation pattern more typical of "upland" seasonal fluctuations. This result also supports the finding of distinct shallower and deeper BAL-zones.

Hydrographs for the wells screened in the BAU zone are similar and are distinct from hydrographs of wells screened in the BAL zone (Figure 2-25). The hydrographs for well RI-MW8-BAU and BAMW-3 show that the two wells are completed in the same hydrostratigraphic zone. Note that these wells are located along the trend of the hypothesized fault/fracture system at the east end of the former smelter plant. Cross-sections shown in Figures 2-12 and 2-15 show that the water-bearing zones are at different elevations with RI-MW8-BAU correlated across the site as a shallower (BAU1 zone) and well RI-BAMW-3 correlated across the site as a deeper (BAU2 zone). The fact that these two wells respond so similarly suggest interconnection along the trend of the fault/fracture system. The effect of periodic drawdown of the stormwater pond can be seen in the hydrograph data for well RI-MW2-BAU.

2.3.8 Groundwater Chemistry Results

This section summarizes the water quality results for the RI groundwater monitoring program and includes geochemistry results and water quality results for the four quarters of groundwater sampling performed at the site. The results for groundwater sampling performed during the WPA are presented in Section 2.4

The initial RI baseline sampling round (Q1) was completed in January/February (Winter) 2017. Subsequent quarterly rounds of sampling were completed in May (Spring – Q2) 2017, August (Summer – Q3) 2017, and November (Fall – Q4) 2017. The groundwater sampling activities were completed in accordance with the Ecology-approved Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a). All groundwater samples were shipped to TestAmerica Laboratories of Tacoma, Washington, a WA ELAP laboratory, for specified groundwater analyses (refer to Table 2-3). Samples were routinely shipped and received by the laboratory in reported good condition and under standard chain-of-custody protocol. Sample results were validated by an independent third-party data validation contractor, Laboratory Data Consultants of Carlsbad, California. Completed



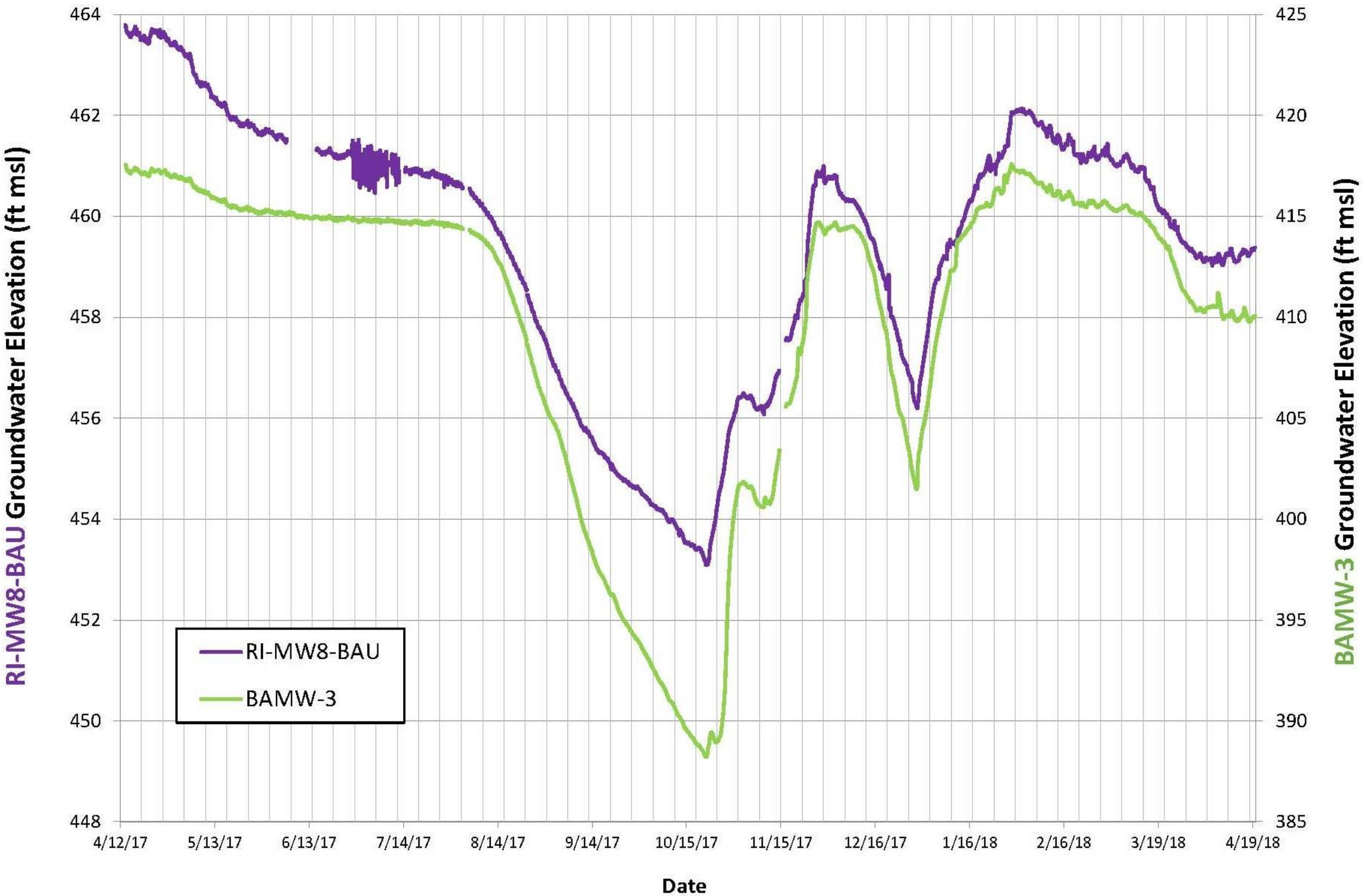
Legend

ft msl = Feet mean sea level
BAL = Basalt Aquifer Lower

Figure 2-24

BAL Aquifer Zone Water-Level Elevations
Plant Area and RI-MW17-BAL near Columbia River

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

ft msl = Feet mean sea level
BAU = Basalt Aquifer Upper

Figure 2-25

BAU Water-Level Elevations,
RI-MW8-BAU and BAMW-3

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

field forms for the GWAOC work effort are provided in Volume 5, Appendix D-11. Laboratory analytical data reports for the initial RI field investigation are provided in Volume 5, Appendix H-1 and Data Validation reports are provided in Volume 5, Appendix I-1. The groundwater sample results and associated information for all four quarters of monitoring have been uploaded to Ecology's Environmental Information Management System (EIMS) under Study Identification Number (AODE 10483).

2.3.8.1 Geochemistry Results

Major ion chemistry for each aquifer zone was characterized during the initial baseline sampling round during Winter 2017. Piper diagrams for various groupings of the data are included in Volume 5, Appendix D-14 and include: upgradient wells, UA wells, BAU wells, BAL wells, stormwater and springs, and industrial production wells. The major ions sampled and included on the plots include: Ca, Mg, Na, K, Cl, F, SO_4, HCO_3, and CO_3. The draft Piper diagrams were prepared using a Nevada USGS excel tool at https://nevada.usgs.gov/tech/excelforhydrology/Listing_and_Description.htm.

The primary objectives of the geochemical sampling were to determine if there is a clear chemical signature for individual aquifer zones at the site. A potential complication for this analysis is that some of the major ions represent either site contaminants (e.g., fluoride and sulfate) or are associated with aluminum smelter wastes (e.g., Na, Cl).

Piper Plots provided in the Draft RI Report incorrectly incorporated the bicarbonate alkalinity and carbonate alkalinity values into the Piper Plots. In the Revised RI Report, the values were converted to bicarbonate and carbonate and revised Piper Plots are included in Volume 5, Appendix D-14. The conversion did not significantly change the results.

The upgradient wells that are completed in the UA and BAU zones tightly cluster together and represent waters of the calcium bicarbonate facies, which is typical of shallow, fresh, groundwater. The upgradient wells are characterized by low levels of fluoride and sulfate. There is no upgradient background well for the BAL Zone. Two of the industrial wells (Production Well 1 and Well 3) plot in the calcium bicarbonate facies similar to the upgradient shallow wells. These wells are deep (up to around 1,000 ft deep with surface casing and seal extending from the ground surface to between 7 and 23 ft bgs and are open-hole over broad intervals) and are not impacted by fluoride and sulfate, suggesting that the geochemistry of the deeper aquifer zone for areas outside of the plume is similar to the shallow BAU and UA zones.

Water from the UA, BAU, and BAL zone most commonly represents calcium bicarbonate water facies and calcium sulfate water facies. There are also wells characterized by sodium and sulfate as the dominant cation and anion including: BAMW-3, BAMW-4, IB-2A, IB-5, IB-5A, IB-9, MW-10A, MW-12, MW-14A, RI-GW1, and RI-GW5. Sodium and sulfate are associated with aluminum smelter-related wastes. This shallowest zone UA zone has the widest distribution of major ion results.

Based on the collected data, it does not appear that the aquifer zones vary significantly in geochemistry and it appears that most major ion variations are related to the distribution of fluoride and sulfate (site contaminants), as well as sodium in groundwater. The piper diagrams are provided in Volume 5, Appendix D-14. Well locations are shown by aquifer zone in Figure 2-2.

2.3.8.2 Chemicals of Potential Concern Results

This section summarizes groundwater results for chemicals of potential concern (COPCs) for all four quarters of groundwater sampling conducted as part of the RI. An additional round of well sampling in the plant area was conducted as part of the WPA and the results are summarized in Section 2.4. As described in Section 2.2.8, the quarterly groundwater monitoring program included a comprehensive baseline sampling round. While the results from the baseline sampling round showed some exceedance of groundwater screening levels for aluminum smelter-related COPCs in all three aquifer zones, several groups of chemicals were either not detected or routinely detected below groundwater screening levels. For this reason, the results for the comprehensive baseline (Q1) Winter 2017 sampling round for the UA, BAU, and BAL aquifer zones are summarized in the body of the text as Tables 2-7, 2-8, and 2-9, respectively. Tables summarizing the groundwater results for the second, third, and fourth quarters are provided for completeness in Volume 5, Appendix D-15. Figures showing results for all four quarters of groundwater sampling for smelter-related COPCs are included as referenced in the following sections. The geochemical results summarized in Section 2.3.8.1 are also included in the baseline round data summary tables referenced above.

Table 2-7
Groundwater AOC - Unconsolidated Aquifer (UA) Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 4)

Parameter Name	Units	Screening Levels							Analytical Results															
		MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	ESI-1-01 2/22/2017	IB-9-01 2/22/2017	MW-2A-01 2/23/2017	MW-6B-01 2/16/2017	RI-MW42-01 (Duplicate of MW-6B) 2/16/2017	MW-8-01 2/16/2017	MW-8A-01 2/21/2017	MW-10-01 2/22/2017	MW-10A-01 2/14/2017	MW-11A-01 2/22/2017	MW-12A-01 2/15/2017	MW-14A-01 2/15/2017	MW-15A-01 2/16/2017	MW-16A-01 2/21/2017	MW-17A-01 2/21/2017	MW-E1A-01 1/27/2017
Aluminum Smelter																								
Total Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	0.06 U	0.06 U	**0.4**	**0.39**	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 UJ	**0.095**	**0.22**	**0.23**	0.06 U
Cyanide, Free	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 U	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 J	0.0015 UJ	0.0015 U
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	Total	**31 J**	**4.5 J**	0.19	**1.2**	**1.2**	**20**	0.19	**8 J**	**1.5**	0.2 J	**1.7**	**5**	0.13	0.9	**2.2**	**11 J**
Sulfate	mg/L	NE	NE	NE	250	250	32	Total	43	**2,500**	13	20	18	48	8.7	50	**3,900**	9.3	**710**	**1,600**	140	22	14	27
Polynuclear Aromatic Hydrocarbons (PAHs)																								
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	1.5	NE	Total	0.0062 U	0.0066 U	0.0064 U	0.0061 U	0.0061 U	0.0064 U	0.0064 U	0.0062 U	0.006 U	0.0062 U	0.006 U	0.0061 U	0.0064 U	0.0061 U	0.006 U	0.0061 U
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	Total	0.0093 U	0.0098 U	0.0097 U	0.0092 U	0.0092 U	0.0096 U	0.0095 U	0.0093 U	0.0089 U	0.0093 U	0.0091 U	0.0091 U	0.0095 U	0.0091 U	0.009 U	0.0092 U
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	Total	0.003 J	0.0022 U	0.0021 U	0.002 U	0.002 U	0.015 J	0.0021 U	0.0021 U	0.002 U	0.0031 J	0.015 J	0.0075 J	0.0021 U	0.002 U	0.0027 J	0.002 U
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0021 U	0.0022 U	0.0021 U	0.0041 B	0.002 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.0021 U	0.0031 B	0.0035 B	0.0021 U	0.002 U	0.002 U	0.002 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	Total	0.0096 J	0.0044 J	0.0032 U	0.0068 B	0.0031 U	0.015 B	0.0032 U	0.0031 U	0.0038 J	0.0031 U	0.0036 B	0.0056 B	0.0032 U	0.003 U	0.003 U	0.011 J
Benzo[a]anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.015 B	0.0053 B	0.003 J	0.0059 B	0.0049 B	0.008 B	0.0048 B	0.0048 B	0.002 U	0.0076 B	0.0061 B	0.0074 B	0.0057 B	0.0036 B	0.0035 B	0.0048 J
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	0.023	NE	Total	0.0031 U	0.0033 U	0.0032 U	0.0031 U	0.0031 U	0.0032 U	0.0032 U	0.0031 U	0.003 U	0.0034 J	0.003 U	0.003 U	0.0032 U	0.003 U	0.003 U	0.0031 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0087 J	0.0087 U	0.0086 U	0.0082 U	0.0082 U	0.0085 U	0.0085 U	0.0083 U	0.0079 U	0.0083 U	0.0081 U	0.0081 U	0.0085 U	0.0081 U	0.008 U	0.0082 U
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0058 J	0.0033 U	0.0032 U	0.0031 U	0.0031 U	0.0032 U	0.0032 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0033 J	0.0032 U	0.003 U	0.003 U	0.0031 U
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0093 U	0.0098 U	0.0097 U	0.0092 U	0.0092 U	0.0096 U	0.0095 U	0.0093 U	0.0089 U	0.0093 U	0.0091 U	0.0091 U	0.0095 U	0.0091 U	0.009 U	0.0092 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0062 U	0.0066 U	0.0064 U	0.0061 U	0.0061 U	0.0064 U	0.0064 U	0.0062 U	0.006 U	0.0062 U	0.006 U	0.0061 U	0.0064 U	0.0061 U	0.006 U	0.0061 U
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0025 J	0.0022 U	0.0021 U	0.002 U	0.002 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.0048 J	0.002 U	0.0049 J	0.0021 U	0.002 U	0.002 U	0.002 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0042 B	0.0023 B	0.0021 U	0.009 B	0.0059 B	0.0021 U	0.0035 J	0.0021 U	0.002 U	0.0063 B	0.0051 B	0.0085 B	0.0043 B	0.002 U	0.0025 J	0.002 U
Fluorene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0031 U	0.0033 U	0.0032 U	0.0031 U	0.0031 U	0.0032 U	0.0032 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0056 J	0.0032 U	0.003 U	0.003 U	0.0031 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0072 U	0.0076 U	0.0075 U	0.0072 U	0.0071 U	0.0074 U	0.0074 U	0.0072 U	0.0069 U	0.0073 U	0.0071 U	0.0071 U	0.0074 U	0.0071 U	0.007 U	0.0071 U
Naphthalene	µg/L	160	160	350	NE	160	NE	Total	0.013 U	0.014 U	0.014 U	0.013 J	0.013 U	0.014 U	0.014 U	0.013 U	0.015 J	0.014 U	0.013 J	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0041 U	0.0044 U	0.0043 U	0.01 B	0.0095 B	0.0085 B	0.0042 U	0.0041 U	0.004 U	0.0076 B	0.0068 B	0.0081 B	0.0045 B	0.0041 U	0.004 U	0.0058 B
Pyrene	µg/L	NE	480	1,100	NE	480	NE	Total	0.0041 U	0.0044 U	0.0043 U	0.008 B	0.005 B	0.0043 U	0.0042 U	0.0041 U	0.004 U	0.0061 J	0.0055 B	0.039 B	0.0042 B	0.0041 U	0.004 U	0.005 J
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	Total	0.005026	0.003628	0.003327	0.0035005	0.0033955	0.003812	0.003487	0.003406	0.002915	0.005916	0.003455	0.0039755	0.003577	0.0032055	0.00318	0.0033855
Polychlorinated Biphenyls (PCBs)																								
PCB-aroclor 1016	µg/L	NE	1.1	2.5	NE	1.1	NE	Total	0.022 U	0.022 U	0.021 U	0.021 U	0.022 U	0.023 U	0.023 U	0.022 U	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U
PCB-aroclor 1221	µg/L	NE	NE	NE	NE	NE	NE	Total	0.031 U	0.032 U	0.03 U	0.03 U	0.031 U	0.032 U	0.033 UJ	0.031 U	0.03 U	0.031 U	0.031 U	0.03 U	0.031 U	0.031 UJ	0.031 UJ	0.031 U
PCB-aroclor 1232	µg/L	NE	NE	NE	NE	NE	NE	Total	0.028 UJ	0.029 UJ	0.027 UJ	0.027 U	0.028 U	0.029 U	0.03 UJ	0.028 UJ	0.027 U	0.028 UJ	0.028 U	0.027 U	0.028 U	0.028 UJ	0.027 UJ	0.028 U
PCB-aroclor 1242	µg/L	NE	NE	NE	NE	NE	NE	Total	0.029 U	0.03 U	0.028 U	0.028 U	0.029 U	0.03 U	0.031 UJ	0.029 U	0.028 U	0.029 U	0.029 U	0.028 U	0.029 U	0.029 UJ	0.029 UJ	0.029 U
PCB-aroclor 1248	µg/L	NE	NE	NE	NE	NE	NE	Total	0.022 U	0.022 U	0.021 U	0.021 U	0.022 U	0.023 U	0.023 UJ	0.022 U	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U	0.022 UJ	0.021 UJ	0.022 U
PCB-aroclor 1254	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.021 U	0.021 U	0.02 U	0.02 U	0.021 U	0.021 U	0.022 UJ	0.021 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U	0.021 UJ	0.02 UJ	0.021 UJ
PCB-aroclor 1260	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.027 U	0.028 U	0.026 U	0.026 UJ	0.027 UJ	0.028 UJ	0.029 U	0.027 U	0.026 U	0.027 U	0.027 UJ	0.026 UJ	0.027 UJ	0.027 U	0.026 U	0.027 UJ
PCB-aroclor 1262	µg/L	NE	NE	NE	NE	NE	NE	Total	0.032 UJ	0.033 UJ	0.031 UJ	0.031 U	0.032 U	0.033 U	0.034 U	0.032 UJ	0.031 U	0.032 UJ	0.032 U	0.031 U	0.032 U	0.032 U	0.032 U	0.032 UJ
PCB-aroclor 1268	µg/L	NE	NE	NE	NE	NE	NE	Total	0.026 U	0.027 U	0.025 U	0.025 U	0.026 U	0.027 U	0.028 U	0.026 U	0.025 U	0.026 U	0.026 U	0.025 U	0.026 U	0.026 U	0.025 U	0.026 U
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	0.044	NE	Total	0.021 U	0.021 U	0.02 U	0.02 U	0.021 U	0.021 U	0.022 U	0.021 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U
Metals																								
Aluminum	mg/L	NE	16	35	NE	16	1.14	Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Aluminum	mg/L	NE	16	35	NE	16	0.433	Total	0.29	0.1 U	0.1 U	1.4	1.2	0.12	0.1 U	0.1 U	0.1 U	0.1 U	0.22	0.1 U	0.1	0.4	0.22	0.1 U
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.0023	**0.0079**	0.0012	0.0032	0.0033	0.0024	0.001	0.0054	0.0059	0.0016	**0.0084**	**0.04**	0.0028	0.0045	0.0034	**0.0085**
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0018	**0.007**	0.00068 J	0.0029	0.0027	0.0017	0.00067 J	**0.0049**	**0.0061**	0.0012	**0.008**	**0.038**	0.0021	**0.0049**	**0.0035**	**0.0074**
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Dissolved	0.000028 U	0.000087 B	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000045 B	0.000028 U	0.000037 B	0.000028 U	0.000058 J	0.000037 J	0.000035 J	0.000034 J	0.000028 U
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Total	0.000028 U	0.000042 J	0.000028 U	0.000061 J	0.000063 J	0.00004 J	0.000028 U	0.000028 U	0.00022 J	0.000028 U	0.000072 J	0.000028 U	0.000061 J	0.000028 U	0.000046 J	0.000028 U
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	Dissolved	0.018	0.001	0.00092	0.0016	0.0016	0.0058	0.00083	0.0092	0.00086	0.00087	0.0014	0.00041	0.0043	0.00096	0.0016	0.00065
Chromium	mg/L	0.05	24	53	0.1	0.1	0.055	Total	0.018	0.00065 B	0.00077	0.0027	0.0024	0.0058	0.00079 B	0.0089	0.00094 B	0.00086 B	0.002	0.00056	0.0024	0.0017	0.002	0.00036 J
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Dissolved	0.0014 J	0.0035	0.0006 U	0.00091 J	0.00082 J	0.0038	0.00083 J	0.0021	0.0035	0.0006 U	0.001 J	0.0051	0.0011 J	0.0016 J	0.0018 J	0.0014 J
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Total	0.0014 J	0.0029	0.0006 U	0.0039	0.0038	0.0037	0.0006 U	0.0016 J	0.0027	0.0006 U	0.0023	0.0053	0.00097 J	0.0023	0.0016 J	0.0013 J
Iron	mg/L	NE	11	25	0.3	13	13	Dissolved	0.11	0.007 J	NA	NA	NA	0.02 B	NA	0.028 J	NA	NA	NA	NA	NA	NA	NA	NA
Iron	mg/L	NE	11	25	0.3	1.361	1.361	Total	0.28	0.017 J	0.18 U	**3.3**	**3**	0.18 U	0.18 U	0.05	0.44 J	0.18 U	0.68	0.21 J	0.24 J	1	0.71	0.18 U
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Dissolved	0.000034 U	0.000045 B	0.00021 B	0.000034 U	0.000034 U	0.000034 U	0.00015 J	0.000034 U	0.000034 U	0.00011 B	0.00012 J	0.00015 J	0.000055 J	0.00029 B	0.00026 B	0.000054 B
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Total	0.00014 B	0.000034 U	0.000043 B	0.0033	0.0027	0.000034 B	0.000034 U	0.000034 U	0.00013 J	0.00018 B	0.0013	0.001	0.00036 J	0.0006	0.00024 J	0.000056 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Dissolved	0.000041 U	0.000041 U	0.000041 U	0.00007 B	0.000066 B	0.000057 B	0.000041 U	0.000041 U	0.00041 U	0.000041 U	0.000052 B	0.000065 B	0.000041 U	0.000041 U	0.000041 U	0.000043 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Total	0.000041 U	0.000041 U	0.000041 U	0.000064 B	0.000066 B	0.000071 B	0.000041 U	0.000041 U	0.00041 U	0.000041 U	0.000073 B	0.0001 B	0.000073 B	0.000041 U	0.000041 U	0.000041 U

Table 2-7
Groundwater AOC - Unconsolidated Aquifer (UA) Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter Name	Units	Screening Levels: MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	Analytical Results: ESI-1-01 2/22/2017	IB-9-01 2/22/2017	MW-2A-01 2/23/2017	MW-6B-01 2/16/2017	RI-MW42-01 (Duplicate of MW-6B) 2/16/2017	MW-8-01 2/16/2017	MW-8A-01 2/21/2017	MW-10-01 2/22/2017	MW-10A-01 2/14/2017	MW-11A-01 2/22/2017	MW-12A-01 2/15/2017	MW-14A-01 2/15/2017	MW-15A-01 2/16/2017	MW-16A-01 2/21/2017	MW-17A-01 2/21/2017	MW-E1A-01 1/27/2017
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.00043 J	0.0013 J	0.0004 U	0.0004 U	0.0004 U	0.0012 J	0.0004 U	0.0004 U	0.001 J	0.0004 U	0.00053 J	0.0018 J	0.0025 J	0.0004 U	0.0004 U	0.0004 U
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	Total	0.00044 J	0.0012 J	0.0004 U	0.002 J	0.0017 J	0.00096 J	0.0004 U	0.0004 U	0.0014 J	0.0004 U	0.001 J	0.0017 J	0.00093 J	0.0012 J	0.0007 J	0.0004 U
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Dissolved	0.00095 B	0.0037	0.0003 U	0.00083 J	0.00099 J	0.0039	0.0003 U	0.0011 B	0.0015	0.00037 B	0.00088 J	0.0013	0.0014	0.00099 B	0.00086 B	0.0018 B
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Total	0.00075 B	0.0038	0.0003 U	0.0014 B	0.0012 B	0.004	0.0003 U	0.0012 B	0.0015	0.0005 B	0.0012 B	0.0019 B	0.0015 B	0.00053 J	0.00044 J	0.0014
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Dissolved	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0033 J	0.0024 J	0.0019 U	0.0019 U	0.0027 J	0.0019 U	0.0019 U	0.0019 U
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Total	0.0019 U	0.0019 U	0.0019 U	0.0085	0.0092	0.0019 U	0.0019 U	0.0019 U	0.0087	0.0062 B	0.011	0.0023 J	0.002 J	0.0036 J	0.002 J	0.0019 U
Total Petroleum Hydrocarbons (TPHs)																								
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (VOCs)																								
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	µg/L	700	800	1,800	700	700	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Geo Chemistry																								
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	5.3	260	15	26	26	39	16	4	110	19	4.9	14	62	32	24	27
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	2.4	130	6.3	12	12	23	6.7	2	32	8	0.75 J	2.4	29	12	9.6	12
Potassium	mg/L	NE	NE	NE	NE	NE	NE	Total	7	26	3.7	4.7	4.8	6.5	3.6	3.3	22	3.5	3.3	5.5	6.8	5	4.5	5.3
Sodium	mg/L	NE	NE	NE	NE	NE	NE	Total	160	910	6.4	29	30	80	7.8	96	2,100	8	400	830	33	32	48	47
Chloride	mg/L	NE	NE	NE	NE	NE	NE	Total	4.9 J	42 J	3.5	3.6	3.5	7.8	3.9	2.3 B	110	4 J	58	68	23	3.3	3.3	5.1
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	5.3	260	15	26	26	39	16	4	110	19	4.9	14	62	32	24	27
Total Dissolved Solids	mg/L	NE	NE	NE	NE	NE	NE	Total	490	3,900	150	220	200	420	150	250	6,700	150	1,300	2,600	440	240	250	300
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	2.4	130	6.3	12	12	23	6.7	2	32	8	0.75 J	2.4	29	12	9.6	12
Alkalinity, Total	mg/L	NE	NE	NE	NE	NE	NE	Total	270	320	58	110	120	220	59	100	220	71	130	210	130	130	130	130
Bicarbonate Alkalinity as CaC03	mg/L	NE	NE	NE	NE	NE	NE	Total	230	320	58	110	120	220	59	100	220	71	130	210	130	130	130	130
Carbonate Alkalinity as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	37	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity as Hydroxide	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hardness as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	28	4,000	65	110	110	180	150	17	410	72	20	44	3,000	120	95	120

Notes:
Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.

cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration
µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated biphenyls
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volatile Organic Compounds

Table 2-7
Groundwater AOC - Unconsolidated Aquifer (UA) Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter Name	Units	Screening Levels: MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	Analytical Results: MW-E7-01 1/27/2017	MW-W1-01 2/14/2017	MW-W4-01 1/27/2017	RI-GW1-01 2/21/2017	RI-GW2A-01 1/25/2017	RI-GW4A-01 2/13/2017	RI-GW5-01 1/27/2017	RI-GW6-01 1/25/2017	RI-GW7-01 1/26/2017	RI-MW40-01 (Duplicate of RI-GW7) 1/26/2017	RI-GW8-01 1/25/2017	RI-GW9-01 1/25/2017	RI-MW4-UA-01 3/1/2017	RI-MW5-UA-01 2/28/2017
Aluminum Smelter																						
Total Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	**0.06**	0.06 U	**0.065**	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	**0.48 J**	0.06 U	0.06 U	0.06 U	0.06 U
Cyanide, Free	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.0015 U	0.0015 U	0.0015 U	0.0015 UJ	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.002 J	0.0015 U	0.0015 U	0.0015 U	0.0015 U
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	Total	**3.3 J**	0.41	0.67 J	0.77	**2.7**	**4.8**	**17**	**10**	**17**	**18**	**4.4**	**2.7**	0.15 J	0.27
Sulfate	mg/L	NE	NE	NE	250	250	32	Total	47 J	**630**	43 J	**1,100**	43	33	180	4	17 J	160 J	32	0.56 B	14	22
Polynuclear Aromatic Hydrocarbons (PAHs)																						
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	1.5	NE	Total	0.0062 U	0.0062 U	0.006 U	0.0063 U	0.0063 U	0.026	0.0061 U	0.4	0.0061 U	0.0061 U	0.006 U	**10**	0.006 U	0.0065 U
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	Total	0.0093 U	0.0093 U	0.009 U	0.0095 U	0.0095 U	0.028 J	0.0092 U	0.0097 U	0.0091 U	0.0091 U	0.009 U	0.36	0.0091 U	0.0097 U
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	Total	0.005 J	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.002 U	0.71	0.002 U	0.002 U	0.002 U	1	0.002 U	0.0022 U
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0052 J	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.002 U	0.19	0.002 U	0.002 U	0.002 U	0.38	0.002 U	0.0022 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	Total	0.012 J	0.0031 U	0.003 U	0.0032 U	0.0053 J	0.017 J	0.019 J	0.11	0.003 U	0.0083 J	0.003 U	0.43	0.003 U	0.0032 U
Benzo[a]anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.063	0.0043 J	0.002 U	0.0051 B	0.0021 U	0.0068 J	0.0078 J	0.0021 U	0.002 U	0.0044 J	0.002 U	0.0021 U	0.002 U	0.0022 U
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	0.023	NE	Total	**0.11**	0.0035 J	0.003 U	0.0032 U	0.0032 U	0.003 U	0.0031 U	0.0066 J	0.003 U	0.003 U	0.003 U	0.0031 U	0.003 U	0.0032 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.19	0.0083 U	0.008 U	0.0084 U	0.0084 U	0.0081 U	0.013 J	0.013 J	0.0081 U	0.0081 U	0.008 U	0.0083 U	0.0081 U	0.0086 U
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.13	0.0031 U	0.003 U	0.0032 U	0.0032 U	0.003 U	0.012 J	0.0066 J	0.003 U	0.003 U	0.003 U	0.0031 U	0.003 U	0.0032 U
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.069	0.0093 U	0.009 U	0.0095 U	0.0095 U	0.0091 U	0.0092 U	0.0097 U	0.0091 U	0.0091 U	0.009 U	0.0093 U	0.0091 U	0.0097 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.097	0.0062 U	0.006 U	0.0063 U	0.0063 U	0.0075 J	0.012 J	0.0064 U	0.0061 U	0.0061 U	0.006 U	0.0062 U	0.006 U	0.0065 U
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.019 J	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.002 U	0.0068 J	0.002 U	0.002 U	0.002 U	0.0021 U	0.002 U	0.0022 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	Total	0.12	0.0058 J	0.002 U	0.0021 U	0.0021 U	0.011 J	0.036 B	0.041	0.002 U	0.0056 J	0.002 U	0.0021 U	0.002 U	0.0022 U
Fluorene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0031 U	0.0031 U	0.003 U	0.0032 U	0.0032 U	0.003 U	0.0031 U	2.1	0.0085 J	0.003 U	0.003 U	2.8	0.003 U	0.0032 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.13	0.0072 U	0.007 U	0.0074 U	0.0074 U	0.007 U	0.01 J	0.011 J	0.0071 U	0.0071 U	0.007 U	0.0073 U	0.007 U	0.0075 U
Naphthalene	µg/L	160	160	350	NE	160	NE	Total	0.013 U	0.018 J	0.013 U	0.14 J	0.014 U	0.015 J	0.013 U	0.15	0.013 U	0.013 U	0.013 U	0.33	0.013 U	0.014 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.033 B	0.0044 B	0.0041 B	0.0042 U	0.0048 B	0.01 B	0.0072 B	0.0043 U	0.0085 B	0.0052 B	0.004 U	2.6	0.0064 B	0.0066 B
Pyrene	µg/L	NE	480	1,100	NE	480	NE	Total	0.11	0.0057 J	0.004 U	0.0042 U	0.0042 U	0.01 J	0.034 B	0.0043 U	0.004 U	0.0063 J	0.004 U	0.0042 U	0.004 U	0.0043 U
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	Total	0.15807	0.005306	0.00293	0.0035115	0.0031065	0.003565	0.00531	0.010302	0.0029455	0.0032855	0.00293	0.003036	0.00294	0.0031425
Polychlorinated Biphenyls (PCBs)																						
PCB-aroclor 1016	µg/L	NE	1.1	2.5	NE	1.1	NE	Total	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U	0.021 U	0.021 U	0.023 U	0.021 U
PCB-aroclor 1221	µg/L	NE	NE	NE	NE	NE	NE	Total	0.03 U	0.031 U	0.031 U	0.032 UJ	0.031 UJ	0.03 U	0.031 UJ	0.032 UJ	0.03 UJ	0.031 UJ	0.03 UJ	0.03 UJ	0.033 U	0.03 U
PCB-aroclor 1232	µg/L	NE	NE	NE	NE	NE	NE	Total	0.027 U	0.028 U	0.028 U	0.029 UJ	0.028 U	0.027 U	0.028 U	0.028 U	0.027 U	0.028 U	0.027 U	0.027 U	0.029 U	0.027 U
PCB-aroclor 1242	µg/L	NE	NE	NE	NE	NE	NE	Total	0.028 U	0.029 U	0.029 U	0.03 UJ	0.029 U	0.028 U	0.029 U	0.029 U	0.028 U	0.029 U	0.028 U	0.028 U	0.031 U	0.028 U
PCB-aroclor 1248	µg/L	NE	NE	NE	NE	NE	NE	Total	0.021 U	0.022 U	0.022 U	0.022 UJ	0.022 U	0.021 U	0.022 U	0.022 U	0.021 U	0.022 U	0.021 U	0.021 U	0.023 U	0.021 U
PCB-aroclor 1254	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.02 UJ	0.021 U	0.021 UJ	0.021 UJ	0.021 U	0.02 UJ	0.021 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U	0.022 U	0.02 U
PCB-aroclor 1260	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.026 UJ	0.027 U	0.027 UJ	0.028 U	0.027 U	0.026 UJ	0.027 U	0.027 U	0.026 U	0.027 U	0.026 U	0.026 U	0.028 U	0.026 U
PCB-aroclor 1262	µg/L	NE	NE	NE	NE	NE	NE	Total	0.031 UJ	0.032 U	0.032 UJ	0.033 U	0.032 U	0.031 UJ	0.032 U	0.033 U	0.031 U	0.032 U	0.031 U	0.031 U	0.034 U	0.031 U
PCB-aroclor 1268	µg/L	NE	NE	NE	NE	NE	NE	Total	0.025 U	0.026 U	0.026 U	0.027 U	0.026 U	0.025 U	0.026 U	0.026 U	0.025 U	0.026 U	0.025 U	0.025 U	0.027 U	0.025 U
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	0.044	NE	Total	0.02 U	0.021 U	0.021 U	0.021 U	0.021 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U	0.022 U	0.02 U
Metals																						
Aluminum	mg/L	NE	16	35	NE	16	1.14	Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.22	0.1 U	0.13 J	0.19 J	0.1 U	0.1 U	0.1 U	1.9
Aluminum	mg/L	NE	16	35	NE	16	0.433	Total	3.7	9.3	1.3	0.1 U	2.7	0.28	0.63	0.1 U	1.1	1	0.1 U	0.18	0.9	1.4
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.0019	0.0027	0.005	0.0062	0.0027	0.0017	0.002 B	0.00089 J	0.0024	0.0022	0.0022	0.0045	0.0013	**0.0072**
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0011	**0.011**	**0.005**	**0.0059**	0.0028	0.0013	0.0007 J	0.00042 J	0.0017 J	0.0013 J	0.0016	**0.004**	0.001	**0.0069**
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Dissolved	0.000028 U	0.000028 U	0.000028 U	0.000045 J	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 J
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Total	0.00005 J	0.00026 J	0.000028 U	0.000028 U	0.000039 J	0.00003 J	0.000051 J	0.000028 U	0.000028 U	0.000064 J	0.000028 U	0.000028 U	0.000036 J	0.000041 J
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	Dissolved	0.00072	0.0015	0.00062	0.00085	0.004	0.00035 J	0.00041 B	0.00029 J	0.0023 J	0.0015 J	0.00027 J	0.00031 J	0.00086	0.0015
Chromium	mg/L	0.05	24	53	0.1	0.1	0.055	Total	0.0026	**0.18**	0.002	0.00062 B	0.0049	0.00039 J	0.00033 B	0.00018 B	0.0025	0.0021	0.00028 B	0.00026 B	0.0015	0.0011
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Dissolved	0.00092 J	0.0006 U	0.0006 U	0.0028	0.00067 J	0.0006 U	0.00088 J	0.0006 U	0.00081 J	0.00086 J	0.0069	0.0013 J	0.0006 U	0.002
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Total	0.0095	0.02	0.0022	0.0015 J	0.004	0.00062 J	0.0011 B	0.0031 B	0.0013 J	0.0013 J	0.0011 B	0.0006 U	0.002	0.0014 J
Iron	mg/L	NE	11	25	0.3	13	13	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	mg/L	NE	11	25	0.3	1.361	1.361	Total	**5.2**	**25**	**2.6**	0.19 J	**4.8**	0.49 J	NA	**11**	1.2	0.96	0.18 U	**4**	NA	**1.6**
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Dissolved	0.000047 J	0.000037 J	0.00017 J	0.00029 J	0.000048 B	0.000094 J	0.000034 U	0.000049 B	0.000042 J	0.000034 U	0.000034 U	0.00013 B	0.00041	0.00043
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Total	0.0014	0.012	0.0012	0.000087 J	0.0012	0.00011 J	0.00018 B	0.00016 B	0.00026 B	0.00036 J	0.000034 U	0.00004 B	0.00072	0.00025 J
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Dissolved	0.000041 U	0.000069 B	0.000051 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000054 B	0.000072 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Total	0.000041 U	0.000068 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000043 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000057 B	0.000041 U

Table 2-7
Groundwater AOC - Unconsolidated Aquifer (UA) Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

		Screening Levels							Analytical Results														
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	MW-E7-01 1/27/2017	MW-W1-01 2/14/2017	MW-W4-01 1/27/2017	RI-GW1-01 2/21/2017	RI-GW2A-01 1/25/2017	RI-GW4A-01 2/13/2017	RI-GW5-01 1/27/2017	RI-GW6-01 1/25/2017	RI-GW7-01 1/26/2017	RI-MW40-01 (Duplicate of RI-GW7) 1/26/2017	RI-GW8-01 1/25/2017	RI-GW9-01 1/25/2017	RI-MW4-UA-01 3/1/2017	RI-MW5-UA-01 2/28/2017
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.0004 U	0.0043	0.0005 J	0.0013 J	0.00056 J	0.0018 J	0.0029 J	0.0004 U	0.0004 U	0.00042 J	0.0049	0.0015 J	0.0004 U	0.0008 J
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	Total	0.003	**0.12**	0.0019 J	0.0016 J	0.0024 J	0.0017 J	0.0032 B	0.0004 U	0.00044 J	0.001 J	**0.0046**	0.0006 J	0.00085 J	0.00056 J
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Dissolved	0.0011 B	0.011	0.00064 B	0.00096 J	0.00074 B	0.0003 U	0.0012	0.00033 B	0.0012 B	0.0029 J	0.00057 B	0.0003 U	0.0003 U	0.001
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Total	0.0012	0.012	0.00044 J	0.00081 J	0.00067 J	0.0003 U	0.00091 J	0.0003 U	0.0011 B	0.0033 J	0.00045 J	0.0003 U	0.00032 J	0.0011
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Dissolved	0.0019 U	0.0019 U	0.0028 J	0.0019 U	0.0019 U	0.0034 J	0.003 J	0.0019 U	0.0019 J	0.0019 U	0.002 J	0.0027 J	0.0019 U	0.0046 J
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Total	0.01	0.042	0.0065 J	0.0019 U	0.012 B	0.0022 J	0.0035 B	0.0025 B	0.0025 J	0.0037 J	0.0019 B	0.0019 U	0.005 J	0.003 J
Total Petroleum Hydrocarbons (TPHs)																							
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NE	Total	NA	NA	NA	0.027 U	0.027 U	0.027 U	NA	0.27	NA	NA	0.027 U	0.79	NA	NA
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	0.036 B	0.1 B	0.064 J	NA	**3.8**	NA	NA	0.26	**3.3**	NA	NA
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	0.032 U	0.059 J	0.03 U	NA	**0.54**	NA	NA	0.13 J	0.32	NA	NA
Volatile Organic Compounds (VOCs)																							
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	Total	NA	NA	NA	0.025 U	0.025 U	0.42 U	NA	0.036 J	NA	NA	0.025 U	0.044 J	NA	NA
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	Total	NA	NA	NA	0.077 J	0.025 U	0.18 U	NA	0.025 U	NA	NA	0.025 U	0.025 U	NA	NA
Ethylbenzene	µg/L	700	800	1,800	700	700	NE	Total	NA	NA	NA	0.064 J	0.03 U	0.21 U	NA	0.03 U	NA	NA	0.03 U	0.03 U	NA	NA
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	0.066 J	0.05 U	0.3 U	NA	0.05 U	NA	NA	0.05 U	0.05 U	NA	NA
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	0.06 U	0.06 U	0.49 U	NA	0.075 J	NA	NA	0.06 U	0.14 J	NA	NA
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	Total	NA	NA	NA	0.025 U	0.025 U	0.025 U	NA	0.025 U	NA	NA	0.025 U	0.025 U	NA	NA
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	Total	NA	NA	NA	0.025 U	0.025 U	0.025 U	NA	0.025 U	NA	NA	0.025 U	0.025 U	NA	NA
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	Total	NA	NA	NA	0.025 U	0.025 U	0.025 U	NA	0.025 U	NA	NA	0.025 U	0.025 U	NA	NA
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	Total	NA	NA	NA	0.07 U	0.07 U	0.07 U	NA	0.07 U	NA	NA	0.07 U	0.07 U	NA	NA
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	Total	NA	NA	NA	0.076 J	0.025 U	0.025 U	NA	0.025 U	NA	NA	0.025 U	0.025 U	NA	NA
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	Total	NA	NA	NA	**0.13**	0.013 U	0.013 U	NA	0.013 U	NA	NA	0.013 U	0.013 U	NA	NA
Geo Chemistry																							
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	35	160	55	49	28	30	33	41	27 J	46 J	49	67	15	20
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	19	69	30	21	12	14	19	18	5.2	26	23	38	6.2	8.8
Potassium	mg/L	NE	NE	NE	NE	NE	NE	Total	6.6	18	5.5	9	5.9	6.7	6.2	6.8	4.2 J	8.9 J	11	9.8	3.5	4.9
Sodium	mg/L	NE	NE	NE	NE	NE	NE	Total	24	96	24	580	17	12	70	20	26 J	71 J	20	17	8.8	7.5
Chloride	mg/L	NE	NE	NE	NE	NE	NE	Total	12 J	18	5.5 J	28	7.7	17	8.2	3.1	16 J	10 J	9.2	4.9	3.2	3.2
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	35	160	55	49	28	30	33	41	27 J	46 J	49	67	15	20
Total Dissolved Solids	mg/L	NE	NE	NE	NE	NE	NE	Total	290	1,200	360	2,000	200	220	440	260	230 J	530 J	330	400	130	160
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	19	69	30	21	12	14	19	18	5.2	26	23	38	6.2	8.8
Alkalinity, Total	mg/L	NE	NE	NE	NE	NE	NE	Total	120	150	220	190	73	80	65	200	52 J	120 J	190	370	52	80
Bicarbonate Alkalinity as CaC03	mg/L	NE	NE	NE	NE	NE	NE	Total	120	150	220	190	73	80	65	200	52 J	120 J	190	370	52	80
Carbonate Alkalinity as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity as Hydroxide	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hardness as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	170	800	280	160	120	130	160	200	180 J	230 J	230	350	1,400	92

Notes:
Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.

cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration
µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established

PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated biphenyls
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volatile Organic Compounds

Table 2-8
Groundwater AOC - Basalt Aquifer - Upper (BAU) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 4)

Parameter Name	Units	Screening Levels: MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	Analytical Results: BAMW-1-01 2/14/2017	BAMW-3-01 1/26/2017	IB-1-01 2/23/2017	IB-2-01 3/1/2017	IB-2A-01 2/16/2017	IB-3-01 2/25/2017	IB-4-01 2/25/2017	IB-5-01 2/24/2017	IB-5A-01 2/24/2017	IB-5AA-01 2/24/2017	IB-10-01 2/24/2017	IB-11-01 2/24/2017	IB-12A-01 3/2/2017	MW-2B-01 2/23/2017	RI-MW43-01 (Duplicate of MW-2B) 2/23/2017	MW-3B-01 2/15/2017	MW-7B-01 2/23/2017	MW-18-01 3/1/2017
Aluminum Smelter																										
Total Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.06 U	**0.49**	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 UJ	0.06 UJ	0.06 UJ	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 U	0.06 U
Cyanide, Free	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.0015 U	0.0022 J	0.0015 UJ	0.0015 U	0.0015 UJ	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 UJ	0.0015 U
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 UJ	0.06 UJ	0.06 UJ	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	Total	0.3	**19**	**1.1**	0.56 J	**13**	0.31	0.5	0.25 J	0.16	0.14	0.2	0.68	**4.4 J**	0.18	0.19	0.09 J	0.27	0.08 J
Sulfate	mg/L	NE	NE	NE	250	250	32	Total	34	170	29	**550**	38	18	64	**480 J**	**1,000 J**	**380**	250	83	**930**	12	13	**1,800**	140	**1,400**
Polynuclear Aromatic Hydrocarbons																										
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	1.5	NE	Total	0.0061 UJ	0.0063 U	0.006 U	0.0063 U	0.0063 U	0.0061 U	0.0065 U	0.0066 U	0.013 J	0.0063 U	0.0065 U	0.0062 U	0.0062 U	0.0062 U	0.0064 U	0.0065 U	0.0063 U	0.0062 U
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	Total	0.0091 UJ	0.0094 U	0.009 U	0.0094 U	0.0094 U	0.0091 U	0.0097 U	0.0099 U	0.016 J	0.0094 U	0.0098 U	0.0094 U	0.0093 U	0.0094 U	0.0096 U	0.0098 U	0.0094 U	0.0093 U
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	Total	0.002 UJ	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.0022 U	0.0022 U	0.0021 U	0.0074 J	0.0022 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.002 UJ	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.0022 U	0.0022 U	0.0021 U	0.0053 J	0.0022 U	0.0021 U	0.006 J	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	Total	0.003 UJ	0.008 J	0.003 U	0.0031 U	0.0031 U	0.003 U	0.0032 U	0.0033 U	0.0031 U	0.0043 J	0.0033 U	0.0031 U	0.023	0.0031 U	0.0032 U	0.0033 U	0.0031 U	0.0031 U
Benzo[a]anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.002 UJ	0.0051 J	0.003 J	0.022	0.0021 U	0.0021 J	0.0022 U	0.0022 U	0.0039 J	0.0083 J	0.0022 U	0.0021 U	0.038	0.0035 J	0.0026 J	0.0072 B	0.0023 J	0.0021 U
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	0.023	NE	Total	0.003 UJ	0.0053 J	0.003 U	**0.029**	0.0031 U	0.003 U	0.0032 U	0.0033 U	0.0037 J	0.009 J	0.0033 U	0.0031 U	**0.027**	0.0031 U	0.0032 U	0.0037 J	0.0031 U	0.0031 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0081 UJ	0.0084 U	0.008 U	0.046	0.0084 U	0.0081 U	0.0087 U	0.0088 U	0.0083 U	0.011 J	0.0087 U	0.0083 U	0.044	0.0083 U	0.0086 U	0.0087 U	0.0084 U	0.0083 U
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.003 UJ	0.0052 J	0.003 U	0.031	0.0031 U	0.003 U	0.0032 U	0.0033 U	0.0031 U	0.0093 J	0.0033 U	0.0031 U	0.026	0.0031 U	0.0032 U	0.0033 U	0.0031 U	0.0031 U
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0091 UJ	0.0094 U	0.009 U	0.018 J	0.0094 U	0.0091 U	0.0097 U	0.0099 U	0.0093 U	0.013 J	0.0098 U	0.0094 U	0.02 J	0.0094 U	0.0096 U	0.0098 U	0.0094 U	0.0093 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0061 UJ	0.0063 U	0.006 U	0.035	0.0063 U	0.0061 U	0.0065 U	0.0066 U	0.0062 U	0.0099 J	0.0065 U	0.0062 U	0.027	0.0062 U	0.0064 U	0.0065 U	0.0063 U	0.0062 U
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.002 UJ	0.0021 U	0.002 U	0.0021 U	0.0021 U	0.002 U	0.0022 U	0.0022 U	0.0021 U	0.0058 J	0.0022 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	Total	0.002 UJ	0.0058 J	0.003 J	0.036	0.0021 U	0.002 U	0.0022 U	0.0022 U	0.0067 J	0.011 J	0.0022 U	0.0027 J	0.038	0.003 J	0.0022 J	0.005 B	0.0021 U	0.0021 U
Fluorene	µg/L	NE	640	1,400	NE	640	NE	Total	0.003 UJ	0.0031 U	0.003 U	0.0031 U	0.0031 U	0.003 U	0.0032 U	0.0033 U	0.0031 U	0.0041 J	0.0033 U	0.0031 U	0.0031 U	0.0031 U	0.0032 U	0.0033 U	0.0031 U	0.0031 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0071 UJ	0.0073 U	0.007 U	0.032	0.0073 U	0.0071 U	0.0076 U	0.0077 U	0.0072 U	0.0073 U	0.0076 U	0.0073 U	0.027	0.0073 U	0.0075 U	0.0076 U	0.0073 U	0.0072 U
Naphthalene	µg/L	160	160	350	NE	160	NE	Total	0.013 UJ	0.014 U	0.013 U	0.024 J	0.014 U	0.013 U	0.014 U	0.014 U	0.029 B	0.014 U	0.014 U	0.014 U	0.013 U	0.03 J	0.014 U	0.014 U	0.014 U	0.013 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0041 UJ	0.005 B	0.004 U	0.022 B	0.0042 U	0.0054 B	0.0043 U	0.0046 B	0.0063 B	0.0099 B	0.0044 U	0.0045 B	0.018 B	0.0044 J	0.0043 U	0.0046 B	0.0042 U	0.0059 B
Pyrene	µg/L	NE	480	1,100	NE	480	NE	Total	0.0041 UJ	0.0082 J	0.004 U	0.034	0.0042 U	0.004 U	0.0043 U	0.0044 U	0.01 J	0.0097 J	0.0044 U	0.0042 U	0.04	0.0042 U	0.0043 U	0.0056 B	0.0042 U	0.0041 U
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	Total	0.0029455	0.0072015	0.00313	0.041255	0.0030465	0.0030555	0.0031525	0.003223	0.005466	0.013274	0.0032075	0.003041	0.040275	0.003286	0.003282	0.0058675	0.0031715	0.003031
Polychlorinated Biphenyls																										
PCB-aroclor 1016	µg/L	NE	1.1	2.5	NE	1.1	NE	Total	0.021 U	0.022 U	0.023 U	0.021 U	0.022 U	0.022 U	0.024 U	0.023 U	0.021 U	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.021 U	0.022 U
PCB-aroclor 1221	µg/L	NE	NE	NE	NE	NE	NE	Total	0.03 U	0.032 UJ	0.032 U	0.03 U	0.032 U	0.031 UJ	0.034 UJ	0.033 UJ	0.03 UJ	0.03 UJ	0.032 UJ	0.032 UJ	0.031 U	0.031 U	0.031 U	0.031 U	0.03 U	0.031 U
PCB-aroclor 1232	µg/L	NE	NE	NE	NE	NE	NE	Total	0.027 U	0.029 U	0.029 UJ	0.027 U	0.028 U	0.028 UJ	0.031 UJ	0.03 UJ	0.027 UJ	0.027 UJ	0.029 UJ	0.029 UJ	0.028 U	0.028 UJ	0.028 UJ	0.028 U	0.027 UJ	0.028 U
PCB-aroclor 1242	µg/L	NE	NE	NE	NE	NE	NE	Total	0.028 U	0.03 U	0.03 U	0.028 U	0.03 U	0.029 UJ	0.032 UJ	0.031 UJ	0.028 UJ	0.028 UJ	0.03 UJ	0.03 UJ	0.029 U	0.029 U	0.029 U	0.029 U	0.028 U	0.029 U
PCB-aroclor 1248	µg/L	NE	NE	NE	NE	NE	NE	Total	0.021 U	0.022 U	0.023 U	0.021 U	0.022 U	0.022 U	0.024 U	0.023 U	0.021 U	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.021 U	0.022 U
PCB-aroclor 1254	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.02 U	0.021 U	0.022 U	0.02 U	0.021 U	0.021 U	0.023 U	0.022 U	0.02 U	0.02 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.02 U	0.021 U
PCB-aroclor 1260	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.026 U	0.028 U	0.028 U	0.026 U	0.027 UJ	0.027 U	0.029 U	0.029 U	0.026 U	0.026 U	0.028 U	0.028 U	0.027 U	0.027 U	0.027 U	0.027 UJ	0.026 U	0.027 U
PCB-aroclor 1262	µg/L	NE	NE	NE	NE	NE	NE	Total	0.031 U	0.033 U	0.034 UJ	0.031 U	0.033 U	0.032 U	0.035 U	0.034 U	0.031 U	0.031 U	0.033 U	0.033 U	0.032 U	0.032 UJ	0.032 UJ	0.032 U	0.031 UJ	0.032 U
PCB-aroclor 1268	µg/L	NE	NE	NE	NE	NE	NE	Total	0.025 U	0.027 U	0.027 U	0.025 U	0.026 U	0.026 U	0.028 U	0.028 U	0.025 U	0.025 U	0.027 U	0.027 U	0.026 U	0.026 U	0.026 U	0.026 U	0.025 U	0.026 U
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	0.044	NE	Total	0.02 U	0.021 U	0.022 U	0.02 U	0.021 U	0.021 U	0.023 U	0.022 U	0.02 U	0.02 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.02 U	0.021 U
Metals																										
Aluminum	mg/L	NE	16	35	NE	16	1.4	Dissolved	0.1 U	0.2	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Aluminum	mg/L	NE	16	35	NE	16	0.433	Total	0.15	1.1	0.12	0.17	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.13	0.15	0.1 U	0.1 U	0.1 U	2.4	0.1 U
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.0018	0.0021	0.0025	0.0066	0.0017	0.0015	0.0029	0.0021	0.0034	0.004	0.0032	**0.0093**	0.0047	0.0013	0.0012	0.0044	0.0019	0.0061
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0014	0.0013	0.0021	**0.0063**	0.0011	0.0011	0.0026	0.0014	0.003	**0.0038**	0.0028	**0.0089**	**0.004**	0.00067 J	0.00068 J	**0.0036 B**	0.00097 J	**0.005**
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Dissolved	0.00004 J	0.000028 U	0.000028 U	0.0026	0.000032 J	0.000028 U	0.000052 B	0.000039 B	0.000034 B	0.000085 B	0.000028 U	0.000028 U	0.00007 J	0.000028 U	0.000028 U	0.000028 U	0.00013 B	0.000028 U
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Total	0.000028 U	0.000028 U	0.000028 U	0.0029	0.000028 U	0.000028 B	0.000099 B	0.000028 U	0.00046	0.00023 B	0.000028 U	0.000056 B	0.00015 J	0.000028 U	0.000028 U	0.000042 J	0.00011 B	0.00003 J
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	Dissolved	0.00061	0.0016	0.00049	0.00055	0.00029 J	0.00051	0.00062	0.0013	0.0005	0.00058	0.00082	0.00045	0.00052	0.00099	0.00089	0.00029 J	0.00052	0.00032 J
Chromium	mg/L	0.05	24	53	0.1	0.1	0.055	Total	0.0054	0.0021	0.00053	0.01	0.00079	0.00037 J	0.00071	0.0019	0.0015	0.0059	0.0063	0.00075 B	0.0046	0.00084	0.00079	0.00089	0.0023	0.0016
Copper	mg/L	NE	0.64	1.4	13	0.64	NE	Dissolved	0.0006 U	0.001 J	0.00082 J	0.0045	0.0047	0.00063 J	0.0046	0.0022	0.0006 U	0.0022	0.0018 J	0.00089 J	0.005	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
Copper	mg/L	NE	0.64	1.4	13	0.64	NE	Total	0.001 B	0.0015 J	0.0009 J	0.0069	0.0043	0.0006 U	0.005	0.0019 J	0.0026	0.0047	0.0036	0.0011 J	0.008	0.0006 U	0.0006 U	0.0013 J	0.0043	0.0012 J
Iron	mg/L	NE	11	25	0.3	13	13	Dissolved	NA	NA	NA	0.013 J	0.017 B	0.0092 B	0.011 B	0.0082 B	0.2	0.0064 B	0.01 B	0.0059 B	0.016 J	NA	NA	NA	NA	NA
Iron	mg/L	NE	11	25	0.3	1.361	1.361	Total	0.8	0.97	0.18 U	0.31	0.18 U	0.089	0.11	0.18 U	0.24 B	0.18 U	0.18 U	0.18 U	0.63	0.18 U	0.18 U	0.23 J	**7.3**	NA
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Dissolved	0.00004 J	0.000034 U	0.00004 B	0.0004	0.000034 U	0.00011 B	0.000065 B	0.00014 B	0.00047	0.00014 B	0.00013 B	0.00004 B	0.00072	0.000053 B	0.000073 B	0.000037 J	0.000054 B	0.00087
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Total	0.00056	0.00044	0.00032 J	0.0049	0.000063 B	0.00011 J	0.000095 J	0.00046	0.0021	0.0022	0.000034 U	0.00056	0.0016	0.000058 B	0.000034 U	0.0017	0.0017	0.00017 J
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Dissolved	0.00008 B	0.000041 B	0.000041 U	0.000047 B	0.000068 B	0.000045 B	0.000093 B	0.000041 U	0.000044 J	0.000041 U	0.000041 U	0.000041 U	0.000046 B	0.000041 U	0.000041 U	0.000048 B	0.000041 U	0.00006 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Total	0.00007 B	0.000041 U	0.000041 U	0.000064 B	0.000066 B	0.000041 U	0.000098 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000064 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000065 B
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.00046 J	0.00043 J	0.0004 U	**0.014**	0.0014 J	0.0004 U	0.0021 J	0.0014 J	0.00082 J	**0.0068**	0.0018 J	0.00046 J	0.0055	0.0004 U	0.0004 U	0.00071 J	0.0004 U	0.00059 J
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	Total	0.0036	0.00084 J	0.0004 U	**0.018**	0.0013 J	0.0004 U	0.0026 J	0.002 J	0.0022 J	**0.0096**	**0.0045**	0.002 J	**0.024**	0.0004 U	0.0004 U	0.0014 J	0.0021 J	0.00091 J
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Dissolved	0.00035 J	0.003	0.0022	0.00043 J	0.00044 J	0.00061 J	0.00041 J	0.0009 J	0.0003 U	0.00034 J	0.0003 U	0.0003 U	0.00059 J	0.00032 J	0.0003 U	0.0011	0.0003 U	0.001
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Total	0.0003 U	0.003	0.0023	0.00053 J	0.00074 B	0.00079 B	0.00089 B	0.00094 B	0.00065 B	0.00079 B	0.00051 B	0.00056 B	0.00065 J	0.0003 U	0.0003 U	0.0013 B	0.0003 U	0.0011
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Dissolved	0.0019 J	0.0051 J	0.0019 U	1.3	0.002 J	0.002 J	0.0019 U	0.0034 J	0.0019 U	0.0022 J	0.0019 U	0.0019 J	0.0053 J	0.0019 U	0.0019 U	0.0019 U	0.0079	0.0019 U
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Total	0.003 J	0.0038 J	0.002 J	1.3	0.0019 U	0.0019 U	0.0041 J	0.0051 B	0.01 B	0.0045 B	0.0019 U	0.0027 B	0.0088	0.0019 U	0.0019 U	0.002 J	0.013	0.0025 J

Table 2-8
Groundwater AOC - Basalt Aquifer - Upper (BAU) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

		Screening Levels							Analytical Results																	
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	BAMW-1-01 2/14/2017	BAMW-3-01 1/26/2017	IB-1-01 2/23/2017	IB-2-01 3/1/2017	IB-2A-01 2/16/2017	IB-3-01 2/25/2017	IB-4-01 2/25/2017	IB-5-01 2/24/2017	IB-5A-01 2/24/2017	IB-5AA-01 2/24/2017	IB-10-01 2/24/2017	IB-11-01 2/24/2017	IB-12A-01 3/2/2017	MW-2B-01 2/23/2017	RI-MW43-01 (Duplicate of MW-2B) 2/23/2017	MW-3B-01 2/15/2017	MW-7B-01 2/23/2017	MW-18-01 3/1/2017
Total Petroleum Hydrocarbons																										
Gasoline	mg/L	1.0	NE	NE	NE	1.0	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
#2 Diesel	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Motor Oil	mg/L	0.5	NE	NE	NE	0.5	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds																										
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	µg/L	700	800	1,800	700	700	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Geochemistry																										
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	23	47	9.4	57	27	16	24	78	220	80	81	39	300	15	16	320	47	350
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	10	26	5.1	28	16	9.7	14	34	110	38	46	20	130	6.4	6.6	150	23	150
Potassium	mg/L	NE	NE	NE	NE	NE	NE	Total	3.7	9	3.9	4.9	5.5	3 J	3 J	12	5.8	5.5	6.8	7	9.6	3.9	3.9	15	5.7	11
Sodium	mg/L	NE	NE	NE	NE	NE	NE	Total	12	72	40	180	47	7.5	19	120	54	81	22	64	260	6.7	6.8	260	13	60
Chloride	mg/L	NE	NE	NE	NE	NE	NE	Total	3.1	10	3.4	14	20	2.1	6.5	6.6 J	13	4.9	18	26	11	3.5	3.5	95	11	83
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	23	47	9.4	57	27	16	24	78	220	80	81	39	300	15	16	320	47	350
Total Dissolved Solids	mg/L	NE	NE	NE	NE	NE	NE	Total	170	530	220	930	250	160	250	870	1,600	810	630	410	1,600	160	140	2,900	290	2,100
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	10	26	5.1	28	16	9.7	14	34	110	38	46	20	130	6.4	6.6	150	23	150
Alkalinity, Total	mg/L	NE	NE	NE	NE	NE	NE	Total	95	140	70	120	130	69	88	120	60	110	130	150	140	59	57	110	70	93
Alkalinity as Bicarbonate	mg/L	NE	NE	NE	NE	NE	NE	Total	95	140	70	120	130	69	88	120	60	110	130	150	140	59	57	110	70	93
Alkalinity as Carbonate	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity as Hydroxide	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hardness as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	96	250	43	2,500	120	77	120	1,700	11,000	2,000	2,000	170	13,000	64	62	14,000	420	16,000

Notes:

Bold values denote exceedances of one or more screening levels and background concentrations.

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.

J = Estimated concentration

MTCA = Model Toxics Control Act

NA = Not Analyzed

NE = Not Established

TEC = Toxicity Equivalent Concentration

U = Chemical was not detected. The associated value represents the method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.

Table 2-8
Groundwater AOC - Basalt Aquifer - Upper (BAU) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

		Screening Levels							Analytical Results														Spring and Stormwater Features		
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	RI-MW2-BAU-01 2/13/2017	RI-MW3-BAL-01 2/15/2017	RI-MW5-BAU-01 2/28/2017	RI-MW6-BAU-01 1/26/2017	RI-MW7-BAU-01 1/26/2017	RI-MW8-BAU-01 1/26/2017	RI-MW9-BAU-01 1/27/2017	RI-MW10-BAU-01 2/25/2017	RI-MW11-BAU-01 1/24/2017	RI-MW12-BAU-01 1/25/2017	RI-MW13-BAU-01 1/25/2017	RI-MW14-BAU-01 1/25/2017	RI-MW15-BAU-01 2/14/2017	RI-MW16-BAU-01 1/27/2017	NESI Wetland-01 3/2/2017	Spring 1-01 2/25/2017	Stormwater Pond-01 3/2/2017
Aluminum Smelter																									
Total Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.06 UJ	0.06 UJ	0.06 U	0.06 U	0.06 U	**0.15**	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Cyanide, Free	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.0015 U	0.0015 UJ	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	0.01	0.01	Total	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	Total	**3.8**	0.094 J	0.63	**3.2**	0.84	**9.8**	0.87 J	**1.2**	**2.2**	**1.3**	**2.2**	**2.4**	**2**	0.79 J	**20 J**	**3.9**	**4.2 J**
Sulfate	mg/L	NE	NE	NE	250	250	32	Total	39	**2,000**	31	93	210	110	40	27	90	42	43	44	120	51 J	120	64	100
Polynuclear Aromatic Hydrocarbons																									
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	1.5	NE	Total	0.0061 U	0.0062 U	0.0062 U	0.0063 U	0.0062 U	0.0062 U	0.006 U	0.0061 U	0.0061 U	0.0061 U	0.006 U	0.0063 U	0.0062 UJ	0.0064 U	0.0068 U	0.006 U	0.0064 U
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	Total	0.0092 U	0.0092 U	0.0093 U	0.0095 U	0.0092 U	0.0094 U	0.0091 U	0.0092 U	0.0092 U	0.0091 U	0.0091 U	0.0094 U	0.0093 UJ	0.0096 U	0.01 U	0.009 U	0.0095 U
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	Total	0.002 U	0.014 J	0.0021 U	0.0021 U	0.0052 J	0.0021 U	0.052	0.002 U	0.002 U	0.002 U	0.002 U	0.0021 U	0.0021 UJ	0.0021 U	0.0023 U	0.002 U	0.0021 U
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.002 U	0.0078 B	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0042 J	0.0021 U	0.0021 UJ	0.0021 U	0.0023 U	0.002 U	0.0021 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	Total	0.0031 U	0.009 B	0.0031 U	0.0032 U	0.0031 U	0.0055 J	0.003 U	0.0058 J	0.012 J	0.0058 J	0.015 J	0.005 J	0.0031 UJ	0.0032 U	0.01 J	0.003 U	0.015 J
Benzo[a]anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.002 U	0.014 B	0.0021 U	0.0023 J	0.0021 U	0.0025 J	0.2	0.002 U	0.0053 J	0.002 U	0.012 J	0.0021 U	0.0021 UJ	0.0043 J	0.0023 U	0.0043 J	0.079
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	0.023	NE	Total	0.0031 U	0.0069 J	0.0031 U	0.0032 U	0.0031 U	0.0031 U	0.003 U	0.0031 U	0.0031 U	0.003 U	0.0076 J	0.0031 U	0.0031 UJ	0.0032 U	0.0034 U	0.0057 J	**0.12**
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0082 U	0.0094 J	0.0082 U	0.0085 U	0.0082 U	0.0083 U	0.008 U	0.0087 J	0.0081 U	0.0081 U	0.013 J	0.0084 U	0.0082 UJ	0.0085 U	0.0091 U	0.012 J	0.25
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0031 U	0.01 J	0.0031 U	0.0032 U	0.0031 U	0.0031 U	0.003 U	0.0031 U	0.0031 U	0.003 U	0.011 J	0.0031 U	0.0031 UJ	0.0032 U	0.0034 U	0.0051 J	0.14
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0092 U	0.01 J	0.0093 U	0.0095 U	0.0092 U	0.0094 U	0.0091 U	0.0092 U	0.0092 U	0.0091 U	0.012 J	0.0094 U	0.0093 UJ	0.0096 U	0.01 U	0.009 U	0.078
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0061 U	0.01 B	0.0062 U	0.0063 U	0.0062 U	0.0062 U	0.006 U	0.0061 U	0.0061 U	0.0061 U	0.0093 J	0.0063 U	0.0062 UJ	0.0064 U	0.0068 U	0.0072 J	0.19
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.002 U	0.014 J	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0094 J	0.0021 U	0.0021 UJ	0.0021 U	0.0023 U	0.002 U	0.028
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	Total	0.002 U	0.015 B	0.0021 U	0.003 J	0.0021 U	0.0028 J	0.11	0.021	0.002 U	0.002 U	0.021	0.0021 U	0.0021 UJ	0.0045 B	0.0023 U	0.0083 J	0.19
Fluorene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0031 U	0.0031 U	0.0031 U	0.0032 U	0.0031 U	0.0031 U	0.022	0.0031 U	0.0031 U	0.003 U	0.0081 J	0.0031 U	0.0031 UJ	0.0032 U	0.0034 U	0.003 U	0.0032 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0071 U	0.011 J	0.0072 U	0.0074 U	0.0072 U	0.0073 U	0.007 U	0.0071 U	0.0071 U	0.0071 U	0.0087 J	0.0073 U	0.0072 UJ	0.0075 U	0.0079 U	0.007 U	0.17
Naphthalene	µg/L	160	160	350	NE	160	NE	Total	0.1 U	0.025 J	0.018 J	0.014 U	0.013 U	0.014 U	0.013 U	0.1 UJ	0.1 UJ	0.013 U	0.013 U	0.014 U	0.1 UJ	0.014 U	0.015 U	0.013 U	0.1 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0041 U	0.013 B	0.0085 B	0.0057 B	0.0061 B	0.0055 B	0.004 U	0.027 B	0.0059 B	0.004 B	0.022 B	0.0042 U	0.0041 UJ	0.0071 B	0.0083 B	0.005 B	0.04 B
Pyrene	µg/L	NE	480	1,100	NE	480	NE	Total	0.0041 U	0.015 B	0.0041 U	0.0046 J	0.0041 U	0.0042 U	0.11	0.015 J	0.0041 U	0.004 U	0.019 J	0.0042 U	0.0041 UJ	0.0083 B	0.0045 U	0.0093 J	0.16
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	Total	0.0030055	0.01284	0.003026	0.0032365	0.003021	0.003186	0.022835	0.0034655	0.0034305	0.0029455	0.013203	0.0030465	0.003026	0.003447	0.003314	0.008302	0.1824
Polychlorinated Biphenyls																									
PCB-aroclor 1016	µg/L	NE	1.1	2.5	NE	1.1	NE	Total	0.023 U	0.022 U	0.021 U	0.022 U	0.021 U	0.021 U	0.021 U	0.023 U	0.022 U	0.021 U	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U	0.021 U	0.021 U
PCB-aroclor 1221	µg/L	NE	NE	NE	NE	NE	NE	Total	0.033 U	0.031 U	0.03 U	0.031 UJ	0.031 UJ	0.03 UJ	0.03 U	0.032 UJ	0.031 U	0.031 UJ	0.031 UJ	0.031 UJ	0.031 U	0.031 U	0.032 U	0.03 UJ	0.03 U
PCB-aroclor 1232	µg/L	NE	NE	NE	NE	NE	NE	Total	0.029 U	0.028 U	0.027 U	0.028 U	0.028 U	0.027 U	0.027 U	0.029 U	0.028 U	0.028 U	0.028 U	0.028 U	0.028 U	0.028 U	0.029 U	0.027 UJ	0.027 U
PCB-aroclor 1242	µg/L	NE	NE	NE	NE	NE	NE	Total	0.03 U	0.029 U	0.028 U	0.029 U	0.029 U	0.028 U	0.028 U	0.03 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.03 U	0.028 UJ	0.028 U
PCB-aroclor 1248	µg/L	NE	NE	NE	NE	NE	NE	Total	0.023 U	0.022 U	0.021 U	0.022 U	0.021 U	0.021 U	0.021 U	0.023 U	0.022 U	0.021 U	0.021 U	0.022 U	0.022 U	0.022 U	0.022 U	0.021 U	0.021 U
PCB-aroclor 1254	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.022 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U	0.02 UJ	0.022 U	0.021 UJ	0.02 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U
PCB-aroclor 1260	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.028 U	0.027 UJ	0.026 U	0.027 U	0.027 U	0.026 U	0.026 UJ	0.028 U	0.027 UJ	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.027 U	0.026 U	0.026 U
PCB-aroclor 1262	µg/L	NE	NE	NE	NE	NE	NE	Total	0.034 U	0.032 U	0.031 U	0.032 U	0.032 U	0.031 U	0.031 UJ	0.033 U	0.032 UJ	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.033 U	0.031 U	0.031 U
PCB-aroclor 1268	µg/L	NE	NE	NE	NE	NE	NE	Total	0.027 U	0.026 U	0.025 U	0.026 U	0.025 U	0.025 U	0.025 U	0.027 U	0.026 U	0.025 U	0.026 U	0.026 U	0.026 U	0.026 U	0.026 U	0.025 U	0.025 U
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	0.044	NE	Total	0.022 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U	0.02 U	0.022 U	0.021 U	0.02 U	0.02 U	0.021 U	0.021 U	0.02 U	0.021 U	0.02 U	0.02 U
Metals																									
Aluminum	mg/L	NE	16	35	NE	16	1.4	Dissolved	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.11	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.89	0.1 U	0.14
Aluminum	mg/L	NE	16	35	NE	16	0.433	Total	0.1 U	0.1 U	0.1 U	0.45	0.83	1.2	0.59	1.8	0.1 U	1.5	0.2	0.1 U	0.1 U	0.1 U	1.1	0.1 U	0.23
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.0027	0.0038	0.0039	0.002	0.002	0.0025	0.0027	0.004	0.0016	0.0015	0.0018	0.0018	0.0021	0.0024	0.002	0.0022	0.0015
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.002	**0.0033 B**	0.0032	0.0014	0.0011	0.0019	0.0022	**0.004**	0.0013	0.0013	0.0014	0.0014	0.0012	0.0013	0.0014	0.002	0.0012
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Dissolved	0.000028 U	0.000033 J	0.000028 U	0.000028 U	0.000028 U	0.000028 J	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000046 J
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Total	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000065 J
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	Dissolved	0.00033 J	0.00029 J	0.0006	0.00034 J	0.00044	0.0016	0.00036 J	0.00041	0.00039 J	0.00033 J	0.0067	0.0068	0.00038 J	0.0004	0.00032 J	0.00039 J	0.00065
Chromium	mg/L	0.05	24	53	0.1	0.1	0.055	Total	0.0002 J	0.00071	0.00039 J	0.00047 B	0.00078 B	0.0023	0.00021 J	0.0011	0.0003 J	0.00094 B	0.0067	0.0069	0.00089 B	0.00014 U	0.00026 J	0.0003 J	0.00069
Copper	mg/L	NE	0.64	1.4	13	0.64	NE	Dissolved	0.0014 J	0.0006 U	0.0015 J	0.0006 U	0.0006 U	0.001 J	0.0006 U	0.00074 J	0.00068 J	0.0006 U	0.00064 J	0.0006 U	0.0006 J	0.0006 U	0.0015 J	0.00097 J	0.0011 J
Copper	mg/L	NE	0.64	1.4	13	0.64	NE	Total	0.0013 J	0.0006 U	0.00073 J	0.00061 J	0.0011 J	0.0021	0.0011 J	0.002	0.0011 J	0.0011 B	0.0006 U	0.0006 U	0.00061 B	0.0006 U	0.0023	0.0017 J	0.0013 J
Iron	mg/L	NE	11	25	0.3	13	13	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.081	NA	NA
Iron	mg/L	NE	11	25	0.3	1.361	1.361	Total	0.18 U	0.72	0.19 J	1	**19**	**1.9**	0.69	**2.4**	0.18 U	1.1	0.24 J	0.18 U	0.42 J	0.18 U	0.16	0.18 U	NA
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Dissolved	0.000034 U	0.000034 J	0.00019 J	0.000078 J	0.000041 J	0.000068 J	0.00022 J	0.000042 J	0.000035 J	0.000037 B	0.00004 B	0.000038 B	0.000034 U	0.000034 U	0.00011 J	0.000059 B	0.00019 J
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Total	0.00016 B	0.00068 B	0.00014 J	0.00022 J	0.00029 J	0.00017 J	0.000097 B	0.00046	0.000034 U	0.0011	0.000068 B	0.000034 U	0.00007 J	0.00007 B	0.00061	0.0002 J	0.00024 J
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Dissolved	0.000056 B	0.000062 B	0.000075 B	0.000045 B	0.000041 U	0.000041 U	0.00005 B	0.000047 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000057 B	0.000041 U	0.000047 B	0.000083 B	0.000047 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Total	0.000065 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000057 B	0.000041 U	0.000041 U	0.000065 B	0.000041 U	0.00006 B	0.000081 B	0.000064 B
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.0004 U	0.00041 J	0.00098 J	0.0004 U	0.0004 U	0.0004 U	0.0022 J	0.0004 J	0.00086 J	0.00049 J	0.0004 U	0.0004 U	0.0017 J	0.00053 J	0.0021 J	0.0004 U	0.0024 J
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	Total	0.0004 U	0.00067 J	0.0011 J	0.0004 U	0.0004 U	0.00076 J	0.0024 J	0.0019 J	0.00084 J	0.00092 J	0.0004 U	0.0004 U	0.0018 J	0.00056 J	0.0021 J	0.0004 U	0.0028 J
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Dissolved	0.0005 J	0.0003 U	0.0003 U	0.0003 U	0.0003 U	0.0027	0.0012	0.002	0.00056 J	0.0005 B	0.00061 B	0.00069 B	0.00048 J	0.0012 B	0.00064 J	0.0011	0.0033
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Total	0.00062 J	0.0003 U	0.0003 U	0.00052 B	0.00054 B	0.003	0.0016	0.003	0.00063 J	0.0003 U	0.00056 J	0.00056 J	0.00036 J	0.00098 J	0.00055 J	0.0014 B	0.0033
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Dissolved	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.006 J	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0027 J	0.0027 J	0.0019 U	0.003 J	0.0019 U	0.0024 J	0.0019 U	0.0078
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Total	0.0019 U	0.0038 J	0.0019 U	0.0021 J	0.014	0.0045 J	0.0026 J	0.0047 J	0.0063 J	0.0058 B	0.0019 U	0.0019 U	0.0041 J	0.0019 U	0.0033 J	0.0024 J	0.011

Table 2-8
Groundwater AOC - Basalt Aquifer - Upper (BAU) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

		Screening Levels							Analytical Results														Spring and Stormwater Features		
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	Fraction Analyzed	RI-MW2-BAU-01 2/13/2017	RI-MW3-BAL-01 2/15/2017	RI-MW5-BAU-01 2/28/2017	RI-MW6-BAU-01 1/26/2017	RI-MW7-BAU-01 1/26/2017	RI-MW8-BAU-01 1/26/2017	RI-MW9-BAU-01 1/27/2017	RI-MW10-BAU-01 2/25/2017	RI-MW11-BAU-01 1/24/2017	RI-MW12-BAU-01 1/25/2017	RI-MW13-BAU-01 1/25/2017	RI-MW14-BAU-01 1/25/2017	RI-MW15-BAU-01 2/14/2017	RI-MW16-BAU-01 1/27/2017	NESI Wetland-01 3/2/2017	Spring 1-01 2/25/2017	Stormwater Pond-01 3/2/2017
Total Petroleum Hydrocarbons																									
Gasoline	mg/L	1.0	NE	NE	NE	1.0	NE	Total	0.027 U	NA	NA	NA	NA	NA	NA	0.027 B	0.03 B	0.027 U	0.54 U	0.029 B	0.027 U	NA	NA	NA	0.027 U
#2 Diesel	mg/L	0.5	NE	NE	NE	0.5	NE	Total	0.025 B	NA	NA	NA	NA	NA	NA	0.04 B	0.043 J	0.037 B	0.019 U	0.02 U	0.029 B	NA	NA	NA	0.056 J
Motor Oil	mg/L	0.5	NE	NE	NE	0.5	NE	Total	0.03 U	NA	NA	NA	NA	NA	NA	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	NA	NA	NA	0.034 J
Volatile Organic Compounds																									
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	NA	NA	NA	0.025 U
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.033 B	NA	NA	NA	0.025 U
Ethylbenzene	µg/L	700	800	1,800	700	700	NE	Total	0.03 U	NA	NA	NA	NA	NA	NA	0.03 UJ	0.03 U	0.03 U	0.03 U	0.03 U	0.053 J	NA	NA	NA	0.03 U
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	0.05 U	NA	NA	NA	NA	NA	NA	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.16 J	NA	NA	NA	0.05 U
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NE	Total	0.06 U	NA	NA	NA	NA	NA	NA	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	NA	NA	NA	0.06 U
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	NA	NA	NA	0.025 U
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	NA	NA	NA	0.025 U
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	NA	NA	NA	0.025 U
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	Total	0.07 U	NA	NA	NA	NA	NA	NA	0.07 UJ	0.07 U	0.07 U	0.07 U	0.07 U	0.07 U	NA	NA	NA	0.07 U
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	Total	0.025 U	NA	NA	NA	NA	NA	NA	0.025 UJ	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	NA	NA	NA	0.025 U
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	Total	0.013 U	NA	NA	NA	NA	NA	NA	0.013 UJ	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	NA	NA	NA	0.013 UJ
Geochemistry																									
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	31	490	23	46	69	46	30	34	48	37	24	26	48	40	38	30	36
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	18	180	11	24	37	25	14	18	23	19	9.7	10	26	22	23	17	18
Potassium	mg/L	NE	NE	NE	NE	NE	NE	Total	6.5	9.5	2.6 J	7.7	8.4	9.6	5.4	10	7.4	6.3	4.8	4.6	7.5	2.8 J	7.5	5.8	5.3
Sodium	mg/L	NE	NE	NE	NE	NE	NE	Total	28	150	19	49	15	72	47	29	15	18	16	17	33	17	86	26	21
Chloride	mg/L	NE	NE	NE	NE	NE	NE	Total	9.8	92	8.1	90	9.8	11	15	7.3	18	5.6	8.3	8.4	15	12 J	15	14	14
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	31	490	23	46	69	46	30	34	48	37	24	26	48	40	38	30	36
Total Dissolved Solids	mg/L	NE	NE	NE	NE	NE	NE	Total	280	3,100	160	430	540	490	330	310	350	280	180	190	430	300	490	280	290
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	18	180	11	24	37	25	14	18	23	19	9.7	10	26	22	23	17	18
Alkalinity, Total	mg/L	NE	NE	NE	NE	NE	NE	Total	150	100	100	72	NA	120	130	140	96	130	70	70	140	130	200	110	77
Alkalinity as Bicarbonate	mg/L	NE	NE	NE	NE	NE	NE	Total	150	100	100	72	120	120	130	140	96	130	70	70	140	130	200	110	77
Alkalinity as Carbonate	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity as Hydroxide	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hardness as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	150	18,000	110	200	320	200	130	160	210	170	110	110	230	180	3,200	150	3,900

Notes:

Bold values denote exceedances of one or more screening levels and background concentrations.

B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.

J = Estimated concentration

MTCA = Model Toxics Control Act

NA = Not Analyzed

NE = Not Established

TEC = Toxicity Equivalent Concentration

U = Chemical was not detected. The associated value represents the method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.

Table 2-9
Groundwater AOC - Basalt Aquifer - Lower (BAL) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

		Screening Levels							Analytical Results															
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Lowest Screening Level	Site Background	Fraction Analyzed	BAMW-2-01 2/25/2017	BAMW-4-01 2/24/2017	IB-8-01 2/24/2017	IB-13-01 3/2/2017	IB-13A-01 3/2/2017	RI-MW44-01 (Duplicate of IB-13A) 3/2/2017	RI-MW1-BAL-01 2/22/2017	RI-MW2-BAL-01 2/23/2017	RI-MW17-BAL-01 1/27/2017	RI-MW41-01 (Duplicate of RI-MW17) 1/27/2017	RI-MW18-BAL-01 3/2/2017	RI-MW19-BAL-01 3/2/2017	RI-MW20-BAL-01 3/1/2017	Well 1-01 1/27/2017	Well 3-01 2/23/2017
Aluminum Smelter																								
Total Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	0.06 UJ	**0.069 J**	0.06 U	0.06 U	0.06 U	**0.083**	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Cyanide, Free	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 UJ	0.0015 UJ	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 U	0.0015 UJ
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	0.01	NE	Total	0.06 U	0.06 UJ	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 UJ	0.06 U	0.06 U	0.06 U	0.06 UJ	0.06 U
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	Total	0.89	**9**	0.95	**3.4 J**	**1.9 J**	**1.9 J**	**2.7 J**	0.76	**2.8**	**2.8**	0.71 J	0.5 J	0.34 J	0.65	0.34
Sulfate	mg/L	NE	NE	NE	250	250	32	Total	230	250	**770**	**380**	78	77	**260**	61	120	120	88	93	**340**	96	20
Polynuclear Aromatic Hydrocarbons (PAHs)																								
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	1.5	NE	Total	0.0074 U	0.0069 U	0.0069 U	0.0061 U	0.0063 U	0.0062 U	0.0062 U	0.006 U	0.0062 U	0.0061 U	0.0062 U	0.0061 U	0.007 U	0.006 U	0.0063 U
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	Total	0.011 U	0.01 U	0.01 U	0.0091 U	0.0095 U	0.0093 U	0.0094 U	0.009 U	0.0093 U	0.0091 U	0.0092 U	0.0091 U	0.011 U	0.009 U	0.0094 U
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	Total	0.0025 U	0.0023 U	0.0023 U	0.002 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.0021 U	0.002 U	0.0021 U	0.002 U	0.0023 U	0.002 U	0.0021 U
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0025 U	0.0023 U	0.0023 U	0.002 U	0.0021 U	0.0021 U	0.0021 U	0.002 U	0.0021 U	0.002 U	0.0021 U	0.002 U	0.0023 U	0.002 U	0.0021 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	Total	0.0037 U	0.0034 U	0.0034 U	0.003 U	0.0032 U	0.0031 U	0.004 J	0.003 U	0.0073 J	0.0054 J	0.0031 U	0.0049 J	0.0035 U	0.0047 J	0.0031 U
Benzo[a]anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0025 U	0.0023 U	0.0023 U	0.002 U	0.0064 J	0.0021 U	0.014 B	0.003 J	0.0021 U	0.002 U	0.0021 U	0.0078 J	0.0023 U	0.002 U	0.0023 J
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	0.023	NE	Total	0.0037 U	0.0034 U	0.0034 U	0.003 U	0.0032 U	0.0031 U	0.016 J	0.003 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0035 U	0.003 U	0.0031 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0098 U	0.0092 U	0.0092 U	0.0081 U	0.0084 U	0.0083 U	0.028	0.008 U	0.0083 U	0.0081 U	0.0082 U	0.0081 U	0.0094 U	0.008 U	0.0083 U
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0037 U	0.0034 U	0.0034 U	0.003 U	0.0032 U	0.0031 U	0.017 J	0.003 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0035 U	0.003 U	0.0031 U
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.011 U	0.01 U	0.01 U	0.0091 U	0.0095 U	0.0093 U	0.012 J	0.009 U	0.0093 U	0.0091 U	0.0092 U	0.0091 U	0.011 U	0.009 U	0.0094 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0074 U	0.0069 U	0.0069 U	0.0061 U	0.0069 J	0.0062 U	0.013 J	0.006 U	0.0062 U	0.0061 U	0.0062 U	0.0061 U	0.007 U	0.006 U	0.0063 U
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0025 U	0.0023 U	0.0023 U	0.002 U	0.0021 U	0.0021 U	0.0048 J	0.002 U	0.0021 U	0.002 U	0.0021 U	0.002 U	0.0023 U	0.002 U	0.0021 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0025 U	0.0023 U	0.0029 J	0.002 U	0.0079 J	0.0042 J	0.023	0.002 U	0.0021 U	0.002 U	0.0021 U	0.0063 J	0.0023 U	0.012 B	0.0021 U
Fluorene	µg/L	NE	640	1,400	NE	640	NE	Total	0.0037 U	0.0034 U	0.0034 U	0.003 U	0.0032 U	0.0031 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0031 U	0.003 U	0.0035 U	0.003 U	0.0031 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	Total	0.0086 U	0.008 U	0.008 U	0.0071 U	0.0074 U	0.0073 U	0.019 J	0.007 U	0.0073 U	0.0071 U	0.0072 U	0.0071 U	0.0082 U	0.007 U	0.0073 U
Naphthalene	µg/L	160	160	350	NE	160	NE	Total	0.016 U	0.015 B	0.015 U	0.013 U	0.014 U	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U	0.013 J	0.013 U	0.015 U	0.013 U	0.014 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	Total	0.0051 B	0.0064 B	0.0046 U	0.0041 U	0.0078 B	0.0068 B	0.011 B	0.004 U	0.0042 U	0.004 U	0.01 B	0.0096 B	0.012 B	0.022 B	0.0042 U
Pyrene	µg/L	NE	480	1,100	NE	480	NE	Total	0.0049 U	0.0046 U	0.0046 U	0.0041 U	0.0074 J	0.0041 U	0.02 J	0.004 U	0.0042 U	0.004 U	0.0041 U	0.0061 J	0.0047 U	0.0041 B	0.0042 U
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	Total	0.003607	0.0033245	0.0033245	0.0029455	0.003679	0.003036	0.02391	0.00313	0.003036	0.0029455	0.003021	0.0036255	0.003445	0.00293	0.0031665
Polychlorinated Biphenyls (PCBs)																								
PCB-aroclor 1016	µg/L	NE	1.1	2.5	NE	1.1	NE	Total	0.025 U	0.022 U	0.026 U	0.022 U	0.022 U	0.022 U	0.021 U	0.021 U	0.19 J	0.22 J	0.021 U	0.022 U	0.022 U	0.022 U	0.021 U
PCB-aroclor 1221	µg/L	NE	NE	NE	NE	NE	NE	Total	0.036 UJ	0.031 UJ	0.038 UJ	0.031 U	0.031 U	0.031 U	0.031 U	0.031 U	0.03 UJ	0.031 UJ	0.031 U	0.031 U	0.031 U	0.031 UJ	0.03 U
PCB-aroclor 1232	µg/L	NE	NE	NE	NE	NE	NE	Total	0.033 UJ	0.028 UJ	0.034 UJ	0.028 U	0.028 U	0.028 U	0.027 UJ	0.028 UJ	0.027 U	0.027 U	0.028 U	0.028 U	0.028 U	0.028 U	0.027 UJ
PCB-aroclor 1242	µg/L	NE	NE	NE	NE	NE	NE	Total	0.034 UJ	0.029 UJ	0.035 UJ	0.029 U	0.029 U	0.029 U	0.028 U	0.029 U	0.028 U	0.028 U	0.029 U	0.029 U	0.029 U	0.029 U	0.028 U
PCB-aroclor 1248	µg/L	NE	NE	NE	NE	NE	NE	Total	0.025 U	0.022 U	0.026 U	0.022 U	0.022 U	0.022 U	0.021 U	0.021 U	0.021 U	0.021 U	0.021 U	0.022 U	0.022 U	0.022 U	0.021 U
PCB-aroclor 1254	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.024 U	0.021 U	0.025 U	0.021 U	0.021 U	0.021 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.021 U	0.021 U	0.021 U	0.02 U
PCB-aroclor 1260	µg/L	NE	0.044	0.44	NE	0.044	NE	Total	0.032 U	0.027 U	0.033 U	0.027 U	0.027 U	0.027 U	0.026 U	0.027 U	**0.3 J**	**0.42 J**	0.027 U	0.027 U	0.027 U	0.027 U	0.026 U
PCB-aroclor 1262	µg/L	NE	NE	NE	NE	NE	NE	Total	0.038 U	0.032 U	0.039 U	0.032 U	0.032 U	0.032 U	0.032 UJ	0.032 UJ	0.031 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 UJ	0.031 UJ
PCB-aroclor 1268	µg/L	NE	NE	NE	NE	NE	NE	Total	0.03 U	0.026 U	0.032 U	0.026 U	0.026 U	0.026 U	0.025 U	0.026 U	0.025 U	0.025 U	0.026 U	0.026 U	0.026 U	0.026 UJ	0.025 U
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	0.044	NE	Total	0.024 U	0.021 U	0.025 U	0.021 U	0.021 U	0.021 U	0.02 U	0.02 U	**0.49**	**0.64**	0.02 U	0.021 U	0.021 U	0.021 U	0.02 U

Table 2-9
Groundwater AOC - Basalt Aquifer - Lower (BAL) Zone Wells - 1st Quarter (Q1) 2017 Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Parameter Name	Units	Screening Levels						Fraction Analyzed	Analytical Results														
		MTCA Method A	MTCA Method B	MTCA Method C	MCL	Lowest Screening Level	Site Background		BAMW-2-01 2/25/2017	BAMW-4-01 2/24/2017	IB-8-01 2/24/2017	IB-13-01 3/2/2017	IB-13A-01 3/2/2017	RI-MW44-01 (Duplicate of IB-13A) 3/2/2017	RI-MW1-BAL-01 2/22/2017	RI-MW2-BAL-01 2/23/2017	RI-MW17-BAL-01 1/27/2017	RI-MW41-01 (Duplicate of RI-MW17) 1/27/2017	RI-MW18-BAL-01 3/2/2017	RI-MW19-BAL-01 3/2/2017	RI-MW20-BAL-01 3/1/2017	Well 1-01 1/27/2017	Well 3-01 2/23/2017
Metals																							
Aluminum	mg/L	NE	16	35	NE	16	1.14	Dissolved	0.1 U	0.31	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	0.1 U
Aluminum	mg/L	NE	16	35	NE	16	0.433	Total	1.1	3.6	0.11	0.1 U	0.1 U	0.1 U	13	0.13	2.8 J	1.1 J	0.1 U	0.16	**29**	0.1 U	0.1 U
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.0024	0.0019	0.0022	0.002	0.0024	0.0023	0.0025	0.0013	0.0031 B	0.0029 B	0.0051	**0.011**	0.0045	NA	0.0015
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0021	0.0019	0.0016	0.0013	0.0019	0.0019	**0.0073**	0.00059 J	0.0017	0.0017	**0.0047**	**0.01**	**0.01**	0.00027 U	0.0011
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Dissolved	0.000035 B	0.000028 U	0.000054 B	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000028 U	0.000031 J	0.000067 J	0.000028 U	NA	0.000099 J
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	Total	0.000077 B	0.000054 B	0.000065 B	0.000028 U	0.000028 U	0.000028 U	0.00018 J	0.000028 U	0.00003 J	0.000028 U	0.000028 U	0.000036 J	0.00023 J	0.000028 U	0.00015 B
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	Dissolved	0.00035 J	0.00086	0.00077	0.0004	0.00053	0.0005	0.00026 J	0.00053	0.00058 B	0.00057 B	0.0003 J	0.00036 J	0.00026 J	NA	0.00086
Chromium	mg/L	0.05	24	53	0.1	0.1	0.055	Total	0.00063	0.0029	0.025	0.00035 J	0.00062 J	0.00044 J	0.025	0.00039 J	0.0025 B	0.0011 B	0.00024 J	0.00049	0.004	0.0002 B	0.00079
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Dissolved	0.0006 U	0.00095 J	0.0026	0.0006 U	0.00079 J	0.00064 J	0.0006 U	0.00066 J	0.001 J	0.00097 J	0.001 J	0.0026	0.0006 U	NA	0.012
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	Total	0.0011 J	0.0035	0.015	0.00093 J	0.0014 J	0.0012 J	0.025	0.0006 U	0.0032 B	0.0017 B	0.0014 J	0.0037	0.012	0.011	0.016
Iron	mg/L	NE	11	25	0.3	13	13	Dissolved	NA	0.41	0.022 B	0.0058 U	0.0061 J	0.0058 U	NA	NA	NA	NA	NA	0.2	NA	NA	NA
Iron	mg/L	NE	11	25	0.3	1.361	1.361	Total	0.68 B	**4.5**	0.38 B	0.014 J	0.068 J	0.022 J	**18**	0.18 U	NA	NA	NA	0.36	NA	NA	0.18 U
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Dissolved	0.00014 B	0.00018 B	0.00016 B	0.00033 J	0.00045	0.00047	0.000038 J	0.000047 B	0.000034 U	0.000034 U	0.0022	0.00018 J	0.00065	NA	0.000068 J
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	Total	0.00066	0.0018	0.0059	0.00046	0.0003 J	0.000089 J	0.012	0.000075 B	0.00031 J	0.00016 B	0.00046	0.00022 J	**0.048**	0.0006	0.00015 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Dissolved	0.000042 B	0.000041 U	0.000041 U	0.000042 B	0.000041 U	0.000042 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000055 B	NA	0.00019 B
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	Total	0.000075 B	0.000041 U	0.000041 U	0.000054 B	0.000058 B	0.000055 B	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000041 U	0.000052 B	0.000046 B	0.000044 B	0.000041 U
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00651	0.00651	Dissolved	0.00093 J	0.0004 U	0.0015 J	0.00041 J	0.00042 J	0.0004 U	0.0025 J	0.0004 U	0.00055 J	0.00053 J	0.0036	0.0059	0.00089 J	NA	0.00041 J
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	Total	0.0014 J	0.0015 J	0.003	0.0005 J	0.0034	0.0007 J	**0.01**	0.0004 U	0.0012 B	0.00078 B	0.0037	**0.0061**	0.0037	0.00091 B	0.00052 J
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Dissolved	0.0003 U	0.0016	0.00094 J	0.00063 J	0.00033 J	0.00034 J	0.00054 J	0.00076 J	0.00077 J	0.00082 J	0.00044 J	0.00031 J	0.00083 J	NA	0.00036 J
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	Total	0.00069 B	0.0024 B	0.0013 B	0.00065 J	0.0003 J	0.0003 U	0.0013 B	0.00089 J	0.00077 J	0.00084 J	0.0004 J	0.00038 J	0.003	0.0003 U	0.00038 J
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Dissolved	0.0024 J	0.0032 J	0.012	0.002 J	0.0019 U	0.0019 U	0.0026 J	0.0019 U	0.0019 U	0.0019 U	0.0041 J	0.012	0.0019 U	NA	0.015
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	Total	0.0066 J	0.012 B	0.022 B	0.0019 J	0.0021 J	0.0019 U	0.043 B	0.0019 U	0.0055 B	0.0037 B	0.0088	0.012	0.038	0.02 B	0.017
Geo Chemistry																							
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	60	22	170	75	17	18	90	40	55	55	36	37	110	45	16
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	39	9.8	79	36	8.6	9.3	44	20	27	26	20	19	51	23	6.6
Potassium	mg/L	NE	NE	NE	NE	NE	NE	Total	4.5	5.8	13	8.6	3.4	3.6	11	5.1	9	8.8	12	5	10	4.6	4.3
Sodium	mg/L	NE	NE	NE	NE	NE	NE	Total	52	180	120	77	44	47	39	16	35	35	32	33	48	15	10
Chloride	mg/L	NE	NE	NE	NE	NE	NE	Total	18	58	21	19	3.1	3	22 J	11	12	12	11	7	19	8	2.9
Calcium	mg/L	NE	NE	NE	NE	NE	NE	Total	60	22	170	75	17	18	90	40	55	55	36	37	110	45	16
Total Dissolved Solids	mg/L	NE	NE	NE	NE	NE	NE	Total	560	710	1,400	740	290	270	590	290	420	410	340	340	730	350	140
Magnesium	mg/L	NE	NE	NE	NE	NE	NE	Total	39	9.8	79	36	8.6	9.3	44	20	27	26	20	19	51	23	6.6
Alkalinity, Total	mg/L	NE	NE	NE	NE	NE	NE	Total	150	110	120	110	92	82	120	100	120	120	140	140	110	110	67
Bicarbonate Alkalinity as CaC03	mg/L	NE	NE	NE	NE	NE	NE	Total	150	110	120	110	92	82	120	100	120	120	140	140	110	110	67
Carbonate Alkalinity as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Alkalinity as Hydroxide	mg/L	NE	NE	NE	NE	NE	NE	Total	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Hardness as CaCO3	mg/L	NE	NE	NE	NE	NE	NE	Total	35	2,500	8,000	4,300	78	80	4,000	170	250	250	170	170	6,200	200	68

Notes:

Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration

μg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established

PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated biphenyls
TEC = Toxicity Equivalent Concentration
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.

This section is organized to show the main groundwater COPCs summarized by aquifer zone, including fluoride, cyanide, sulfate, and PAHs including result figures that show the distribution in each aquifer zone from shallowest to deepest. The discussion of the main smelter-related groundwater COPCs is followed by a summary of metals distribution (including As, Fe, Al, Cr, Pb, and Ni), petroleum hydrocarbons at the former Compressor Building UST, well MW-1 results summary, and a summary of limited detection chemicals.

The results summarized in Tables 2-7, 2-8, and 2-9 and associated figures have been compared against appropriate groundwater screening levels, including MTCA Method A and B and State maximum contaminant levels (MCLs). Site background concentrations are also included for fluoride, sulfate and selected metals for comparative review.

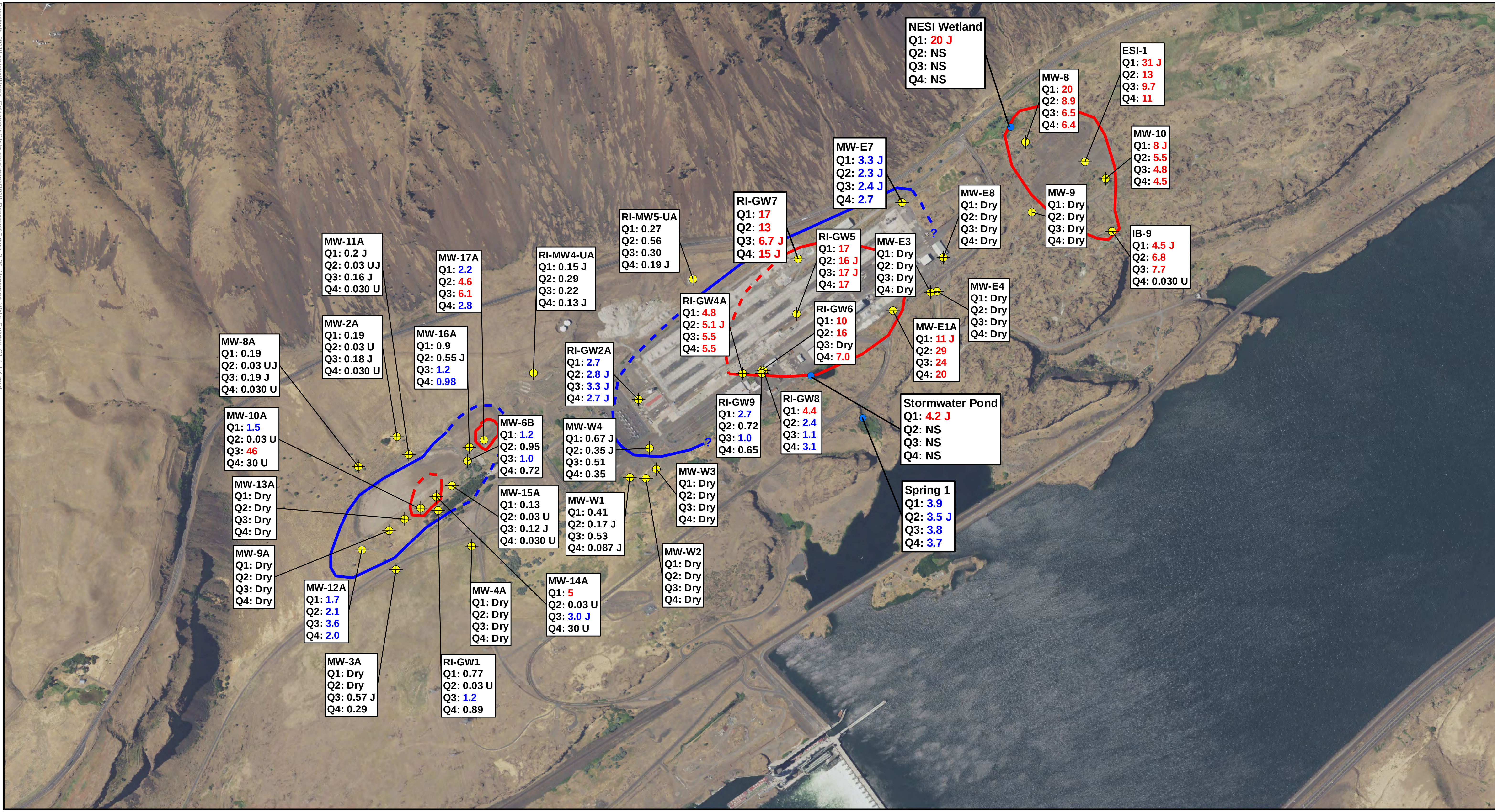
2.3.8.3 Fluoride Results Summary

Figures 2-26, 2-27, and 2-28 show the distribution of fluoride in the UA, BAU, and BAL zones for the 4 quarters of sampling of the RI. Similar to historical data, fluoride is elevated above screening levels in all three aquifer zones. Fluoride exceeds the MCL [4.0 milligrams per liter (mg/L)] most commonly in the UA zone and rarely in the BAL. Note that additional wells were installed, and groundwater data was collected in the plant area footprint as part of the WPA and the WPA chemical groundwater results are summarized in Section 2.4.

UA Aquifer Zone Fluoride Results

Concentrations of fluoride above the MCL of 4.0 mg/L were found in the eastern portion of the site in the vicinity of the ESI and NESI areas, the central portion of the site in the main plant area, and the western portion of the site at the WSI and West SPL Storage Areas (refer to Figure 2-26).

Well ESI-1 (31 mg/L), which is located within the ESI cap (Figure 2-26) has among the highest fluoride concentrations detected at the site. This well was installed in 1991 to determine if groundwater was in contact with sludge enclosed within the ESI and was originally dry. Well ESI-1 was found to have about 9 ft of static water during the baseline sampling round. The water-levels at well ESI-1 were within the capped waste during all 4 quarters of sampling. The NESI wetland spring also contained high levels of fluoride (up to 20 mg/L) and is located in close proximity to buried smelter wastes in the NESI area.



Legend

Unconsolidated Aquifer (UA) Well

MW-12A 1.7 — Well Identification / Concentration

Spring/Pond/Wetland Water Sample

Screening Levels

4 mg/L MCL

0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NESI: North of the East Surface Impoundment Area
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

J: Estimated Concentration
U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

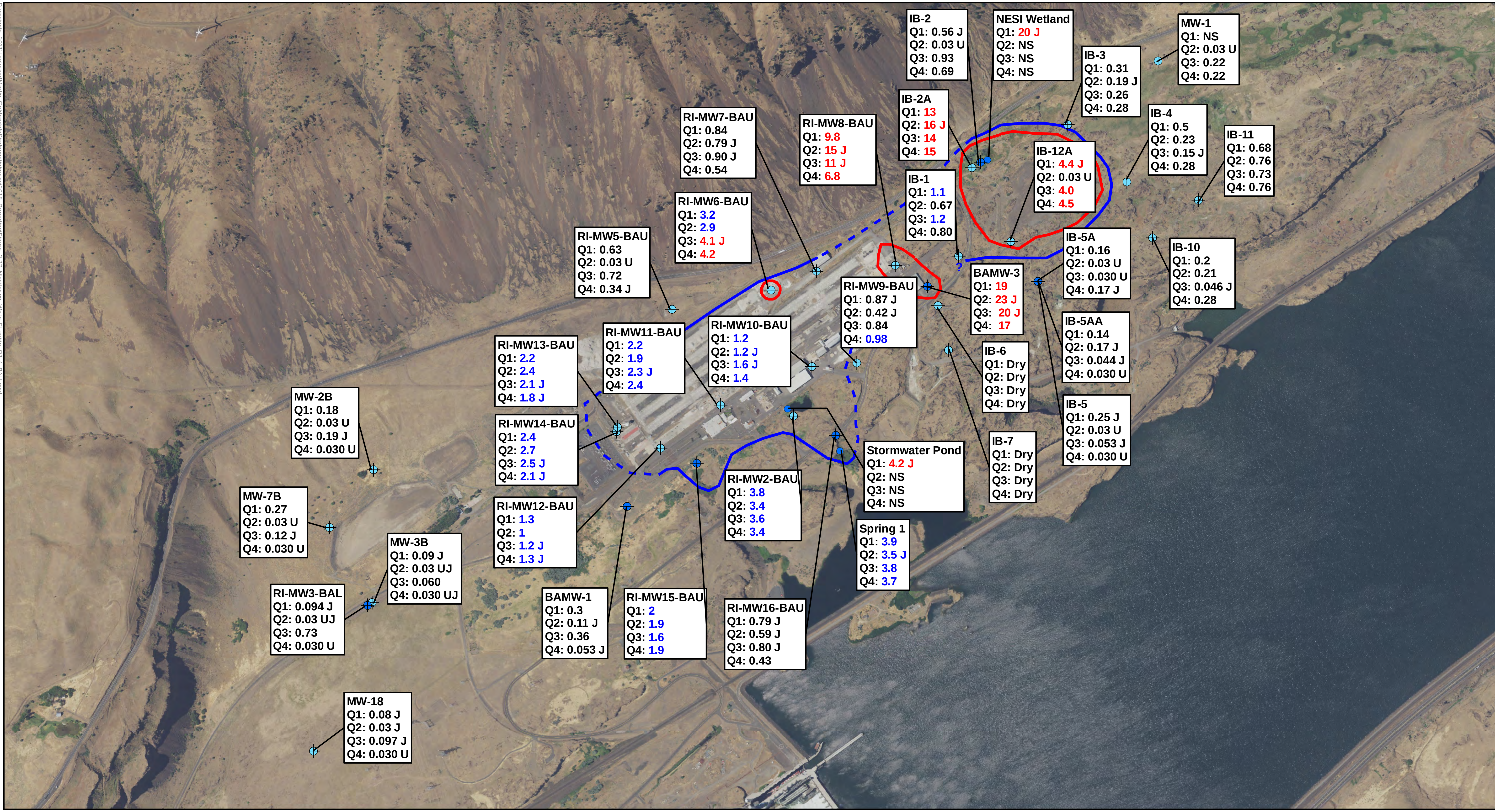
N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-26
Concentrations for Fluoride In Unconsolidated Aquifer (UA) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Uppermost Basalt Aquifer Well (BAU)

BAU1 - Shallower Water-bearing Zone

BAU2 - Deeper Water-bearing Zone

MW-12A 1.7 — Well Identification / Concentration

Spring/Pond/Wetland Water Sample

Screening Levels

4 mg/L MCL

0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NESI: North of the East Surface Impoundment Area
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

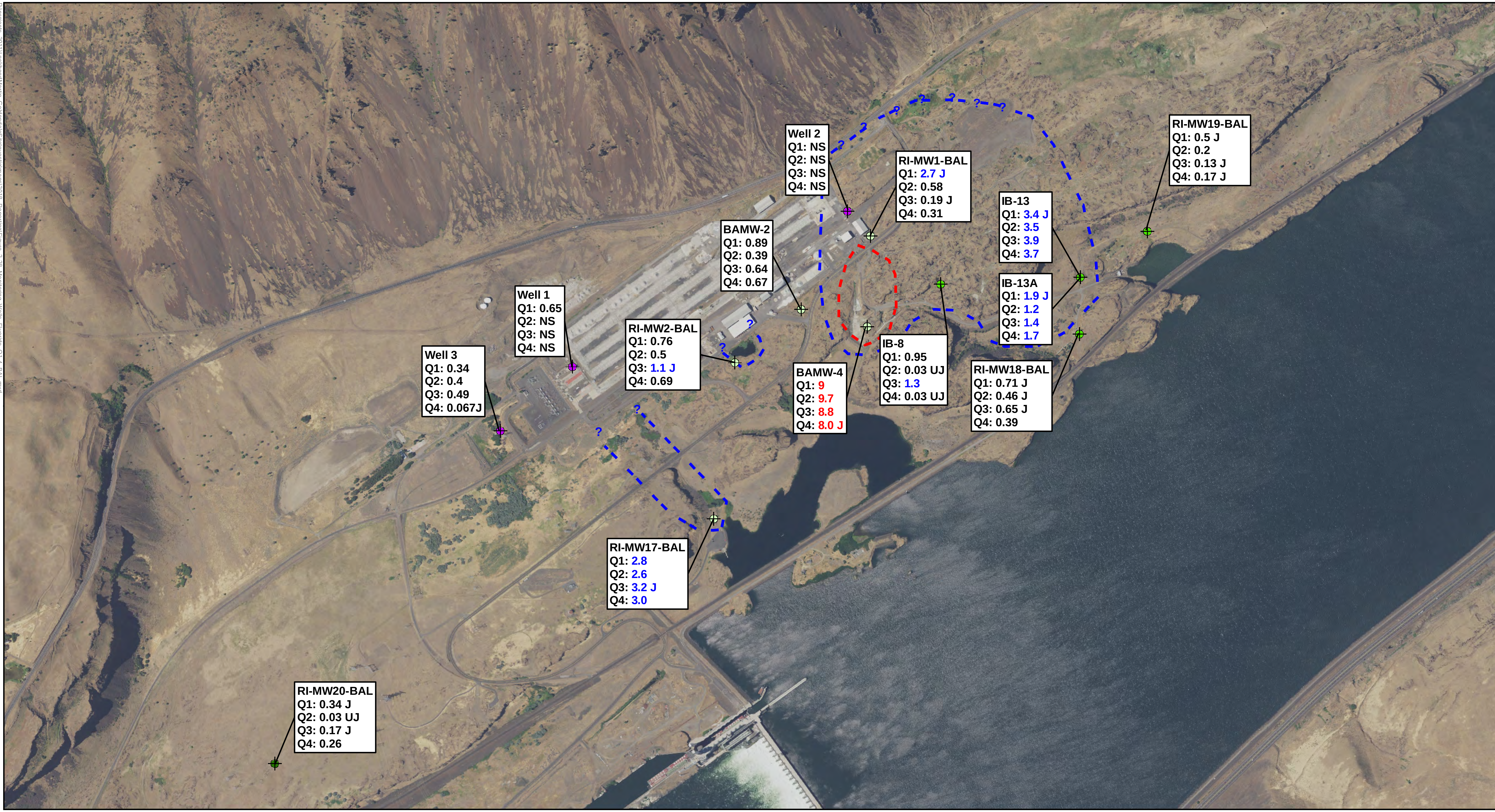
J: Estimated Concentration
U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N / W / E / S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-27
Concentrations for Fluoride In Uppermost Basalt Aquifer (BAU) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Lower Basalt Aquifer Well (BAL)

- BAL₁ - Shallower Water-bearing Zone
- BAL₂ - Deeper Water-bearing Zone
- BAL₃ - Deepest Water-bearing Zone

RI-MW20-BAL 0.34 J — Well Identification, Concentration

Production Well

Screening Levels
- 4 mg/L MCL
- 0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
Concentrations in milligrams per liter (mg/L)
NS: Not Sampled

J: Estimated Concentration
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-28
Concentrations for Fluoride In
Lower Basalt Aquifer (BAL) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

During the 3rd Quarter, fluoride in well MW-10A, located near and hydraulically downgradient of the WSI, had an anomalously high fluoride concentration (46 mg/L). This well has previously contained elevated levels of fluoride and sulfate above screening levels, but the detected concentration of fluoride during Quarter 3 is an order of magnitude higher than previously detected at this well and represents the highest concentration of fluoride detected in groundwater at the site (refer to Table 2-7 and Figure 2-25). The result is clearly anomalous as it an order-of magnitude higher than fluoride concentrations detected in the well during the WSI groundwater monitoring program (GeoPro 2021). It appears most likely that this result represents a lab error that was not identified or confirmed during data validation.

BAU Aquifer Zone Fluoride Results

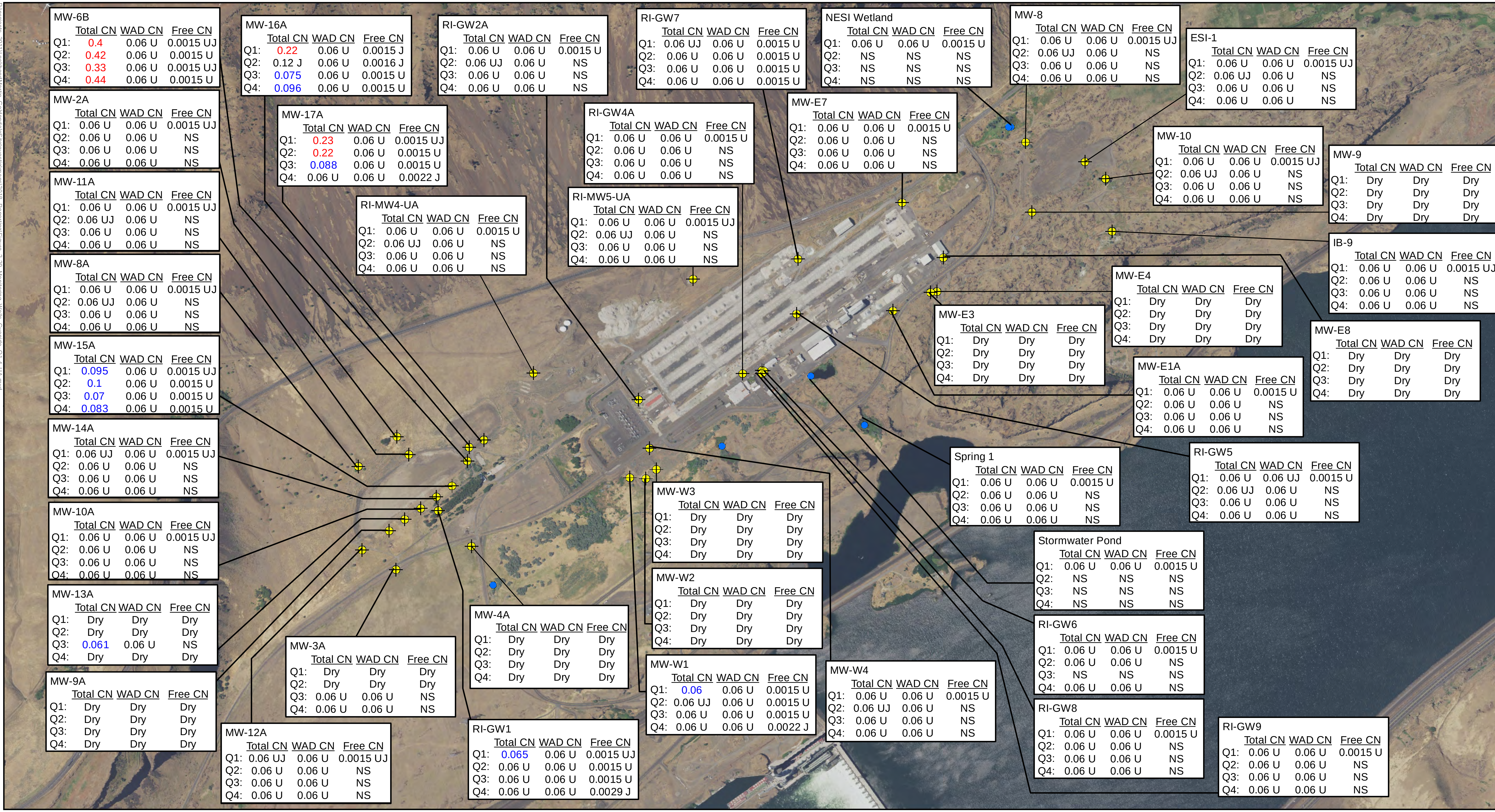
In the BAU zone, fluoride occurs above screening levels in the plant area and also in the eastern portion of the site. Exceedances of the MCL are found in the east end of the site near the ESI and NESI, the east end of the plant area near the North and South Pot Liner Soaking Stations and East SPL Storage Area (cryolite storage also occurred in this building), and in the central plant area near the Tertiary Treatment Plant, and the Lines B, C, and D Secondary Scrubber Recycle System (Figure 2-26). Highest concentrations were detected in well BAMW-3 (maximum of 23 mg/L). Fluoride was detected (4.2 J mg/L) in the Stormwater Pond (which appears to be in hydraulic connection with the BAU based on multiple lines of evidence) at concentrations above the MCL (refer to Table 2-8 and Figure 2-27).

BAL Aquifer Zone Fluoride Results

In the BAL zone, the occurrence of fluoride above screening levels is limited to the eastern portion of the site and an area near RI-MW-17 BAL at the western end of the plant (Figure 2-27). The highest detected concentrations of fluoride in the BAL zone were observed at well BAMW-4 (maximum of 9.7 mg/L), which is located near the NPDES Pond A and down gradient of the East SPL Storage Area (refer to Table 2-9 and Figure 2-28).

2.3.8.4 Cyanide Results Summary

Figures 2-29, 2-30, and 2-31 show the distribution of total cyanide, WAD cyanide, and free cyanide in the UA, BAU, and BAL aquifer zones, respectively. Note that both the MCL and MTCA screening levels for cyanide are based on free cyanide, which was not detected above screening levels during any of the quarterly sampling rounds. Total cyanide results have been conservatively compared against free cyanide screening levels during the RI consistent with the Phase 2 RI Work



Legend

Unconsolidated Aquifer (UA) Well

Spring/Pond/Wetland Water Sample

Screening Levels

0.200 mg/L MCL

0.010 mg/L MTCA Method B

MW-12A				
	Total CN	WAD CN	Free CN	Analyte
Q1:	0.06 UJ	0.06 U	0.0015 UJ	Q1 Concentration
Q2:	0.06 U	0.06 U	NS	Q2 Concentration
Q3:				Q3 Concentration
Q4:				Q4 Concentration

(MW-12A = Well Identification)

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
J: Estimated Concentration

U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Concentrations in milligrams per liter (mg/L)
CN: Cyanide
NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

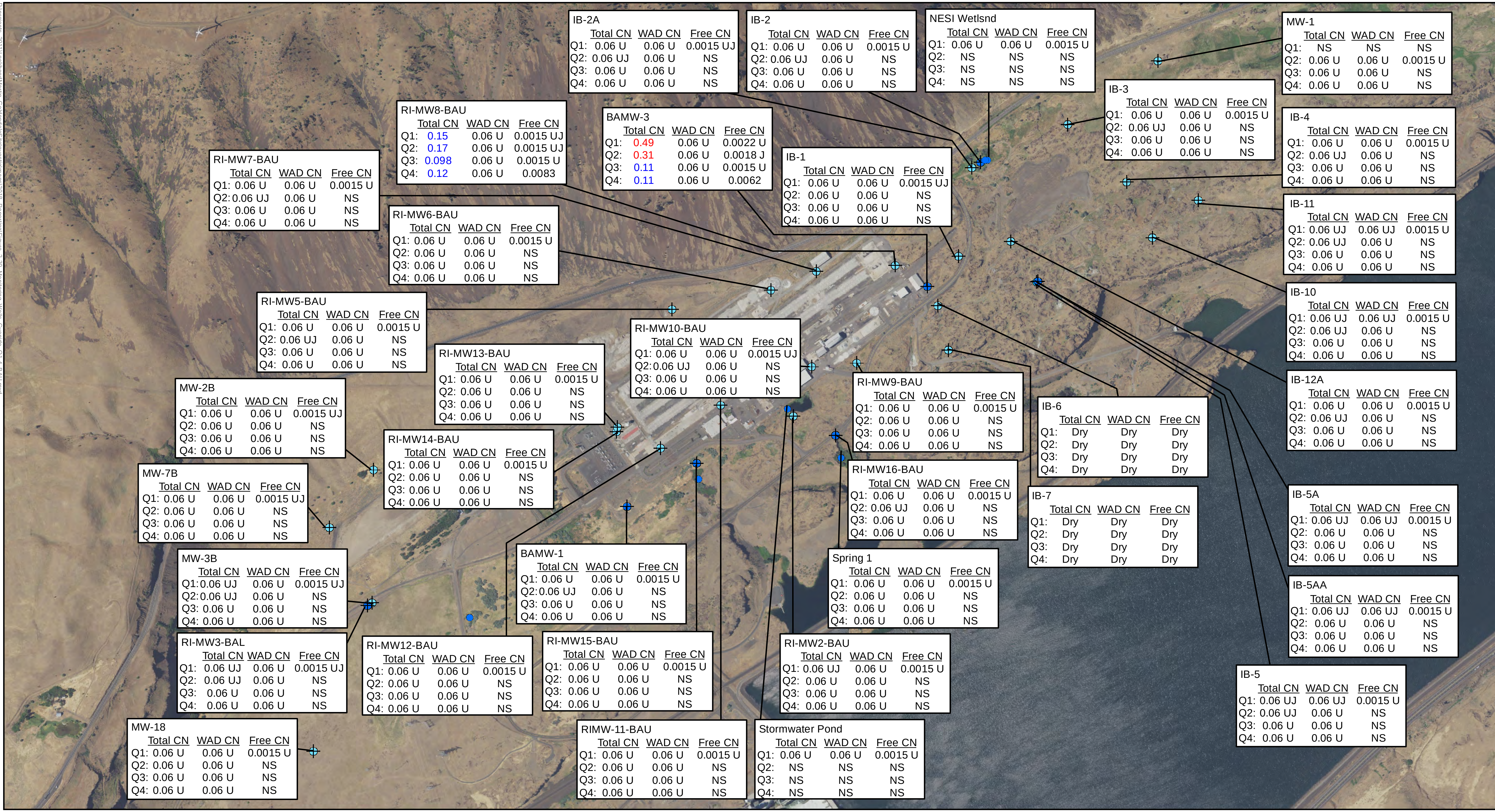
N / W / E / S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-29
Concentrations for Total Cyanide, WAD Cyanide, and Free Cyanide in Unconsolidated Aquifer (UA) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Uppermost Basalt Aquifer Well (BAU)

BAU₁ - Shallower Water-bearing Zone

BAU₂ - Deeper Water-bearing Zone

Spring/Pond/Wetland Water Sample

Screening Levels

0.200 mg/L MCL

0.010 mg/L MTCA Method B

MW-18			
	Total CN	WAD CN	Free CN
Q1:	0.06 U	0.06 U	0.0015 U
Q2:	0.06 U	0.06 U	NS
Q3:	0.06 U	0.06 U	NS
Q4:	0.06 U	0.06 U	NS

Well Identification
Analyte
Q1 Concentration
Q2 Concentration
Q3 Concentration
Q4 Concentration

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
J: Estimated Concentration

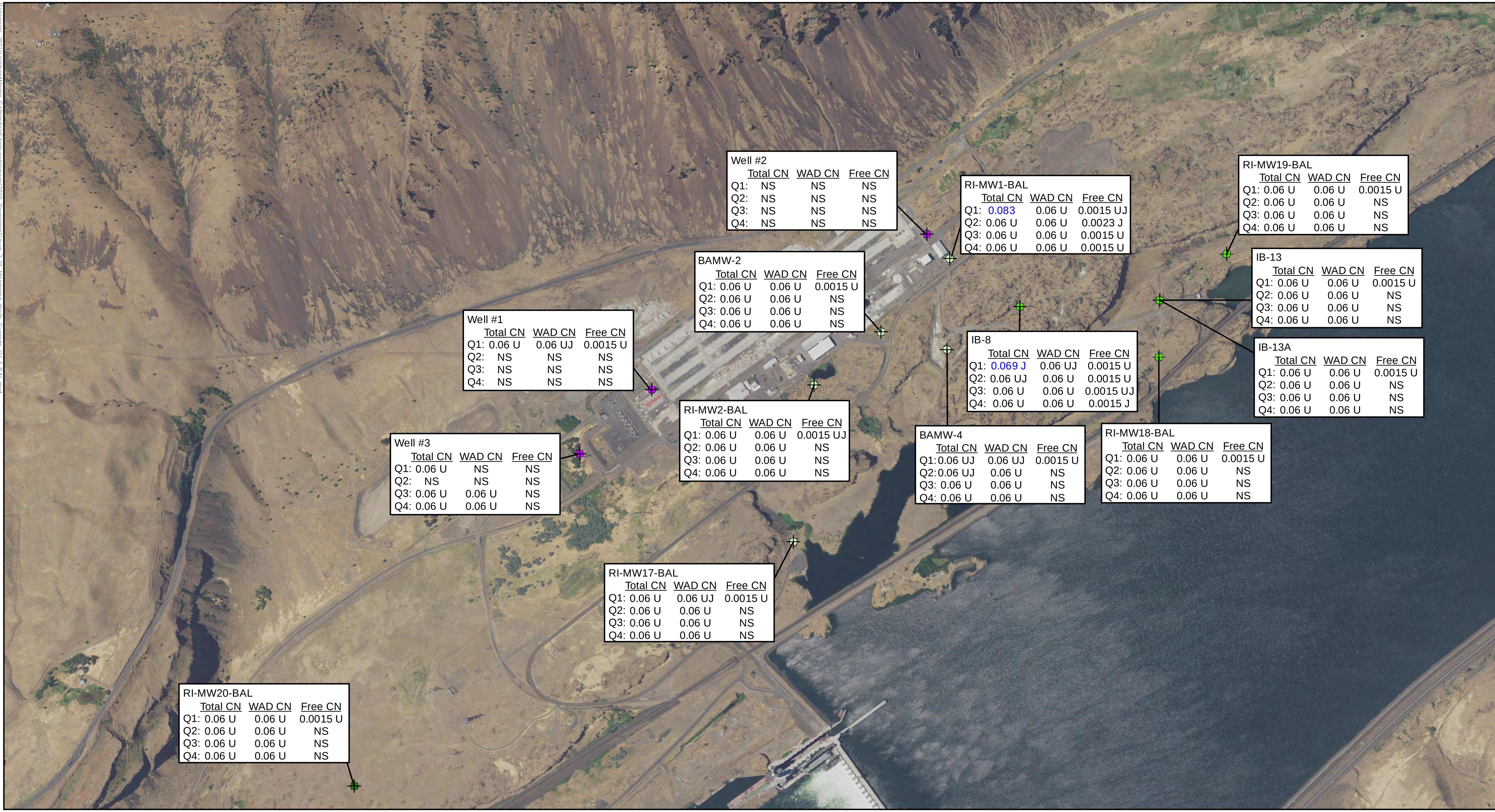
U:Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Concentrations in milligrams per liter (mg/L)
CN: Cyanide
NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-30
Concentrations for Total Cyanide, WAD Cyanide, and Free Cyanide in Uppermost Basalt Aquifer (BAU) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Lower Basalt Aquifer Well (BAL)

- BAL₁ - Shallower Water-bearing Zone
- BAL₂ - Deeper Water-bearing Zone
- BAL₃ - Deepest Water-bearing Zone
- Production Well

RI-MW20-BAL				Well Identification
	Total CN	WAD CN	Free CN	Analyte
Q1:	0.06 U	0.06 U	0.0015 U	Q1 Concentration
Q2:	0.06 U	0.06 U	NS	Q2 Concentration
Q3:	0.06 U	0.06 U	NS	Q3 Concentration
Q4:	0.06 U	0.06 U	NS	Q4 Concentration

Screening Levels
0.200 mg/L MCL
0.010 mg/L MTCA Method B
MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act

J: Estimated Concentration
U:Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Concentrations in milligrams per liter (mg/L)
CN: Cyanide
NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-31
Concentrations for Total Cyanide, WAD Cyanide, and Free Cyanide in Lower Basalt Aquifer (BAL) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Plan. The groundwater results show that total cyanide concentrations are generally low, free cyanide is not detected above screening levels, and that cyanide occurs in a less toxic metal-complexed form in groundwater.

UA Aquifer Zone Cyanide Results

In the UA zone, free cyanide was not detected above screening levels. Total cyanide concentrations exceeded the MCL for free cyanide of 0.20 mg/L at three locations in the UA zone (wells MW16A, MW-17A, and MW-6B) (refer to Figure 2-28). These wells are located in the vicinity of the West SPL storage Area and WSI. WAD cyanide and free cyanide were not detected in these wells. Total cyanide concentrations at MW-6B were above the MCL during all four quarters while total cyanide concentrations at MW-16A and MW-17A decreased to concentrations below the MCL, but above the MTCA Method B of 0.010 mg/L (refer to Table 2-7 and Figure 2-28).

A few additional UA wells were characterized by total cyanide levels above MTCA Method B screening levels and below the MCL including three wells near the WSI (MW-13A, MW-15A, and RI-GW1), one well near the WELF (MW-W1) and one well near the Tertiary Treatment Plant (RI-GW7).

BAU Aquifer Zone Cyanide Results

In the BAU zone, free cyanide was not detected above screening levels.

Total cyanide concentrations exceeded the MCL only in well BAMW-3, which is located at the downgradient (south) side of the East SPL Storage Area and North and South Pot Liner Soaking Stations (refer to Figure 2-29). RI-MW8-BAU was the only other BAU zone with total cyanide concentrations exceeding MTCA Method B screening levels. This well is located downgradient of the North and South Pot Liner Soaking Stations and upgradient of the East SPL Storage Building (refer to Table 2-8 and Figure 2-29).

BAL Aquifer Zone Cyanide Results

In the BAL zone free cyanide was not detected above screening levels. Total cyanide was not detected above the MCL in any of the BAL zone monitoring wells. Detections of total cyanide above MTCA Method B screening levels include RI-MW1-BAL, which is located near the East SPL Storage Building, and well IB-8, which is located near the NPDES Pond A and downgradient of the East SPL Storage Building (refer to Table 2-9 and Figure 2-30).

2.3.8.5 Sulfate Results Summary

Figures 2-32, 2-33, and 2-34 show the distribution of sulfate in the UA, BAU, and BAL aquifer zones, respectively based on the 4 quarters of RI monitoring. An additional round of groundwater sampling was performed in the plant area footprint as part of the WPA and these results are summarized in Section 2.4. Based on the 4 quarters of RI sampling, sulfate exceeds the secondary MCL of 250 mg/L primarily at the eastern and western ends of the site in all three aquifer zones. Additional investigation of groundwater in the Plant Area performed during the WPA also shows elevated sulfate concentrations in the UA and the BAU zone. These results are summarized separately in Section 2.4.

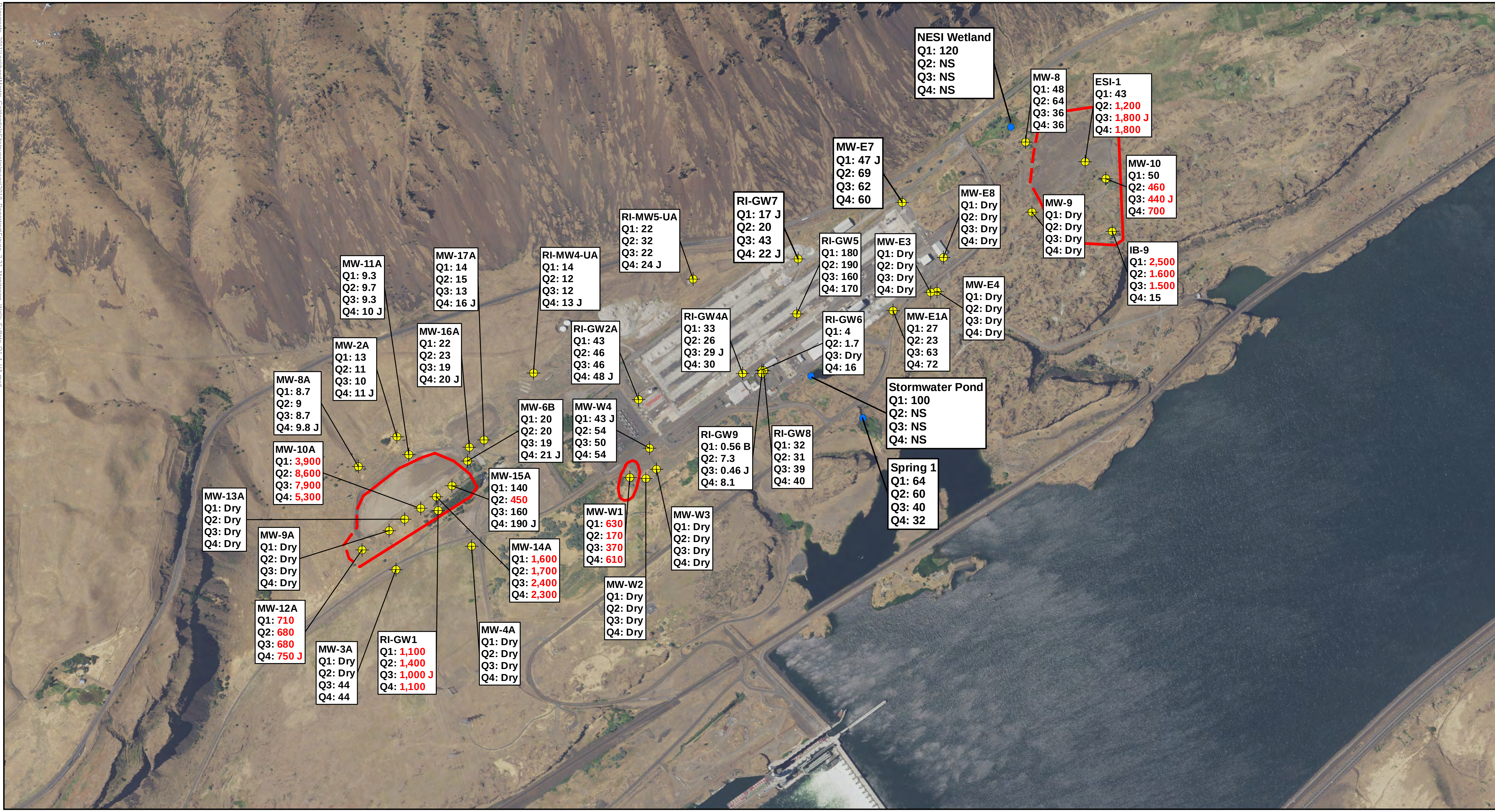
2.3.8.6 PAHs Results Summary

The distribution of PAHs in each aquifer zone are shown in Figures 2-35, 2-36, and 2-37. In general, the detection of PAHs in groundwater across the site was limited as was expected due to the low mobility and tendency of PAHs to sorb to both organic carbon and inorganic mineral surfaces. For the UA zone, cPAHs were detected above MTCA groundwater screening levels only in well MW-E7, which is located on the eastern end of the main plant area, during the initial baseline sampling round. For the BAU zone, wells IB-2, IB-12A, RI-MW9-BAU, and RI-MW3-BAL exceeded MTCA screening levels for PAHs. Of these BAU wells, only Well IB-12A, which is located on the southwest side of the ESI, had repeated PAH exceedances. For the BAL zone, well RI-MW1-BAL contained TTEC cPAH above the MTCA Method B screening level during the initial baseline sampling round only (refer to Figure 2-37).

For comparison, the stormwater pond sample contained PAH concentrations above MTCA groundwater screening levels, and PAH concentrations at Spring 01, which located down gradient of the stormwater pond, did not show PAHs above MTCA groundwater screening levels. PAHs were not detected in the NESI wetland surface water sample (refer to Tables 2-7, 2-8, and 2-9; and Figures 2-35, 2-36, and 2-37).

2.3.8.7 Metals

This section summarizes the distribution of metals that exceed screening levels and background concentrations at the site. Site groundwater background concentrations were calculated for a subset of metals (Al, As, Cr, Fe, Pb, and Ni) based on the 4 quarters of results from eight upgradient wells completed in the UA and BAU zones. The background concentration calculations are summarized in Volume 1, Section 5.4.1.2 and Volume 5, Appendix A-2.



Legend
- Unconsolidated Aquifer (UA) Well
- MW-12A 710 — Well Identification, Concentration
- Spring/Pond/Wetland Water Sample

Screening Levels
250 mg/L Secondary MCL

MCL: Maximum Contaminants Level
J: Estimated Concentration
Concentrations in milligrams per liter (mg/L)

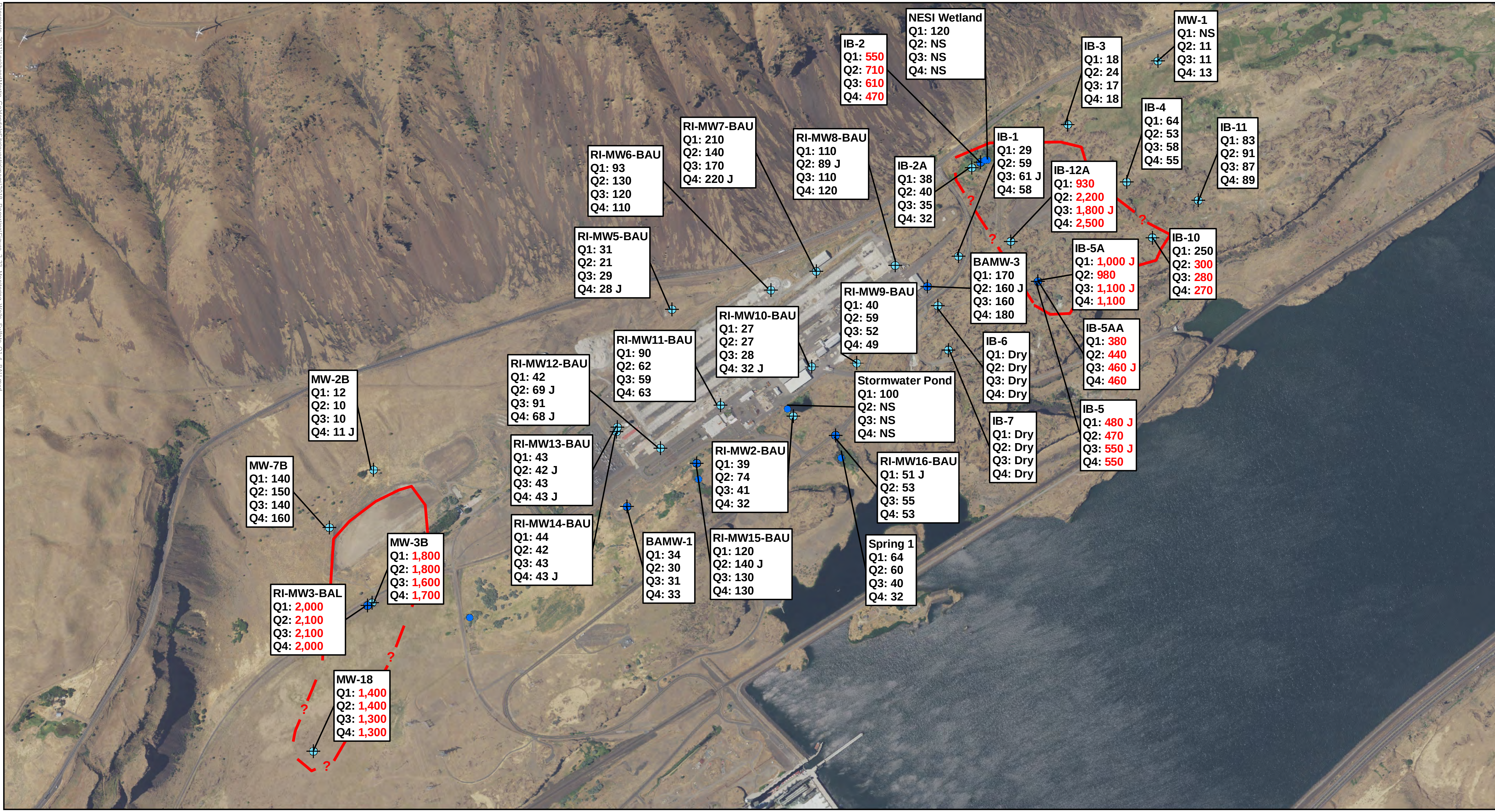
NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N / W / E / S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-32
Concentrations for Sulfate In Unconsolidated Aquifer (UA) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Uppermost Basalt Aquifer Well (BAU)

BAU₁ - Shallower Water-bearing Zone

BAU₂ - Deeper Water-bearing Zone

MW-18 1,400 — Well Identification Concentration

Spring/Pond/Wetland Water Sample

Screening Levels

250 mg/L Secondary MCL

MCL: Maximum Contaminants Level

J: Estimated Concentration

Concentrations in milligrams per liter (mg/L)

NS: Not Sampled

Q1: Quarter 1 (Winter 2017)

Q2: Quarter 2 (Spring 2017)

Q3: Quarter 3 (Summer 2017)

Q4: Quarter 4 (Fall 2017)

N W E S

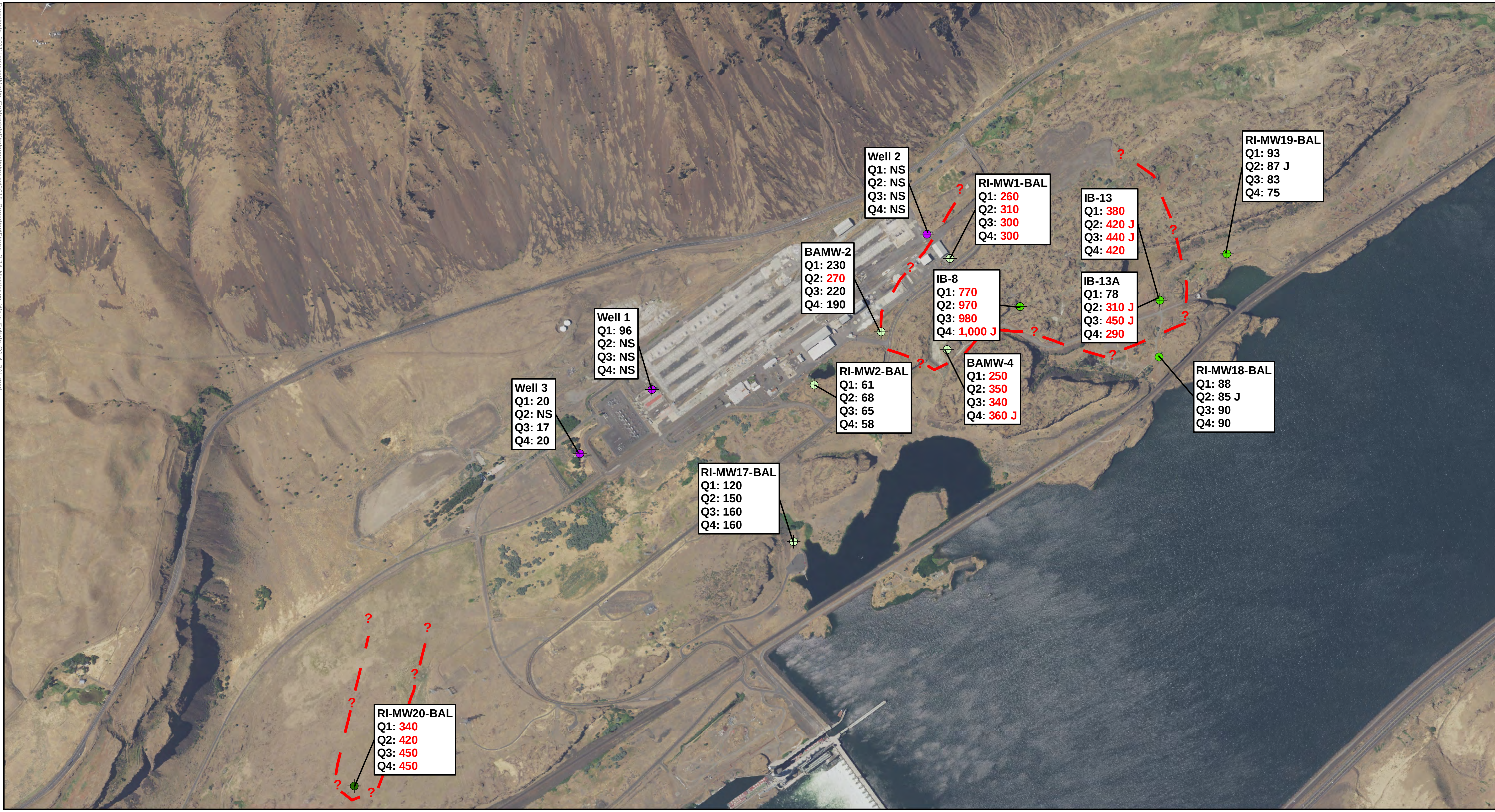
0 500 1,000 2,000

Feet

Imagery Source: NAIP 2017

Figure 2-33
Concentrations for Sulfate In
Uppermost Basalt Aquifer (BAU) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Lower Basalt Aquifer Well (BAL)

- BAL_1 - Shallower Water-bearing Zone
- BAL_2 - Deeper Water-bearing Zone
- BAL_3 - Deepest Water-bearing Zone

RI-MW20-BAL 340 — Well Identification / Concentration

Production Well

Screening Levels
250 mg/L Secondary MCL

MCL: Maximum Contaminants Level
J: Estimated Concentration
Concentrations in milligrams per liter (mg/L)

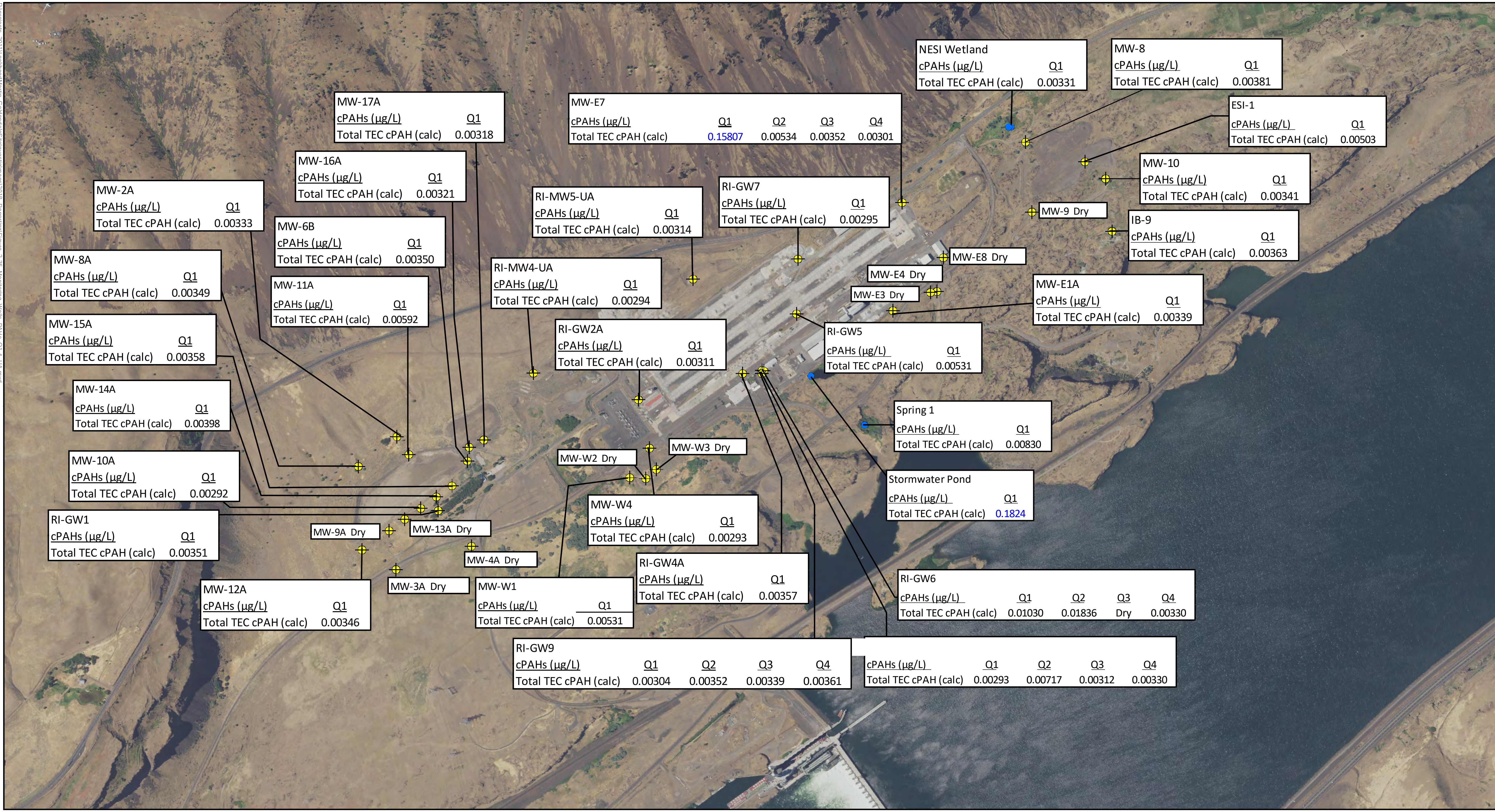
NS: Not Sampled
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-34
Concentrations for Sulfate In
Lower Basalt Aquifer (BAL) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

- Unconsolidated Aquifer (UA) Well
- Spring/Pond/Wetland Water Sample

red: Exceeds MCL Level of 0.2 ug/L
blue: Exceeds MTCA Method A Level of 0.1 ug/L
black: ND or Below Screening Level

J - Estimated Concentration
UJ - Chemical was not detected. Associated limit is estimated.

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled
cPAH - Carcinogenic Polycyclic Aromatic Hydrocarbon
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

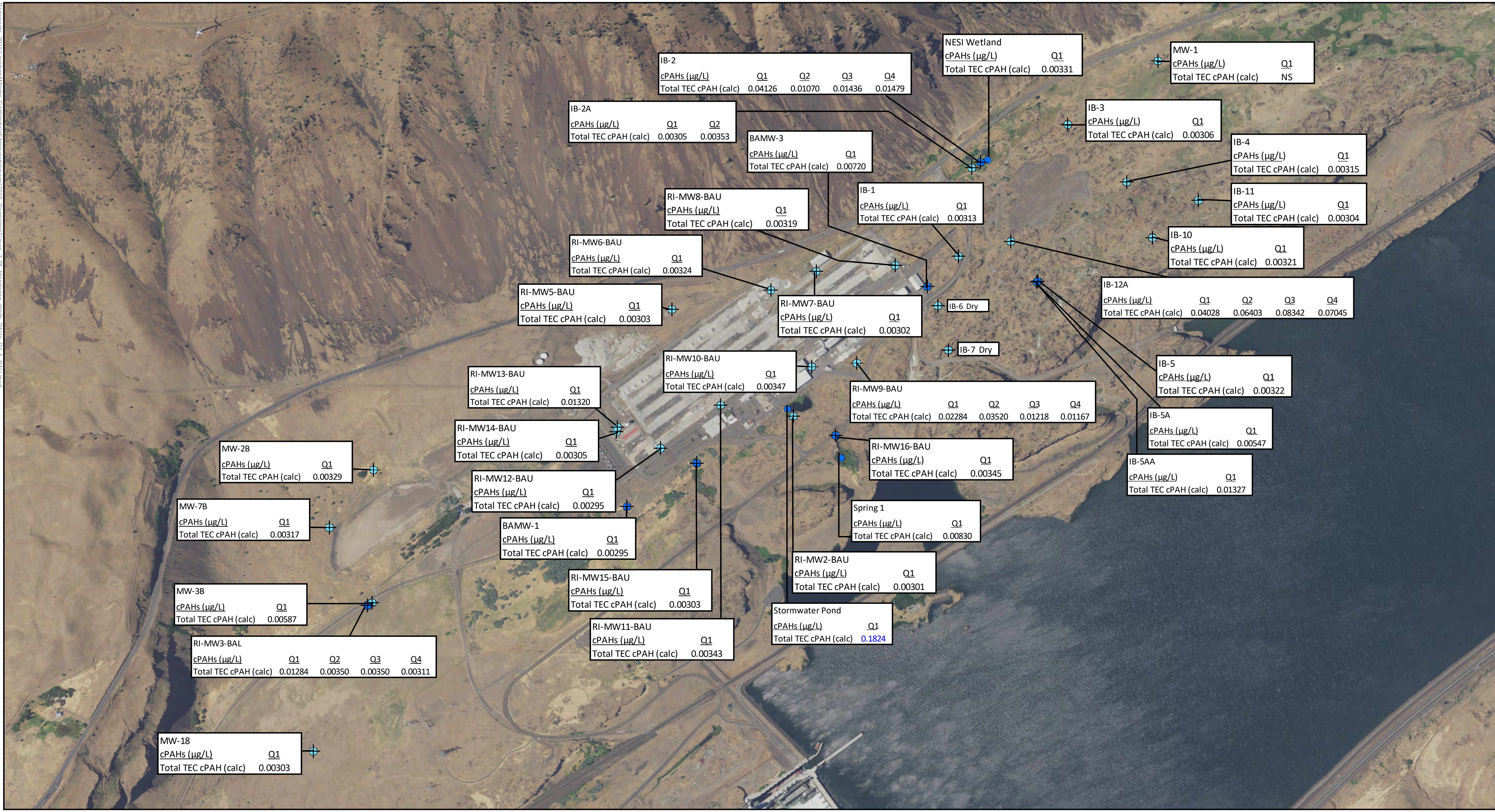
N W E S

0 500 1,000 2,000
Feet

Imagery Source: NAIP 2017

Figure 2-35
Concentrations of cPAHs in Unconsolidated Aquifer (UA) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Legend

Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone
- Spring/Pond/Wetland Water Sample

red: Exceeds MCL Level of 0.2 ug/L
blue: Exceeds MTCA Method A Level of 0.1 ug/L
black: ND or Below Screening Level

B - Chemical was detected in the blank and the sample
J - Estimated Concentration
UJ - Chemical was not detected. Associated limit is estimated.

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled
cPAH - Carcinogenic Polycyclic Aromatic Hydrocarbon
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-36
Concentrations of cPAHs in
Uppermost Basalt Aquifer (BAU) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Legend

Lower Basalt Aquifer Well (BAL)

- BAL1 - Shallower Water-bearing Zone
- BAL2 - Deeper Water-bearing Zone
- BAL3 - Deepest Water-bearing Zone
- Production Well

red: Exceeds MCL Level of 0.2 ug/L
blue: Exceeds MTCA Method A Level of 0.1 ug/L
black: ND or Below Screening Level

B - Chemical was detected in the blank and the sample
J - Estimated Concentration
UJ - Chemical was not detected. Associated limit is estimated.

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
ND: Not Dectecte
NS: Not Sampled
cPAH - Carcinogenic Polycyclic Aromatic Hydrocarbon
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)

N W E S

0 500 1,000 2,000
Feet
Imagery Source: NAIP 2017

Figure 2-37
Concentrations of cPAHs in
Lower Basalt Aquifer (BAL) Wells

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Arsenic

Site-specific groundwater background for arsenic was calculated at 0.0069 mg/L, which is higher than the MTCA Method B formula value of 0.00058 mg/L, and slightly higher than the MTCA Method A level of 0.0050 mg/L that is based on state-wide background concentrations.

In general, arsenic results are similar for the total and dissolved (field-filtered) samples, which suggests that most of the arsenic is in the dissolved fraction. The distribution of arsenic in groundwater in each aquifer zone is summarized as follows:

- **UA Zone.** Arsenic was detected in three well locations (MW-3A, MW-14A, and MW-W1) above the MCL. At MW-3A and MW-14A both total and dissolved fractions exceeded the MCL. At MW-14A, total and dissolved fractions exceeded the MCL during all four quarters of sampling. At MW-W1, arsenic concentrations only exceeded the MCL during the 1st quarter in the total fraction (refer to Table 2-7).

- **BAU Zone**. No BAU-zone wells exceeded background levels or the MCL during any of the sampling rounds (refer to Table 2-8).

- **BAL Zone.** Samples for two BAL zones exceeded the MCL of 0.010 mg/L in the BAL zone during the first sampling round (RI-MW19-BAL and RI-MW20-BAL). These wells did not exceed calculated background levels in the subsequent three sampling rounds (refer to Table 2-9).

Iron

Calculated background iron concentrations for groundwater (13 mg/L) are above the secondary MCL of 0.3 mg/L and the MTCA Method B formula value of 11 mg/L. Note that secondary MCL does not represent a risk-based screening level. In general, for those wells exhibiting elevated iron concentrations, total iron concentrations are higher than dissolved (field-filtered) iron concentrations for the same well, which suggests that some portion of the iron is associated with suspended particles.

Exceedances of background concentrations and screening levels for iron are summarized for each aquifer zone as follows:

- **UA Zone.** Concentrations of total iron exceeded the MTCA Method C formula value of 25 mg/L at well MW-W1 during the baseline sampling round. During the subsequent three sampling rounds, iron was below the MTCA Method C formula value at this well. Dissolved iron concentrations were below MTCA screening levels. Well MW-W1 is located at the WELF, a landfill area with buried metal debris (refer to Table 2-7).

- **BAU Zone.** Concentrations of total iron exceeded background concentrations and the MTCA Method B formula value in RI-MW7-BAU during three of four sampling rounds. Dissolved iron concentrations were generally below the MTCA Method B screening level (refer to Table 2-8).
- **BAL Zone.** Concentrations of total iron exceeded background concentrations and the MTCA Method B formula value in RI-MW1-BAL during the baseline sampling round. Total iron concentration at this well location were not elevated during subsequent sampling rounds Dissolved iron concentrations were below the MTCA Method B screening level (refer to Table 2-9).

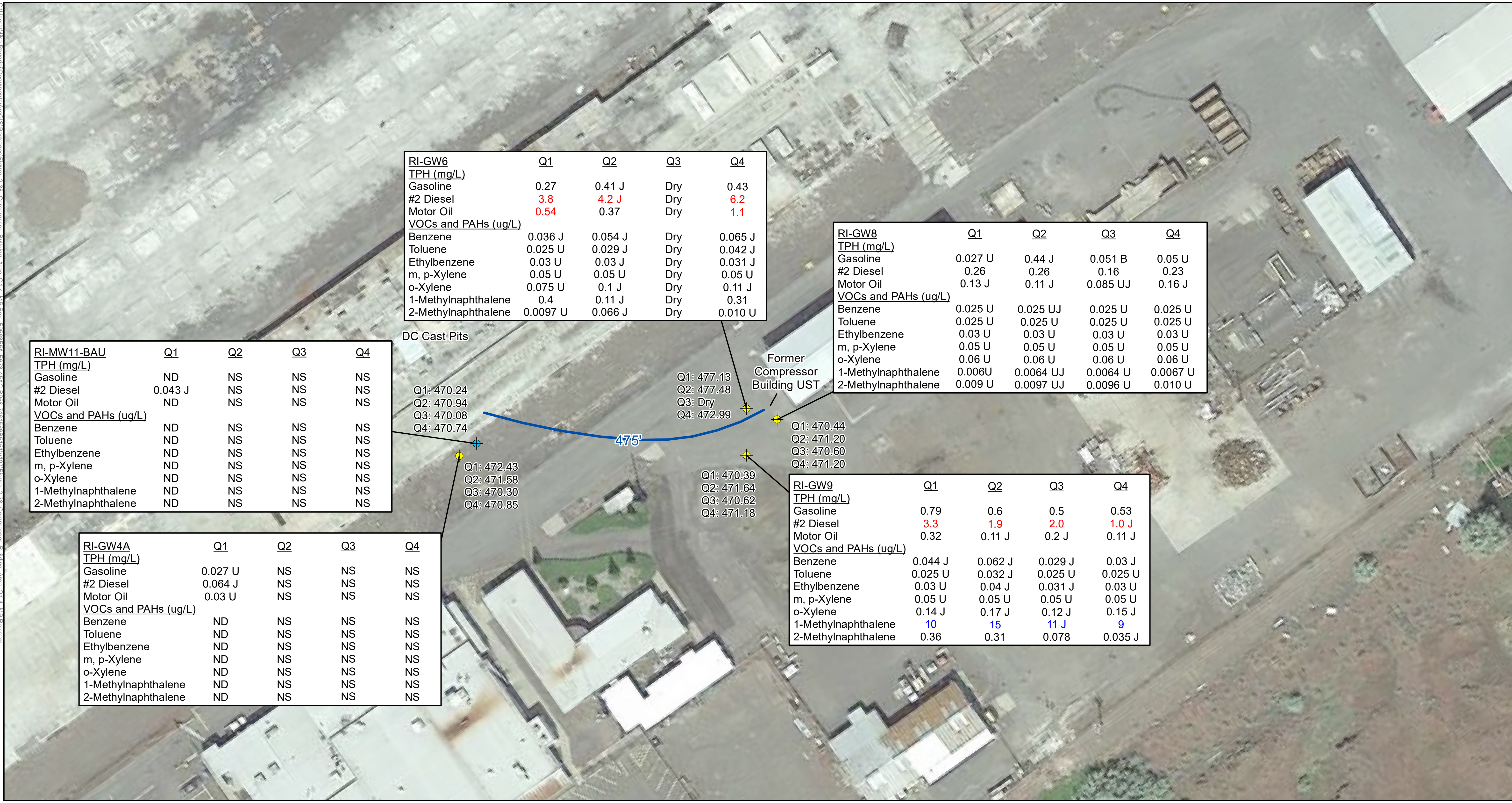
Other Metals

In addition to arsenic and iron, a few metals (aluminum, lead, and nickel) exceeded screening levels and site-specific background concentrations in a few well locations as follows (refer to Tables 2-7, 2-8, and 2-9):

- **Aluminum.** Aluminum only exceeded the MTCA Method B groundwater screening levels at well RI-MW20-BAL (29 mg/L) in the total fraction during the baseline sampling round. Aluminum was not detected in the dissolved fraction. During subsequent sampling rounds, aluminum was not detected above screening levels.
- **Chromium.** Chromium was detected (0.18 mg/L) in the total fraction above the MTCA Method B screening level in well MW-W2 during the baseline round but was not detected above screening levels during subsequent sampling rounds.
- **Lead.** Lead exceeded the MTCA Method A screening level in well RI-MW20-BAL (maximum of 0.048 mg/L) in the total fraction during the first and second quarters. Lead was not detected above screening levels in the dissolved (field -filtered) fraction.
- **Nickel.** Nickel was detected (0.12 mg/L) above the MCL in the total fraction in well MW-W2 during the baseline sampling round, and not detected above screening levels during subsequent sampling rounds.

2.3.8.8 Former Compressor Building UST Results Summary

Groundwater contamination in this area was originally identified based on the chemical results for development water from temporary well RI-GW6 in December 2015. Diesel-range petroleum hydrocarbons [maximum of 6.2 mg/L in RI-GW6], and motor-oil range petroleum hydrocarbons (maximum of 1.1 mg/L in RI-GW6) were detected above MTCA groundwater screening levels in wells located near and downgradient of the Compressor Building Former UST (Figure 2-38). 1-methylnaphthalene (maximum of 15 µg/L in RI-GW9) was also detected above the MTCA Method B screening level (refer to Table 2-7). No measurable petroleum product was found at the wells.



RI-GW6	Q1	Q2	Q3	Q4
TPH (mg/L)				
Gasoline	0.27	0.41 J	Dry	0.43
#2 Diesel	3.8	4.2 J	Dry	6.2
Motor Oil	0.54	0.37	Dry	1.1
VOCs and PAHs (ug/L)				
Benzene	0.036 J	0.054 J	Dry	0.065 J
Toluene	0.025 U	0.029 J	Dry	0.042 J
Ethylbenzene	0.03 U	0.03 J	Dry	0.031 J
m, p-Xylene	0.05 U	0.05 U	Dry	0.05 U
o-Xylene	0.075 U	0.1 J	Dry	0.11 J
1-Methylnaphthalene	0.4	0.11 J	Dry	0.31
2-Methylnaphthalene	0.0097 U	0.066 J	Dry	0.010 U

RI-GW8	Q1	Q2	Q3	Q4
TPH (mg/L)				
Gasoline	0.027 U	0.44 J	0.051 B	0.05 U
#2 Diesel	0.26	0.26	0.16	0.23
Motor Oil	0.13 J	0.11 J	0.085 UJ	0.16 J
VOCs and PAHs (ug/L)				
Benzene	0.025 U	0.025 UJ	0.025 U	0.025 U
Toluene	0.025 U	0.025 U	0.025 U	0.025 U
Ethylbenzene	0.03 U	0.03 U	0.03 U	0.03 U
m, p-Xylene	0.05 U	0.05 U	0.05 U	0.05 U
o-Xylene	0.06 U	0.06 U	0.06 U	0.06 U
1-Methylnaphthalene	0.006U	0.0064 UJ	0.0064 U	0.0067 U
2-Methylnaphthalene	0.009 U	0.0097 UJ	0.0096 U	0.010 U

RI-MW11-BAU	Q1	Q2	Q3	Q4
TPH (mg/L)				
Gasoline	ND	NS	NS	NS
#2 Diesel	0.043 J	NS	NS	NS
Motor Oil	ND	NS	NS	NS
VOCs and PAHs (ug/L)				
Benzene	ND	NS	NS	NS
Toluene	ND	NS	NS	NS
Ethylbenzene	ND	NS	NS	NS
m, p-Xylene	ND	NS	NS	NS
o-Xylene	ND	NS	NS	NS
1-Methylnaphthalene	ND	NS	NS	NS
2-Methylnaphthalene	ND	NS	NS	NS

RI-GW4A	Q1	Q2	Q3	Q4
TPH (mg/L)				
Gasoline	0.027 U	NS	NS	NS
#2 Diesel	0.064 J	NS	NS	NS
Motor Oil	0.03 U	NS	NS	NS
VOCs and PAHs (ug/L)				
Benzene	ND	NS	NS	NS
Toluene	ND	NS	NS	NS
Ethylbenzene	ND	NS	NS	NS
m, p-Xylene	ND	NS	NS	NS
o-Xylene	ND	NS	NS	NS
1-Methylnaphthalene	ND	NS	NS	NS
2-Methylnaphthalene	ND	NS	NS	NS

RI-GW9	Q1	Q2	Q3	Q4
TPH (mg/L)				
Gasoline	0.79	0.6	0.5	0.53
#2 Diesel	3.3	1.9	2.0	1.0 J
Motor Oil	0.32	0.11 J	0.2 J	0.11 J
VOCs and PAHs (ug/L)				
Benzene	0.044 J	0.062 J	0.029 J	0.03 J
Toluene	0.025 U	0.032 J	0.025 U	0.025 U
Ethylbenzene	0.03 U	0.04 J	0.031 J	0.03 U
m, p-Xylene	0.05 U	0.05 U	0.05 U	0.05 U
o-Xylene	0.14 J	0.17 J	0.12 J	0.15 J
1-Methylnaphthalene	10	15	11 J	9
2-Methylnaphthalene	0.36	0.31	0.078	0.035 J

Legend

- Unconsolidated Aquifer (UA) Well
- Uppermost Basalt Aquifer (BAU) Well

Q1: 470.39
Q2: 471.64
Q3: 470.62
Q4: 471.18
Water-level Elevation (ft AMSL)

475' Water-level Elevation Contour (Q1)

Screening Levels

concentration Exceeds MTCA Method A

concentration Exceeds MTCA Method B

MTCA: Model Toxics Control Act
NS: Not Sampled
B: Compound was found in the blank and sample
J: Estimated Concentration
U: Chemical was not detected. The associated value represents the method detection limit.
UJ: Chemical was not detected. Associated limit is estimated.
Q1: Quarter 1 (Winter 2017)
Q2: Quarter 2 (Spring 2017)
Q3: Quarter 3 (Summer 2017)
Q4: Quarter 4 (Fall 2017)
TPH in mg/L and VOC and PAH in ug/L

N W E S

0 25 50 100
Feet
Imagery Source: Google Earth 2016

Figure 2-38
Groundwater Chemical Concentrations
Compressor Building UST

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Gasoline-range petroleum hydrocarbons (maximum of 0.79 mg/L in RI-GW9) and benzene, toluene, ethylbenzene, and total xylenes (BTEX) were also detected at all three wells but at concentrations below MTCA Method A screening levels.

These same petroleum hydrocarbons were also detected in subsurface soil above MTCA screening levels in the vicinity of the former compressor building UST (refer to Volume 3, Section 2.4 for a summary of the subsurface soil results for the Former Compressor Building UST).

2.3.8.9 Well MW-1 Results Summary

A purple-pink material was discovered in Well MW-1 during well development activities. Well MW-1 is located upgradient (east) of areas where smelter-related wastes were historically disposed of and historical site operations. The material is concentrated at the bottom of the well but does not appear to represent a petroleum product based on the lack of a response from the oil-water interface probe and the analytical results. The material looked somewhat similar to antifreeze, potassium permanganate, or dye at the time of inspection. Well MW-1 is a pre-existing monitoring well located east of the ESI, as shown in Figure 2-1.

The data for the MW-1 is summarized in a separate Table (Table 2-10) because the characterization analytical program for the unidentified pink-purple material found in the well was different from the other wells and included analysis of a long list of TICs. During the baseline round, a grab sample of the purple-pink material was collected with a disposable bailer and analyzed for waste profiling as described in Section 2.2.8.3. Subsequent sampling rounds included grab sampling of both the purple-pink material and sampling of the groundwater using low-flow sampling techniques. The analytical program at MW-1 included aluminum smelter chemicals (cyanide, fluoride, sulfate), metals (As, Ba, Cd, Cr, Fe, Pb, Ni, Hg, Se, and Ag), PAHs, glycols, SVOCs (including TICs), PCBs, TPH-Dx, TPH-Gx, VOCs (including TICs), chlorinated herbicides, and chlorinated pesticides.

The purple-pink material contained elevated concentrations of iron (15 mg/L), lead (0.024 J mg/L), diesel-range organics (0.92 B mg/L, motor-oil-range organics (0.85 J mg/L), vinyl chloride (1.8 J µg/L), and heptachlor epoxide (0.016 J µg/L) above MTCA Method A and B groundwater screening levels (refer to Table 2-10). Concentrations of these constituents were not detected above screening levels in the groundwater samples collected using low-flow sampling techniques.

Table 2-10
Groundwater AOC – Results Summary for MW-1
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Parameter Name	Units	Screening Level: MTCA Method A	MTCA Method B	MTCA Method C	MCL	Fraction Analyzed	Analytical Results: Purple-Pink Material (Grab Sample with Bailer)	Maximum Concentration Groundwater Samples (Low-Flow Sampling, Center of Screen)
Aluminum Smelter								
Total Cyanide	mg/L	NE	0.01	0.022	0.2	Total	NA	ND
Cyanide, Free	µg/L	NE	0.01	0.022	0.2	Total	NA	ND
Cyanide, Weak Acid Dissociable	mg/L	NE	0.01	0.022	0.2	Total	NA	ND
Fluoride	mg/L	NE	0.96	2.1	4.0	Total	NA	0.22
Sulfate	mg/L	NE	NE	NE	250	Total	NA	13
Metals								
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	Total	**0.021 B**	**0.00073 J**
Barium	mg/L	NE	3.2	7.0	2.0	Total	ND	NA
Cadmium	mg/L	0.005	0.008	0.018	0.005	Total	ND	NA
Chromium	mg/L	0.05	24	53	0.1	Total	0.0034 J	NA
Iron	mg/L	NE	11	25	0.3	Total	**15**	0.13 J
Lead	mg/L	0.015	NE	NE	0.015	Total	**0.024 J**	0.00078 J
Nickel	mg/L	NE	0.000096	0.00096	0.1	Total	NA	NA
Mercury	mg/L	0.002	NE	NE	0.002	Total	0.000061 B	NA
Selenium	mg/L	NE	0.08	0.18	0.05	Total	ND	NA
Silver	mg/L	NE	0.08	0.18	NE	Total	ND	NA
Polynuclear Aromatic Hydrocarbons	µg/L	Various				Total	ND	NA
Glycols	µg/L	Various				Total	ND	NA
Semi-Volatiles Organic Compounds (including TICs for Bailer Sample)								
Phenol	µg/L	NE	2,400	5,300	NE	Total	24	NA
m,p-Cresol (2:1 ratio)	µg/L	NE	400	880	NE	Total	16	NA
PCBs	µg/L	Various				Total	ND	NA
Total Petroleum Hydrocarbons								
Gasoline	mg/L	0.1	NE	NE	NE	Total	ND	NA
#2 Diesel	mg/L	0.5	NE	NE	NE	Total	**0.92 B**	0.05 B
Motor Oil	mg/L	0.5	NE	NE	NE	Total	**0.85 J**	ND
Volatile Organic Compounds (including TICs for Bailer Sample)								
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	Total	**1.8**	ND
Chlorinated Herbicides	µg/L	Various				Total	ND	ND
Chlorinated Pesticides								
4,4'-DDD	µg/L	NE	0.36	1.1	NE	Total	0.057	ND
4,4'-DDE	µg/L	NE	0.26	2.6	NE	Total	ND	ND
4-4-DDT	µg/L	0.3	0.26	2.6	NE	Total	0.036	ND
Heptachlor epoxide	µg/L	NE	0.0048	0.048	0.2	Total	**0.016 J**	ND

Notes:
Bold values denote exceedances of one or more screening levels and background concentrations.
B = Chemical was detected in the blank and the sample
J = Estimated Concentration
MCL = Maximum Contaminant Level
MTCA = Model Toxics Control Act
NA = Not Analyzed
ND = Not Detected at laboratory reporting limit
NE = Not Established
TICs = Tentatively Identified Compounds

2.3.8.10 Limited Detection Chemicals

Several chemicals were comprehensively analyzed for during the first (baseline) sampling round with few to very few detections above screening levels. Chemicals detected above screening levels in a given well were carried forward for that chemical for all groundwater sampling rounds.

PCBs

PCBs were detected only at well RI-MW17-BAL, which is located near the Boat Basin, during the baseline Winter 2017 sampling round. PCBs were not detected in any of the subsequent quarterly rounds of monitoring from this well or in field duplicate samples for this constituent. Note that PCBs have historically been detected in soils in this general area (use of waste oil on dam roadways) that were related to past dam operations (USACE 1994).

VOCs

VOCs such as BTEX and chlorinated solvent constituents were not detected in in collected groundwater samples at the site with two exceptions (monitoring wells RI-GW1 and MW-1). Well RI-GW1 is located at the former laboratory drain field in the western portion of the site near the WSI. During the baseline round of groundwater sampling, vinyl chloride (0.1 µg/L) was detected above the MTCA Method B screening level of 0.023 µg/L, however, it was not detected above MTCA screening levels at RI-GW1 during subsequent sampling rounds. Trichloroethene (TCE) (maximum of 0.076 µg/L) was also detected at RI-GW1 at very low concentrations below MTCA Method B groundwater screening levels during three quarterly sampling rounds. MW-1 results are summarized previously in more detail in Section 2.3.8.9.

2.4 WPA RESULTS – GROUNDWATER MIGRATION IN THE FORMER PLANT AREA VICINITY

The WPA groundwater investigation has focused on characterization of the plant area including the extent of groundwater contamination in the plant area and suspected sources, interaction of the various line groups with shallow groundwater, and the potential flow paths between features near and associated with the former plant NPDES Ponds Drainage, Wetland K western intermittent drainage, and Wetland F Eastern Intermittent Drainage, and the flow path between shoreline wells and the Lake Umatilla reservoir.

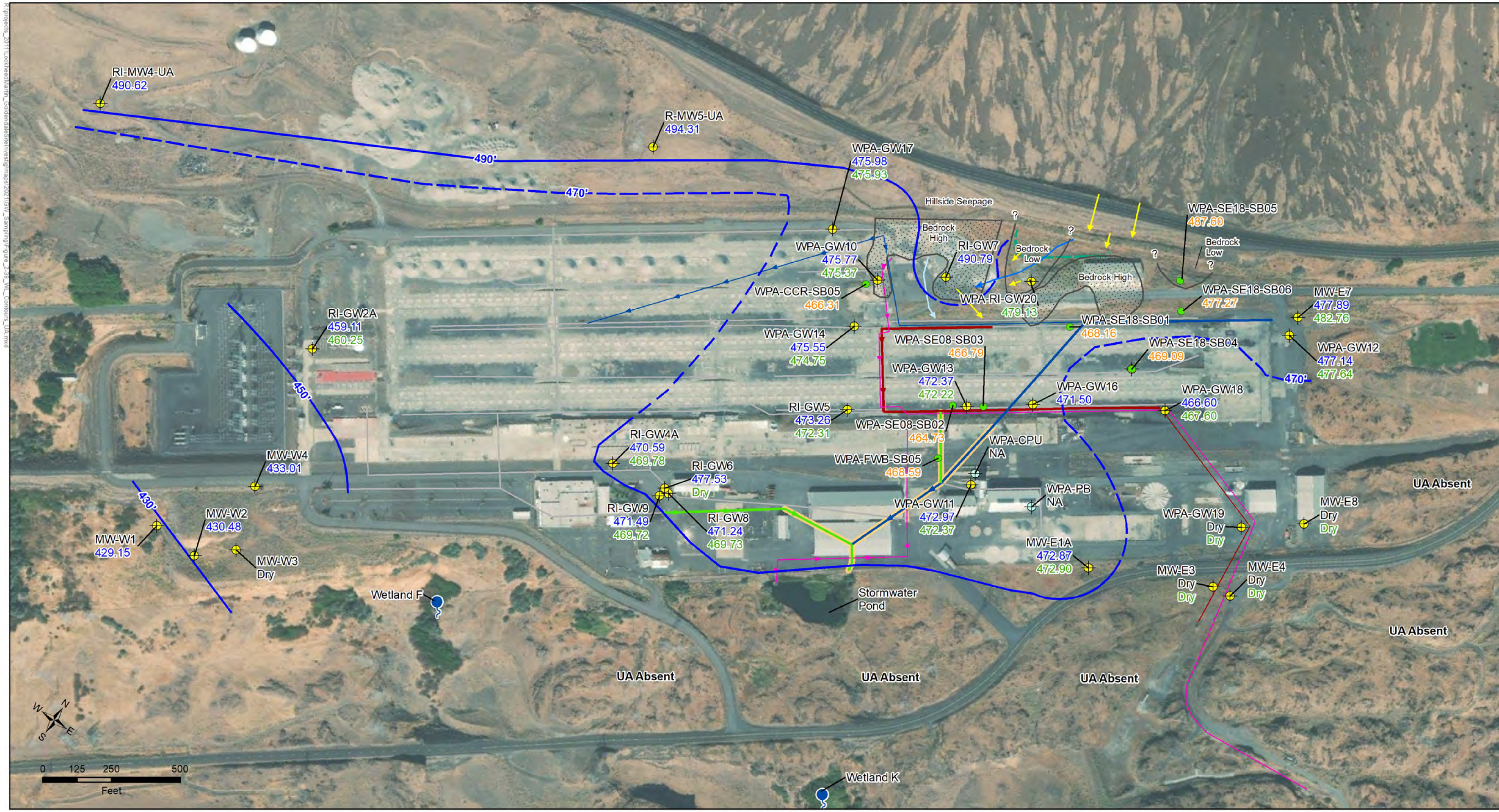
2.4.1 WPA Groundwater Water-Level Elevations

Figures 2-39 and 2-40 summarize the water-level elevations made in the Plant Area footprint for the UA zone and BAU zone, respectively. Mapping and observations from the plant area line evaluation section (Volume 3, Section 2.5) showing locations where water is consistently present in the lines are also included as relevant.

Water-level measurements were collected from 30 pre-existing monitoring wells and 11 newly constructed monitoring well during the WPA field investigation. A subset of these wells were measured again in May 2021 to check variability and seasonality. Water-level measurements were also made near the time of drilling at groundwater borings in the plant area. However, the measuring point and ground surface elevations were not surveyed and were estimated. These measurements are included in Figures 2-39 and 2-40 for informational purposes, but were not used directly in developing the water-level elevation contours.

Based on the water-level elevations, there is a groundwater mound in the central part of the site that extends southward from the area of the Tertiary Treatment plant all the way to the area of the stormwater pond. This feature can be seen in the water-level elevation contour maps for both the UA Zone and the underlying BAU zone, which indicates significant hydraulic communication between the UA and BAU zone.

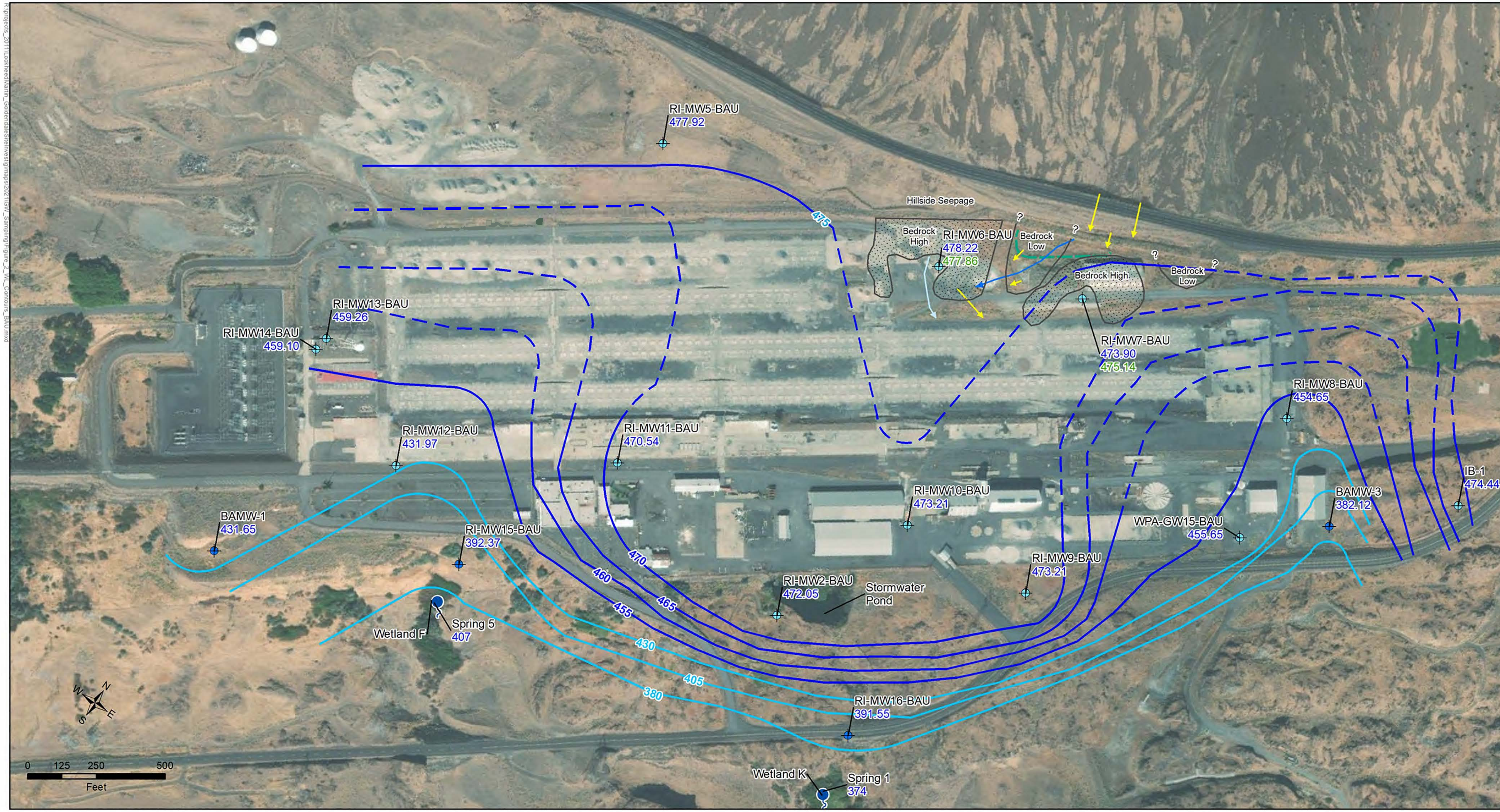
The vertical gradient between the zones appear to vary between the north and south portion of the plant area. In the northern portion of the plant area, wells RI-GW7 (UA) and RI-MW6-BAU indicate a downward flow potential in late Fall 2020, with the water level elevation in the UA at 490.79 and in the BAU at 478.22. Nearby wells WPA-RI-GW20 (UA) and RI-MW7-BAU showed a difference with the UA at 479.13 and the BAU at 475.14 in Spring 2021. In the southern portion of the plant area wells RI-GW4A (UA) and RI-MW11-BAU showed water-level elevations of 470.59 and 470.54 respectively, indicating no significant difference in water-levels between the zones. A pair of proximal wells, also in the southern plant area, WPA-GW11 (UA) and RI-MW0-BAU showed water level elevations of 472.97 and 473.21 respectively, indicating the BAU water-level elevation is higher than the UA in this area in Fall 2020.



Unconsolidated Aquifer Well (UA)
Sump
Groundwater Boring
Spring
20-foot Water-Level Elevation Contour
Bedrock Elevation Contour
Bedrock High
Stormwater Drainage Berm
Stormwater Drainage Piping
Stormwater Runoff Path
Potential Shallow Groundwater Flow
Stormwater Collection System
Groundwater Collection System
Industrial and Monitoring Collection System
Scrubber Effluent Collection System
Thicker Lines Indicate Year-Round Flow
Thinner Lines Indicate Intermittent Flow
Volume 3, Section 2.5 Summarizes the Line Layout
Stormwater Pond Backs Up into Lines
Gray-scale Indicate No Persistant Flow was Observed
331.21 Work Plan Addendum (Late October - Early December 2020) Water Level Elevation
331.21 Work Plan Addendum (May 11, 2021) Water Level Elevation
331.21 Work Plan Addendum Estimated Water Level Elevation in Boring. Measurement not used in water level elevation contouring.

Figure 2-39
Water-Level Elevation Contour Map
Unconsolidated Aquifer Wells (UA) and
Persistantly Wet Areas of the Line System
Former Plant Area Footprint
WPA Field Program
Late October 2020 - May 2021

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington



Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone
- Spring
- 5-foot Water-Level Elevation Contour
- 25-foot Water-Level Elevation Contour
- Bedrock Elevation Contour
- Bedrock High
- Stormwater Drainage Berm
- Stormwater Drainage Piping
- Stormwater Runoff Path
- Potential Shallow Groundwater Flow

331.21 Work Plan Addendum (Late October - Early December 2020) Water Level Elevation

331.21 Work Plan Addendum (May 11, 2021) Water Level Elevation

Figure 2-40
Water-Level Elevation Contour Map
Uppermost Basalt Aquifer Wells (BAU)
Former Plant Area Footprint
WPA Field Program
Late October 2021 - May 2021

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

During the RI and WPA, hillside seeps were observed in the hillside immediately north of the Tertiary Treat Plant Building (SWMU 8). In addition, a bermed area and associated culvert system was found northwest of the North SPL Building (SWMU 14) that was constructed to manage runoff from the SR14 highway and hillslope. This feature serves to route runoff from this area to the southwest into the area of secondary clarifier east of the Line B, C and Secondary Scrubber System Tertiary Treatment Plant (SWMU 8) and then into the Courtyard C portion of the stormwater system (refer to Volume 3, Section 2.2.7 and Figure 2.2.7-1, for further details of this area. A bedrock high was also found in this area and may help explain the observed hillside seepage as well as influence the occurrence and migration of shallow groundwater and runoff in the area. The bedrock observed in the area of hillside seepage results in less thickness of fill/unconsolidated material and acts to divert flow toward the south in this area.

The hillside seepage, bedrock topography and the presence of the hillside stormwater system help explain the presence of the groundwater mound that is present in the area of SWMU 6 and 8 and the associated clarifiers and was originally observed in wells RI-GW7 and RI-MW6-BAU. There is radial flow away from the groundwater mound to the southeast-southwest in both aquifer zones.

Areas of the line systems with persistent water and intermittent water observed have been mapped and included with the UA zone water-level (Figure 2-39) and chemical concentration maps. This portion of the line system represents the areas where shallow groundwater-underground line hydraulic interaction and contaminant migration are most likely to occur and may correlate with areas of groundwater infiltration into the lines, and suspected leakage out of the lines.

A key observation and finding of the WPA related to groundwater-line interactions is that the stormwater pond backs up into the groundwater and stormwater line systems and forms a groundwater mound in the stormwater pond vicinity. The backup from the stormwater pond occurs throughout the year but is particularly acute during the winter months with higher rainfall. This line area is shown in gold in Figure 2-39 and the layout of the line systems fully summarized in Volume 3, Section 2.5. The northern edge of the area where the lines backup is near the intersection of the combined stormwater and groundwater line with the east-west scrubber effluent line segment that leads to the head of the NPDES Pond drainage.

A second important finding of the WPA is that one large and significant breach was observed in eastern Courtyard A-4. This portion of the SE line is partially below the water table and groundwater was observed flowing into the pipe. Another key observation and finding of the WPA field investigation is the pipe that discharges water to the head of the NPDES Ponds is connected to the southern east-west segment of the SE line system. Encrustation in the SE line had previously prevented completion of video surveying in this area.

As the stormwater pond fills from constant input from the groundwater collection line and stormwater runoff during the winter months, comingled groundwater and backed up stormwater, infiltrates into the southern SE line through the one significant observed breach in the SE line in Courtyard A and then travels within the pipe, and is discharged at the head of NPDES Pond A. Discharge of water at the head of the NPDES pond drainage occurs over a 5-month period from about December through May. The cessation of discharge at the SE line outlet is in response to the elevation of the water table decreasing to below the level of the significant breach. Leakage of water out of the SE line may occur at the MH18L4 manhole that is the connection between the original wood line and the reinforced concrete pipe extension built before construction of the John Day Dam Road. Potential leakage out of the SE line at MH18L4 is based on observations made during the video surveys (see Volume 3, Section 2.5 for a full summary of the line groups).

Leakage from the SE line near the MH18L4 is in the SE-17 investigation area, where WPA-MW15-BAU and WPA-GW19 were installed as part of WPA investigation activities. The SB-SE17 investigation area was included for investigation in the WPA because of the presence of soil contamination at depth and the presence of moist to wet soils above the bedrock contact. This area is within the footprint of the EELF, and smelter wastes 11 feet thick were encountered during drilling of well WPA-MW15-BAU. Suspected leakage south of MH18L4 in the SE line may be occurring within the EELF footprint based on the results of the video survey.

Soil analytical results from well WPA-GW15-BAU in this area indicate that soil contamination extends significantly below the waste and down to the bedrock contact (refer to Volume 3, Section 17 for a complete summary of the soil analytical results in this area). It appears that the SE line leakage may be influencing contaminant migration to groundwater in this area.

Temporary well RI-GW19 was installed to verify that there was no accumulation of groundwater on top of bedrock. Similar to other shallow wells in this area (wells MW-E3, MW-E4, and MW-E8), the well is dry, which indicates that the BAU zone represents the uppermost aquifer zone in this area.

A river-water vault was observed to leaking north of the well WPA-GW12, which is located north (upgradient) of the North Pot Liner Soaking Station (SWMU 10). This vault appears to be locally recharging shallow groundwater in this area. A north-south trending fracture system is present in this area that corresponds to a groundwater trough in the BAU zone in this area. The infiltrating groundwater appears to recharge shallow groundwater that enters the fracture system and flows downward and south toward the East SPL Storage Area (SWMU 12). Note that the groundwater is encountered at a depth of about 20 ft bgs at MW-E7 and WPA-GW12 and that this shallow water-bearing zone (UA zone) is absent south of the North Pot Liner Soaking Station (SWMU 10) where the water-bearing zone is significantly deeper at RI-MW8-BAU (about 23 feet difference in water-level elevation).

2.4.2 Groundwater and Line Group Water Results

The WPA groundwater sampling program included sampling of existing wells, new wells installed during the WPA, and groundwater sampling from borings. Tables 2-11 and 2-12 summarize the WPA results for the UA and BAU zones, respectively, and Figures 2-41 and 2-42 show the fluoride results for the UA and BAU aquifer zones. Figures 2-43 and Figures 2-44 and summarize the sulfate results for the UA and BAU zones. The intent of these maps is to be able see the distribution of the fluoride and sulfate in various water media with the intent of identifying potential source area and transport pathways.

Water results for the line groups (groundwater line groups.SE lines, I&M lines, stormwater lines, river water line) are included on the UA zone Figures 2-41 and 2-43 for comparison and the line group results are fully summarized in Volume 3, Section 2.5. Note that with the exception of water results for the groundwater lines, the water results do not represent groundwater concentrations, and accordingly the results are bracketed to visually differentiate the line results from the groundwater lines and groundwater sample result. Due to space limitations, only the most recent WPA line results are shown on the Figures. If the available data represents initial RI results, the sampling date is indicated with the result.

Results for Wetland K and Wetland F Spring Samples collected during the WPA are also included on the Figures. Spring results summarized in the Wetlands AOC in Section 3.0.

Table 2-11
Groundwater AOC - UA Aquifer Zone - WPA Groundwater Analytical Results Summary
November - December 2020
Columbia Gorge Aluminum Smelter Site, Goldendale, WA
(Page 1 of 3)

Parameter Name	Units	Screening Levels						Analytical Results										
												WPA-GW10	WPA-GW11	WPA-GW11	WPA-GW13	WPA-GW14	WPA-GW17	WPA-GW18
		MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	MW-E1A-05 11/19/2020	MW-E7-05 11/17/2020	MW-W1-05 11/18/2020	MW-W4-05 12/8/2020	PAAOC-WPA-CCR-GW10-GW01 11/11/2020	PAAOC-WPA-CPU-GW11-GW01 11/3/2020	PAAOC-WPA-CPU-GW11-GW01D (Duplicate of PAAOC-WPA-CPU-GW11-GW01) 11/3/2020	PAAOC-WPA-SE08-GW13-GW01 11/11/2020	PAAOC-WPA-CCR-GW14-GW02 11/11/2020	PAAOC-WPA-CCR-GW17-GW01 11/11/2020	PAAOC-WPA-MH17L4-GW18-GW01 11/11/2020
Aluminum Smelter																		
Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	NA	0.006 J	NA	NA	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U
Free Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	NA	0.001 U	NA	NA	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	NA
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	**13.6**	**5.96**	0.54	0.92	**4.02**	**2.94**	**2.91**	**7.26**	**4.64**	**1.05**	**9.69**
Sulfate	mg/L	NE	NE	NE	250	250	32	22.9	17.4 J	224	38.8	**1,010**	50	49	**289**	**735**	80.4	**269**
Polynuclear Aromatic Hydrocarbons (PAHs)																		
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	NA	NA	NA	NA	0.0065 B	0.012 B	0.012 B	0.0013 U	0.0044 B	0.019 B	0.0067 B
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	NA	NA	NA	NA	0.0035 B	0.0031 J	0.0032 J	0.0012 U	0.0044 B	0.0052 B	0.0035 B
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	NA	NA	NA	NA	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U
Benzo(a)anthracene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.0024 B	0.0028 B	0.0026 B	0.0013 U	0.0085 B	0.0049 B	0.0028 B
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	NL	NE	NA	NA	NA	NA	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.0012 B	0.0015 B
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.0012 B	0.0012 B	0.0014 B	0.00076 U	0.0011 B	0.003 B	0.0018 B
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	NA	NA	NA	NA	0.0032 B	0.0036 B	0.0032 B	0.00082 U	0.0019 B	0.008 B	0.0017 B
Fluorene	µg/L	NE	640	1,400	NE	640	NE	NA	NA	NA	NA	0.0013 B	0.0012	0.0012	0.0011 U	0.0049 B	0.0011 U	0.0011 U
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	NA	NA	NA	NA	0.00089 UJ	0.00089 U	0.00089 U	0.00089 UJ	0.00089 UJ	0.00089 UJ	0.00000089 UJ
Naphthalene	µg/L	160	160	350	NE	160	NE	0.088 UJ	NA	NA	NA	0.0071 B	0.0052 B	0.0047 B	0.002 B	0.0074 B	0.016 B	0.088 U
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA	0.0022 B	0.0025 B	0.0026 B	0.0011 U	0.0012 B	0.0011 U	0.0012 B
Pyrene	µg/L	NE	480	1,100	NE	480	NE	NA	NA	NA	NA	0.0034 B	0.0031 B	0.0034 B	0.0041 B	0.014 B	0.0064 B	0.0024 B
Total TTEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	NA	NA	NA	NA	0.001	0.00104	0.001022	0.0009518	0.001609	0.0013465	0.0011545
Metals																		
Aluminum	mg/L	NE	16	35	NE	16	1.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0275
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00151
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.000011 J
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00021
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0005
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.000017 J
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00002 U
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00049
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.003
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0012 J
Total Petroleum Hydrocarbons (TPHs)																		
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NE	0.25 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.034 B	0.03 B	0.028 B	0.026 B	0.047 B	0.029 B	0.036 B	0.028 B	0.036 B	0.039 B	0.048 B
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.051 B	0.039 B	0.039 B	0.038 B	0.073 B	0.051 B	0.083 B	0.061 B	0.042 B	0.045 B	0.096 B
Volitile Organic Compounds (VOCs)																		
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	0.062 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.062 U
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	0.054 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.054 U
Ethylbenzene	µg/L	700	800	1800	700	700	NE	0.05 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.05 U
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	0.11 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.11 U
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	0.074 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.074 U
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	0.075 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.075 U
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	0.08 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.08 U
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	0.067 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.067 U
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	0.099 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.099 U
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	0.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	0.075 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.075 U

Notes:

Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration

µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed

NE = Not Established
PAHs = Polynuclear Aromatic Hydrocarbon
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons

TTEC = Total Toxicity Equivalent Concentration
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volitile Organic Compounds

Table 2-11
Groundwater AOC - UA Aquifer Zone - WPA Groundwater Analytical Results Summary
November - December 2020
Columbia Gorge Aluminum Smelter Site, Goldendale, WA
(Page 2 of 3)

		Screening Levels						Analytical Results										
								WPA-SE18-SB01	WPA-SE08-SB02	WPA-SE08-SB02	WPA-SE08-SB03	WPA-SE18-SB04	WPA-SE18-SB04	WPA-CCR-SB05	WPA-FWB-SB05	WPA-SE18-SB05	WPA-SE18-SB05	WPA-SE18-SB06
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	PAAOC-WPA-SE18-SB01-GW01 11/3/2020	PAAOC-WPA-SE08-SB02-GW01 10/27/2020	PAAOC-WPA-SE08-SB02-GW01D (Duplicate of PAAOC-WPA-SE08-SB02-GW01) 10/27/2020	PAAOC-WPA-SE08-SB03-GW01 10/28/2020	PAAOC-WPA-SE18-SB04-GW01 11/3/2020	PAAOC-WPA-SE18-SB04-GW01D (Duplicate of PAAOC-WPA-SE18-SB04-GW01) 11/3/2020	PAAOC-WPA-CCR-SB05-GW01 10/25/2020	PAAOC-WPA-FWB-SB05-GW01 10/29/2020	PAAOC-WPA-SE18-SB05-GW01 4/7/2021	PAAOC-WPA-SE18-SB05-GW01D (Duplicate of PAAOC-WPA-SE18-SB05-GW01) 4/7/2021	PAAOC-WPA-SE18-SB06-GW01 4/7/2021
Aluminum Smelter																		
Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	NA	0.0005 U	0.0005 U	0.0005 U	NA	NA	0.0005 U	0.0005 U	NA	NA	NA
Free Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	0.0001 U	NA	NA	NA	0.0001 U	0.0001 U	0.001 U	0.0001 U	NA	NA	NA
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	**14.6**	**8.36**	**8.38**	**5.06**	**9.92**	**10.1**	**4.21**	**8.64**	0.01 U	0.01 U	0.4
Sulfate	mg/L	NE	NE	NE	250	250	32	179 J	219	224	236	**499 J**	**491 J**	**831**	189	28.3	29.3	105
Polynuclear Aromatic Hydrocarbons (PAHs)																		
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	0.0065 B	0.034	0.037	0.009 B	NA	NA	0.044	0.042	0.000018 J	0.017 J	0.000076
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	0.0035 B	0.013	0.012	0.0035	NA	NA	0.0024 B	0.0048 B	0.0000029 J	0.0026 J	0.0000038 J
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	0.0011 U	0.0029	0.0032	0.002	NA	NA	0.0011 U	0.0031	0.0000011 U	0.0011 U	0.0000011 U
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	0.00082 U	0.012	0.0091	0.003	NA	NA	0.00082 U	0.0024 B	0.00000082 U	0.00082 U	0.00000082 U
Benzo(a)anthracene	µg/L	NL	NL	NL	NE	NL	NE	0.0024 B	0.13	0.12	0.0052 B	NA	NA	0.0027 B	0.0045 B	0.0000021 B	0.0026 B	0.0000078 B
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	NL	NE	0.0011 U	0.22	0.18	0.0011 U	NA	NA	0.0011 U	0.0016 B	0.0000011 U	0.0011 U	0.0000011 U
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	0.00083 U	0.33	0.29	0.0028	NA	NA	0.00083 U	0.0035 B	0.00000083 U	0.00083 U	0.00000083 U
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	0.00086 U	0.23	0.19	0.00086 U	NA	NA	0.00086 U	0.0017 B	0.00000086 U	0.00098 J	0.0000012 J
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	0.00094 U	0.12	0.092	0.00094 U	NA	NA	0.00094 U	0.0016 B	0.00000094 U	0.00094 U	0.00000094 U
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	0.0012 B	0.21	0.18	0.0068	NA	NA	0.00089 B	0.0054 B	0.00000093 J	0.00098 J	0.00000076 U
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	0.0013 U	0.042	0.037	0.0013 U	NA	NA	0.0013 U	0.0013 U	0.0000013 U	0.0013 U	0.0000013 U
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	0.0032 B	0.19	0.16	0.047	NA	NA	0.003 B	0.03 B	0.00000082 U	0.00082 U	0.0000036 J
Fluorene	µg/L	NE	640	1,400	NE	640	NE	0.0013 B	0.011 B	0.011 B	0.0043 B	NA	NA	0.003 B	0.0063 B	0.0000013 J	0.0012 J	0.0000036 J
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	0.00089 UJ	0.21	0.18	0.00089 U	NA	NA	0.00089 U	0.0016 B	0.00000089 U	0.00089 U	0.00000098 J
Naphthalene	µg/L	160	160	350	NE	160	NE	0.0071 B	0.025 B	0.027 B	0.0096 B	NA	NA	0.01 B	0.012 B	0.0000088 J	0.0088 J	0.000019 J
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	0.0022 B	0.072	0.066	0.037	NA	NA	0.016 B	0.036 B	0.0000036 J	0.004 J	0.000018 J
Pyrene	µg/L	NE	480	1,100	NE	480	NE	0.0034 B	0.2	0.18	0.051	NA	NA	0.0023 B	0.024 B	0.0000015 J	0.0016 J	0.0000043 J
Total TTEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	0.001	**0.3053**	**0.2537**	0.0015745	NA	NA	0.0010269	0.002839	0.0000009673	0.0009673	0.0000015853
Metals																		
Aluminum	mg/L	NE	16	35	NE	16	1.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Petroleum Hydrocarbons (TPHs)																		
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.047 B	0.046	0.052	0.019	NA	NA	0.087 B	0.058 B	NA	NA	NA
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.073 B	0.051 B	0.055 B	0.019 U	NA	NA	0.048 B	0.038 B	NA	NA	NA
Volitile Organic Compounds (VOCs)																		
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	µg/L	700	800	1800	700	700	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration
µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established
PAHs = Polynuclear Aromatic Hydrocarbon
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
TTEC = Total Toxicity Equivalent Concentration
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volitile Organic Compounds

Table 2-11
Groundwater AOC - UA Aquifer Zone - WPA Groundwater Analytical Results Summary
November - December 2020
Columbia Gorge Aluminum Smelter Site, Goldendale, WA
(Page 3 of 3)

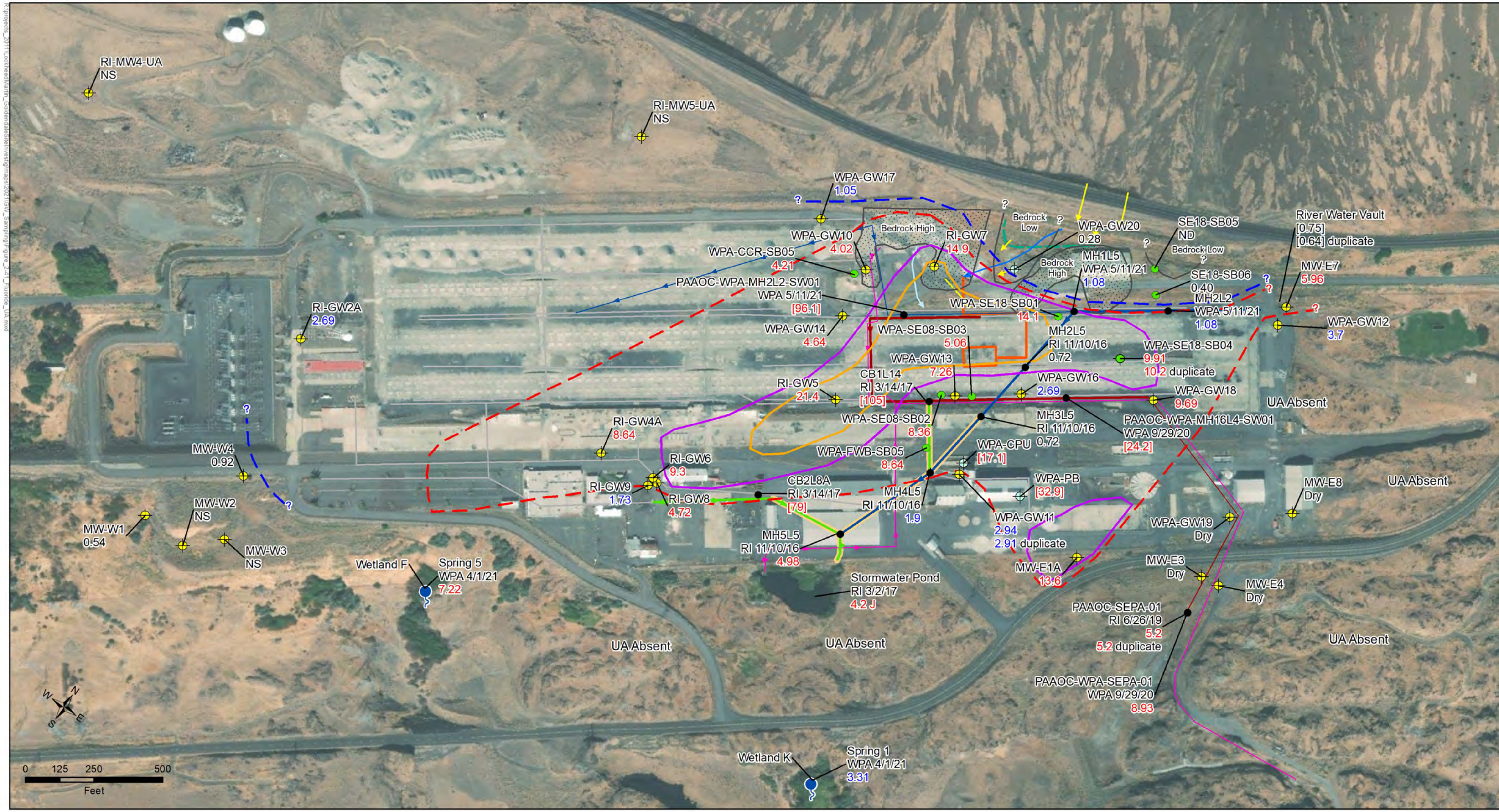
Parameter Name	Units	Screening Levels						Analytical Results										
								WPA-GW16	WPA-GW16	WPA-GW20								
		MTCA Method A	MTCA Method B	MTCA Method C	MCL	Selected Screening Level	Site Background	PAAOC-WPA-VS01-GW16-GW01 11/4/2020	PAAOC-WPA-VS01-GW16-GW01D (Duplicate of PAAOC-WPA-VS01-GW16-GW01) 11/4/2020	PAAOC-WPA-SE18-GW20-GW01 4/7/2021	RI-GW2A-05 11/18/2020	RI-GW4A-05 11/16/2020	RI-GW5-05 11/16/2020	RI-GW6-05 11/20/2020	RI-GW7-05 11/17/2020	RI-GW8-05 11/20/2020	RI-GW9-05 11/20/2020	WPA-GW12-05 12/8/2020
Aluminum Smelter																		
Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	0.0005 U	0.0005 U	NA	NA	NA	NA	NA	NA	NA	NA	0.009 J
Free Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NE	0.001 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0032
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.72	**2.69**	**3.23**	0.28	**2.69**	**8.64**	**21.4**	**9.3**	**14.9**	**4.72**	**1.73**	**3.7**
Sulfate	mg/L	NE	NE	NE	250	250	32	**255**	**258**	**527**	39.3	13.5 J	**260 J**	23	14.7 J	44.8	13.4 J	38.6
Polynuclear Aromatic Hydrocarbons (PAHs)																		
2-Methylnaphthalene	µg/L	NL	32	70	NE	32	NE	0.0026 J	0.0053 J	0.000013 J	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	µg/L	NE	960	2,100	NE	960	NE	0.0012 U	0.0028 J	0.0000019 J	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	µg/L	NE	NE	NE	NE	NE	NE	0.0011 U	0.0011 U	0.0000011 U	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	µg/L	NE	4,800	11,000	NE	4,800	NE	0.00082 U	0.00082 U	0.00000082 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	µg/L	NL	NL	NL	NE	NL	NE	0.0016 J	0.0018 J	0.0000035 B	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	µg/L	0.1	0.023	0.88	0.2	NL	NE	0.0011 U	0.0011 U	0.0000011 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	0.00083 U	0.00083 U	0.00000083 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(ghi)perylene	µg/L	NE	NE	NE	NE	NE	NE	0.00086 U	0.00086 U	0.00000086 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	µg/L	NL	NL	NL	NE	NL	NE	0.00094 U	0.00094 U	0.00000094 U	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	µg/L	NL	NL	NL	NE	NL	NE	0.00076 U	0.00076 U	0.00000076 U	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	µg/L	NL	NL	NL	NE	NL	NE	0.0013 U	0.0013 U	0.0000013 U	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	µg/L	NE	640	1,400	NE	640	NE	0.00082 U	0.0014 J	0.00000082 U	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	µg/L	NE	640	1,400	NE	640	NE	0.0012 J	0.0016 J	0.0000015 J	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/L	NL	NL	NL	NE	NL	NE	0.00089 U	0.00089 U	0.00000089 U	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	µg/L	160	160	350	NE	160	NE	0.088 U	0.088 U	0.000019 J	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	µg/L	NE	NE	NE	NE	NE	NE	0.0032 J	0.0028 J	0.0000032 J	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	µg/L	NE	480	1,100	NE	480	NE	0.001 U	0.0017 J	0.0000015 J	NA	NA	NA	NA	NA	NA	NA	NA
Total TTEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	0.2	NE	0.0009118	0.0009318	0.0000011018	NA	NA	NA	NA	NA	NA	NA	NA
Metals																		
Aluminum	mg/L	NE	16	35	NE	16	1.14	6.6	6.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	0.48 J	0.58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	mg/L	0.005	0.008	0.018	0.005	0.005	NE	0.014 J	0.009 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	mg/L	0.05	24	53	0.1	0.1	0.03	0.24	0.19 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	mg/L	NE	0.64	1.4	1.3	0.64	NE	0.67	0.17	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	mg/L	0.015	NE	NE	0.015	0.015	0.00046	0.024	0.028	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	mg/L	0.002	NE	NE	0.002	0.002	NE	0.02 U	0.02 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	mg/L	NE	0.000096	0.00096	0.1	0.00384	0.00384	0.69	1.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	mg/L	NE	0.08	0.18	0.05	0.05	NE	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	mg/L	NE	4.8	11	NE	4.8	NE	1.2 J	1.5 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Petroleum Hydrocarbons (TPHs)																		
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NE	NA	NA	NA	NA	NA	NA	0.154 J	NA	0.0268 B	0.253	NA
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.016 J	0.015 J	NA	0.042 B	0.036 B	0.03 B	0.0053	0.048 B	0.36	3	0.026 B
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	NE	0.023 J	0.019 U	NA	0.059 B	0.064 B	0.053 B	0.5 J	0.051 B	0.21 B	0.24 B	0.029 B
Volitile Organic Compounds (VOCs)																		
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NE	0.062 U	0.062 U	NA	NA	NA	NA	0.08 J	NA	0.062 U	0.062 U	NA
Toluene	µg/L	1,000	640	1,400	1,000	640	NE	0.07 J	0.07 J	NA	NA	NA	NA	0.06 J	NA	0.054 U	0.08 J	NA
Ethylbenzene	µg/L	700	800	1800	700	700	NE	0.05 U	0.05 U	NA	NA	NA	NA	0.05 U	NA	0.05 U	0.05 U	NA
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	0.11 U	0.11 U	NA	NA	NA	NA	0.11 U	NA	0.11 U	0.11 U	NA
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1600	NE	0.074 U	0.074 U	NA	NA	NA	NA	0.08 J	NA	0.074 U	0.09 J	NA
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NE	0.075 U	0.075 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NE	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NE	0.067 U	0.067 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NE	0.099 U	0.099 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NE	0.1 U	0.1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NE	0.075 U	0.075 U	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration
µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established
PAHs = Polynuclear Aromatic Hydrocarbon
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
TTEC = Total Toxicity Equivalent Concentration
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volitile Organic Compounds

Table 2-12
Groundwater AOC –Analytical Results Summary BAU Aquifer Zone
November-December 2020
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 1)

Parameter Name	Units	Method A Industrial	Method B	Method C Industrial	MCL	Selected Screening Level	Analytical Results																	
							BAMW-1-05 11/19/2020	BAMW-41-05 (Duplicate of BAMW-1-05 11/19/2020	RI-MW2-BAU-05 11/17/2020	RI-MW40-BAU-05 (Duplicate of RI-MW2-BAU-05 11/17/2020	BAMW-3-05 11/18/2020	RI-MW10-BAU-05 11/16/2020	RI-MW11-BAU-05 11/16/2020	RI-MW12-BAU-05 11/16/2020	RI-MW13-BAU-05 11/18/2020	RI-MW14-BAU-05 11/18/2020	RI-MW15-BAU-05 11/19/2020	RI-MW16-BAU-05 11/17/2020	RI-MW6-BAU-05 12/8/2020	RI-MW7-BAU-05 11/17/2020	RI-MW8-BAU-05 11/17/2020	RI-MW9-BAU-05 11/19/2020	WPA-GW15-BAU-05 12/8/2020
Aluminum Smelter																								
Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NA	NA	NA	NA	**0.093**	NA	NA	NA	NA	NA	NA	NA	NA	NA	**0.096**	NA	**0.06**
Free Cyanide	mg/L	NE	0.01	0.022	0.2	0.01	NA	NA	NA	NA	0.0001 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0001 U	NA	0.00273
Fluoride	mg/L	NE	0.96	2.1	4.0	0.96	0.3	0.3	**3.19**	**3.2**	**18.5**	**1.63**	**2.25**	**1.47**	**1.7**	**1.79**	**1.7**	**1.22**	**3.65**	**1.33**	**5.91**	0.64	**19.3**
Sulfate	mg/L	NE	NE	NE	250	250	32	32.6	30.4 J	28	162	31.1 J	52.2 J	27.1 J	38.4	37.2	96.7	53.9	88.2	182	74.8	72.8	**700**
Petroleum Hydrocarbons																								
Gasoline Range Organics	mg/L	1.0	NE	NE	NE	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25 U
Diesel Range Organics	mg/L	0.5	NE	NE	NE	0.5	0.035 B	0.025 B	0.027 B	0.024 B	0.042 B	0.014 B	0.031 B	0.024 B	0.028 B	0.037 B	0.028 B	0.044 B	0.027 B	0.03 B	0.024 B	0.079 B	0.04 B
Residual Range Organics	mg/L	0.5	NE	NE	NE	0.5	0.079 B	0.054 B	0.047 B	0.034 B	0.064 B	0.037 B	0.037 B	0.047 B	0.039 B	0.04 B	0.056 B	0.1 B	0.031 B	0.035 B	0.044 B	0.063 B	0.074 B
Volatile Organic Compounds (VOCs)																								
Benzene	µg/L	5.0	0.8	8.0	5.0	0.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.062 U	0.062 U
Toluene	µg/L	1,000	640	1,400	1,000	640	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.054 U	0.054 U
Ethylbenzene	µg/L	700	800	1,800	700	700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.05 U	0.05 U
m, p-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.11 U	0.11 U
o-Xylene	µg/L	1,000	1,600	3,500	10,000	1,600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.074 U	0.074 U
1,1,1-Trichloroethane	µg/L	200	16,000	35,000	200	200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.075 U	0.075 U
1,2-Dichloroethane	µg/L	5.0	0.48	4.8	5.0	0.48	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.08 U	0.08 U
Cis-1,2-Dichloroethene	µg/L	NE	16	35	70	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.067 U	0.067 U
Tetrachloroethene	µg/L	5.0	21	110	5.0	5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.099 U	0.099 U
Trichloroethene	µg/L	5.0	0.54	8.8	5.0	0.54	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.27 J
Vinyl Chloride	µg/L	0.2	0.029	0.29	2.0	0.029	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.075 U	0.075 U

Notes:
Bold values denote exceedances of one or more screening levels and background concentrations.
B = The sample result is less than 5 times the blank contamination. The result is considered not to have originated from the environmental sample, because cross-contamination is suspected.
cPAH = Carcinogenic Polynuclear Aromatic Hydrocarbon
J = Estimated concentration
µg/L = micrograms per liter
mg/L = milligrams per liter
MTCA = Model Toxics Control Act
NA = Not Analyzed
NE = Not Established
PAHs = Polynuclear Aromatic Hydrocarbon
TEC = Toxicity Equivalent Concentration
TPHs = Total Petroleum Hydrocarbons
TTEC = Total Toxicity Equivalent Concentration
U = Chemical was not detected. The associated value represents the method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.
VOCs = Volitile Organic Compounds



Unconsolidated Aquifer Well (UA)
Sump
Manhole or Catchbasin
Groundwater Boring
Spring
MW-W1 Well Identification
0.54 Concentration

Screening Levels
15 mg/L (3.85 x MCL)
10 mg/L (2.5 x MCL)
4 mg/L MCL
0.96 mg/L MTCA Method B

South Dry/Wet SO_2 Scrubber

Bedrock Elevation Contour
Bedrock High
Stormwater Drainage Berm
Stormwater Drainage Piping
Stormwater Runoff Path
Potential Shallow Groundwater Flow

Stormwater Collection System
Groundwater Collection System
Industrial and Monitoring Collection System
Scrubber Effluent Collection System

Thicker Lines Indicate Year-Round Flow
Thinner Lines Indicate Intermittent Flow
Volume 3, Section 2.5 Summarizes the Line Layout

Stormwater Pond Backs Up into Lines
Gray-scale Indicate No Persistant Flow was Observed

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled
[17.1] Sump or Line Water Concentration that is not representative of groundwater. Not used in contouring.

Figure 2-41
Concentrations for Fluoride In Unconsolidated Aquifer Wells (UA) and Line Water Sample Results
Former Plant Area Footprint
WPA Field Program
Late October 2020 - May 2021
Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Uppermost Basalt Aquifer Well (BAU)

- BAU₁ - Shallower Water-bearing Zone
- BAU₂ - Deeper Water-bearing Zone
- Spring

BAMW-1 Well Identification
0.3 Concentration

Screening Levels
- 4 mg/L MCL
- 0.96 mg/L MTCA Method B

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled

- Bedrock Elevation Contour
- Bedrock High
- Stormwater Drainage Berm
- Stormwater Drainage Piping
- Stormwater Runoff Path
- Potential Shallow Groundwater Flow

Figure 2-42
Concentrations for Fluoride In
Uppermost Basalt Aquifer Wells (BAU)
Former Plant Area Footprint
WPA Field Program
Late October 2020 - May 2021

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Unconsolidated Aquifer Well (UA)
Sump
Manhole or Catchbasin
Groundwater Boring
Spring
MW-W1 0.54 Well Identification Concentration

East End Landfill
Screening Levels
250 mg/L (Secondary MCL)
500 mg/L (2 x MCL)
[290] Sump or Line Water Concentration that is not representative of groundwater. Not used in contouring.
South Dry/Wet SO_2 Scrubber

Bedrock Elevation Contour
Bedrock High
Stormwater Drainage Berm
Stormwater Drainage Piping
Stormwater Runoff Path
Potential Shallow Groundwater Flow

Stormwater Collection System
Groundwater Collection System
Industrial and Monitoring Collection System
Scrubber Effluent Collection System
Thicker Lines Indicate Year-Round Flow
Thinner Lines Indicate Intermittent Flow
Volume 3, Section 2.5 Summarizes the Line Layout

Stormwater Pond Backs Up into Lines
Gray-scale Indicate No Persistant Flow was Observed

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled

Figure 2-43
Concentrations of Sulfate In Unconsolidated Aquifer Wells (UA) and Line Water Sample Results
Former Plant Area Footprint
WPA Field Program
Late October 2021 - May 2021

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

Uppermost Basalt Aquifer Well (BAU)

- BAU_1 - Shallower Water-bearing Zone
- BAU_2 - Deeper Water-bearing Zone
- Spring

BAMW-1 0.3 Well Identification Concentration

East End Landfill

Screening Level

250 mg/L (Secondary MCL)

MCL: Maximum Contaminants Level
MTCA: Model Toxics Control Act
NS: Not Sampled

- Bedrock Elevation Contour
- Bedrock High
- Stormwater Drainage Berm
- Stormwater Drainage Piping
- Stormwater Runoff Path
- Potential Shallow Groundwater Flow

Figure 2-44
Concentrations of Sulfate In
Uppermost Basalt Aquifer Wells (BAU)
Former Plant Area Footprint
WPA Field Program
Late October 2021 - May 2021

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

2.4.2.1 Fluoride Results

This section summarizes the WPA results for fluoride for water samples in the plant area footprint. Figures 2-41 and 2-42 show the fluoride results for the UA and lines, and the BAU zone, respectively.

UA zone and Line Groups

In the UA zone, the results show a fluoride plume with concentration that exceed the MCL extending from RI GW-7 near the Tertiary Treatment Plant (SWMU 8) and clarifiers and extending radially to the southwest to the Line A Secondary Scrubber Recycle Unit (SWMU 5) (Figure 2-41). The highest concentrations of fluoride in groundwater appear to correspond spatially to scrubber treatment system piping associated with the Line A Secondary Scrubber Recycle Station (SWMU 5); Line B, C, and D Secondary Scrubber Recycle Stations (SWMU 6); Tertiary Treatment Plant (SWMU 8); and specifically including the South Dry/Wet $S0_2$ scrubber and associated piping beneath Passage Number 4 and the area of the clarifiers south and east of the Tertiary Treatment Plant. These small-diameter piping systems are routed north-south through Passage Number 4 and may serve as a preferential flow pathway in addition to a likely source of historical piping leak releases.

The air pollution control system for the plant included dry and wet scrubbers for removal of fluoride and sulfate, respectively, from the gas and particulate waste stream that was captured in cell buildings during aluminum production. The scrubber system was installed and modified during the 1979 to 1983 period. The original roof-mounted Wet Electrostatic Precipitator (WESP) (SWMU 7) emission control system was replaced with a multistage dry/wet scrubber system in 1978. Changes in operations and configuration of the scrubber systems are interrelated with the period of operations of the ESI (SWMU 2, 1973 to 1985), WSI (SWMU 4, 1981 to 2004), and Tertiary Treatment Plant (SWMU 8, constructed in 1983). The SO2 Dry/Wet system was interconnected with the Secondary Scrubber Recycle System (SWMU 6) that was constructed around 1983.

A diagram of the lines that connects the South Dry/Wet SO_2 scrubber, the clarifiers and the Tertiary Treatment system is included in Volume 5, Appendix G-3 (Plant Drawing A 14840) and is described in greater detail in Volume 3, Section 2.2.1 and shown in Volume 3, Figure 2.2.1-5.

Based on this documentation, the South Dry/Wet SO_2 line system is not connected with other line systems (e.g., SE line system, I&M line system, stormwater line system).

The South Dry/Wet SO_2 scrubber unit servicing Production Buildings A and B was in Courtyard Segment B4. Prior to 2000, 1.5-inch chemical and corrosion resistant piping connected the south and north scrubber units via Courtyard B and Passage No. 1. Scrubber discharge was then conveyed by similar piping to the West Surface Impoundment (SWMU 4).

Based on Plant Drawing A14840, the 1.5-inch purge lines were abandoned in-place around 2000 and replaced by new 2-inch purge lines that independently connected the North and South Dry/Wet SO_2 scrubber units to the secondary treatment system (part of SWMU 6) (90-ft clarifier). The line from the South Dry/Wet SO_2 scrubber unit was constructed above-ground between the unit and Passage No. 4 to the east, then was laid underground along with a spare 2-inch line, in a shallow trench extending north-south beneath the concrete floor of Passage No. 4 to the 90-ft clarifier (part of SWMU 6). Scrubber wastewater was pumped via the 90-ft clarifier drain system in underground piping to the Tertiary Treatment Plant (SWMU 8) for further treatment then combined in the pool of treated water that was sent back to the production buildings for use as makeup water.

Highest fluoride groundwater concentrations were detected in well RI-GW5, 21.4 mg/L), groundwater boring RI-GW7 (14.7 mg/L), and WPA-SE18-SB01 (14.1 mg/L), which is located to the southeast of some of the main SWMUs and WPA investigation areas. Investigation of the SB-SE18 area and associated line groups did not show a significant source of contamination to groundwater in the vicinity. Refer to Volume 3, Section 2.2 for a complete summary of investigation results.

An additional potential source area related to water treatment has been identified in this area based on file review, the South Dry/Wet SO_2 Scrubber (refer to Volume 3, Section 2.2 for additional description). The South Dry/Wet Scrubber is connected by piping to the secondary clarifier to the north as shown in Figure 2-41. This unit and associated piping are located in the center of the fluoride shallow groundwater source area and leakage from the small-diameter piping associated with the treatment system represents a likely source of groundwater contamination in the area.

Widespread areas of soil contamination have not been identified and releases from the piping systems and migration along underground line corridors appears to be the likely source and mechanism for the observed fluoride groundwater contamination.

The groundwater lines generally show low levels of fluoride with exception of locations nearest the stormwater pond. The stormwater lines and SE lines are characterized by higher concentrations of fluoride in water than the groundwater lines. This suggests that the groundwater lines convey mostly clean groundwater from the upgradient (northern areas) and contribute to mounding in the stormwater pond area, but do not contribute substantially to contaminant loading in the stormwater pond.

The stormwater pond is characterized by fluoride concentrations above the MCL (4.2 J) and contains pond sediments that have elevated fluoride concentrations (refer to Volume 2, Section 32 for a complete results summary for the stormwater pond (SWMU 32). Wetland K, Spring 1 is characterized by similar concentrations (3.3 mg/L) that are typically more elevated than the groundwater lines. The sediments in the pond may potentially be contributing to contaminant loading of the pond water that is spread when the pond backs up into the lines and recharges the BAU aquifer zone and Wetland K spring. The stormwater lines may also be contributing to loading within the pond based on stormwater results (79 mg/L fluoride, CB2L8A). There is significant shallow fluoride soil contamination present in the Courtyards and other areas served by the stormwater system that may be mobilized by runoff to the stormwater system (refer to Volume 3, Section 2.5).

The SE lines contain elevated concentrations of fluoride (e.g., MH-16L4, 24.2 mg/L) in areas where they contain persistent water, and it appears that there is a source of water contamination in the SE lines as well as the lines serving as a flow pathway largely in the southern SE line segment associated with the identified significant breach (refer to Volume 3, Section 2.5).

BAU Zone

In the BAU zone, fluoride groundwater source areas with concentrations above the 4.0 mg/L MCL occur in the eastern portion of the plant area in wells RI-MW8-BAU (5.91 mg/L), BAMW-3 (18.5 mg/L), and WPA-GW15-BAU (19.3 mg/L) (Figure 2-42). These wells are located down gradient or in the footprint of the North and South Pot Liner Soaking Station (SWMU 10 and 11), the East SPL Storage Area (SWMU 12), and EELF (SWMU 17), respectively, that represent sources for the observed groundwater plume.

2.4.2.2 Sulfate

This section summarizes the distribution of sulfate in the UA aquifer zone, line groups, and the BAU aquifer zone. The sulfate plume for the UA and BAU zone is shown in Figures 2-43 and 2-44, respectively.

<u>UA Zone and Line Groups</u>

Sulfate was not found above the 250 mg/L secondary MCL in the plant area footprint during the initial RI field investigation. During additional WPA groundwater characterization activities, a sulfate plume was found in the central portion of the plant area. This plume is less widespread in the UA zone than the fluoride plume. and does not extend to the stormwater pond or as far southeast as RI-GW8.

Highest sulfate groundwater concentrations were detected in well WPA-GW10 (1,010 mg/L), groundwater boring WPA-CCR-SB05 (831 mg/L), and WPA-GW14 (735 mg/L) that are located in an area with a large amount of small-diameter piping associated with treatment and return lines for the Tertiary Treatment Plant that extends north-south in this area. There is also an adjoining area of shallow groundwater sulfate contamination to the southeast of the Tertiary Treatment plant and defined by well WPA-GW20 (527 mg/L), WPA-GW18 (267 mg/L), WPA-GW16 (255 mg/L), and WPA-GW13 (289 mg/L). Elevated sulfate concentrations in groundwater appear to correspond spatially to scrubber treatment system piping associated with the Line A Secondary Scrubber Recycle Station (SWMU 5), Line B, C, and D Secondary Scrubber Recycle Stations (SWMU 6), Tertiary Treatment Plant (SWMU 8), and specifically including the South Dry/Wet $S0_2$ scrubber and associated small-diameter piping beneath Passage Number 4 and the area of the clarifiers south and east of the Tertiary Treatment Plant.

An additional potential source of sulfate contamination has been identified in this area based on file review, the South Dry/Wet SO_2 Scrubber (refer to Volume 3, Section 2.2 for additional description). The South Dry/Wet SO_2 Scrubber is connected by piping to the backup clarifier to the north as shown in Figure 2-43. This unit and associated piping is located in the center of the sulfate groundwater hotspot and leakage from the piping associated with the treatment system represents a likely source of groundwater contamination in the area.

Sulfate water concentrations in the SE line segment that discharges to the NPDES pond drainage (e.g., Manhole MH16L4, 290 mg/L) are generally comparable to groundwater concentrations in close proximity of the line (e.g., WPA-GW16, 255 mg/L) and groundwater sulfate concentrations down gradient (south) of the line are significantly lower than 250 mg/L screening level. This suggests that SE line could be intercepting shallow flow and conveying it to the head of the NPDES Ponds. The discharge at the head of the NPDES Ponds (maximum of 213 mg/L) is elevated relative to site background groundwater concentrations, but is below screening levels.

BAU Zone

The sulfate secondary MCL of 250 mg/L was only exceeded at new well WPA-GW15-BAU (700 mg/L), which was installed within the footprint of the EELF (Figure 2-44). This concentration represents the highest concentration of sulfate found at site in the BAU and BAL aquifer zones during the RI and WPA characterization activities. Smelter wastes including suspected K088 wastes were encountered during drilling of this well and the EELF represents a likely source for this contamination.

2.4.2.3 Cyanide

Free cyanide was not detected above screening levels during the WPA sampling round. Note that the MTCA screening levels for cyanide are based on free cyanide and that detected concentrations of free cyanide are significantly lower than for total cyanide in site groundwater. The RI and WPA groundwater results show that the cyanide occurs in primarily in a less toxic, metal-complexed form. Both sets of results are presented for completeness and as a conservative comparison.

During the WPA, total cyanide was detected in wells above the MTCA Method B screening level 0.0096 mg/L at three well locations in the eastern end of the site including BAMW-3 (0.093 mg/L), RI-MW8-BAU (0.096 mg/L) and WPA-GW15-BAU (0.06 mg/L). Free cyanide was also detected at only one well (WPA-GW15-BAU) during the WPA sampling round at a concentration of 0.00273 mg/L, which is below the MTCA Method B screening level.

Total cyanide was previously detected at similar concentrations during the RI at wells RI-MW8-BAU and BAMW-3 that may be related to the East SPL Storage Area (SWMU 12) and the North and South Pot Liner Soaking Stations (SWMUs 10 and 11). Well WPA-GW15-BAU is located within the footprint of the EELF, and the total cyanide detection is likely related to the presence of smelter wastes (including suspected SPL) in the subsurface in this area.

2.4.2.4 PAHs

Of the 21 wells and groundwater boring sampled for PAHs, cPAHs were detected above the MTCA Method B groundwater screening level for TTEC cPAHs of 0.2 µg/L only in groundwater boring (WPA-SE08-SB2) in both the sample and field duplicate (maximum of 0.3053 µg/L). Note that this sample was collected from a temporary well screen as opposed to a constructed well that was fully developed. This result may reflect suspended particulate in the sample.

2.4.2.5 Petroleum Hydrocarbons

Petroleum hydrocarbons were only detected at concentration above MTCA Method A screening levels for diesel-range organics of 0.5 mg/L in one well (RI-GW9, 3.3 mg/L), which is located near the Former Compressor Building UST and was characterized by similar diesel-range organic concentrations during the RI sampling program (refer to Figure 2-38) No additional areas of petroleum hydrocarbon contamination in groundwater were identified from the TPH sampling that was included for existing wells near the plant area or based on WPA soil sampling.

2.4.2.6 Volatile Organic Compounds Results

Groundwater samples were collected in five wells and analyzed for VOC as specified in the Final WPA. Similar to the RI groundwater sampling program results, individual VOC chemicals did not exceed MTCA Method B groundwater screening levels in any of the samples. The sample collected at RI-MW15-BAU, which is located in the EELF (SWMU 17) footprint and near the scrubber effluent line contained low levels of TCE (0.27 µg/L) below the MTCA Method B screening level of 0.54 µg/L. Soils collected from this area during the initial phase of the RI also contained low levels of TCE.

2.4.2.7 Metals Results

Only one well or groundwater boring sample (WPA-GW18) was analyzed for metals. Well WPA-GW18 was analyzed for total (unfiltered) metals and metals concentrations did not exceed MTCA groundwater screening levels or site natural background concentrations.

2.4.3 Water Balance Assessment

This section presents a water balance assessment for the stormwater pond, Wetland K/Spring 01, Wetland F, and the former NPDES Pond drainage. The purpose of this data evaluation is to develop a rough estimate of the water balance for hydrogeologic system in areas where there is a potential transport pathway to the Columbia River (e.g., Stormwater Pond-Wetland K and NPDES drainage).

2.4.3.1 Assumptions and Approach for Calculating Inputs for the Water Balance Assessment

The objective for the water balance assessment is roughly estimate the balance of water passing through the stormwater pond and various drainages near the former plant footprint. The purpose is to better conceptualize and estimate the various flow pathways at the site. The process of developing the water balance was iterative and assumptions were made based on available data.

The water balance is based on annual averages for all components that include 2017 data for some parameters and long-term averages for others, which creates uncertainty. For this study, seepage from the pond to the BAU is of primary importance and is expected to remain relatively constant since the pond level is maintained with a relatively narrow range except for a short period where discharge occurs.

The estimation approach for the major inflows and outflows to the Stormwater Pond and drainages is summarized in the following subsections. Calculations and assumptions are provided in Appendix D-16.

Stormwater Pond

The main inflows to the stormwater pond include the following and the estimation approach is summarized as follows:

- **Stormwater Discharge**. This was estimated based on annual precipitation 17.5 inches, the surface area of the paved (concrete and asphalt surface) of the Plant area that is served by the stormwater drainage systems (69.32 acres). It is estimated that about 20 percent of the potential stormwater runoff make it into and through the line system and reaches the pond. Note that about 50 percent of the stormwater drainage area represents demolished building with an irregular concrete surface that tends to pool water and that the current stormwater drainage system is not designed to address the foundation areas. Some portions of the stormwater drainage system have been blocked off during and after plant demolition activities. Also, note that there is a minimal threshold of precipitation needed to generate runoff, which is not accounted for in calculation approach. Based on field observations, the largest stormwater contribution appears to occur following snowfall events during melting.

- **Groundwater Line Baseflow to the Stormwater Pond.** Flow was estimated to be 30 gallons per minute based on measurements in the line upstream of the pond. About 80 percent of this water was assumed to reach the pond based on suspected line leakage and mounding in the pond vicinity.

- **Direct Precipitation**. This was estimated based on the surface area of the pond (32, 303 square feet) and the annual precipitation of 17.5 inches for Goldendale.

The main outflows/losses from the pond include:

- **Evaporation and Evapotranspiration**. This was estimated for the surface area of the pond and adjoining vegetated areas and meteorologic data for Goldendale and Yakama. Note that evaporation exceeds average precipitation during most months. See section below on Evapotranspiration methods for a summary of the approach.

- **Pumping and Discharge of the Pond under NPDES Permit.** This was estimated based on the hydrographs for the pond and nearby well RI-MW2-BAU. There were five pond pumping events over the year of the hydrograph study. The estimate is based on the reported pumping rate of 375 gallons per minute for the duration of each pumping event as determined by drawdown curves, and adjusted upward by 5 percent to account for the 2017 hydrograph study period being a drier than average year.

  This estimate was corroborated by calculating the change of pond volume, groundwater line baseflow during pumping, and groundwater recharge for each pumping event. The pond volume during pumping was estimated based on the surface area of the pond and the drawdown of the pond. Groundwater line baseflow during pumping was estimated based on observed flow in the line and the duration of pumping for each event from the hydrographs. The groundwater recharge from pumping was based on the drawdown differences between the pond and well RI-MW2-BAU for each pumping event using the Dupuit-Forsheimer Equation.

- **Groundwater Recharge to the BAU zone and Migration to Wetland K**. This pathway has been estimated based on the measure flow of the spring, and the BAU zone hydraulic gradient (0.1 between wells RI-MW2-BAU and RI-MW16-BAU), median hydraulic conductivity for the BAU zone (28.11 ft/day from RI Table 2.6), saturated zone thickness of 7.5 feet, and width of the seepage zone for Wetland K (150 feet). The amount of discharge from the springs was estimated from the average flow rate of the two channels (7 gallons per minute) in Wetland K and is considered as a sub-portion of the overall groundwater recharge.

Wetlands F, K, and NPDES Drainage

The water balance for Wetlands K, Wetland F, and the NPDES Ponds drainage was estimated based on wetland spring flow rate estimates or SE Line pipe discharge, the estimated groundwater seepage volume in the case of Wetlands F and K, and estimated evapotranspiration within the drainages.

Evapotranspiration Methods

Evapotranspiration is the loss of water from plant and soil surfaces to the atmosphere, primarily driven by solar energy, air temperature, dryness of the air, and lateral input of heat via wind (Pickering et al. 2021). There are several methods for estimating crop evaporation that are based on crop/soil surface energy balance related to net radiation and heat flux and that incorporate local weather data inputs such as average temperature, precipitation, relative humidity, daytime hours, and daytime wind.

An evaluation of evaporation and evapotranspiration (ET) for the stormwater ponds and wetlands at the Goldendale site was conducted for the period of April 2017 to March 2018 and is presented in Appendix D-16. An onsite weather station was not available, so the following sources of monthly historic data were used:

- Yakima, WA – temperature averages, dew point, precipitation, and wind available on Weather Underground (https://www.wunderground.com/)
- Goldendale, WA - precipitation data available (https://www.usclimatedata.com/climate/goldendale/washington/united-states/uswa0514)
- Bureau of Reclamation AgriMet station in Goldendale (GOLW) for reference evapotranspiration for alfalfa (https://www.usbr.gov/pn/agrimet/monthlyet.html).

The first calculation was done to determine evaporation from a water surfaces using the method of Linacare (1977), which was developed to estimate evaporation off a lake. This method was used for areas with ponded water including the stormwater pond. The estimate is based on the weather data from Yakima because of the need for dew point and more detailed temperature data. Once the evaporation rate was determined, the evaporation for the entire pond was determined.

The second calculation was used to determine evapotranspiration from wetland area that contain standing water. The data available on the AgriMet website for Goldendale is for alfalfa and represent the monthly average reference evapotranspiration (ETr) for the period between 1991 and 2010. As stated on the website, the ETr values were computed using the Kimberly-Penman 1982 procedure. The ET value is generally calculated as

$$ET = ETr * Kc$$

where Kc is a crop coefficient used to adjust the reference value to the crop of interest, in this case wetlands. A Kc = 0.9296 was used during the growing season for the wetland area based on work on ET rates (USGS 2013). A Kc = 1 was used for the non-growing season (USGS 2013). The calculated ET value was then used to calculate the ET for the various ponds on site.

The evapotranspiration values selected for the drainage water balances were based on the Yakama data set. These values were selected because the weather station data set was more robust, and it was unclear that Goldendale station is more representative of site conditions along the Columbia River than the Yakama station. The Yakama evapotranspiration values are higher than the evapotranspiration values based on the Goldendale data set.

Note that evapotranspiration tables summarize evapotranspiration and precipitation together (with precipitation reducing the amount of evapotranspiration) or net evapotranspiration.

2.4.3.2 Stormwater Pond Water Balance

Table 2-13 and Figure 2-45 shows the estimated water balance for the pond. From the water balance, it appears that most of the water that reaches the pond from groundwater line baseflow (38.71 acre-feet) that causes mounding near the stormwater pond and estimated stormwater runoff (20.22 acre-feet). A significant amount of the water from the pond recharges Wetland K (-27.10 acre-feet with the springs generating -11.29 acre-feet per year of this total). Periodic

Table 2-13
Stormwater Pond Water Balance Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Stormwater Pond Inflows	Gallons	Acre-Feet	Notes
Stormwater Runoff from Stormwater Lines	6,587,919	20.22	Calculated based on stormwater drainage area (69.32 acres) and 17.5 inches of precipitation with long-term meteorologic records. It is assumed approximately 20% of the storm water runoff makes it into and through the line system and reaches the pond.
Groundwater Line Baseflow	12,614,400	38.71	Based on 30 gpm measured discharge calculate over one year. It is assumed that 80 percent of this water reaches the pond and 20 percent infiltrates the subsurface in the plant area outside of the stormwater pond area that recharges Wetland K.
Inflows Total	19,202,319	58.93	
Stormwater Pond Outflows	**Gallons**	**Acre-Feet**	**Notes**
Groundwater/Pond Recharge to Wetland K	-8,829,748	-27.10	Groundwater volume seepage estimate including observed flow in channels (-11.29 acre-feet)
Pond Pumping - NPDES Permitted Discharge	-8,046,281	-24.69	Estimated based on reported pumping of 375 gallons per minute for the duration of each pumping event as determined by drawdown curves, and adjusted upward by 5 percent to account for 2017 being a drier than average year. For comparison, the estimated pond volume during drawdo-19.08 acre-feet) groundwater line base flow during pumping (-1.88 acre-feet), and groundwater recharge (-0.27 acre-feet) during pumping for 5 pumping events during year-long hydrograph study equals -21.23 acre-feet.
Net Precipitation and Evaporation/Evapotranspiration	-909,124	-2.79	From Evapotranspiration calculations
Outflows Total	-17,785,154	-54.58	
Water Balance Sum Total	1,417,166	4.35	Result suggests net inflow into the pond. However, there are uncertainties associated with calculation of all of the estimated inflows and outflows. In particular, the stormwater runoff inflow estimate is subject to uncertainty. Result represents about 4 percent of the total estimated inflows and outflows for the stormwater pond.

Notes:
gpm = Gallons Per Minute
NPDES = National Pollutant Discharge Elimination System
SE = Scrubber Effluent

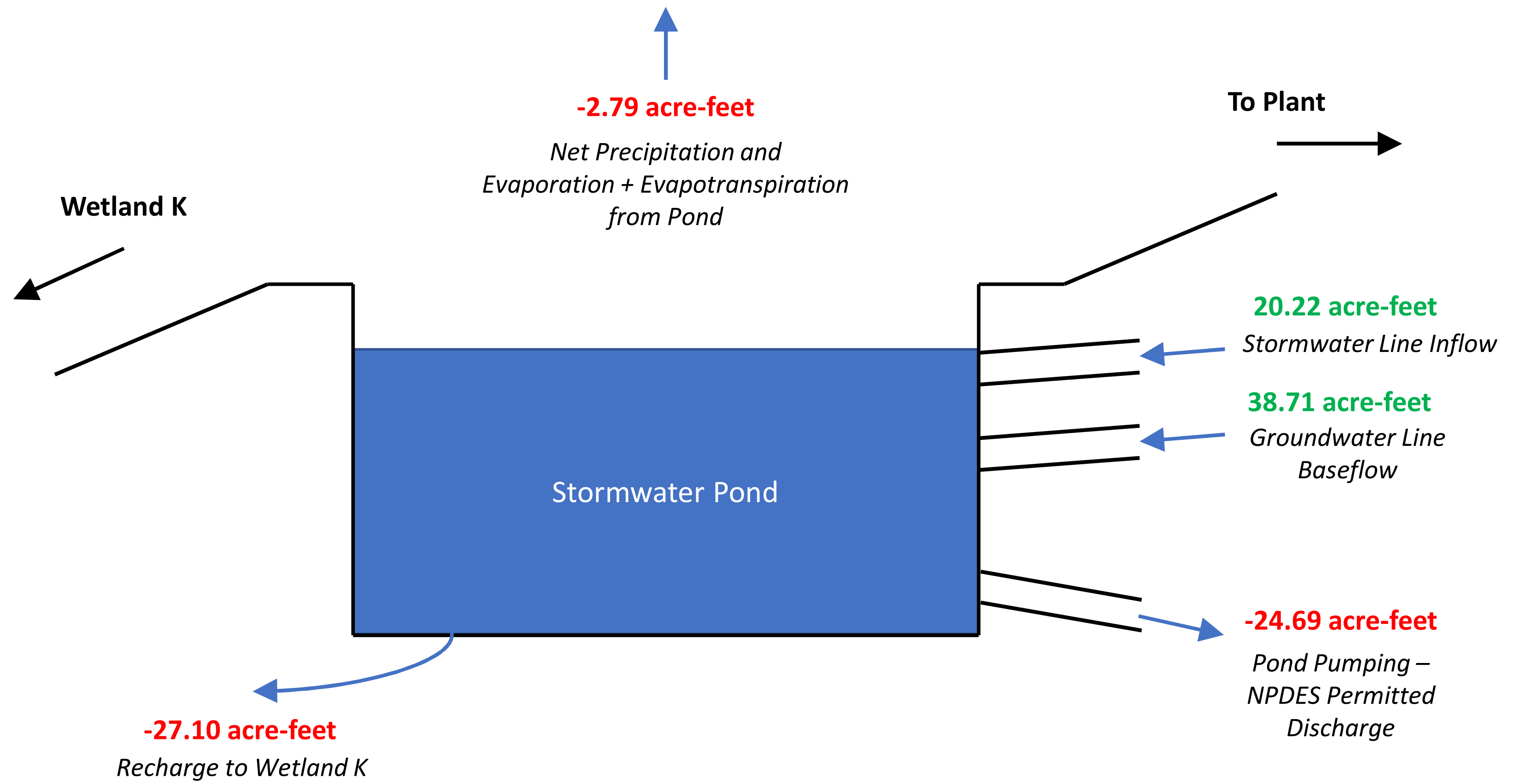


Figure 2-45

Stormwater Pond Water Balance Schematic

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

pumping of the stormwater pond (-24.69 acre-feet per year) under the NPDES permit represents the second largest outflow for the stormwater pond.

The water balance total (total inflows versus total outflows) is 4.35 acre-feet, which suggest net inflow into the stormwater pond. However, there are uncertainties associated with calculation of all of the estimated inflows and outflows. The result represents about 4 percent of the total estimated inflows and outflows for the stormwater pond.

The parameters with the greatest uncertainty are the amount of stormwater reaching the pond, the amount of groundwater baseflow reaching the stormwater pond, and the amount of groundwater recharge reaching Wetland K. However, even with modification of these inputs and outputs, the water balance for the stormwater pond still shows significant recharge of the basalt aquifer system in the vicinity of the pond and Wetland K. This is supported by the 2017 hydrograph study and pond drawdown test that show strong hydraulic connection between the pond and the BAU aquifer zone.

2.4.3.3 Wetlands K, F, and NPDES Drainages Water Balance

Table 2-14 summarizes the water balance for Wetland K, Wetland F, and the NPDES Drainage. The main inflow to Wetlands K and F is the estimated groundwater seepage volume into the wetland that includes the estimated spring discharge, while the principal output is estimated evapotranspiration within the wetlands. For Wetland K, the estimated evapotranspiration within Wetland K (-4.36 acre-feet) does not balance the estimated spring discharge (11.29 acre-feet) or the estimated groundwater recharge to Wetland K that includes the spring discharge (27.10 acre-feet). This indicates potential for infiltration and groundwater recharge and eventual discharge to the Lake Umatilla Reservoir.

At Wetland F, the estimated evapotranspiration (-2.98 acre-feet) exceeds the spring discharge (2.42 acre-feet), but does not balance the annual estimated groundwater recharge with the Wetland F drainage (19.76 acre-feet), indicating infiltration and potential groundwater migration within the Western Intermittent Drainage downslope of Wetland F.

Table 2-14
Drainage Water Balance Summary
WPA Field Investigation
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Drainage	Annual Groundwater Recharge (Acre Feet)	Annual Spring Discharge (Acre Feet)	Annual Evapotranspiration (Acre Feet)	Difference	Notes
Wetland K	27.10	11.29	-4.36	22.74	Evapotranspiration does not balance spring discharge input or the total estimated groundwater recharge Difference suggests infiltration and/or potential groundwater recharge of underlying basalt in Wetland K or downslope.
Wetland F	19.76	2.42	-2.98	16.78	Evaporation exceeds spring discharge in Wetland F. However, evapotranspiration does not balance estimated groundwater annual recharge in the spring and suggests infiltration and/or potential groundwater migration down slope of Wetland F.
NPDES Ponds A and B	NA	6.72	-3.90	2.82	Difference equals infiltration because water does not leave Pond A/Pond B based on field observations. A portion may represent recharge to the BAL zone. No indication of groundwater seepage/springs in this area.

Notes:
NA - Not Applicable
NPDES - National Pollutant Discharge Elimination System

In the case of the NPDES Ponds, the amount of groundwater recharge is estimated to be negligible as no groundwater seepage or springs have been observed in this area during the course of the RI or the WPA. The main inflow is the amount of discharge from the SE line outfall at NPDES Pond, and the main output is evaporation and evapotranspiration in the combined area of NPDES Ponds A and B. The amount of runoff from tributary areas was not accounted for in this analysis but is assumed to be small based on field observations. The result show that the estimated annual evapotranspiration in the combined area of NPDES Ponds A and B (-3.90 acre-feet) does not balance the estimated inflow (6.72 acre-feet) from the SE line. Since ponding water has not been observed to drain from Pond B during the RI and WPA field program, the difference between the inflow and the evapotranspiration (2.82 acre-feet) represents infiltration in the vicinity of NPDES Ponds A and B. A portion of the infiltration may recharge deeper basalt (BAL) aquifer zones.

2.4.4 Lag and Dampening and Shoreline Water-Level Elevation Analyses and Results

This section summarizes the methodology, input parameters, and results for the lag and dampening analyses and shoreline well water-level elevation analyses.

2.4.4.1 Methodology, and Input Parameters

Methods of Ferris (1963) was used to analyze stage ratios and time lag for shoreline wells and the Columbia River to evaluate transmissivity and groundwater flux. The regulation of a surface water reservoir, such as the Lake Umatilla Reservoir, produces correlative water-level changes in hydraulically connected wells that are near the reservoir. As the surface water stage rises, the head upon the subaqueous outcrop (defined as the subaqueous area of the aquifer that interacts with the surface water body) of the aquifer increases and thereby either increases the rate of flow into the aquifer or reduces the rate of flow from it. The increase in recharge or reduction in discharge results in a general rise of the water-level in the aquifer. Conversely, a falling surface water stage causes a corresponding decline of the water-level in the aquifer. In this manner, changes in the reservoir stage are propagated inland as a train of sinusoidal waves. The amplitude of the wave decreases, and the lag time increases, with increased distance from the subaqueous aquifer outcrop.

The average values for time lag and stage ratio were calculated for RI-MW18-BAL and RI MW19-BAL and the surface water pond based on the year-long hydrograph study. These stations are shown on Figure 2-7.

The stage ratio is defined for a given rising or falling stage as the range in water-level fluctuation in a given observation well to the corresponding range in water-level fluctuation for the surface water intake pond. The data was reviewed to identify maximums and minimums for the surface water reservoir that can be clearly paired with corresponding maximums and minimums for the select BAL_2 aquifer zone wells. These maximum and minimums were used to determine the average stage ratio and time lag for each well with respect to the surface water intake pond. An equal number of rising stages and falling stages were used in the calculation of the average stage ratio. Transmissivity (T) was independently calculated using the average stage ratio and time lag for each well and using a range of representative storage (S) values. For the purposes of this analysis, the shortest distance from the well to the Columbia River or Surface Water Intake Pond is assumed to be the distance to the subaqueous outcrop (i.e., the assumption is that the groundwater is hydraulically affected by the changes in river stage at the closest shoreline location).

As part of the initial WPA data evaluation, a comparison of barometric pressure versus the shoreline wells and the stilling well was performed. A Barotroll™ was present on-site that collected atmospheric pressure readings during the RI for the period of the one-year hydrograph study. A strong inverse correlation between the pressure and the water- level elevations was found in the data set with lower pressure correlating with higher water-level elevations. Note that all the pressure transducers used during the hydrograph study and aquifer tests were vented.

In examining the long-term hydrographs, it was determined that the water levels in the monitoring wells were affected by the barometric efficiency of the aquifer. From inspection, a barometric efficiency of about 10 percent was noted. A graphical method was employed (Halford, K.J., 2006) to remove the component of water-level change attributable to barometric pressure. The graphical method applies the principle of superposition to separate the effects of barometric efficiency from other influences on groundwater elevation in the aquifer. Synthetic adjusted groundwater elevations with the effect of aquifer barometric efficiency removed were then used to perform the lag-dampening analysis. The supporting calculations for the analyses are presented in Appendix D-17.

2.4.4.2 Lag and Dampening Results

Table 2-15 summarizes the results for the lag and dampening analysis.

Table 2-15
Shoreline Well Lag and Dampening Analyses Results
Former Columbia Gorge Aluminum Smelter Site, Goldendale, Washington

Well	Slug Test Transmissivity (ft^2/day)[a]	Time Lag Transmissivity (ft^2/day)	Stage-Ratio Transmissivity (ft^2/day)
RI-MW18-BAL	20.7	0.9	73
RI-MW19-BAL	35.5	0.07	7

Notes:
a Average of slug-in and slug out tests multiplied by aquifer thickness of 10 feet.
ft^2/day = square feet per day

The results suggest the aquifer is more permeable in the immediate area of the well screen based on the slug tests, than it is based on the response to changes in the river stage, which is expected if the degree of river connection is relatively small. The high degree of confinement of the aquifer zone that has necessitated the barometric correction and low storativity of the aquifer zone also suggest that that much of the gradient change may not represent physical flow. Ferris (1963) notes that if an aquifer has no subaqueous outcrop, but is confined by an extensive aquiclude, the rise and fall of the surface water stage changes the total weight upon the aquifer. Resulting variations in compressive stress are borne in part by the formation matrix of the aquifer and in part by its confined water. The relative compressibility of the formation materials and the confined water determine the ratio of stress assignment and the net response of the piezometric surface to the surface force.

The results of the lag and dampening analysis further support the findings of the initial RI hydrograph study (refer to Section 2.3.7) that suggested limited hydraulic connection based on the hydrographs, field observations and site hydrogeology. The presence of fine-grained sediments in the reservoir may also serve to limit connectivity with the BAL-zone.

The calculation of transmissivity (T) for both stage ratio and time lag is sensitive to the periodicity of the stage fluctuations of the reservoir (estimated at 4 days), and the frequency and periodicity of river fluctuations is not very regular. Another assumption of the analysis is that the groundwater is connecting with the reservoir water at the shoreline. If the interconnection with the reservoir occurred in a subcrop area that is a significant distance from the shoreline, the results would be affected.

2.4.4.3 Shoreline Flow Directions

A more detailed analysis of head differences between the shoreline wells and the river was performed as part of the WPA-related data analysis. Figure 2-46 and Figure 2-47 show the daily average water-level elevation difference between the reservoir and RI-MW18-BAL and RI-MW19-BAL, respectively. Positive differences indicate that the gradient is toward the reservoir and negative differences indicate that the gradient is from the reservoir to the shoreline wells. For RI-MW18-BAL, the horizontal gradient is from the reservoir toward the shoreline wells about 76 percent of the time. For RI-MW19-BAL, the gradient is from the reservoir toward the shoreline wells 66 percent of the time. The average head difference when the gradient is from the reservoir into the aquifer is -0.31 ft at RI-MW18-BAL and -0.41 ft at RI-MW19-BAL, respectively.

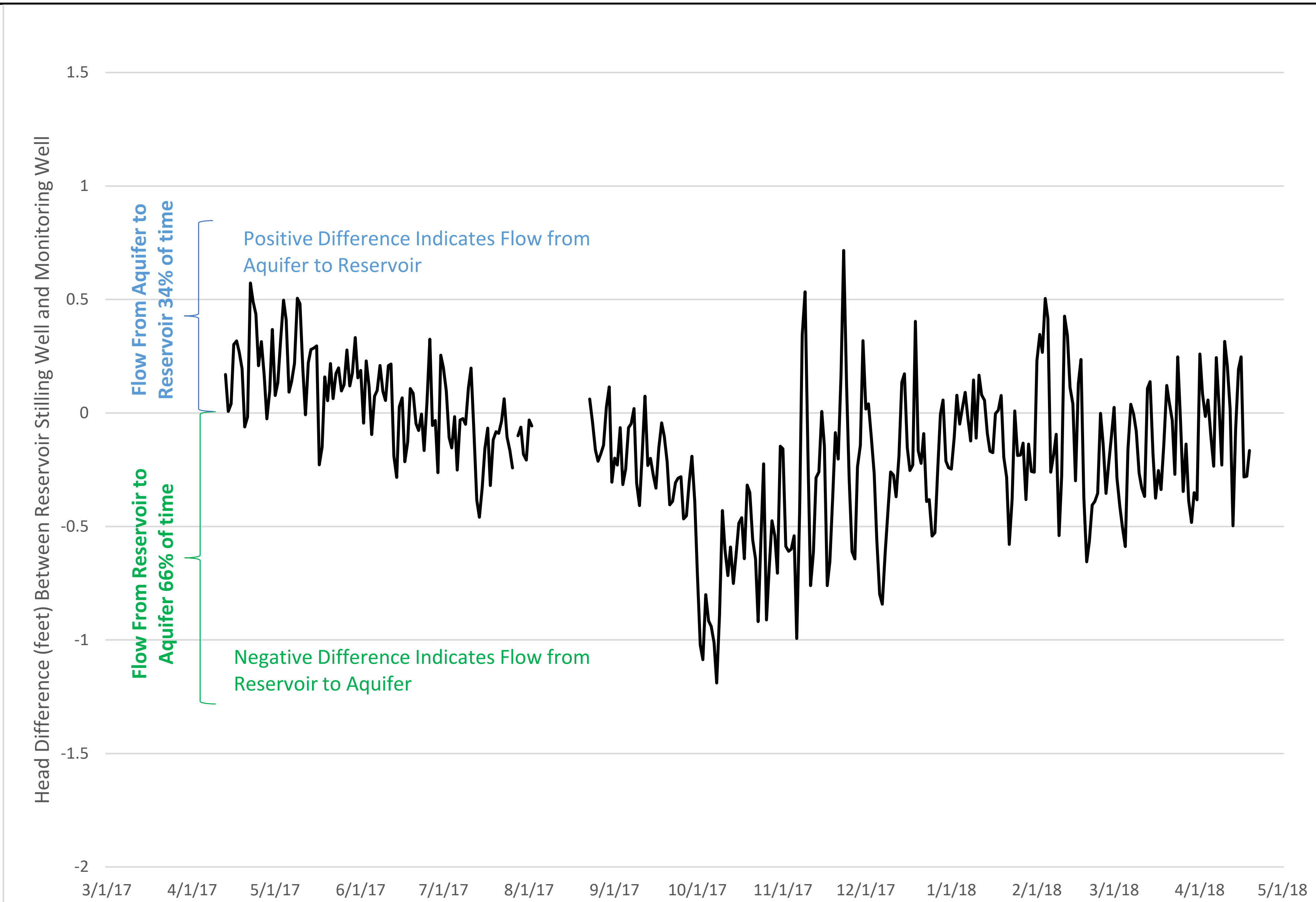


Figure 2-46

Daily Average Head Difference Between Reservoir Stilling Well and RI-MW18-BAL

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

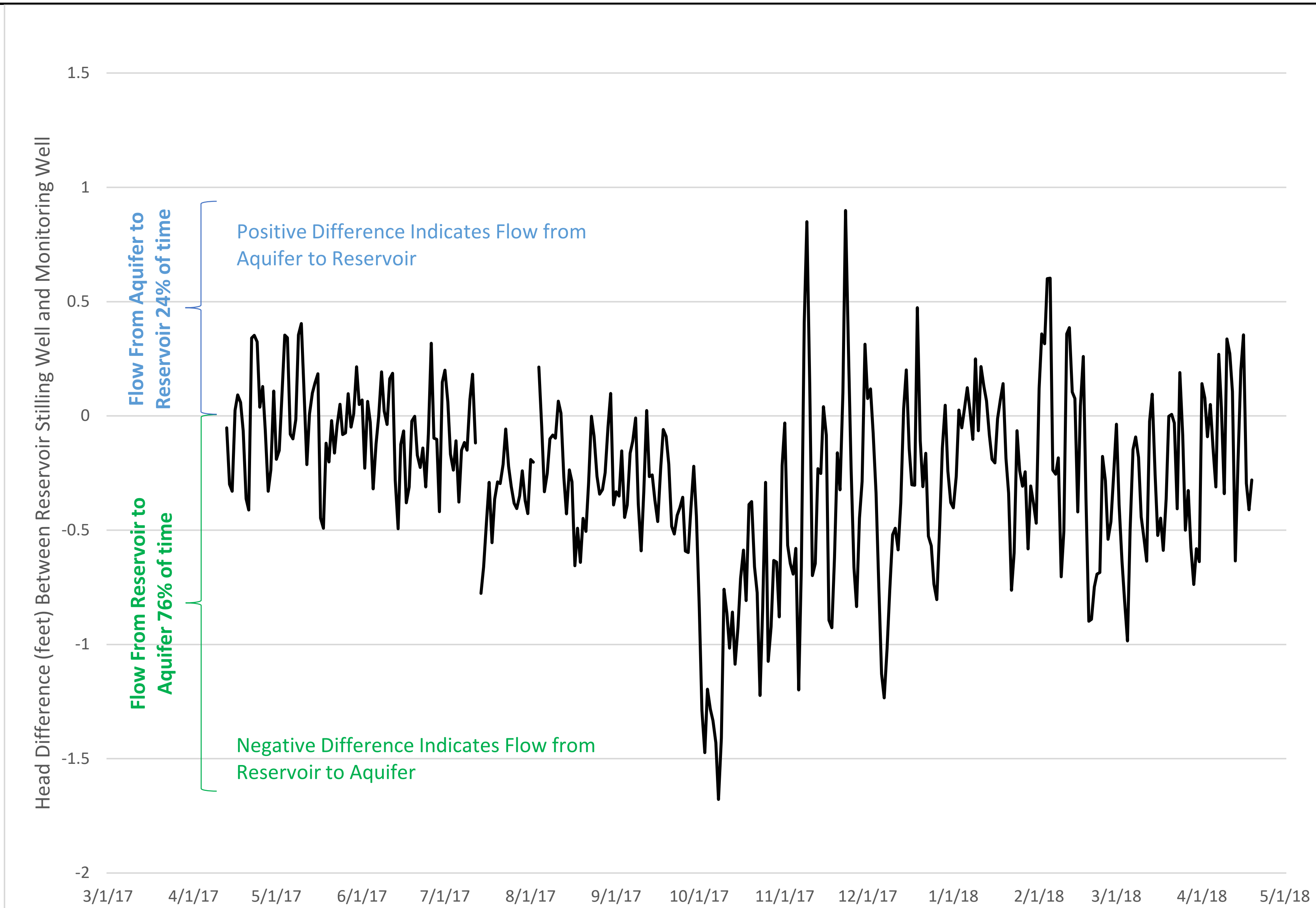


Figure 2-47

Daily Average Head Difference Between Reservoir Stilling Well and RI-MW19-BAL

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

When gradient is from the aquifer to the reservoir, the average head difference is less, and ranges from 0.18 feet at well RI-MW18-BAL to 0.19 feet at well RI-MW19-BAL, respectively.

2.5 SUMMARY AND RECOMMENDATIONS

The RI work effort has confirmed and enhanced the understanding of the hydrostratigraphy at the site, particularly for deeper basalt bedrock zones. The conceptual understanding of a three-zone aquifer system consisting of a shallow unconsolidated aquifer (UA zone), an upper basalt aquifer zone (BAU zone) at an elevation significantly above the Columbia River, and a deeper basalt aquifer zone near the Columbia River elevation (BAL zone) has been generally confirmed at the site. This section summarizes site hydrogeology, groundwater quality, and recommends specific source areas to be addressed in the FS regarding groundwater impacts.

2.5.1 Hydrogeology Summary

The water-level elevation gradient is steep in all three zones and generally toward the Columbia River. However, based on the detailed analysis of water levels in the reservoir and shoreline well, there is limited potential or discharge from the BAL zone aquifer adjacent to the shoreline as described above in Section 2.4.4.3. The vertical gradient between the water bearing zones is downward. However, as discussed below, the steep gradient does not indicate significant groundwater flow. Site contaminants have migrated downward to the BAL in limited areas and at significantly lower concentrations than in shallower aquifer zones.

A previously mapped northwest trending strike-slip fault extends between the west end of the Boat Basin to the former plant area. Based on core results, groundwater chemical distribution, and water-level distributions, there appears to be two additional similar faults/fractures systems: 1) near the stormwater pond and extending to Spring 01, and 2) in the eastern portion of the former plant area and extending into the NPDES drainage. The fault areas coincide with topographic lows and are oriented parallel to groundwater flow. It appears that groundwater may migrate along these fault/fracture systems both horizontally and vertically and is summarized as follows:

- Groundwater from the BAU zone migrates from the vicinity of the stormwater pond to Spring 01 where it discharges into Wetland K (refer to cross-section A-A' Figure 2-9). The water currently seeps back into unconsolidated deposits (Missoula flood deposits and colluvium) may be perched at the contact with the underlying basalt bedrock, or may be infiltrating into the underlying basalt bedrock. The drainage water balance

(Section 2.4.3.3) suggests potential for migration of water to the Lake Umatilla Reservoir either through seepage along the basalt bedrock contact or through infiltration into the basalts and eventual groundwater discharge to the Columbia River.

- In the eastern portion of the former plant area (refer to cross-section C-C' Figure 2-12), faulting and fracturing has interconnected the BAU_1 and BAU_2 aquifer zones (refer to RI-MW8-BAU, and BAMW-3 water-level characterization study results). Contaminated groundwater appears to migrate downward through the fault/fracture system near suspected source areas near the eastern end of the former plant area and then migrate downgradient toward the NPDES ponds drainage. Groundwater seeps or discharge is not observed in the NPDES Ponds drainage, indicating that groundwater in the BAU and BAL zones does not appear to obviously recharge the NPDES ponds drainage.

  The SE line seasonally discharges water from the pipe at the head of NPDES Pond A. The water in pipe consists primarily of groundwater from the plant area and is contaminated with fluorides. The water accumulates in Ponds A and B and evaporates and infiltrates into the ground. Water has not been observed exiting Pond B during the course of the RI and WPA field investigation. Based on the results of the drainage water balance (Section 2.4.3.2), the estimated evaporation and evapotranspiration in Ponds A and B is does not balance the estimated seasonal pipe discharge, indicating infiltration into the subsurface in this location.

- In the western intermittent drainage that corresponds to the mapped strike-slip fault (refer to cross-section C-C', Figure 2-14), groundwater is discharges from the BAU zone to a spring in Wetland F. The water flows as surface water through the wetland where is seeps back into unconsolidated deposits upstream (north of John Day dam road). Based on the drainage water balance analysis in Section 2.4.3.3, estimated evapotranspiration within Wetland F balances the estimated spring inflow. However, the estimated Wetland F groundwater discharge as calculated based on groundwater gradient, aquifer thickness, and the width of the wetland recharge zone is significantly greater, which indicates infiltration and potential shallow groundwater migration within the drainage. No seeps or springs have been noted between the Wetland F spring and the Boat Basin. A portion of the water may continue to migrate in the unconsolidated deposits down the gulley (fault trace) toward the Boat Basin or potentially may migrate downward along the fault trace to the deeper BAL zones.

The UA aquifer is based on the occurrence of water-bearing surficial unconsolidated deposits. The UA aquifer is absent in areas where basalt bedrock outcrops, including significant areas located southeast of the main plant area. The UA and BAU zones are locally interconnected and have similar water-level elevations. Water-level elevations in the UA and BAU zones generally reflect the original or modified surface topography, and fault/fracture zones. Water-level elevations in both the UA and BAU aquifer zones converge on the fault/fracture zones that also represent topographic lows.

For example, there is a mounded area in the groundwater elevations for the UA and BAU aquifer zones that coincides with the central portion of the former plant area and the French-drain shallow groundwater collection system that routes shallow groundwater to the stormwater pond. The scrubber effluent lines also seasonally route contaminated shallow groundwater to the head of the former NPDES Pond A (SWMU 1). These constructed features represent preferential flow pathways. Based on the stormwater pond water balance (Section 2.4.3.2), the groundwater line represents the largest inflow to the stormwater pond.

Based on the coring results and drilling program, there appears to be about three basalt flows that comprise the basalt aquifer system at the site, with water-bearing zones occurring predominantly in the fractured and vesicular flowtops. The BAU aquifer zone has more than one water-bearing zone in some areas (i.e., BAU_1 and BAU_2) as shown in cross-sections, but the water-levels within the BAU are similar. The BAU zone discharges to springs at two locations with elevations significantly above the Columbia River. These springs appear to coincide with fracture/fault zones. Surface water flow from the springs appears to seep back into the unconsolidated deposits does not reach the Columbia River; no seeps were observed along the shoreline of the Columbia River.

Water-level elevations in the BAL zone are significantly lower than the shallower UA and BAU zones. The BAL zone has more than water-bearing zone in some areas (i.e., BAL_1 and $BAL_{2,}$ and potentially a third zone). The BAL_1 water-bearing zone occurs at an elevation just above or slightly below the elevation of the Columbia River (Lake Umatilla Pool). The BAL_2 water-bearing zone occurs at an elevation about 40 ft below the elevation of the Columbia River. There appears to be a low permeability flow interior separating the two BAL water-bearing zones.

Based on evaluation of hydrographs developed from the water-level characterization study and cross-sections, it appears that the BAL water-bearing zones do not significantly discharge to the Columbia River in most areas. For some BAL_2 zone wells along the shoreline (well RI-MW18-BAL and well RI-MW19-BAL) the surface water elevation of Lake Umatilla Reservoir is slightly higher than the groundwater elevations for most of the year (refer to Section 2.4.4.3), which suggests limited discharge. An evaluation of lag and dampening of the shoreline wells and the Lake Umatilla Reservoir (refer to Section 2.4.2) suggests that the aquifer is more permeable in the immediate area of the shoreline wells based on the slug tests, than it is based on the response to changes in the river stage, which is expected if the degree of river connection is relatively small.

For shoreline well RI-MW1-BAL, which is completed in the BAL_1 zone, the hydrograph is significantly different than the BAL_2 zone wells along the Columbia River (well RI-MW18-BAL and well RI-MW19-BAL) and the river, which suggests a lack of interconnection. These findings are further supported by the results of the Columbia River Sediments AOC (refer to Section 1) that do not show high levels of groundwater COPCs in the Boat Basin and plant surface water intake pond sediments.

Based on the coring and packer test results and the basalt aquifer drilling program, there is a substantial thickness of low permeability basalt flow interiors between the BAU zone and the BAL zone. Migration of contaminants to the BAL zone appears most likely where: 1) sources of contamination are at a lower elevation than a portion of the flow interiors due topographic relief at the site (such as the NPDES ponds), and 2) areas where the basalt bedrock is fractured or faulted as discussed previously.

The unlined stormwater pond is interconnected with and appears to locally recharge the BAU aquifer zone based on multiple lines of evidence including the results of the pond-drawdown test, water quality results, and geochemistry. The stormwater pond is connected by subsurface piping to a series of shallow groundwater collection lines in the former plant area that drain the UA zone.

2.5.2 Groundwater Quality Summary

Groundwater water quality has been impacted in portions of all three aquifer zones particularly for common aluminum smelter-related chemicals including fluoride, sulfate, and to a lesser extent, PAHs. While total cyanide has been detected above groundwater screening levels based of free cyanide, free cyanide was not detected above groundwater screening levels. Soil screening levels for protection of groundwater were developed for these chemicals and used in the screening comparisons for all SWMUs and AOCs. In general, for these chemicals, areas that exceed the soil screening levels for protection of groundwater also correlate with the main areas of groundwater exceedances. The correlation is weakest for PAHs that exceed soil screening levels for protection of groundwater over a broad area, but only sporadically exceed groundwater screening levels. The correlation between soil and groundwater areas exceeding screening levels is strongest for those areas of the site with smelter-related wastes present in the subsurface. In these areas, PAHs typically also exceed terrestrial ecological screening levels and will need to be addressed for that reason.

Similar to historical results, fluoride represents the most widespread of these chemicals with groundwater chemical concentrations exceeding the MCL of 4 mg/L as well as the 0.96 mg/L MTCA Method B groundwater screening level in the UA zone in the western portion of the site near the WSI and West SPL Storage Area, the area of the main plant, and the eastern end of the site near the ESI. In the deeper BAU and BAL zones, fluoride concentrations above the MCL are limited to the eastern plant area (near the East SPL Storage Area, EELF, the North and South Pot Liner Soaking Stations, and NPDES Pond A), and the eastern end of the site near the ESI and NESI.

Sulfate exceeds the secondary MCL of 250 mg/L in all three aquifer zones primarily at the eastern and western portions of the site and also within the central portion of the plant. The secondary MCL for sulfate does not represent a risk-based standard, and reference dose information was not available in Ecology’s Cleanup Level and Risk Calculation database (CLARC). Sulfate is commonly associated with the anodes and associated air pollution scrubber systems and associated sludges. Elevated concentrations in groundwater are associated with SWMUs where these materials have been managed or landfilled including: the WSI and WELF to the west; and the ESI and NESI to the east of the main plant. In the central portion of the plant, the sulfate plume appears to be related to scrubber treatment system piping releases associated with the Line A Secondary Scrubber Recycle Station (SWMU 5), Line B, C, and D Secondary Scrubber Recycle Stations (SWMU 6) and Tertiary Treatment Plant (SWMU 8), and specifically including the South Dry/Wet $S0_2$ scrubber and associated piping beneath Passage no. 4 and clarifiers south and east of the Tertiary Treatment Plant.

In general, the cyanide detections in groundwater are typically associated with SPL handling and storage areas. The MCL and MTCA groundwater screening levels are based on free cyanide; free cyanide and WAD cyanide were either not detected or detected at concentrations below screening levels in all wells and all aquifer zones.

cPAHs were detected at low concentrations scattered across the site but were detected above MTCA Method B groundwater screening levels. PAHs do not appear to represent a significant risk driver for groundwater and there does not appear to be a distinct groundwater plume.

Petroleum hydrocarbons (primarily diesel- and residual-range organics) were found above MTCA groundwater screening levels in monitoring wells installed near the former Compressor Building

USTs. Similar chemicals were detected above soil screening levels in subsurface soil samples from this area.

A few other chemicals were detected above groundwater screening levels at limited well location(s) including PCBs, metals (As, Al, Fe, Cr, and Ni), and vinyl chloride. The occurrence of these chemicals was inconsistent between quarterly sampling events, was limited to the total fraction for some metals, and was limited to a single well location in some cases. Also, Well MW-1 that contained the purple-pink material showed only limited chemical detections above associated groundwater screening levels.

2.5.3 Feasibility Study Recommendations

The GWAOC is recommended for further evaluation in the Feasibility Study (FS) based primarily on MTCA and/or MCL groundwater screening level exceedances of fluoride and sulfate in multiple wells during RI and WPA sampling in all three aquifer zones. A few areas also are characterized by low concentrations of cyanide in groundwater that serve as a plume indicator. Based on the results of the RI and WPA, the following identified source areas of groundwater contamination have been identified for specific evaluation in the FS.

2.5.3.1 Western Area

In the Western portion of the site, the WSI (SWMU 4) and the West SPL Storage Area (SWMU 13) are associated with a persistent fluoride and sulfate plume in this area. Both of these closed units have designed caps. The WSI is subject to a long-term monitoring groundwater monitoring program and the West SPL Storage Area cap inspection and maintenance program was recently resumed during 2021 is will be continued on an annual basis.

The WELF (SWMU 18) represents a potential source of groundwater contamination because of the presence of buried non-SPL carbon waste and low levels of groundwater contamination in the area and location near the Wetland F spring. This landfill was also informally closed with a soil cover, rather than an engineered cap that meets solid waste regulations (WAC 173-304).

2.5.3.2 Plant Area

This section summarizes suspected source areas for groundwater contamination in the Plant Area that will be addressed for the GWAOC in the FS.

Eastern Portion of the Plant Footprint

In the eastern portion of the plant, a fluoride groundwater plume is present in the UA, BAU, and BAL aquifer zones. The North and South Pot Liner Soaking Stations (SWMUs 10 and 11) and East SPL Storage Area (SWMU 12) are likely source areas of groundwater contamination in this area based on the groundwater results and soil results. A leaking river line catch basin is infiltrating into the subsurface on the upgradient side of the North SPL Pot Liner Storage area and may be recharging the shallow aquifer zone in this area.

A significant thickness of mixed construction and smelter waste including suspected SPL (up to about 15 feet thick) is found at the EELF (SWMU 17) that likely serves as a source of groundwater contamination. Elevated concentrations of fluoride and sulfate were found in recently installed well WPA-GW12-BAU located in the waste footprint. The SE line near this well may also be leaking and infiltrating water in this area.

Water and Wastewater Line Systems

As described in Section 2.4 of this volume, the different underground line systems interact with shallow groundwater in portions of the plant area footprint. These line systems include the groundwater line and SE line systems that conceptually have the most significant impact on groundwater contaminant transport as well as the stormwater pond and associated stormwater line and I&M line systems. Results for characterization of the line systems are summarized in Volume 3, Section 2.5, and the interaction of the line systems with shallow groundwater is summarized in Section 2.4 of this volume.

The stormwater pond (SWMU 32) recharges the basalt aquifer system and Wetland K and the results of the RI show that both stormwater pond sediments and water are contaminated. Also, contamination in stormwater catch basins and the presence of surface soil contamination in the Courtyards and other areas served by the stormwater system are likely to be contributing to contaminant loading in the stormwater pond.

The SE lines affect the migration of shallow groundwater contamination in the Plant Area and will be included for evaluation in the FS. During high water periods groundwater enters the southern SE line in Courtyard A4 through a large breach and discharges fluoride-contaminated water at the head of the NPDES Pond A. In addition to serving as a flow pathway, sediment in the line is contaminated. It also appears the SE line may be leaking water just downstream from MH18L4 in the footprint of the EELF and could affect contaminant migration in that area.

The groundwater lines collect and convey groundwater from the northern edge of the plant footprint to the stormwater pond and contributes to groundwater mounding in the stormwater pond vicinity. Based on measured flow in the line, groundwater line base flow to the stormwater pond represents the largest inflow to the stormwater pond (refer to Section 2.4). While the water results for the groundwater line are not significantly elevated, groundwater line discharge appears to effect groundwater migration in the Plant Area including back-up of water in the stormwater pond and the associated stormwater and groundwater lines. This process results in mounding of shallow groundwater in the central area of the former Plant Area footprint. For this reason, the groundwater lines will be further evaluated in the FS.

All of the line systems (groundwater lines, SE lines, stormwater pond and associated lines, and I&M lines) will be carried into the FS for further evaluation as summarized in Table 2.6-1, Volume 3.

Other Suspected Groundwater Sources in the Plant Area Footprint

In this central area of the plant footprint, the fluoride and sulfate shallow aquifer plumes appear to be related to scrubber treatment system piping releases associated with the Line A Secondary Scrubber Recycle Station (SWMU 5), Line B, C, and D Secondary Scrubber Recycle Stations (SWMU 6),Tertiary Treatment Plant (SWMU 8), and the South Dry/Wet $S0_2$ scrubber and associated piping beneath Passage no. 4 and the area of the clarifiers east of the Tertiary Treatment Plant. Refer to Section 2.4 for a summary of the lines and water-level elevations and groundwater contaminant distribution in this area. The RI and WPA investigations did not find significant soil contamination at depth in these areas. The treatment system piping for these SWMUs is interconnected and generally matches the plume distribution in this area. There is also a significant groundwater mound in this area that interacts with the piping in Passages 3 and 4 and may serve as preferential groundwater migration pathways.

The former Compressor Building USTs represent a source of groundwater contamination due to exceedances of soil and groundwater screening levels for TPH-related constituents.

Eastern Area

In the eastern portion of the site, the NESI subarea (part of SWMU 31) has buried solid waste mixed carbon waste zone (that includes suspected SPL) up to 8-feet thick with wastes in contact with shallow groundwater. The wastes are adjoining a wetland area and the wetland spring and nearby monitoring wells are characterized by elevated fluoride concentrations.

The ESI (SWMU 2) represents a capped and closed unit that has undergone groundwater monitoring for several years. Elevated concentrations of fluoride and sulfate in shallow groundwater persist in this area. There is groundwater mounding within the capped area as evidenced by the groundwater water-level elevation pattern.

Well MW-1 is located east of the ESI. The purple-pink material in well MW-1 is characterized by a few low-level exceedances of groundwater screening levels. However, because the nature and quantity of the purple/pink material remains unclear, further evaluation is recommended.

Section 3
Wetlands

This section summarizes the RI results for the Wetlands Area of Concern. Investigation of the Wetlands AOC was included in the Agreed Order and the main RI Work Plan objective was characterization of the nature and extent of soil/sediment contamination in the wetlands related to smelter operations. The Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) includes a detailed summary of background information about the Wetlands AOC.

3.1 BACKGROUND SUMMARY

Site wetlands were previously investigated voluntarily by NSC Smelter, LLC (NSC) because they were identified as a concern of the Yakama Nation (Ecology 2011). NSC performed wetland delineation and characterization of wetland areas on a portion of the facility (PGG 2013a).

In addition, wetland delineation was conducted by Lockheed Martin Corporation (Lockheed Martin) during 2011 for a portion of the Smelter Sign Area (SWMU 31). RI and WPA soil results for the SWMU 31 wetlands are summarized separately in Volume 2, Section 31.

As previously summarized in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a), two wetland investigations were previously performed at the site. The investigations included a field survey and classification of the wetland areas (PGG 2013a), and an investigation of soil types and groundwater conditions at the largest wetland (Wetland D) located west of former production area of the plant (PGG 2013b). Wetland water quality was also characterized during the 2013 investigation (PGG 2013b).

The 2013 field survey (PGG 2013a) resulted in delineation of thirteen wetlands designated Wetlands A through M. The wetlands are located south, west, and northwest of the former production area and are shown on the Wetland and Surface Water Location Map on Figure 3-1. The 13 delineated wetlands consist primarily of Category III and IV Palustrine emergent and/or scrub/shrub wetlands. Palustrine wetlands represent a category of inland, non-tidal wetlands characterized by the presence of trees, shrubs, and emergent vegetation (vegetation that is rooted

Legend

- RI Surface Soil Sample Location
- WPA Sediment Sample Location
- WPA Soil Sample Location
- Spring
- Wetland Area Name

N
W E
S

0 250 500 1,000
Feet

Imagery Source: NAIP 2017

Figure 3-1
Wetlands Area of Concern
Wetland and Soil Sample Locations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

below water but grows above the surface). Category III and IV wetlands represent wetlands with moderate- to low-level functions that generally have been disturbed in some ways and are often smaller, less diverse, and/or more isolated from other natural resources than other higher functional category wetlands. The wetlands have generally been used for livestock grazing and have been historically disturbed to a degree by grading, clearing, and other activities. Category II palustrine wetlands represent those wetlands that provide habitat for sensitive or important animals or plants, and are either difficult to replace or characterized by high wetland functions particularly for wildlife.

A wetland pond is shown on Figure 3-1, southwest of the WSI. This wetland was not among the 13 delineated wetlands (PGG 2013a,b). This wetland was not sampled or characterized as part of the RI and WPA field investigations because of its distance (about 0.75-miles) southwest from the WSI. This wetland is also an example of similar available habitats in the general site vicinity.

The least physically disturbed wetlands include Wetlands I and K, with Wetland I representing the only Category II wetland. Wetlands A, B, and C are the smallest wetland areas (less than 2,500 square feet) and would not be regulated for development under the Klickitat County Critical Areas Ordinance and were not included for sampling in the Ecology-approved Final RI Phase 2 Work Plan (Tetra Tech et al. 2015b). Like many wetlands, the current main functions of the wetlands include wildlife habitat, groundwater recharge/discharge, and water purification (Ecology 2001).

Based on the wetland surveys (PGG 2013a,b), the physical description of the wetland areas (as shown on Figure 3-1) were presented in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) and are summarized as follows:

- **Wetland A (0.027 acres):** This wetland area is located topographically higher and north of the WSI west of upgradient monitoring wells MW-2A and MW-2B. Wetland A occurs at the site of a spring, which has been piped to an overflowing livestock watering trough.

- **Wetlands B (0.107 acres) and H (0.7 acres):** These wetlands are in the western portion of the site near the Plant Construction Landfill, R&D laboratory and Well 3 Pumphouse. Run-off from the western portion of the site is directed by a ditch that flows towards Wetlands B and H, and from Wetland H flows through a culvert to Wetland D. Standing surface water is reportedly present during wetter months of the year in Wetlands B and H (PGG 2013a,b).

- **Wetland C (0.048 acres):** Wetland C is located north of the western end of Wetland D. Seasonal standing water is present in Wetland C (PGG 2013a,b), and water may be derived from groundwater seepage associated with the spring at the western margin of Wetland D.

- **Wetland D (17 acres):** The largest wetland, Wetland D, is approximately 17 acres and is located immediately south of the Plant Construction Landfill (SWMU 19) and west of the WELF (SWMU 18). Wetland D was formerly the site of a pond, termed the Duck Pond, from the 1980s to around 2003. The Duck Pond was in the northeast portion of Wetland D.

  A modified spring is present at the southwestern margin of Wetland D that discharges into a small pond, and then flows westward through a roadway culvert that pools in an open area to the west where it infiltrates into the ground.

- **Wetland E (0.23 acres):** A seasonal seep is located south of the facility parking lot entrance road which flows through Wetland E, and infiltrates into the ground before reaching the flow channel located in Wetland F.

- **Wetland F (0.057 acres):** Wetland F occupies a ravine that becomes deeper and wider south of the John Day Dam Road and ends at the Boat Basin near the Treaty Fishing Access Site (TFAS) (the ravine is referred to as the western intermittent drainage to the Boat Basin in historical reports). A year-round spring is present south of the plant parking entrance road. Water from the spring flows in an established channel through Wetland F, but infiltrates into the ground before reaching the culvert beneath the John Day Dam Road.

- **Wetlands G (0.109 acres), J (0.434 acres), I (0.072 acres), L (0.464 acres), and M (0.187 acres):** These small wetlands are all located on the south side of the main plant area. Localized pooled water has been observed in Wetlands G, J, I, L, and M only during the wettest periods. These wetlands may receive water from runoff and/or shallow groundwater flow.

- **Wetland K (1.297 acres):** A year-round spring is present south of John Day Dam Road. This spring flows through Wetland K in two shallow and moderately well-developed channels (runnels) that are termed the eastern intermittent drainage to the Boat Basin (as referred to in historical reports). Recharge from the stormwater pond appears to represent the main source of water for the Wetland K as is described in Section 3.3.2.2 as well as Section 2.4. Waters from the spring correspond to areas of the wetland and the spring discharge has not been observed to reach the Columbia River.

Water in wetlands at the site (Wetlands D, E, F, and K) was previously sampled during 2013 (PGG 2013a). Aluminum, lead, and zinc were detected in water samples collected in the wetlands above freshwater chronic surface water screening levels, and fluoride was consistently detected up to a maximum concentration of 8.7 mg/L in Wetland F, which exceeds the fluoride MCL of 4.0 mg/L. Low-level concentrations of PAHs have also been detected in wetland water. These findings are discussed in more detail in the Final RI Phase 1 Work Plan (Tetra Tech et al. 2015a) and a summary of the results is included in Volume 5, Appendix E-3.

3.2 WETLAND TRANSPORT PATHWAYS

Contaminants may have been transported to the wetlands through historical air emissions and windblown dust, through runoff and snowmelt caused by precipitation, and through groundwater discharge at springs and seeps.

Recharge associated with the identified wetlands comes primarily from springs and groundwater flow in the UA- and BAU-aquifer zones, along with snow melt and runoff. Surface/standing water is present at least seasonally in most of the wetlands although the overall area/volume of water is small. Year-round springs were found at Wetlands A, D, F, and K. The springs at Wetlands A and D are recharged from the UA-aquifer zone and the springs at Wetlands F and K are recharged from the BAU-aquifer zone.

In most cases, wetland-associated surface water infiltrates into the ground at locations that are a significant distance from the Columbia River. Conceptually, wetland surface water infiltrates into the ground a relatively short distance downstream of a given wetland and may migrate downward through surficial deposits and form a perched aquifer zone at topographic lows along the contact between surficial deposits and the basalt.

In some cases, surface water moves to a ravine as is the case with Wetland F, or unconsolidated slope debris and Missoula flood deposits as is the case with Wetland K. Water runoff or springs have not been observed at lower elevations near the Boat Basin in these two areas in the past several years since aluminum production ceased, which reduced the volume of water potentially released to the subsurface beneath the former production area, disposal area, settling ponds, and from other water use. Based on the findings of the water balance assessment (refer to Section 2.4), estimated evapotranspiration does not balance the amount of groundwater recharge to Wetlands F and K as estimated based on hydraulic conductivity, groundwater gradient, and aquifer zone geometry. This finding suggests that there is infiltration and potential for groundwater migration down slope within these drainages.

Alluvial terraces are present near the Boat Basin along the shoreline of the Columbia River and extending uphill from the mouths of gullies. These sedimentary deposits appear to represent Missoula Flood Deposits, based on the occurrence of granitic clasts and the high abundance of sand. These deposits are commonly 5- to 10-ft thick and up to a maximum of about 20-ft thick and are generally absent from the topographic bench where the main plant is situated. Due to the thin nature of the unconsolidated deposits and based on RI well drilling observations, it does not appear that this perched zone is well developed along the shoreline of the Columbia River. In these areas, infiltrating wetland water could locally infiltrate into the basalt and migrate to the lower BAL-aquifer zone. Migration to reservoir from the BAL aquifer zone appears localized given that the horizontal gradient is from the reservoir back to the aquifer for most of the year. The scenario of recharge to the lower BAL aquifer zone appears localized, given the thickness of the low permeability basalts (greater than 50 ft) between the BAU-aquifer zone and the BAL-aquifer zone (refer to Section 2 of this volume for further discussion of site hydrogeology).

3.3 FIELD INVESTIGATION AND ANALYTICAL PROGRAM SUMMARY

This section summarizes the initial RI field investigation and follow-on WPA field investigation activities performed. The main RI data need identified was the Wetlands AOC chemical data in soil sufficient to evaluate impacts from former smelter. The overall objective of the wetlands sampling program was to characterize the nature and extent of surface soil contamination in wetland-designated areas. In addition to historical smelter emissions, surface soil in the wetland's areas could also potentially have been impacted by runoff or groundwater discharges.

3.3.1 Initial RI Field Program

Soil sampling locations for the initial RI and WPA field programs are shown in Figure 3-1. The initial RI sampling program focused on the largest wetland feature (Wetland D) as well as the wetlands closest to the former production area, including potential flow pathways such as the intermittent drainage leading from Wetland F toward the Columbia River and the downstream portion of Wetland K. The soil samples were collected with a hand auger. A total of 21 surface soil samples were collected including field duplicates, consistent with the approved plan. Samples were analyzed for PAHs, total cyanide, fluoride, metals (Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, and Zn), and sulfate. Three samples (-SS02, -SS08, and -SS18) were analyzed for PCBs and TPH-Dx.

3.3.2 WPA Field Program

Ecology and Yakama Nation comments (Ecology and Yakama Nation 2019) on the Draft RI Report (Tetra Tech et al. 2019a) requested additional investigation for specific wetland areas including Wetlands D and K. Spring sampling and installation of temporary well points, if possible, downslope of Wetland K and near the Boat Basin were also included in the WPA based on these comments.

3.3.2.1 Wetland D WPA Field Investigation

Wetland D was initially characterized in the RI through collection of 8 surface soil samples. The highest concentrations of PAHs, arsenic, and sulfate were found in sample WLAOC-SS13 (Figure 3-1). As discussed in Section 3.4.2, there appears to be signs of historical soil disturbance/grading observed in the area of the Duck Pond in a 2005 aerial photograph.

Objectives of the Wetland D WPA characterization activities included the following:

- Further investigation of the extent of soil contamination, particularly in the area of the former Duck Pond that corresponds to the location of the soil sample with highest PAH and sulfate concentrations.
- Characterize spring water quality at Wetland D.
- Collection of 15 surface soil samples to evaluate the extent of soil contamination, particularly in the vicinity of the former Duck Pond.
- Collection of one spring sample as described in the Groundwater AOC field investigation.
- Estimation of spring discharge.

The analytical program for the Wetland D WPA soil investigation included total cyanide, fluoride, sulfate, PAHs, total and dissolved metals (Al, As, Cd, Cr, Cu, Hg, Pb, Ni, Se, and Zn), and diesel-range and oil-range petroleum hydrocarbons.

3.3.2.2 Wetland K WPA Field Investigation

Wetland K RI sample stations and WPA sample station locations are shown in Figure 3-1. The initial RI sampling program included collection of two channel soil samples and quarterly sampling of a spring found in Wetland K (Spring 01). Based on the initial RI results, additional investigation of Wetland K was included in the WPA.

WPA investigation objectives for Wetland K include the following:

- Further investigation of the extent of soil contamination in channel and non-channel areas.
- Characterize spring water contamination. Wetland K spring was sampled in three locations within Wetland K to determine the extent of water chemical exceedances within Wetland K.
- Characterize amount of spring discharge to help evaluate the hydrogeologic water balance in the stormwater pond and Wetland K vicinity.

The scope of the WPA field investigation for Wetland K included the following:

- Collection of 10 soil samples including 5 samples from channel areas and 5 samples from non-channel areas.
- Collection of three spring water samples with one sample collected from the Spring 01 location and two samples from the furthest downstream channel locations with flowing water.
- Attempted installation and sampling of one temporary hand-driven well point.
- Measurement of discharge rate in wetland channel segments.

The analytical program for the Wetland K soil investigation included total cyanide, fluoride, sulfate, PAHs, metals, and diesel-range and oil-range petroleum hydrocarbons. The Wetland K water samples were analyzed for the same parameters as soils but will also include both total and dissolved metals and free cyanide.

3.3.2.3 Wetland Seep and Spring Sampling

Springs in the Site vicinity in most cases are associated with wetlands, and in some areas of the Site are associated with faults that appear to represent preferential flow pathways as previously summarized in the Site hydrogeologic conceptual model summary (refer to Volume 1 and Section 2.0 of this volume). Sampling of two springs was included during the initial RI: Wetland K was sampled quarterly coincident and related to the site-wide groundwater sampling program, and the Area North of the East Surface Impoundment (NESI) wetland located in SWMU 31 was sampled during the RI because of the proximity of the spring/seep to buried smelter waste in this area. Refer to Volume 2, Section 31 for further discussion of waste distribution and soil concentrations in the vicinity of the NESI Spring. Based on Ecology and Yakama Nation Comments on the Draft RI Report and Draft WPA, additional seep/spring sampling was included as part of the WPA investigation activities. This sampling program includes sampling of the Wetland D and K springs as mentioned in Sections 3.3.2.1 and 3.3.2.2 as well as sampling of springs in other areas of the site.

Sampling of the springs was performed as to address the following objectives:

- Characterization of water contaminant concentration along suspected preferential flow paths.
- Characterization of the lateral extent of groundwater contamination.
- Verification that total petroleum hydrocarbon (TPH) concentrations are below screening levels in springs, wetland areas, and along flow paths. This was addressed through inclusion of diesel-range and oil-range petroleum hydrocarbons in the analytical program.
- Estimation of spring water discharges.

The five sampled springs are summarized as follows:

- **Wetland D Spring**. This spring appears to drain from the UA zone. A collection system was installed to supply water to a cattle trough at this location.
- **Wetland F Spring**. This spring is assumed to drain from the BAU_2 aquifer zone and appears to be perennial. It is present in the vicinity of the mapped fault that extends up the Western Intermittent Drainage from the Boat Basin.
- **Wetland K Spring (Spring 01).** This spring drains from the BAU_2 aquifer zone and was sampled concurrently with groundwater during each of the four RI groundwater sampling rounds. This spring and Wetland K are recharged by the stormwater pond based on the findings of the Draft RI Report (Tetra Tech et al. 2019a). Wetland K spring was also sampled in two additional locations within Wetland K to determine the extent of water chemical exceedances within Wetland K.
- **NESI Wetland Spring.** This seasonal spring is present during winter through spring and appears to be associated with groundwater discharges from the UA zone and/or BAU_1 zone. The spring is located adjacent to an area of buried smelter waste in the NESI subarea of SWMU 31.
- **Recently Discovered Spring.** This spring was found in the western portion of the Site during well installation activities at RI-MW20-BAL. This spring appears to drain from the BAU_1 zone.

The source of the springs identified in the text is based on hydro-stratigraphy, the occurrence of faults, topography, spring and groundwater water-level elevations, and chemical results as summarized in the Draft RI Report. Groundwater geochemistry data was collected from Wetland K spring and all well locations during the baseline (Q1) groundwater sampling round. However, a clear geochemical pattern was not discerned for each aquifer zone based on the collected geochemical data. Except for the NESI seasonal wetland spring, the springs appear to be perennial.

Spring samples collected during the WPA were analyzed for total cyanide, free cyanide, fluoride, sulfate, PAHs, total and dissolved metals (Al, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, and Zn) and diesel-range and oil-range petroleum hydrocarbons.

3.4 INVESTIGATION RESULTS

This section summarizes the results of the investigation including field observations, historical aerial photograph review, and chemical results. The Wetlands AOC RI soil investigation was completed in May 2016 and the WPA wetland investigation was completed in spring 2021. RI and WPA laboratory reports are provided in Volume 5, Appendix H-1 and H-3, respectively; and RI and WPA data validation reports are provided in Volume 5, Appendix I-1 and I-3. Completed field sampling forms for the Wetlands AOC are included in Volume 5, Appendix E-1 and E-2.

3.4.1 RI and WPA Field Observations and Review of Historical Photographs

This section summarizes observations made of the various wetland areas during the RI and WPA as well as the results of historical aerial photograph review for the wetlands areas. Historical aerial photographs were obtained and reviewed to evaluate the occurrence and distribution of wetlands at the site. Historical aerial photographs are included as Volume 5, Appendix E-4. The review of aerial photographs included the following years: 1967, 1972, 1978, 1979, 1989, 1992, 1995, 2006, and 2009. Photographs for the years 1967, 1972, 1979, 1989, and 2006 are included in Volume 5, Appendix E-4. In addition, historical aerial photographs of the Duck Pond for 1996, 2002, 2003, and 2005 from the PGG (2013a) wetland survey are also included in Volume 5, Appendix E-4. Based on a review of historical aerial photos, the 13 wetlands and the SWMU 31 wetland were primarily formed during the period of plant construction (around 1970) and historical plant operations, and do not represent pre-existing wetland features.

With the exception of the NESI wetland, no aluminum smelter-related wastes were observed in these wetlands. RI field observations and sampling locations are summarized as follows:

- **Wetland A:** Based on RI field observations, the spring appears to draw groundwater from the colluvium on the hillside (part of the UA aquifer zone) (refer to Volume 3, Section 2 cross-sections and Parametrix 2004c) cross-sections. This wetland area was not sampled during the RI because of its location upgradient and upslope of plant operational areas and small size.

- **Wetlands B and H:** Water was not observed in either wetland at the time of RI sampling (May 2016), and two soil samples (-SS10 and -SS11) were collected during the RI at Wetland H.

- **Wetland C:** This wetland area was not sampled due to its small size, limited functions, and proximity to Wetland D. During the May 2016 site reconnaissance, standing water was not observed in Wetland C.

- **Wetland D:** An apparent man-made drainage modification was observed during the RI wetlands sampling event near the spring area of the Wetland D. It appears that a subsurface drainage system has been installed to collect shallow groundwater. The collected groundwater drains by gravity to a series of two above-ground cattle troughs (located east and west of the road culvert). Water from the second trough then drains back into an underground drainage system. At the time of sampling in April 2015 and May 2021, there was no standing water observed at Wetland D.

  Wetland D was observed to be characterized by several non-native species including Russian olives, dog rose, cheat grass, alfalfa, and Himalayan blackberry. Soils at Wetland D consisted primarily of brown dry silt with some fine sand.

  Based on additional review of historical aerial photographs, pond(s) and/or vegetation suggestive of wetlands were not present in the area of the Duck Pond or the rest of the Wetland D area prior to 1972 (refer to Volume 5, Appendix E-4). A depression that may have been a borrow pit was present in the area of the Duck Pond during 1967. Based on review of historical aerial photographs, the Duck Pond has been dry since around 2003. In a 2005 aerial photograph, there appears to be signs of soil disturbance/grading in the area of the Duck Pond. The period in which there was visible standing water in the Duck Pond (1980s-2002) generally overlaps with the period of operation of the WSI (1981-2005).

  Eight surface soil samples (-SS12 through -SS19) were collected at Wetland D during RI activities in May 2016, and 19 surface soil samples were collected from Wetland D during WPA activities during December 2020.

- **Wetland E:** An RI soil sample was collected at Wetland E (-SS09). Russian olives and grasses were the primary vegetation observed in this area. No standing water was observed at the time of sampling.

- **Wetland F:** A year-round spring is present south of the plant parking entrance road. Water from the spring flows in an established channel through Wetland F, but infiltrates into the ground before reaching the culvert beneath the John Day Dam Road. Based on hydrogeologic investigation (refer to Section 2 of this report), it appears that the spring is recharged by BAU-zone groundwater.

  No surface water has been observed in the ravine downstream of John Day Dam Road and Wetland F during the period of the RI and WPA field investigation (2015-2021).

  An RI soil sample was collected at Wetland F (-SS08) from within the spring channel area. The Wetland F spring was sampled as part of WPA sampling activities during April 2021.

- **Wetlands G, J, I, L, and M:** Based on RI field observations, these wetlands appear receive water from direct precipitation and runoff. All of these wetlands represent small shallow swales within the basalt “scabland” topography. These wetlands were all dry at the time of sampling. Soil samples were collected at all of these small wetlands during the RI investigation [-SS07 (Wetland G), -SS03 (Wetland J), -SS04 (Wetland I), -SS06 (Wetland L), and -SS05 (Wetland M)].

- **Wetland K:** A year-round spring is present south of John Day Dam Road. This spring was observed during the RI to flow through Wetland K in two shallow and moderately well-developed channels (runnels) that are termed the eastern intermittent drainage to the Boat Basin (as referred to in historical reports). During the RI, two samples were collected within the westernmost channel (-SS01 was collected from an area of tall grasses and horse tails downstream of the lowermost Russian Olive in Wetland K; -SS02 was collected at the same location as the surface water sampling station at Spring 01). The collected RI soil samples in Wetland K consisted of dark-brown to black, lean clay with some silt and gravel. Ten soil samples were collected from with Wetland K during the WPA.

  The water flow currently infiltrates into the ground at the lower end of the wetland and did not appear to reach the Columbia River at the Boat Basin during the period of the RI field investigation of Fall 2015 through Fall 2017 and the WPA field investigation Fall 2020 through Spring 2021. Wetland K is recharged by groundwater in the BAU-aquifer zone (refer to Section 2 of this Volume for further discussion). In this area of the site, the BAU zone appears to be recharged by the stormwater pond.

  Based on a review of historical aerial photos, a wetland was not present in this area until about 1972-1978, after construction of the plant and the stormwater pond (refer to Volume 5, Appendix E-4).

- **Wetland Near Former Cliffs Community:** During the RI well installation activities in November 2016, an additional wetland and spring was found southwest of the site on the north side of the railway line and south of well RI-MW20-BAL (Figure 3-1). This wetland was not sampled or characterized as part of the RI and WPA field investigations because of its distance (about 0.75-miles) southwest from the WSI. This wetland is also an example of similar available habitats in the general site vicinity.

  The spring was sampled as part of WPA sampling activities during April 2021.

- **NESI Wetland:** A seasonal spring and associated wetland was found in the NESI area of SWMU 31 during pre-RI planning process (Tetra Tech et al. 2015a,b). Buried smelter wastes were found in proximity to the seasonal spring during the initial RI field investigation and the spring was included for sampling during the initial RI and the WPA.

3.4.2 Soil Sample Results Summary

This section summarizes the analytical results for soil samples collected during the initial RI and WPA field mobilizations. Wetland K is in an area zoned as open space and is on land owned by USACE. Accordingly, soil/sediment samples in this area have been compared against MTCA Method B, MTCA Method A Unrestricted Land Use (TPH only), MTCA-derived soil screening levels for protection of groundwater, and terrestrial ecological screening for protection of plants, soil biota, and wildlife. All of the other wetland areas are in industrial zoned areas owned by NSC Smelter LLC. For industrial areas of the site, MTCA Method C screening levels, MTCA Method A Industrial (TPH only), MTCA-derived soil screening levels for protection of groundwater, and terrestrial ecological screening levels for protection of wildlife were used in results comparisons.

3.4.2.1 Wetland D Soil Results

Table 3-1 summarizes the RI and WPA results for Wetland D. Figure 3-2 shows the sampling locations and sample exceedances. Results for Wetland D are summarized as follows:

- PAH (maximum of 22.83 mg/kg) exceed the PAH soil screening level for protection of wildlife of 1.1 mg/kg measured as total HMW PAH in 8 of 28 samples. All of the elevated PAH concentrations are within the footprint of the former Duck Pond.

- Sulfate (maximum of 26,200 mg/kg) was detected above the derived soil screening level for protection of groundwater of 2,150 mg/kg in two stations (WLAOC-SS12 and WLAOC-WPA-WTLD-SS-7). Both of these locations are within the footprint of the historical Duck Pond.

Table 3-1
Wetlands AOC - Wetland D RI and WPA Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016 and Winter 2020
(Page 1 of 2)

Parameter Name	Units	MTCA Method A Industrial	MTCA Method C	Ecological Indicator Eco-SSL Wildlife	Protection of Groundwater[a]	Selected Screening Level	Natural Background	Analytical Results WLAOC-SS12 5/4/2016	WLAOC-SS13 5/4/2016	WLAOC-SS14 5/4/2016	WLAOC-SS15 5/4/2016	WLAOC-SS16 5/4/2016	WLAOC-SS17 5/4/2016	WLAOC-SS18 5/4/2016	WLAOC-SS40 (Duplicate of WLAOC-SS18) 5/4/2016	WLAOC-SS19 5/4/2016	WLAOC-WPA-WTLD-SS-1 12/9/2020	WLAOC-WPA-WTLD-SS-2 12/9/2020	WLAOC-WPA-WTLD-SS-3 12/9/2020	WLAOC-WPA-WTLD-SS-57 Duplicate of WLAOC-WPA-WTLD-SS-3) 12/9/2020	WLAOC-WPA-WTLD-SS-4 12/9/2020	WLAOC-WPA-WTLD-SS-5 12/9/2020
Aluminum Smelter																						
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	2.2 UJ	1.9 UJ	2.1 UJ	1.8 UJ	1.9 UJ	2 UJ	2 UJ	2.2 UJ	**5.4 J**	0.09 J	0.12 J	0.21 J	0.62 J	0.12 J	0.82
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	5.5 J	2.8 J	3.5 J	4.8 J	2.4 J	5.6 J	0.33 U	0.69 J	2.3 J	3.7 J	1.1 J	2.7 J	1.9 J	1.5 J	5.2 J
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	**7,700 J**	58 J	11 B	7.8 B	7.3 B	12 B	420 J	380 J	78 J	16.6	1.1 J	28.2 J	34.8 J	1.8 J	37.8
Polycyclic Aromatic Hydrocarbons (PAHs)																						
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	0.028 J	0.0006 U	0.0006 U	0.00054 U	0.0019 J	0.001 J	0.00068 U	0.0023 J	0.0058 U	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.042 J	0.00094 J	0.00043 U	0.00038 U	0.002 J	0.0011 J	0.00049 U	0.0026 J	0.0041 U	0.00099 J	0.0004 U	0.0004 U	0.00069 J	0.00054 J	0.001 J
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.32	0.0067	0.0016 J	0.0024 J	0.0057	0.0055	0.0029 J	0.0048 J	0.0055 U	0.0077	0.00047 J	0.00033 U	0.0015 J	0.00033 U	0.0047 J
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.0057 U	0.00048 U	0.00048 U	0.00043 U	0.00044 U	0.00051 U	0.00054 U	0.00057 U	0.0046 U	0.00032 U	0.00031 U	0.00031 U	0.00031 U	0.00031 U	0.00066 J
Anthracene	mg/Kg	NA	NE	NL	2,300	2300	NE	0.25	0.0049	0.0012 J	0.0011 J	0.0045	0.0028 J	0.0045 J	0.0078	0.0055 U	0.0085	0.00073 J	0.00077 J	0.0017 J	0.00066 J	0.0051 J
Benz[a]anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	2.4	0.077	0.014	0.019	0.075	0.035	0.05	0.072	0.03 J	0.055	0.0068	0.015 J	0.03 J	0.0097	0.12
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	2.7	0.078	0.016	0.024	0.1	0.044	0.056	0.079	0.037 J	0.086	0.012	0.021 J	0.055 J	0.016	0.2
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	4.4	0.12	0.031	0.041	0.18	0.062	0.11	0.14	0.069	0.11	0.019	0.038 J	0.096 J	0.032	0.53
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	2.2	0.071	0.014	0.021	0.1	0.03	0.063	0.075	0.036 J	0.061	0.012	0.019 J	0.053 J	0.017	0.26
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	1.2	0.034	0.0084	0.013	0.059	0.02	0.033	0.042	0.027 J	0.037	0.0057	0.013 J	0.03 J	0.0091	0.15
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	3.4	0.095	0.02	0.028	0.13	0.047	0.12	0.11	0.054	0.07	0.013	0.023 J	0.059 J	0.019	0.21
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.43	0.013	0.0025 J	0.0037 J	0.025 J	0.0054	0.0099	0.013	0.0066 U	0.015	0.0026 J	0.0046 J	0.013 J	0.0039 J	0.069
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	4.2	0.11	0.027	0.031	0.12	0.066	0.091	0.12	0.061	0.087	0.012	0.023 J	0.046 J	0.015	0.13
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.16	0.0031 J	0.00048 U	0.00043 U	0.0034 J	0.00051 U	0.004 J	0.0063	0.0046 U	0.0041 J	0.00062 U	0.00062 U	0.001 J	0.00063 U	0.0025 J
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	2.6	0.076	0.016	0.026	0.1	0.038	0.066	0.083	0.039 J	0.068	0.012	0.02 J	0.057 J	0.017	0.27
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.068	0.0017 J	0.00076 U	0.00068 U	0.0042 J	0.0017 J	0.0033 J	0.0082	0.0073 U	0.0029 J	0.00063 J	0.00075 J	0.0016 J	0.0015 J	0.0022 J
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	1.6	0.039	0.0095	0.0099	0.038	0.025	0.027 J	0.054 J	0.019 J	0.041	0.0044 J	0.0069 J	0.014 J	0.0046 J	0.035
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	3.5	0.098	0.02	0.028	0.1	0.054	0.077	0.1	0.053	0.075	0.011	0.017 J	0.04 J	0.013	0.097
Dibenzofuran	mg/Kg	NA	NL	NL	NL	NL	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0021 J	0.00065 U	0.00065 U	0.0011 J	0.00066 U	0.0019 J
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	3.837	0.11095	0.02339	0.03455	0.1452	0.06051	0.08409	0.1151	0.05437	0.1152	0.01674	0.03029	0.07819	0.02336	0.316
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	6.668	0.16634	0.0393	0.0444	0.1797	0.1031	0.1327	0.206	0.08	0.15219	0.01823	0.03142	0.06649	0.0223	0.18116
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**22.83**	0.662	0.1419	0.2037	0.869	0.3354	0.5849	0.714	0.345	0.577	0.0941	0.1706	0.433	0.1367	**1.906**
Polychlorinated Biphenyls (PCBs)																						
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	NA	NA	NA	NA	NA	NA	0.0078 U	0.0079 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0044 U	0.0045 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0052 U	0.0052 U	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0017 UJ	0.0017 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.0031 UJ	0.0031 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	0.71	NE	NA	NA	NA	NA	NA	NA	0.0016 UJ	0.0016 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	NA	NA	NA	NA	NA	NA	0.002 UJ	0.002 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.00053 UJ	0.00053 UJ	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	0.00095 UJ	0.00096 UJ	NA	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	10	66	0.65	NE	0.65	NE	NA	NA	NA	NA	NA	NA	0.00053 U	0.00053 U	NA	NA	NA	NA	NA	NA	NA
Metals																						
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	5,900	5,200	6,200	6,300	5,400	6,200	6,300	5,400	5,900	6,660	6,080	5,540	5,700	6,070	7,030
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	**16**	1.9	2	2.7	3	3.8	2.3	2.8	4.4	5.16	3.12	2.67	2.63	3.23	5.29
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	0.13	0.081 J	0.092 J	0.11	0.12	0.11	0.11	0.1	0.16	0.108	0.105	0.078	0.092	0.088	0.124
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	15 J	9.7 J	11 J	10 J	8.8 J	9.8 J	10 J	9.1 J	9.5 J	9.85	9.54	8.5	9.38	9.41	15.8
Copper	mg/Kg	NA	140,000	217	280	217	28.4	22	7.4	8.3	8.7	9.2	11	11	10	9.9	9.64	8.85	8.78	9.36	8.63	16.6
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	9.9	3.2	4.2	4.5	5.4	6.3	6.5 J	4.8 J	5.8	6.57	5.28	3.53	3.78	5.24	7.86
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.049	0.0054 U	0.006 U	0.0055 U	0.0062 U	0.0093 J	0.0068 U	0.0064 U	0.007 J	0.006 J	0.006 J	0.005 J	0.008 J	0.009 J	0.015 J
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	13	8	9.2	11	9.3	9.6	10	9.3	9	10.9	9.64	8.98	9.15	9.22	11.4
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**3**	**0.56**	**0.77**	**0.69**	**0.63**	**0.82**	**1.1**	**1.3**	**0.91**	0.1 J	0.1 J	0.09 U	0.1 U	0.1 U	**0.6 J**
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	81	30	35	35	36	38	40	37	110	47	39.4	34.5	37.3	38.3	62.4
Total Petroleum Hydrocarbons (TPHs)																						
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	NA	60	69	NA	42	83	9.2 J	21 J	41	33 J
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	NA	220	260	NA	98 J	130	28 J	68 J	81 J	240

Notes:
Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.
b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.
c Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volume 1 for discussion).
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenyls
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration

Table 3-1
Wetlands AOC - Wetland D RI and WPA Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016 and Winter 2020
(Page 2 of 2)

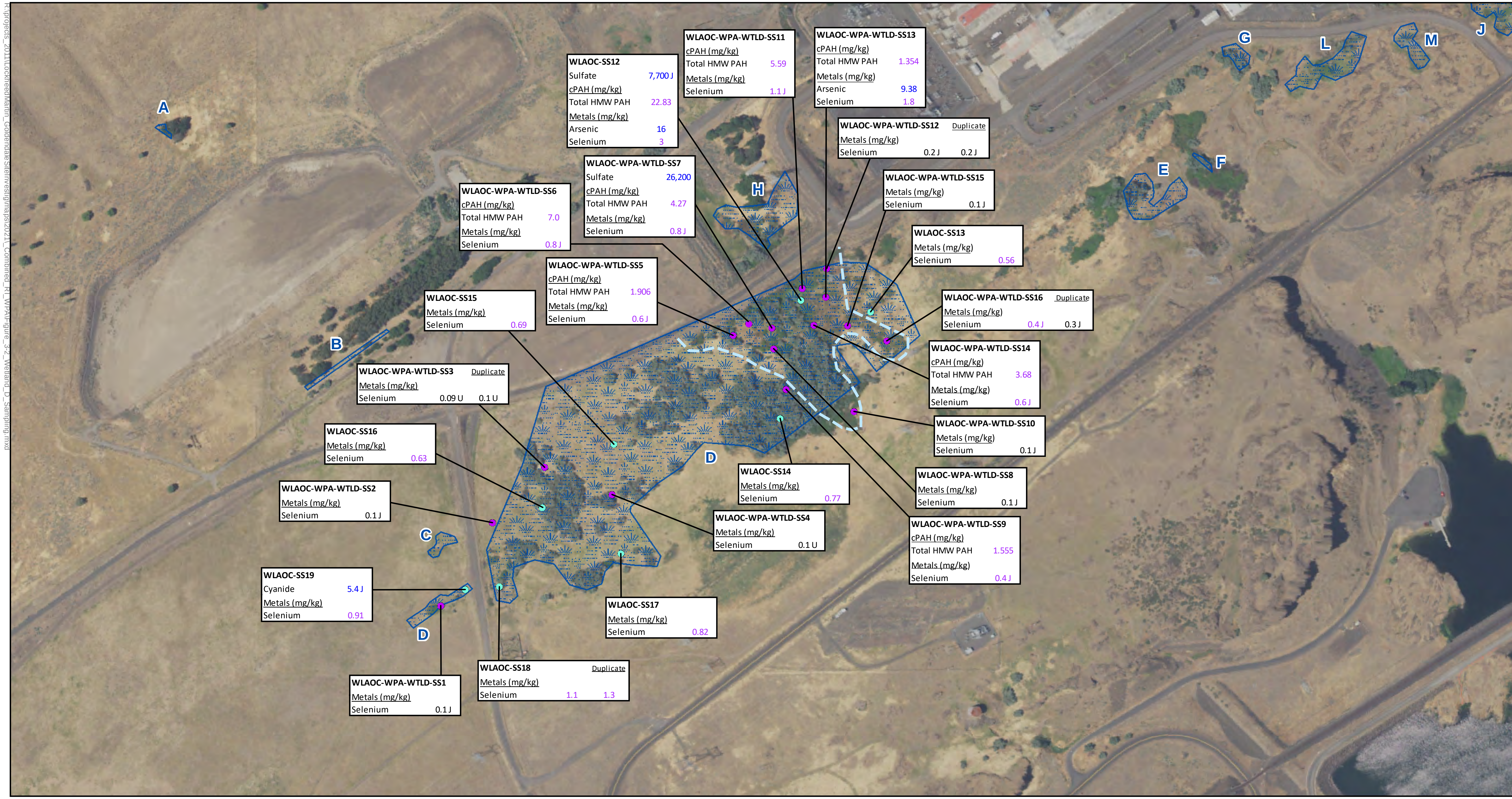
				Ecological Indicator				Analytical Results												
Parameter Name	Units	MTCA Method A Industrial	MTCA Method C	Eco-SSL Wildlife	Protection of Groundwater[a]	Selected Screening Level	Natural Background	WLAOC-WPA-WTLD-SS-6 12/9/2020	WLAOC-WPA-WTLD-SS-7 12/9/2020	WLAOC-WPA-WTLD-SS-8 12/9/2020	WLAOC-WPA-WTLD-SS-9 12/9/2020	WLAOC-WPA-WTLD-SS-10 12/10/2020	WLAOC-WPA-WTLD-SS-11 12/10/2020	WLAOC-WPA-WTLD-SS-12 12/10/2020	WLAOC-WPA-WTLD-SS-58 (Duplicate of WLAOC-WPA-WTLD-SS-12) 12/10/2020	WLAOC-WPA-WTLD-SS-13 12/10/2020	WLAOC-WPA-WTLD-SS-14 12/10/2020	WLAOC-WPA-WTLD-SS-15 12/10/2020	WLAOC-WPA-WTLD-SS-16 12/10/2020	WLAOC-WPA-WTLD-SS-59 (Duplicate of WLAOC-WPA-WTLD-SS-16) 12/10/2020
Aluminum Smelter																				
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	0.24	0.22 J	0.07 U	0.5	0.17 J	0.71	0.2 J	0.2 J	0.17 J	0.3	0.07 U	0.28 J	0.47 J
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	3.8 J	8.8	5.3	3.5 J	2.3 J	0.6 U	2.8 J	1.4 J	3 U	3.1 J	1.6 J	2.6 J	2.1 J
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	70.1	**26,200**	53.1	19.9	4.4	139	1.2 J	1.3 J	662	48.1	1.1 U	38.6 J	24.8 J
Polycyclic Aromatic Hydrocarbons (PAHs)																				
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.0071	0.0066 J	0.00079 J	0.0017 J	0.001 J	0.0077	0.00052 J	0.00067 J	0.00062 J	0.0026 J	0.0018 J	0.00043 J	0.00091 J
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.071	0.054	0.0024 J	0.013	0.0036 J	0.059	0.0017 J	0.0026 J	0.0067	0.029 J	0.0064	0.0015 J	0.00066 J
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.0014 J	0.00081 J	0.00032 U	0.00037 J	0.00042 J	0.0021 J	0.00032 U	0.00031 U	0.00043 J	0.0011 J	0.00032 U	0.00032 U	0.00035 U
Anthracene	mg/Kg	NA	NE	NL	2,300	2300	NE	0.055	0.046	0.0024 J	0.012	0.0034 J	0.056	0.002 J	0.0031 J	0.008	0.026 J	0.006	0.001 J	0.00054 J
Benz[a]anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.73	0.44	0.025	0.13	0.046	0.57	0.023 J	0.044 J	0.12	0.36 J	0.058	0.019 J	0.012 J
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	0.94	0.57	0.032	0.22	0.062	0.71	0.036 J	0.074 J	0.18	0.48 J	0.083	0.027	0.021
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	1.4	0.84	0.05	0.32	0.098	1.1	0.065 J	0.13 J	0.29	0.75 J	0.12	0.052	0.045
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.69	0.41	0.027	0.19	0.057	0.55	0.036 J	0.071 J	0.16	0.39 J	0.066	0.028	0.025
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	0.49	0.28	0.016	0.1	0.033	0.38	0.02 J	0.04 J	0.094	0.23	0.04	0.016	0.012
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	0.96	0.6	0.035	0.19	0.067	0.8	0.038 J	0.068 J	0.17	0.51	0.1	0.032	0.025
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.19	0.11	0.0071	0.045	0.014	0.15	0.0091 J	0.018 J	0.04	0.1	0.017	0.0071	0.0058 J
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	1.1	0.7	0.044	0.2	0.075	0.92	0.036 J	0.063 J	0.18	0.55	0.091	0.026 J	0.015 J
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.03	0.029	0.002 J	0.0072	0.0027 J	0.036	0.00099 J	0.0014 J	0.0034 J	0.014	0.0039 J	0.0007 J	0.00072 J
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	0.73	0.44	0.027	0.19	0.058	0.59	0.036 J	0.073 J	0.16	0.4	0.071	0.026	0.025
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.0081	0.01	0.0013 J	0.0032 J	0.0014 J	0.011	0.0011 J	0.0013 J	0.0016 J	0.0038 J	0.0042 J	0.0011 J	0.0018 J
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	0.41	0.29	0.019	0.082	0.03	0.36	0.012 J	0.02 J	0.051 J	0.18	0.039	0.0083	0.0064
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	0.88	0.58	0.033	0.17	0.059	0.74	0.031 J	0.054 J	0.14 J	0.46	0.076	0.023 J	0.013 J
Dibenzofuran	mg/Kg	NA	NL	NL	NL	NL	NE	0.014	0.015	0.0014 J	0.0041 J	0.0017 J	0.019	0.00072 J	0.00087 J	0.0014 J	0.0061 J	0.0021 J	0.00067 U	0.00092 J
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	1.3036	0.787	0.04486	0.3004	0.08757	0.997	0.05169	0.10518	0.2521	0.6691	0.1146	0.03933	0.03123
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	1.6826	1.13641	0.07189	0.31947	0.11752	1.4518	0.05431	0.09207	0.25175	0.8065	0.1523	0.03903	0.02603
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**7.01**	**4.27**	0.2521	**1.555**	0.494	**5.59**	0.2941	0.572	**1.354**	**3.68**	0.631	0.2301	0.1838
Polychlorinated Biphenyls (PCBs)																				
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	0.71	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	10	66	0.65	NE	0.65	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals																				
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	7,130	7,360	5,160	5,030	5,710	5,980	5,880	5,640	4,810	6,260	4,630	6,320	6,320
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	7.02	6.9	1.77	2.12	2.19	6.64	1.98	2.18	**9.38**	5.58	1.39	3.52	2.94
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	0.084	0.067	0.051	0.102	0.08	0.191	0.127	0.154	0.097	0.102	0.053	0.092	0.077
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	15.3	16.6	8.51	7.49	8.94	12.5	10.5	9.95	11	13.4	8.6	12.4	11.7
Copper	mg/Kg	NA	140,000	217	280	217	28.4	15.6	18	6.93	9.42	8.36	14.8	9.19	8.95	12.3	14.4	5.26	10.5	10.1
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	8.11	7.86	2.8	3.22	3.67	6.95	4.31	4.95	6.45	7.73	2.5	5.7	4.64
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.021 J	0.017 J	0.005 J	0.016 J	0.007 J	0.027	0.01 J	0.011 J	0.02 J	0.02 J	0.013 J	0.02 J	0.014 J
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	10.3	10.4	7.09	7.76	8.33	10.1	8.92	8.57	8.23	8.82	6.32	8.8	8.82
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**0.8 J**	**0.8 J**	0.1 J	**0.4 J**	0.1 J	**1.1 J**	0.2 J	0.2 J	**1.8**	**0.6 J**	0.1 J	**0.4 J**	0.3 J
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	68.9	104	37.7	38.7	32.6	83.9	83.5	97.5	33.4	63.7	28	43.1	41
Total Petroleum Hydrocarbons (TPHs)																				
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	33	41	6.7 J	43	19 J	59	7.1 J	11 J	27 J	43	6.7 J	7.3 J	8.4 J
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	160	220	27 J	230	47 J	370	43 J	64 J	160	240	35 J	34 J	42 J

Notes:

Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.
b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically r
c Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volum
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-cont
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenyls
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration



Legend

- RI Surface Soil Sample Location
- WPA Soil Sample Location
- Spring
- Former "Duck Pond" Area
- A Wetland Area Name

purple: Exceeds Terrestrial Ecological Soil Screening Level
blue: Exceeds MTCA Soil Screening Level for Protection of Groundwater
black: Below Screening Levels

cPAH - Polycyclic Aromatic Hydrocarbon
HMW - High Molecular Weight
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)

N W E S

0 125 250 500
Feet

Figure 3-2
Wetland D
Soil Sample Locations and
Results Above Screening Levels

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

- Total cyanide was detected in WLAOC-SS19 collected from the westernmost spring area of Wetland D. The detected concentrations of total cyanide (5.4 J mg/kg) exceeded the soil screening level for protection of groundwater for free cyanide of 1.9 mg/kg that is based on the MTCA Method B formula value for groundwater of 9.6 µg/L, but well below the MCL-based soil screening level for protection of groundwater of 40.4 mg/kg. Total cyanide soil screening levels for protection of groundwater were derived using the fixed parameter three-phase partitioning model was used in conjunction with literature distribution coefficient (Kd) values as input values (refer to Appendix A-5 for further details). Also, all of the MTCA screening levels for cyanide are based on free cyanide whereas total cyanide analyses include various metal-complexed cyanides where the CN-anion is not available; therefore, use of total cyanide concentrations for screening comparison purposes is quite conservative.

- Selenium (maximum of 3 mg/kg) exceeded the terrestrial ecological soil screening level for protection of wildlife of 0.3 mg/kg and background concentrations in 17 of 28 samples.

- Arsenic (maximum of 16 mg/kg) exceeded the MTCA-derived soil screening level for protection of groundwater of 2.9 mg/kg and background concentrations in two samples (WLAOC-SS12 and WLAOC-WPA-WTLD-SS13). Both sample stations are within the former Duck Pond area.

- Fluoride was not detected above soil screening levels for protection of groundwater of 147.6 in any of the collected samples.

- PCBs were not detected in the two analyzed samples.

- Diesel-range organics and residual-range organics did not exceed screening levels in the 21 samples analyzed.

3.4.2.2 Wetland K Soil Results

Soil samples were collected both from within the two small drainage channels as well as intervening areas of the Wetland.

Table 3-2 and Figure 3-3 summarize the results for the initial RI and the April 2021 WPA soil sample results for Wetland K. Results are summarized as follows:

- PAHs (maximum of 20.2 mg/kg as total HMW PAH) exceed the terrestrial ecologic soil screening level for protection of wildlife for total HMW PAHs of 1.1 mg/kg at 12 of 14 stations. cPAHs (maximum of 3.643 mg/kg as TTEC PAH) also exceed the MTCA Method B TTEC cPAH of 0.19 mg/kg.

- Sulfate (maximum of 4,870 mg/kg) exceeded the soil screening level for protection of groundwater in one of the samples (WLAOC-WPA-WTLK-SS-9).

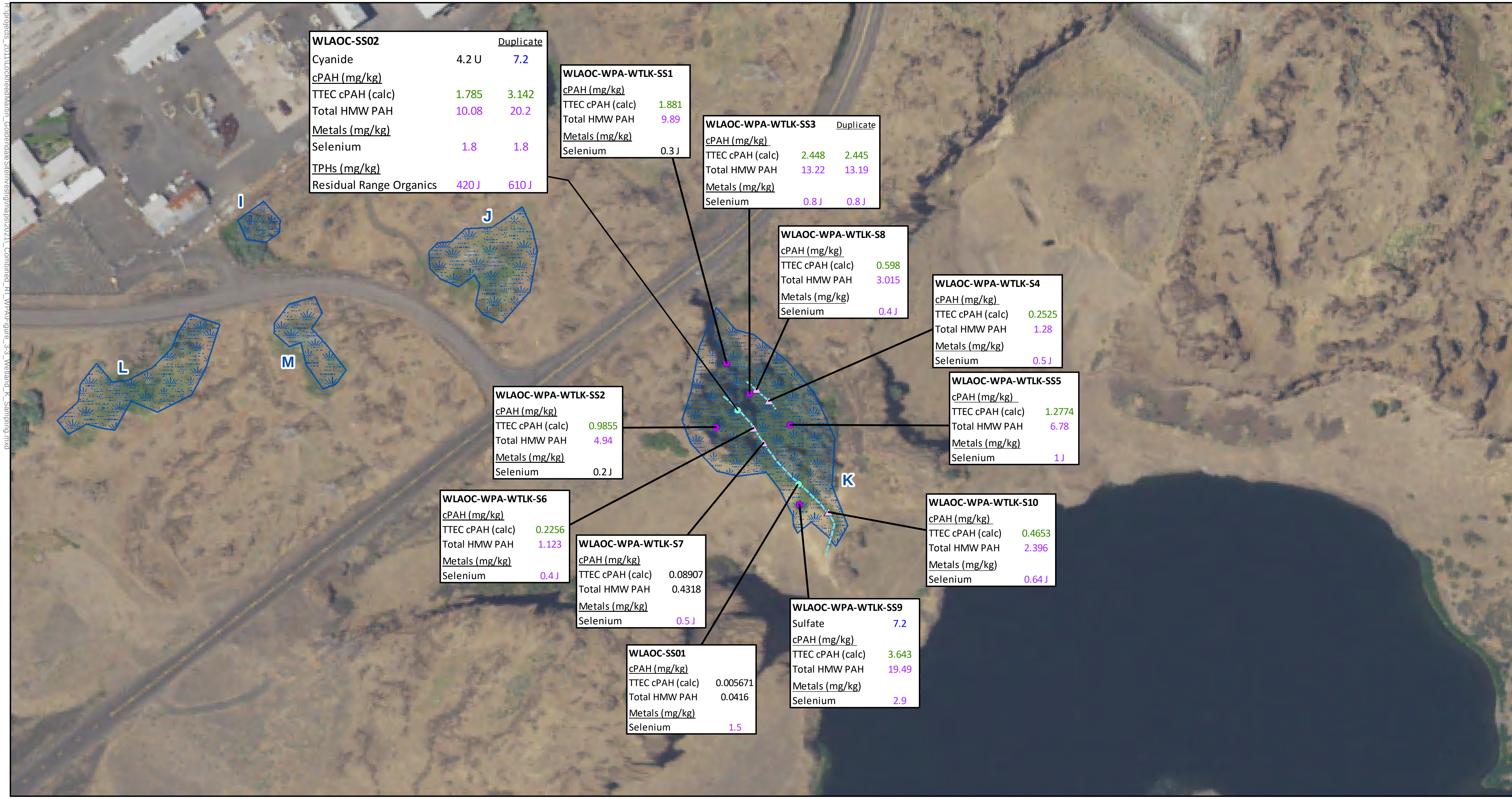
Table 3-2
Wetlands AOC - Wetland K - RI and WPA Soil Results Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016 and Spring 2021

				Ecological Indicator						Analytical Results													
Parameter Name	Units	MTCA Method A Unrestricted Land Use	MTCA Method B	Eco-SSL Plants	Eco-SSL Soil Biota	Eco-SSL Wildlife	Protection of Groundwater Vadose Zone[a]	Selected Screening Level	Natural Background	WLAOC-SS01 5/5/2016	WLAOC-SS02 5/5/2016	WLAOC-SS41 (Duplicate of WLAOC-SS02) 5/5/2016	WLAOC-WPA-WTLK-SS-1 3/30/2021	WLAOC-WPA-WTLK-SS-2 3/30/2021	WLAOC-WPA-WTLK-SS-3 3/30/2021	WLAOC-WPA-WTLK-SS-61 (Duplicate of WLAOC-WPA-WTLK-SS-3) 3/30/2021	WLAOC-WPA-WTLK-S-4 3/30/2021	WLAOC-WPA-WTLK-SS-5 3/30/2021	WLAOC-WPA-WTLK-S-6 3/30/2021	WLAOC-WPA-WTLK-S-7 3/30/2021	WLAOC-WPA-WTLK-S-8 4/1/2021	WLAOC-WPA-WTLK-SS-9 3/30/2021	WLAOC-WPA-WTLK-S-10 3/30/2021
Aluminum Smelter																							
Cyanide[b]	mg/Kg	NA	50	NE	NE	5.0	1.9	1.9	NE	2.7 U	4.2 U	**7.2**	0.18 J	0.25	0.19 J	0.13 J	0.09 U	0.14 J	0.11 U	0.1 U	0.09 U	0.5	0.1 U
Fluoride	mg/Kg	NA	4,800	NE	NE	NE	147.6[c]	147.6	14.11	66	120	120	17.5	2.2 J	42.6	50.1	6.8	27.7	10.2	43.5	7.3	36.8	25
Sulfate	mg/Kg	NA	NE	NE	NE	NE	2,150[c]	2,150	NE	48	490	480	16.8	1.5 B	29.2 J	21.5 J	14.5	68	25.4	24.5	15.8	**4,870**	12.4
Polycyclic Aromatic Hydrocarbons (PAHs)																							
1-Methylnaphthalene	mg/Kg	NL	34	NE	NL	NL	0.082	0.082	NE	0.00092 U	0.011 J	0.029 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	mg/Kg	NL	320	NE	NL	NL	1.7	1.7	NE	0.00065 U	0.016 J	0.035 J	0.013 J	0.0035 J	0.016 J	0.016 J	0.0018 J	0.01 J	0.0015 J	0.00098 J	0.0048 J	0.032 J	0.0033 J
Acenaphthene	mg/Kg	NA	4,800	NL	NL	NL	98	98	NE	0.00087 U	0.12	0.18	0.098	0.033	0.13	0.13	0.011	0.07	0.0099	0.0041 J	0.033	0.27	0.022
Acenaphthylene	mg/Kg	NA	NE	NE	NL	NL	NE	NL	NE	0.00073 U	0.00096 U	0.016	0.0011 J	0.0006 J	0.0015 J	0.0016 J	0.00039 U	0.0029 J	0.00049 U	0.00048 U	0.00068 J	0.0047 J	0.0038 J
Anthracene	mg/Kg	NA	NE	NE	NL	NL	2,300	2,300	NE	0.0016 J	0.13 J	0.28 J	0.11	0.033	0.14	0.15	0.013	0.068	0.01	0.0056 J	0.029	0.22	0.025
Benzo(a)anthracene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.0046 J	1.1 J	1.7 J	0.95	0.42	1.3	1.3	0.11	0.66	0.1	0.04	0.27	2	0.22
Benzo(a)pyrene	mg/Kg	0.1	NL	NE	NL	NL	NL	NL	NE	0.004 J	1.3 J	2 J	1.4	0.74	1.8	1.8	0.19	0.95	0.17	0.068	0.45	2.7	0.35
Benzo(b)fluoranthene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.0053 J	1.7 J	3.8 J	1.8	0.95	2.4	2.4	0.25	1.2	0.21	0.079	0.57	3.5	0.45
Benzo(ghi)perylene	mg/Kg	NA	NE	NE	NL	NL	NE	NL	NE	0.0029 J	0.97 J	1.5 J	1	0.57	1.4	1.4	0.14	0.7	0.12	0.046	0.33	2	0.25
Benzo(k)fluoranthene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.0021 J	0.64 J	3.4 J	0.6	0.31	0.8	0.76	0.078	0.41	0.074	0.029	0.19	1.1	0.14
Chrysene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.0061 J	1.4 J	2.2 J	1.2	0.55	1.6	1.6	0.15	0.84	0.13	0.049	0.35	2.4	0.27
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.001 U	0.17 J	0.4 J	0.24	0.13	0.32	0.33	0.032	0.17	0.029	0.0098	0.075	0.49	0.056
Fluoranthene	mg/Kg	NA	3,200	NE	NL	NL	630	630	NE	0.011	1.9 J	3.5 J	1.2	0.53	1.6	1.6	0.15	0.83	0.14	0.062	0.36	2.4	0.31
Fluorene	mg/Kg	NA	3,200	NE	NL	NL	100	100	NE	0.00073 U	0.065 J	0.15 J	0.052	0.015	0.072	0.069	0.0063 J	0.04	0.0053 J	0.0029 J	0.018	0.14	0.012
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NE	NL	NL	NL	NL	NE	0.0036 J	1.1 J	1.9 J	1.1	0.59	1.5	1.5	0.14	0.75	0.13	0.048	0.34	2.1	0.26
Naphthalene	mg/Kg	5.0	1.6	NE	NL	NL	4.5	4.5	NE	0.0012 U	0.03 J	0.049 J	0.023	0.0052 J	0.029	0.028	0.0031 J	0.016	0.0026 J	0.0015 J	0.0077	0.052	0.0055 J
Phenanthrene	mg/Kg	NA	NE	NE	NL	NL	NE	NL	NE	0.009	0.75 J	1.8 J	0.63	0.22	0.85	0.87	0.073	0.46	0.06	0.029	0.18	1.4	0.17
Pyrene	mg/Kg	NA	2,400	NE	NL	NL	650	650	NE	0.013	1.7 J	3.3 J	1.6	0.68	2.1	2.1	0.19	1.1	0.16	0.063	0.44	3.2	0.4
Dibenzofuran	mg/Kg	NA	NL	NE	NL	NL	NL	NL	NE	NA	NA	NA	0.03	0.0082	0.04	0.039	0.0037 J	0.02	0.0029 J	0.0016 J	0.0099	0.066	0.0064 J
Total TEC cPAH (calc)	mg/Kg	0.1	0.19	NE	NE	NE	3.9	0.19	NE	0.005671	**1.785**	**3.142**	**1.881**	**0.9855**	**2.448**	**2.445**	**0.2525**	**1.2774**	**0.2256**	0.08907	**0.598**	**3.643**	**0.4653**
LMW PAH	mg/Kg	NA	NE	NE	29	100	NE	29	NE	0.0216	3.022	6.039	2.1271	0.8403	2.8385	2.8646	0.2582	1.4969	0.2293	0.10608	0.63318	4.5187	0.5516
HMW PAH	mg/Kg	NA	NE	NE	18	1.1	NE	1.1	NE	0.0416	**10.08**	**20.2**	**9.89**	**4.94**	**13.22**	**13.19**	**1.28**	**6.78**	**1.123**	0.4318	**3.015**	**19.49**	**2.396**
Polychlorinated Biphenyls (PCBs)																							
PCB-aroclor 1016	mg/Kg	NA	5.6	NE	NE	NE	NE	5.6	NE	NA	0.014 U	0.016 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.0082 U	0.0092 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.0096 UJ	0.011 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.0031 U	0.0035 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.0057 U	0.0064 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	0.5	40	NE	NE	0.71	0.5	NE	NA	0.0067 J	0.0038 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	0.5	NE	NE	NE	NE	0.5	NE	NA	0.0037 U	0.0042 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.00097 UJ	0.0011 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NE	NE	NA	0.0018 UJ	0.002 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	1.0	0.5	40	NE	0.65	NE	0.5	NE	NA	0.0067	0.0038	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals																							
Aluminum	mg/Kg	NA	80,000	50	NE	NE	480,000	28,299	28,299	9,000	8,000	6,900	6,730	5,570	9,510	9,630	5,080	7,250	5,240	8,630	6,230	7,560	6,500
Arsenic	mg/Kg	20	0.67	10	60	132	2.9	7.61	7.61	5.1	2	1.8	1.89	1.5	2.95	3.26	1.81	2.82	1.12	1.69	2.47	2.17	1.95
Cadmium	mg/Kg	2.0	80	4.0	20	14	0.69	0.81	0.81	0.15	0.4 J	0.28 J	0.129	0.123	0.179	0.161	0.064	0.142	0.026 J	0.032	0.092	0.15	0.068
Chromium	mg/Kg	2,000	120,000	42	42	67	490,000	42	31.88	12	9.9	9.1	7.54	6.53	10.5	10.9	7.29	8.38	7.35	14.1	8.06	10.4	8.95
Copper	mg/Kg	NA	3,200	100	50	217	280	50	28.4	24	18	17	12.6	15.4	16.2	16.1	10.4	14.9	10.5	16.5	13.4	19.1	10.7
Lead	mg/Kg	250	NE	50	500	118	3,000	50	13.1	3.6	5.6	5.3	5.21	3.4	7.62	7.59	2.62	3.76	2.02	3.74	3.3	4.43	4.44
Mercury	mg/Kg	2.0	24	0.3	0.1	5.5	2.1	0.1	0.04	0.022 J	0.049	0.048	0.006 U	0.005 U	0.006 J	0.007 J	0.007 U	0.007 U	0.008 U	0.007 U	0.006 J	0.009 U	0.007 U
Nickel	mg/Kg	NA	880	30	200	980	130	30	24.54	14	9.9	8.5	6.84	6.93	9.6	9.63	6.03	7.56	4.52	5.59	7.5	9.25	6.51
Selenium	mg/Kg	NA	400	1.0	70	0.3	5.2	0.3	0.29	**1.5**	**1.8**	**1.8**	0.3 J	0.2 J	**0.8 J**	**0.8 J**	**0.5 J**	**1 J**	**0.4 J**	**0.5 J**	**0.4 J**	**2.9**	**0.64 J**
Zinc	mg/Kg	NA	24,000	86	200	360	6,000	86	80.91	38	42	40	32.8	34.6	45.5	44.8	27.3	65.8	17	17.5	30.7	34.1	33.5
Total Petroleum Hydrocarbons (TPHs)																							
Diesel Range Organics	mg/Kg	2,000	NE	1,600	260	2,000	NA	260	NA	NA	160	160	20 J	10 J	22 J	23 J	5.2 J	14 J	7.3 J	3.8 J	5.5 J	36 J	5.1 J
Residual Range Organics	mg/Kg	2,000	NE	1,600	260	2,000	NA	260	NA	NA	**420 J**	**610 J**	91 J	64 J	110 J	100 J	15 J	49 J	20 J	10 J	17 J	140 J	16 J

Notes:
Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.
b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.
c Soil screening levels for cyanide for protection of groundwater derived from literature or empirical demonstration (refer to Volume 1 for discussion).
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenyls
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration



Legend
- RI Surface Soil Sample Location
- WPA Sediment Sample Location
- WPA Soil Sample Location
- Spring
- Channel Area
- A Wetland Area Name

purple: Exceeds Terrestrial Ecological Soil Screening Level
blue: Exceeds MTCA Soil Screening Level for Protection of Groundwater
green: Exceeds MTCA Method B Soil Screening Level
black: Below Screening Levels

cPAH - Polycyclic Aromatic Hydrocarbon
HMW - High Molecular Weight
TPH - Total Petroleum Hydrocarbons
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)

N W E S

0 100 200 400
Feet

Figure 3-3
Wetland K
Soil Sample Locations and
Results Above Screening Levels

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

- Selenium (maximum of 2.9 mg/kg) exceeded the terrestrial ecological soil screening level for protection of wildlife of 0.3 mg/kg and background concentrations in 12 of 14 samples.
- Residual-range organics (maximum of 610 J mg/kg) exceeded the terrestrial ecologic soil screening level for protection of soil biota of 260 mg/kg at one station (WLAOC-SS2) and the associated field duplicate.
- Total cyanide (7.2 mg/kg) exceeded MTCA-derived soil screening level for protection of groundwater of 1.9 mg/kg, and terrestrial ecological screening level for wildlife protection of 5.0 mg/kg, at the upstream duplicate soil sample collected from the Spring 01 channel during the initial RI (WLAOC-SS41). Note that this screening level is based on free cyanide, rather than total cyanide. The detected cyanide concentration is significantly below the MTCA Method B screening level of 50 mg/kg.
- Total PCBs were detected at low concentrations below MTCA Method B screening level for total PCBs of 0.5 mg/kg in the upstream Spring 01 sample.

3.4.2.3 Other Smaller Wetland (E, F, G, H, I J, L, M, and N) Soil Results

These smaller wetlands were sampled as part of the Initial RI sampling program. Table 3-3 and Figure 3-4 summarize the results for the initial RI and in these wetland areas.

Soil results are summarized as follows:

- Cyanide, fluoride, and sulfate were not detected in any of the soil samples collected from these small wetlands at concentrations above the associated soil screening levels.
- Total toxicity equivalent concentrations (TTEC) cPAHs were detected above the MTCA-derived soil for protection of groundwater of 3.9 mg/kg at two of 9 stations (WLAOC-SS4 and WLAOC-SS6) located in Wetlands I and L near the Stormwater Pond. Seven of 9 sample stations terrestrial ecologic soil screening levels of 1.1 mg/kg as total HMW PAH including samples collected at wetlands E, G, H, I, J, and L. The wetlands are located near the plant area and the sample locations may have been impacted by runoff or historical air emissions/wind-blown dust.
- PCBs were not detected above screening levels in sample WLAOC-SS08 (Wetland F).
- Of metals, selenium (maximum of 1.3 mg/kg) exceeded terrestrial ecological screening level of 0.3 mg/kg and background concentrations in all 9 stations. The selenium distribution does not show a clear hotspot or potential source. Also, selenium is not a chemical typically associated with aluminum smelting operations, and the site-specific upland soil background concentrations for selenium used in this screening comparison (PGG 2013a) may not be representative of wetland soil background concentrations.
- Diesel-range and oil-range organics were not detected and/or significantly below screening levels in sample WLAOC-SS08 (Wetland F).

Table 3-3
Wetlands AOC - Smaller Wetlands - Initial RI Soil Results Summary
Wetlands E, F, G, H, I, J, L, and M
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
Spring 2016

Parameter Name	Untis	MTCA Method A Industrial	MTCA Method C	Ecological Indicator Eco-SSL Wildlife	Protection of Groundwater[a]	Selected Screening Level	Natural Background	Analytical Results WLAOC-SS03 5/5/2016 Wetland J	WLAOC-SS04 5/5/2016 Wetland I	WLAOC-SS05 5/5/2016 Wetland M	WLAOC-SS06 5/5/2016 Wetland L	WLAOC-SS07 5/5/2016 Wetland G	WLAOC-SS08 5/5/2016 Wetland F	WLAOC-SS09 5/5/2016 Wetland E	WLAOC-SS10 5/4/2016 Wetland H	WLAOC-SS11 5/4/2016 Wetland H
Aluminum Smelter																
Cyanide[b]	mg/Kg	NA	2,200	5.0	1.9	1.9	NE	2.3 U	2.1 U	2.2 U	2.8 U	2.2 U	2.2 U	2.1 U	1.8 UJ	1.8 UJ
Fluoride	mg/Kg	NA	210,000	NE	147.6[c]	147.6	14.11	90	30	33	47	19	20	13	3.9 J	1.6 J
Sulfate	mg/Kg	NA	NE	NE	2,150[c]	2,150	NE	80	15 B	74	930	6 B	140	240	26 J	5.7 B
Polycyclic Aromatic Hydrocarbons (PAHs)																
1-Methylnaphthalene	mg/Kg	NL	4,500	NL	0.082	0.082	NE	0.0099	0.031	0.00071 U	0.064	0.0094	0.00067 U	0.00067 U	0.00059 U	0.0037 J
2-Methylnaphthalene	mg/Kg	NL	14,000	NL	1.7	1.7	NE	0.014	0.045	0.00051 U	0.099	0.013	0.00048 U	0.0017 J	0.0025 J	0.0054
Acenaphthene	mg/Kg	NA	210,000	NL	98	98	NE	0.13	0.37	0.00067 U	0.57	0.11	0.00064 U	0.013	0.021	0.041
Acenaphthylene	mg/Kg	NA	NE	NL	NE	NL	NE	0.0005 U	0.0039 J	0.00056 U	0.011	0.00052 U	0.00053 U	0.00053 U	0.0017 J	0.00042 U
Anthracene	mg/Kg	NA	NE	NL	2,300	2300	NE	0.13	0.36	0.0016 J	0.59	0.1	0.0012 J	0.01	0.015	0.03
Benz[a]anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	1.1	3.3	0.04	6.6	1.2	0.012	0.13	0.15	0.31
Benzo(a)pyrene	mg/Kg	2.0	NL	NL	NL	NL	NE	1.5	2.7 J	0.015	7.5	1.5	0.014	0.16	0.17	0.37
Benzo(b)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	1.8	6.8	0.051	10	2.3	0.02	0.2	0.24	0.55
Benzo(ghi)perylene	mg/Kg	NA	NE	NL	NE	NL	NE	1.1	2.1 J	0.012	5.3	1.3	0.011	0.12	0.14	0.29
Benzo(k)fluoranthene	mg/Kg	NL	NL	NL	NL	NL	NE	0.72	1.1	0.011	2.8	0.74	0.006	0.073	0.07	0.15
Chrysene	mg/Kg	NL	NL	NL	NL	NL	NE	1.4	3.8 J	0.093	8.5	1.5	0.014	0.16	0.18	0.37
Dibenzo(a,h)anthracene	mg/Kg	NL	NL	NL	NL	NL	NE	0.2	0.4	0.0033 J	1.1	0.25	0.0022 J	0.022	0.024	0.053
Fluoranthene	mg/Kg	NA	140,000	NL	630	630	NE	2	7.3	0.095	11	1.8	0.016	0.19	0.23	0.49
Fluorene	mg/Kg	NA	140,000	NL	100	100	NE	0.055	0.16	0.00056 U	0.28	0.048	0.00053 U	0.0078	0.0094	0.019
Indeno(1,2,3-cd)pyrene	mg/Kg	NL	NL	NL	NL	NL	NE	1.3	2.4 J	0.014	6	1.5	0.013	0.14	0.15	0.32
Naphthalene	mg/Kg	5.0	70	NL	4.5	4.5	NE	0.028	0.075	0.0009 U	0.16	0.027	0.00085 U	0.0036 J	0.0046 J	0.0092
Phenanthrene	mg/Kg	NA	NE	NL	NE	NL	NE	0.76	2.3	0.011	3.9	0.67	0.0074	0.076	0.095	0.2
Pyrene	mg/Kg	NA	110,000	NL	650	650	NE	1.8	6.7	0.058	9.7	1.7	0.014	0.17	0.21	0.43
Total TEC cPAH (calc)	mg/Kg	2.0	130	NE	3.9	3.9	NE	2.026	**4.138**	0.02786	**10.235**	2.114	0.01946	0.2181	0.2352	0.512
LMW PAH	mg/Kg	NA	NE	100	NE	100	NE	3.1269	10.6449	0.1076	16.674	2.7774	0.0246	0.3021	0.3792	0.7983
HMW PAH	mg/Kg	NA	NE	1.1	NE	1.1	NE	**10.92**	**29.3**	0.2973	**57.5**	**11.99**	0.1062	**1.175**	**1.334**	**2.843**
Polychlorinated Biphenyls (PCBs)																
PCB-aroclor 1016	mg/Kg	NA	250	NE	NE	250	NE	NA	NA	NA	NA	NA	0.0084 U	NA	NA	NA
PCB-aroclor 1221	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.0048 U	NA	NA	NA
PCB-aroclor 1232	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.0055 UJ	NA	NA	NA
PCB-aroclor 1242	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.0018 U	NA	NA	NA
PCB-aroclor 1248	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.0033 U	NA	NA	NA
PCB-aroclor 1254	mg/Kg	NA	66	NE	0.71	0.71	NE	NA	NA	NA	NA	NA	0.0017 UJ	NA	NA	NA
PCB-aroclor 1260	mg/Kg	NA	66	NE	NE	66	NE	NA	NA	NA	NA	NA	0.0022 U	NA	NA	NA
PCB-aroclor 1262	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.00057 UJ	NA	NA	NA
PCB-aroclor 1268	mg/Kg	NA	NE	NE	NE	NE	NE	NA	NA	NA	NA	NA	0.001 UJ	NA	NA	NA
Total PCB Aroclor (calc)	mg/kg	10	66	0.65	NE	0.65	NE	NA	NA	NA	NA	NA	0.00057 U	NA	NA	NA
Metals																
Aluminum	mg/Kg	NA	3,500,000	NE	480,000	480,000	28,299	10,000	11,000	9,800	10,000	11,000	9,900	6,500	5,300	6,200
Arsenic	mg/Kg	20	88	132	2.9	7.61	7.61	2.9	2.6	3	3.6	5.9	5.5	2.6	2.4	4.1
Cadmium	mg/Kg	2.0	3,500	14	0.69	0.81	0.81	0.13	0.34	0.13	0.55	0.25	0.19	0.14	0.082 J	0.11
Chromium	mg/Kg	2,000	5,300,000	67	490,000	67	31.88	12	16	13	12	14	12	11	10 J	13 J
Copper	mg/Kg	NA	140,000	217	280	217	28.4	13	17	16	17	12	14	11	7.1	10
Lead	mg/Kg	1,000	NE	118	3,000	118	13.1	5.1	14	4.1	10	12	5.1	3.6	4.6	5
Mercury	mg/Kg	2.0	NE	5.5	2.1	2.1	0.04	0.0078 J	0.02 J	0.011 J	0.028 J	0.018 J	0.0069 U	0.011 J	0.0059 U	0.0058 U
Nickel	mg/Kg	NA	70,000	980	130	130	24.54	12	14	12	20	14	8.8	15	7.8	9.4
Selenium	mg/Kg	NA	18,000	0.3	5.2	0.3	0.29	**0.7**	**0.8**	**0.8**	**1.3**	**1.1**	**1.4**	**0.62**	**0.57**	**0.87**
Zinc	mg/Kg	NA	1,100,000	360	6,000	360	80.91	41	64	42	99	62	50	36	40	41
Total Petroleum Hydrocarbons (TPHs)																
Diesel Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	11 U	NA	NA	NA
Residual Range Organics	mg/Kg	2,000	NE	2,000	NA	2,000	NE	NA	NA	NA	NA	NA	13 B	NA	NA	NA

Notes:
Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for protection of groundwater from Ecology CLARC website except where specifically noted.
b Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.
c Soil screening levels for protection of groundwater derived from literature or empirical demonstration (refer to Volume 1 for discussion).
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.

UJ = Chemical was not detected. The associated limit is estimated.
CLARC = Cleanup Level and Risk Calculations
cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
mg/Kg = milligrams per kilogram
MTCA = Model Toxics Control Act
NA = Not Applicable

NE = Not Established
PAHs = Polycyclic Aromatic Hydrocarbon
PCBs = Polychlorinated Biphenyls
SSL = Soil Screening Level
TPH = Total Petroleum Hydrocarbons
Total TEC = Total Toxicity Equivalent Concentration

Legend

- RI Surface Soil Sample Location
- A Wetland Area Name
- Spring

purple: Exceeds Terrestrial Ecological Soil Screening Level
blue: Exceeds MTCA Soil Screening Level for Protection of Groundwater
black: Below Screening Levels

cPAH - Polycyclic Aromatic Hydrocarbon
HMW - High Molecular Weight
TTEC (calc) - Total Toxicity Equivalent Concentration (calculated)

N
W E
S

0 250 500 1,000
Feet

Figure 3-4
Wetlands Area of Concern
Other Smaller Wetland Areas
(Wetlands E, F, G, H, I, J, K)
Soil Sample Locations and
Results Above Screening Levels

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

3.4.3 Spring and Seep Sample Results Summary

This section summarizes the spring and seep sample result during the RI and WPA. Table 3-4 and Figure 3-5 summarize the water results for the springs sampled during WPA field mobilization in early April 2021 as well as RI sample results collected at Spring 1 and the NESI wetland during initial RI investigation.

Fluoride was detected above groundwater screening levels at all of the sampled springs with the exception of the spring/dug well near the former town of Cliffs (Spring 07). Two of the stations exceeded the MCL for fluoride of 4 mg/L: 1) the NESI wetland (similar detected concentration to past RI data, 16.8 to 20 J mg/L), and 2) the Wetland F Spring 05 (located southeast of the WELF, 7.22 mg/L). All of the three Wetland K water samples collected in the runnel channels exceeded fluoride screening levels (3.05 to 3.9 mg/L) with no significant down-slope attenuation of concentrations observed. For locations in common, the collected RI and WPA spring fluoride results are generally similar to prior 2012 investigation results for Wetland F (3.3 to 8.7 mg/L), Wetland K (4.6 mg/L), and Wetland D (0.44 to 0.49 mg/L) (PGG 2013b).

Sulfate exceeded the secondary MCL of 250 mg/L only at Spring 07, the spring/dug well near the former Cliffs town site (Spring 07). The sulfate concentration did not exceed the screening level for adverse health effects for cattle (calves) of 500 mg/L.

Arsenic exceeded the MTCA Method B groundwater screening at all stations in both total and field-filtered samples. At the Cliffs Spring (Spring 07), total arsenic concentrations (maximum of 0.00443 mg/L) exceeded both the MTCA Method C and site-specific background concentrations; however, the dissolved (field-filtered) sample of similar concentration did not exceed the site groundwater background concentration for dissolved arsenic (refer to Appendix A-3 for calculation of groundwater background concentrations). The sample was also below the MTCA Method A groundwater screening level for arsenic of 0.005 mg/L that takes into account state groundwater background arsenic concentrations.

The PAH spring results exceed the 40 CFR 131.45 surface water screening level of 1.6×10^{-5} µg/L BAP equivalent concentration; however, this value does not appear to be representative of potential exposure as these small springs and runnels that do not appear to have freshwater receptors such as fish. The regulatory status of the 40 CFR 131.45 criteria is also currently unresolved. In comments on the Revised RI Report (Ecology 2022), Ecology stated that if there’s a completed pathway to a

Table 3-4
Wetlands AOC - Spring Water Results - RI and WPA Results
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
2017 and Spring 2021
(Page 1 of 2)

									Analytical Results												
									NESI Wetland			Wetland F	Wetland D	Cliffs	Wetland K						
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Site Background	Selected Screening Level	Fraction Analyzed	NESI Wetland-01 3/2/2017	SWMU31-WPA-NESI-Spring4 4/1/2021	SWMU31-WPA-NESI-Spring11 (Duplicate of SWMU31-WPA-NESI-Spring4) 4/1/2021	WLAOC-WPA-WTLF-Spring5 4/1/2021	WLAOC-WPA-WTLD-Spring6 4/1/2021	WPA-CliffsSpring7 4/1/2021	Spring1-01 2/25/2017	Spring1-02 5/4/2017	Spring1-03 8/24/2017	Spring1-04 11/7/2017	WLAOC-WPA-WTLK-Spring1 4/1/2021	WLAOC-WPA-WTLK-Spring2 4/1/2021	WLAOC-WPA-WTLK-Spring3 4/1/2021
Aluminum Smelter																					
Cyanide[a]	mg/L	NA	0.01	0.022	0.2	NE	0.01	Total	0.06 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.06 U	0.06 U	0.06 U	0.06 U	0.0005 U	0.0005 U	0.0005 U
Cyanide, Free	mg/L	NA	0.01	0.022	0.2	NE	0.01	Total	1.5 U	NA	NA	NA	NA	NA	0.0015 U	NA	NA	NA	NA	NA	NA
Cyanide, Weak Acid Dissociable	mg/L	NA	NE	NE	NE	NE	NE	Total	0.06 U	NA	NA	NA	NA	NA	0.06 U	0.06 U	0.06 U	0.06 U	NA	NA	NA
Fluoride	mg/L	NA	0.96	2.1	4.0	0.72	0.96	Total	**20 J**	**16.8**	**17.3**	**7.22**	**1**	0.77	**3.9**	**3.5 J**	**3.8**	**3.7**	**3.31**	**3.43**	**3.05**
Sulfate	mg/L	NA	NE	NE	250	32	250	Total	120	31.7	32.2	133	22.1	**362**	64	60	40	32	31.2	32.1	34.5
Polycyclic Aromatic Hydrocarbons (PAHs)																					
1-Methylnaphthalene	µg/L	NL	1.5	15	NE	NE	1.5	Total	0.0068 U	NA	NA	NA	NA	NA	0.006 U	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	µg/L	NL	32	70	NE	NE	32	Total	0.01 U	0.0013 U	0.0013 U	0.0018 B	0.0013 U	0.0013 U	0.009 U	NA	NA	NA	0.0013 U	0.0013 U	0.0017 B
Acenaphthene	µg/L	NA	960	2,100	NE	NE	960	Total	0.0023 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.002 U	NA	NA	NA	0.0012 U	0.0016 J	0.0012 U
Acenaphthylene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0023 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.002 U	NA	NA	NA	0.0011 U	0.0011 U	0.0011 U
Anthracene	µg/L	NA	4,800	11,000	NE	NE	4,800	Total	0.01 J	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.003 U	NA	NA	NA	0.0013 J	0.0015 J	0.0014 J
Benzo(a)anthracene	µg/L	NA	NL	NL	NE	NE	NE	Total	0.0023 U	0.002 B	0.0017 B	0.0023 B	0.0016 B	0.0016 B	0.0043 J	NA	NA	NA	0.0047 B	0.0092 J	0.0045 B
Benzo(a)pyrene	µg/L	NL	NL	NL	NL	NE	NL	Total	0.0034 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0057 J	NA	NA	NA	0.0041 J	0.012 J	0.0033 J
Benzo(b)fluoranthene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0091 U	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.00083 U	0.012 J	NA	NA	NA	0.005 J	0.014 J	0.0045 J
Benzo(ghi)perylene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0034 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.00086 U	0.0051 J	NA	NA	NA	0.0032 J	0.008 J	0.0027 J
Benzo(k)fluoranthene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.01 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.00094 U	0.009 U	NA	NA	NA	0.0018 J	0.0047 J	0.0014 J
Chrysene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0068 U	0.00076 U	0.00076 U	0.00076 U	0.00076 U	0.00076 U	0.0072 J	NA	NA	NA	0.0029 J	0.0095 J	0.0028 J
Dibenzo(a,h)anthracene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0023 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.002 U	NA	NA	NA	0.0013 U	0.0022 J	0.0013 U
Fluoranthene	µg/L	NA	640	1,400	NE	NE	640	Total	0.0023 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.00082 U	0.0083 J	NA	NA	NA	0.0036 J	0.014 J	0.0033 J
Fluorene	µg/L	NA	640	1,400	NE	NE	640	Total	0.0034 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.0011 U	0.003 U	NA	NA	NA	0.0089 J	0.0011 U	0.0011 U
Indeno(1,2,3-cd)pyrene	µg/L	NA	NL	NL	NE	NE	NL	Total	0.0079 U	0.00000089 U	0.00000089 U	0.00000089 U	0.00000089 U	0.00000089 U	0.007 U	NA	NA	NA	0.0000033 J	0.0000083 J	0.0000026 J
Naphthalene	µg/L	160	160	350	NE	NE	160	Total	0.015 U	0.0024 B	0.0016 B	0.0042 B	0.0014 U	0.0028 B	0.013 U	NA	NA	NA	0.002 B	0.0028 B	0.0025 B
Phenanthrene	µg/L	NA	NE	NE	NE	NE	NE	Total	0.0083 B	0.0019 B	0.0012 B	0.0011 U	0.0011 U	0.0011 U	0.005 B	NA	NA	NA	0.0029 B	0.007 B	0.0026 B
Pyrene	µg/L	NA	480	1,100	NE	NE	480	Total	0.0045 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0093 J	NA	NA	NA	0.0052 J	0.013 J	0.0039 J
Dibenzofuran	µg/L	NA	16	35	NE	NE	16	Total	NA	0.0012 B	0.00096 U	0.00096 U	0.00096 U	0.00096 U	NA	NA	NA	NA	0.00096 U	0.0012 B	0.0019 B
Total TEC cPAH (calc)	µg/L	0.1	0.2	0.2	0.2	NE	0.2	Total	0.003314	0.0009518	0.0009218	0.0009818	NA	NA	0.008302	NA	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)																					
PCB-aroclor 1016	µg/L	NA	1.1	2.5	NE	NE	1.1	Total	0.022 U	NA	NA	NA	NA	NA	0.021 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1221	µg/L	NA	NE	NE	NE	NE	NE	Total	0.032 U	NA	NA	NA	NA	NA	0.03 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1232	µg/L	NA	NE	NE	NE	NE	NE	Total	0.029 U	NA	NA	NA	NA	NA	0.027 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1242	µg/L	NA	NE	NE	NE	NE	NE	Total	0.03 U	NA	NA	NA	NA	NA	0.028 UJ	NA	NA	NA	NA	NA	NA
PCB-aroclor 1248	µg/L	NA	NE	NE	NE	NE	NE	Total	0.022 U	NA	NA	NA	NA	NA	0.021 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1254	µg/L	NA	0.044	0.44	NE	NE	0.044	Total	0.021 U	NA	NA	NA	NA	NA	0.02 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1260	µg/L	NA	0.044	0.44	NE	NE	0.044	Total	0.027 U	NA	NA	NA	NA	NA	0.026 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1262	µg/L	NA	NE	NE	NE	NE	NE	Total	0.033 U	NA	NA	NA	NA	NA	0.031 U	NA	NA	NA	NA	NA	NA
PCB-aroclor 1268	µg/L	NA	NE	NE	NE	NE	NE	Total	0.026 U	NA	NA	NA	NA	NA	0.025 U	NA	NA	NA	NA	NA	NA
Total PCB Aroclor (calc)	µg/L	0.1	0.044	0.44	0.5	NE	0.044	Total	0.021 U	NA	NA	NA	NA	NA	0.02 U	NA	NA	NA	NA	NA	NA

Table 3-4
Wetlands AOC - Spring Water Results - RI and WPA Results
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
2017 and Spring 2021
(Page 2 of 2)

									Analytical Results												
									NESI Wetland			Wetland F	Wetland D	Cliffs	Wetland K						
Parameter Name	Units	MTCA Method A	MTCA Method B	MTCA Method C	MCL	Site Background	Selected Screening Level	Fraction Analyzed	NESI Wetland-01 3/2/2017	SWMU31-WPA-NESI-Spring4 4/1/2021	SWMU31-WPA-NESI-Spring11 (Duplicate of SWMU31-WPA-NESI-Spring4) 4/1/2021	WLAOC-WPA-WTLF-Spring5 4/1/2021	WLAOC-WPA-WTLD-Spring6 4/1/2021	WPA-CliffsSpring7 4/1/2021	Spring1-01 2/25/2017	Spring1-02 5/4/2017	Spring1-03 8/24/2017	Spring1-04 11/7/2017	WLAOC-WPA-WTLK-Spring1 4/1/2021	WLAOC-WPA-WTLK-Spring2 4/1/2021	WLAOC-WPA-WTLK-Spring3 4/1/2021
Metals																					
Aluminum	mg/L	NA	16	35	NE	1.14	16	Dissolved	0.89	0.783	0.765	0.0122	0.0034 J	0.0047	0.1 U	NA	NA	NA	0.0036 J	0.0027 J	0.0055
Aluminum	mg/L	NA	16	35	NE	0.433	16	Total	1.1	0.83	0.835	0.0922	0.0029 B	0.0031 B	0.1 U	NA	NA	NA	0.0513	0.256	0.539
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.0069	0.0069	Dissolved	0.002	0.00051	0.00058	0.00105	0.00315	0.00453	0.0022	0.0015	0.0017	0.0015	0.00157	0.00159	0.00152
Arsenic	mg/L	0.005	0.000058	0.00058	0.01	0.00324	0.00324	Total	0.0014	0.00059	0.00063	0.00105	0.00324	**0.00443**	0.002	0.0015	0.0018	0.0015	0.00162	0.0016	0.00171
Cadmium	mg/L	0.005	0.008	0.018	0.005	NE	0.005	Dissolved	0.000028 U	0.000008 U	0.000008 U	0.000008 U	0.000008 U	0.000008 U	0.000028 U	NA	NA	NA	0.000008 U	0.000008 U	0.000008 U
Cadmium	mg/L	0.005	0.008	0.018	0.005	NE	0.005	Total	0.000028 U	0.000013 J	0.000009 J	0.000008 U	0.000008 U	0.000008 U	0.000028 U	NA	NA	NA	0.000008 U	0.000011 J	0.000017 J
Chromium	mg/L	0.05	24	53	0.1	0.03	0.05	Dissolved	0.00032 J	0.00013 J	0.00013 J	0.00082	0.00033	0.00045	0.00039 J	NA	NA	NA	0.00013 J	0.00017 J	0.00009 J
Chromium	mg/L	0.05	24	53	0.1	0.055	0.05	Total	0.00026 J	0.00019 B	0.0002 B	0.00085	0.00029	0.00034	0.0003 J	NA	NA	NA	0.00013 B	0.00034	0.00058
Copper	mg/L	NA	0.64	1.4	1.3	NE	0.64	Dissolved	0.0015 J	0.00093	0.00083	0.00037	0.00033	0.00057	0.00097 J	NA	NA	NA	0.00038	0.00037	0.00065
Copper	mg/L	NA	0.64	1.4	1.3	NE	0.64	Total	0.0023	0.00101	0.00103	0.0004	0.00016	0.00029	0.0017 J	NA	NA	NA	0.0007	0.00109	0.00227
Iron	mg/L	NA	11	25	0.3	13	13	Dissolved	0.081	0.000006 J	0.000007 J	0.000015 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	mg/L	NA	11	25	0.3	1.361	1.361	Total	0.16	0.000017 J	0.000016 J	0.000048	NA	NA	0.18 U	NA	NA	NA	NA	NA	NA
Lead	mg/L	0.015	NE	NE	0.015	0.00046	0.015	Dissolved	0.00011 J	0.00002 U	0.00002 U	0.00002 U	0.000014 J	0.000021	0.000059 B	NA	NA	NA	0.000006 U	0.000007 J	0.000021
Lead	mg/L	0.015	NE	NE	0.015	0.00046	0.015	Total	0.00061	0.00002 U	0.00002 U	0.00002 U	0.000006 U	0.000006 U	0.0002 J	NA	NA	NA	0.000028	0.000137	0.00029
Mercury	mg/L	0.002	NE	NE	0.002	NE	0.002	Dissolved	0.000047 B	0.00104	0.00097	0.00018 J	0.00002 U	0.00002 U	0.000083 B	NA	NA	NA	0.00002 U	0.00002 U	0.00002 U
Mercury	mg/L	0.002	NE	NE	0.002	NE	0.002	Total	0.00006 B	0.00111	0.00107	0.00024	0.00002 U	0.00002 U	0.000081 B	NA	NA	NA	0.00002 U	0.00002 U	0.00002 U
Nickel	mg/L	NA	0.000096	0.00096	0.1	0.0065	0.0065	Dissolved	0.0021 J	0.0002 U	0.0002 U	0.0012	0.00011 J	0.0002 J	0.0004 U	NA	NA	NA	0.00012 J	0.00013 J	0.00017 J
Nickel	mg/L	NA	0.000096	0.00096	0.1	0.0038	0.0038	Total	0.0021 J	0.0002 U	0.0002 U	0.0011	0.00009 J	0.00008 J	0.0004 U	NA	NA	NA	0.00019 J	0.00031	0.00072
Selenium	mg/L	NA	0.08	0.18	0.05	NE	0.05	Dissolved	0.00064 J	0.0021	0.0017 J	0.0007 J	0.0006 J	0.001	0.0011	NA	NA	NA	0.0004 J	0.0004 J	0.0006 J
Selenium	mg/L	NA	0.08	0.18	0.05	NE	0.05	Total	0.00055 J	0.003	0.0024	0.0024	0.0006 J	0.0009 J	0.0014 B	NA	NA	NA	0.0004 J	0.0004 J	0.0007 J
Zinc	mg/L	NA	4.8	11	NE	NE	4.8	Dissolved	0.0024 J	NA	NA	NA	0.0018 J	0.0033	0.0019 U	NA	NA	NA	0.0005 J	0.0008 J	0.0011 J
Zinc	mg/L	NA	4.8	11	NE	NE	4.8	Total	0.0033 J	NA	NA	NA	0.0005 U	0.0005 U	0.0024 J	NA	NA	NA	0.0008 J	0.0014 J	0.0029
Total Petroleum Hydrocarbons (TPHs)																					
Diesel Range Organics	mg/L	0.5	NE	NE	NE	NE	0.5	Total	NA	0.054 B	0.069 B	0.024 B	0.015 B	0.019 B	NA	NA	NA	NA	0.018 B	0.022 B	0.017 B
Residual Range Organics	mg/L	0.5	NE	NE	NE	NE	0.5	Total	NA	0.065 B	0.058 B	0.048 B	0.02 B	0.039 B	NA	NA	NA	NA	0.031 B	0.039 B	0.029 B
General Chemistry																					
Calcium	mg/L	NA	NE	NE	NE	NE	NE	Total	38	NA	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA
Magnesium	mg/L	NA	NE	NE	NE	NE	NE	Total	23	NA	NA	NA	NA	NA	17	NA	NA	NA	NA	NA	NA
Potassium	mg/L	NA	NE	NE	NE	NE	NE	Total	7.5	NA	NA	NA	NA	NA	5.8	NA	NA	NA	NA	NA	NA
Sodium	mg/L	NA	NE	NE	NE	NE	NE	Total	86	NA	NA	NA	NA	NA	26	NA	NA	NA	NA	NA	NA
Chloride	mg/L	NA	NE	NE	NE	NE	NE	Total	15	NA	NA	NA	NA	NA	14	NA	NA	NA	NA	NA	NA
Calcium	mg/L	NA	NE	NE	NE	NE	NE	Total	38	NA	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	mg/L	NA	NE	NE	NE	NE	NE	Total	490	NA	NA	NA	NA	NA	280	NA	NA	NA	NA	NA	NA
Magnesium	mg/L	NA	NE	NE	NE	NE	NE	Total	23	NA	NA	NA	NA	NA	17	NA	NA	NA	NA	NA	NA
Alkalinity, Total	mg/L	NA	NE	NE	NE	NE	NE	Total	200	NA	NA	NA	NA	NA	110	NA	NA	NA	NA	NA	NA
Bicarbonate Alkalinity as CaCO3	mg/L	NA	NE	NE	NE	NE	NE	Total	200	NA	NA	NA	NA	NA	110	NA	NA	NA	NA	NA	NA
Carbonate Alkalinity as CaC03	mg/L	NA	NE	NE	NE	NE	NE	Total	5 U	NA	NA	NA	NA	NA	5 U	NA	NA	NA	NA	NA	NA
Hydroxide Alalinity as CaCO3	mg/L	NA	NE	NE	NE	NE	NE	Total	5 U	NA	NA	NA	NA	NA	5 U	NA	NA	NA	NA	NA	NA
Hardness as calcium carbonate	mg/L	NA	NE	NE	NE	NE	NE	Total	3,200	NA	NA	NA	NA	NA	150	NA	NA	NA	NA	NA	NA

Notes:
Bold and shaded values denote exceedances of one or more screening levels and background concentrations.
a Soil screening levels for cyanide are based on the free cyanide form. Results are for total cyanide unless specifically noted.
B = The result is less than 5 times the blank contamination. The result is considered as non-positive because cross-contamination is suspected.
J = The result is an estimated value.
U = The analyte was analyzed for, but was not detected at or above the method reporting limit/method detection limit.
UJ = Chemical was not detected. The associated limit is estimated.

cPAH = Carcinogenic Polycyclic Aromatic Hydrocarbon
µg/L = micrograms per liter
mg/L = milligrams per liter
MCL = Maximum Contaminant Level Goal
MTCA = Model Toxics Control Act
NA = Not Applicable
NE = Not Established

NL = Not Listed
PAHs = Polycyclic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyls
SSL = Soil Screening Level
Total TEC = Total Toxicity Equivalent Concentration
TPH = Total Petroleum Hydrocarbons

R:\projects_2011\LockheedMartin_GoldendaleSite\Investig\maps\2021_Combined_RI_WPA\Figure_3-5_Springs_Sampling_Exceedance.mxd

Legend

- Spring Sample Location
- Wetland Area

orange: Exceeds MCL Screening Level
red: Exceeds MTCA Method C
green: Exceeds MTCA Method B
black: Below Screening Levels

Sulfate MCL represents a secondary MCL and does not represent a health-based criteria.
Total Arsenic exceeds screening level and site background groundwater concentration.

N
W E
S

0 500 1,000 2,000
Feet

Figure 3-5
Wetlands AOC
Wetlands, Initial RI and WPA, Spring and Seep Sample Locations and Results Above Groundwater Screening Levels

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

fish-bearing surface water for carcinogenic PAHs, then values established under 40 CFR 131.45 40 CFR 131.45 (currently in litigation) should be used, but adjusted upward to an appropriate practical quantitation limit consistent with MTCA requirements (WAC 173-340-7006[d]). Ecology also noted that the springs represent a special case since they are largely seasonal and do not provide fish habitat. Based on the current understanding of the site presented in this Final Draft RI Report (dated June 14, 2022), Ecology has stated that the groundwater screening levels will be protective of the potential exposure pathways posed by the springs. Surface water screening levels will be further evaluated in the FS. See Volume 1, Section 5.2.4 for a detailed discussion of surface water screening levels.

Note that several of the low-level positive PAH results are qualified as “B” because of low-level blank contamination and the results do not appear to represent environmental conditions. Most of the other positive detections of PAHs represent estimated concentrations (J qualified) at low concentrations near the reporting limit and/or method detection limit. If the B qualified results are excluded, only samples from Wetland K exceed surface water screening levels (in all three Wetland K water samples).

PCBs were not detected in spring samples collected from Wetland K, Wetland D, or the NESI wetland.

Diesel-range organics and residual-range organics were not positively detected in the 8 samples analyzed for petroleum hydrocarbons.

The WPA results are consistent with the pre-RI sampling results collected during 2013 (PGG 2013b) (Appendix E-3).

3.4.4 Wetland Discharge Measurements

Wetland discharge measurements were made at locations using the procedures specified in the WPA. The WPA included multiple potential measurement methods to be employed depending on conditions. Due to the low flows, shallow depth. irregular channelization observed, measurements were made using a 5-gallon bucket and stop-watch. In a few cases with very low flow where the water could not be collected with a five-gallon bucket, the discharge was estimated. Field sampling logs for WPA discharge measurement and spring sampling are provided in Appendix E-2. Discharge measurements, field observations and field parameters for the WPA Spring Data are summarized in Table 3-5.

Table 3-5
Spring and Seep Discharge and Water Quality Parameter Summary, WPA Field Investigation
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
May 2021

Location	Estimated Discharge (gallons per minute)	Field Observations and Notes	Temperature (degrees C)	pH	Conductivity (ms/cm)	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (millivolts)	Turbidity (NTU)
Wetland K Spring 1	4.5	Rattlesnake Spring also sampled during RI	14.3	7.72	257.2	10.32	62.7	1.33
Wetland K Spring 2	4.5	Downstream area with flowing water	18.1	7.97	294.6	10.2	35.6	2.1
Wetland K Eastern Rill (Spring 3)	2-3	Very steep-walled channel, difficult to access	17.2	8.13	285.7	10.06	47.3	1.09
NESI Spring 4	Standing Water	Slightly yellow	21.0	7.81	370.5	15.96[a]	53.6	1.46
Wetland F Spring 5	1-2	Water only 1-2 inches deep.	19.5	7.82	521	9.45	50.0	0.80
Wetland D Spring 6	2.4	Trough structure that collects water	16.1	7.07	199.6	5.12	77.5	0.10
Cliffs Spring Spring 7	7 to 10	Pipe structure associated with dug well	17.3	7.34	1,015	9.31	75.2	0.07

Notes:

a Dissolved oxygen reading is above the solubility of oxygen at this temperature indicating questionable accuracy.

C = Centigrade
mg/L = Milligrams per liter
ms/cm = Millisiemens per centimeter
NESI = North of the East Surface Impoundment
NTU = Nephelometric Turbidity Unit

3.4.5 Temporary Well Point Results

Consistent with the WPA requirements, installation of temporary wells was attempted downslope from Wetland K and at the mouth of the Western Intermittent Drainage at the Boat Basin (three sublocations each) using hand-driven Solinst™ stainless steel well-points. Refusal occurred at depths of 0.5 to 2 ft bgs in the rocky soils with gravel, cobbles and boulders; no perched groundwater was observed. Some of the drive-rods and points were broken and bent during sampling attempts. Field logs and selected photos are provided in Appendix E-2. The attempted hand-driven well point locations are shown on Figure 3-6.

3.5 CONCLUSIONS AND RECOMMENDATIONS

Based on a review of historical aerial photographs, it appears that Wetlands D and K were created during plant construction and historical operations. These wetlands do not appear to represent natural features that pre-date the period of plant operations. The wetlands are generally Category III and IV wetlands that are relatively small, have been disturbed in some ways, and are less diverse and more isolated from other natural resources in the landscape than higher category wetlands.

In general, PAH concentrations exceeded ecological soil screening levels for wildlife protection of 1.1 mg/kg as total HMW PAHs at several wetland locations including Wetlands D, K, and the NESI wetland as well as smaller wetlands E, G, H, I, J and L.

At Wetland D, all of the elevated PAH concentrations are within the footprint of the former Duck Pond in the northeast portion of the wetland. Elevated sulfate (maximum of 26,200 mg/kg) was also detected above the derived soil screening level for protection of groundwater of 2,150 mg/kg in two stations within the footprint of the historical Duck Pond. Total cyanide was detected above the soil screening level for protection of groundwater in a single sample collected from the westernmost spring area of Wetland D. Arsenic (maximum of 16 mg/kg) exceeded the MTCA-derived soil screening level for protection of groundwater of 2.9 mg/kg and background concentrations in two samples within the former Duck Pond area.

Legend

- Hand-Driven Well Location
- Wetland Area

N
W E
S

0 50 100 200
Feet

Figure 3-6
Hand-Driven Well
Attempted Locations

Columbia Gorge Aluminum Smelter Site
Goldendale, Washington

At Wetland K, soil samples exceed MTCA Method B screening levels of 0.1 mg/kg for TTEC cPAHs that were used for screening levels in this open-space zoned area in virtually all of the sampled stations both within the channels and outside the channel areas. PAHs (maximum of 20.2 mg/kg as total HMW PAH) exceed the terrestrial ecologic soil screening level for protection of wildlife for total HMW PAHs of 1.1 mg/kg at 12 of 14 stations. Sulfate (maximum of 4,870 mg/kg) exceeded the soil screening level for protection of groundwater in one of the samples. Residual-range organics (maximum of 610 J mg/kg) exceeded the terrestrial ecologic soil screening level for protection of soil biota of 260 mg/kg at one station. Total cyanide (7.2 mg/kg) exceeded MTCA-derived soil screening level for protection of groundwater of 1.9 mg/kg, and terrestrial ecological screening level for wildlife protection of 5.0 mg/kg, at the upstream duplicate soil sample collected from the Spring 01 channel during the initial RI. Note that this screening level is based on free cyanide, rather than total cyanide.

Wetland springs are characterized by fluoride concentrations above MTCA Method B screening level of 0.96 mg/L over a widespread area and also exceeded the MCL of 4.0 mg/L in a few locations (Wetland F [Spring 5] and NESI Wetland [Spring 4]). Sulfate exceeded the secondary MCL of 250 mg/L only at the spring/dug well near the former Cliffs town site (Spring 07). The sulfate concentration did not exceed the screening level for adverse health effects for cattle (calves) of 500 mg/L. Arsenic exceeded the MTCA Method B groundwater screening level and background concentrations at all stations in both total and field-filtered samples.

The Wetlands AOC will be included in the FS based the soil chemical results including Wetlands D, E, G, H, I, J, K, and L. Of site contaminants, only low concentrations selenium (maximum of 1.4 mg/kg) that exceeded terrestrial ecological soil screening level for wildlife protection of 0.3 mg/kg were detected in soils at Wetlands F and M. The selenium concentrations in wetland areas will be further evaluated in the FS to determine if inclusion of these wetlands in the FS is warranted.

In addition, discharges of contaminated groundwater through springs at Wetland D, K, F, the NESI wetland, and Cliffs Spring 07 will be addressed as appropriate as part of the GWAOC and the Stormwater Pond and Appurtenant Facilities (SWMU 32), and SWMU 31 NESI FS evaluations.

Section 4
AOC Summary of Recommendations

This section summarizes the RI recommendations for the Columbia River Sediments, Groundwater, and Wetlands AOCs as summarized in this Volume. Table 4-1 provides a summary of the primary RI findings and associated recommendations for individual AOCs, including identification of those AOCs recommended for further evaluation in the FS.

Table 4-1
Areas of Concern (AOC) Major Findings and Recommendation Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 1 of 2)

Area of Concern (AOC)	Major RI Findings Summary	RI Recommendation	FS Evaluation (Yes/No)
Columbia River Sediments	The RI results for the Columbia River Sediments AOC suggests that sediment quality has not been significantly impacted above relevant screening levels from past aluminum smelter operations, or from other potential non-site related historical or ongoing sources. These findings are generally consistent with results from past investigations of sediments in the Columbia River and Boat Basin near the subject site. The bioassay test results indicate that the Columbia River sediments adjacent to the site met the Washington State Sediment Management Standards criteria for acute and chronic survival and chronic sub-lethal biological assessments and do not exhibit a toxic response for fresh water benthic organisms.	The results of the sediment chemistry testing combined with the results of the bioassay testing address the ecological and human health concerns regarding the project site and associated Columbia River sediments. Based on these findings, no further investigation or remedial action is warranted for the Columbia River Sediments AOC.	**No**
Groundwater in the Uppermost Aquifer (GWAOC)	Groundwater water quality has been impacted in portions of all three aquifer zones particularly for common aluminum smelter-related chemicals including fluoride, sulfate, and to a lesser extent PAHs. Free cyanide has not been detected above groundwater screening levels, which are based on free cyanide. Total cyanide has been detected above groundwater screening levels in some areas and represents a plume indicator in these areas. Like historical results, fluoride represents the most widespread of these chemicals with groundwater chemical concentrations exceeding the MCL of 4 mg/L and the MTCA Method B groundwater screening level of 0.96 mg/L in several areas of the site and all three aquifer zones. The conceptual understanding of a three-zone aquifer system consisting of a shallow unconsolidated aquifer (UA zone), an upper basalt aquifer zone (BAU zone) at an elevation significantly above the Columbia River, and a deeper basalt aquifer zone near the Columbia River elevation (BAL zone) has been generally confirmed at the site. Based on the coring results and drilling program, there appears to be about three basalt flows that comprise the basalt aquifer system at the site, with water-bearing zones occurring predominantly in the fractured and vesicular flowtops. The BAU aquifer zone consists of more than one water-bearing zone in some areas (i.e., BAU1 and BAU2) as shown in cross-sections, but the water-levels within the BAU are similar. The BAU zone discharges to springs at two locations with elevations significantly above the Columbia River. These springs appear to coincide with fracture/fault zones. Water-level elevations in the BAL zone are significantly lower than the shallower UA and BAU zones. The BAL zone has more than one water-bearing zone in some areas (i.e., BAL_1 and BAL_2, and potentially a third zone). The BAL_1 water-bearing zone occurs at an elevation just above or slightly below the elevation of the Columbia River (Lake Umatilla Pool). The BAL_2 water-bearing zone occurs at an elevation about 40 ft below the elevation of Lake Umatilla. There appears to be a low permeability flow interior separating the two BAL water-bearing zones. The water-level elevation gradient is steep in all three zones and generally toward the Columbia River. The vertical gradient between the water bearing zones is downward. However, the steep gradient does not indicate significant groundwater flow. Site contaminants have migrated downward to the BAL in limited areas and at significantly lower concentrations than in shallower aquifer zones. Three north-south trending fault/fracture systems have been identified at the site: 1) near the stormwater pond and extending south to Wetland K Spring 01 (the Eastern Intermittent Drainage), 2) in the eastern portion of the plant area and extending south to the NPDES drainage and 3) in the Western Intermittent Drainage that extends from the western portion of the former plant area to the Boat Basin. It appears that groundwater may migrate both vertically and horizontally along these fault/fracture systems. Springs are found associated with Wetland K and Wetland F in the Eastern and Western Intermittent Drainages respectively. These fracture/fault zones also coincide with topographic lows and in some cases correspond to engineered drainage features (i.e., stormwater pond, NPDES Ponds). BAU zone groundwater flow directions converge on the fracture zone at the east end of the plant and in the Western Intermittent Drainage. The stormwater pond (SWMU 32) and associated Stormwater Collection System (Plant Area AOC), Plant Area AOC Groundwater Collection System, Industrial & Monitoring System, and SE System affects groundwater contaminant migration in the UA and BAU aquifer zones within the plant area. Based on the WPA water-level elevations, there is a groundwater mound in the central part of the site that extends southward from the area of the Tertiary Treatment plant all the way to the area of the stormwater pond. This feature can be seen in the water-level elevation contour maps for both the UA Zone and the underlying BAU zone, which indicates significant hydraulic communication between the UA and BAU zone. A key observation and finding of the WPA related to Groundwater Collection System interactions is that the stormwater pond backs up into the groundwater and stormwater lines and forms a groundwater mound in the stormwater pond vicinity. A second important finding of the WPA is that one large and significant breach was observed in the SE line in eastern Courtyard A-4. This portion of the SE line is partially below the water table and groundwater was observed flowing into the pipe. The pipe that discharges water to the head of the NPDES Ponds is the extension of the SE System connected at MH18L4 and downstream of the breach. Conceptually, discharge from the SE line outfall at the head of NPDES Pond A ceases when water-level elevations in the mound area drop to below the elevation of the breach in the SE line. Based on groundwater line flow measurements and the water balance assessment, the groundwater line represents the biggest inflow to the stormwater pond and is the cause of the line backup and shallow groundwater mounding. The stormwater pond recharges the BAU aquifer zone in the pond vicinity and recharges Wetland K. Based on gradient, hydraulic conductivity and aquifer zone geometry, recharge of Wetland K represents the biggest outflow from the stormwater pond. The water balance for the NPDES Pond A and B drainage, Wetland K Spring area (Eastern Intermittent Drainage), Wetland F spring Area (Western Intermittent Drainage show that evaporation and evapotranspiration do not balance inflows (i.e., pipe discharge at the head of NPDES Pond A, and groundwater recharge in the case of Wetland springs) within the drainages. This suggests that infiltration and potential downgradient groundwater migration may occur within the drainage areas. The lag and dampening analysis further support the findings of the initial RI hydrographs that suggested limited hydraulic connection between the shoreline BAL zone wells and the Lake Umatilla Reservoir. A more detailed analysis of head differences between the shoreline wells and the reservoir also showed that the gradient is from the reservoir to the shoreline wells 66 percent to 76 percent of the time.	The GWAOC is recommended for further evaluation in the FS based primarily on MTCA and/or MCL groundwater screening level exceedances of fluoride and sulfate in several wells during multiple rounds of sampling in all three aquifer zones. Specific source areas that will be further evaluated in the GWAOC FS include the following: • **Western Portion of the Site.** The WSI (SWMU 4) and the West SPL Storage Area (SWMU 13) are associated with a persistent fluoride and sulfate groundwater plume in this area. Both closed units have designed caps. The WSI is subject to a long-term monitoring groundwater monitoring program and the West SPL Storage Area cap inspection and maintenance program was recently resumed during 2021 and will be continued on an annual basis. • **Eastern Portion of the Plant Footprint**. In the eastern portion of the plant, a fluoride groundwater plume is present in the UA, BAU, and BAL aquifer zones. The North and South Pot Liner Soaking Stations (SWMUs 10 and 11) and East SPL Storage Area (SWMU 12) are likely source areas of groundwater contamination in this area based on the groundwater results and soil results. A leaking river line catch basin is infiltrating into the subsurface on the upgradient side of the North SPL Pot Liner Storage area and may be recharging the shallow aquifer zone in this area. A significant thickness of mixed construction and smelter waste including suspected SPL (up to about 15 feet thick) is found at the EELF (SWMU 17) that likely serves as a source of groundwater contamination. Elevated concentrations of fluoride and sulfate were found in recently installed well WPA-GW12-BAU located in the waste footprint. The SE line near this well may also be leaking and infiltrating water in this area. • **Water and Wastewater Lines**. The groundwater lines, stormwater lines, Industrial & Monitoring lines, and SE lines (Plant Area AOC) all appear to affect groundwater contaminant migration in the Plant Area as discussed in Section 2.4 of this Volume as well as Volume 3, Section 2.5. The stormwater pond will be evaluated in the GWAOC FS, and all of the various line groups will be evaluated in the Plant Area AOC FS and considered as appropriate as related to cleanup of groundwater in the GWAOC FS. • **Other Suspected Groundwater Sources in the Plant Area Footprint.** In this central area of the plant footprint, the fluoride and sulfate shallow aquifer plumes appear to be related to scrubber treatment system piping releases associated with the Line A Secondary Scrubber Recycle Station (SWMU 5), Lines B, C, and D Secondary Scrubber Recycle Stations (SWMU 6), Tertiary Treatment Plant (SWMU 8), as well as the South Dry/Wet $S0_2$ scrubber and associated piping beneath Passage No. 4 and in the area of the clarifiers east of the Tertiary Treatment Plant. Refer to Volume 4 Section 2.4 for a summary of the lines and water-level elevations and groundwater contaminant distribution in this area. The Former Compressor Building USTs will be considered in the GWAOC FS due to exceedances of soil and groundwater screening levels for TPH-related constituents in this area • **Eastern Area.** The NESI subarea (part of SWMU 31) has buried solid waste mixed carbon waste zone (that includes suspected SPL) up to 8-feet thick with wastes in contact with shallow groundwater. The wastes are adjoining a wetland area and the wetland spring and nearby monitoring wells are characterized by elevated fluoride concentrations. The ESI (SWMU 2) represents a capped and closed unit that has undergone groundwater monitoring for several years. Elevated concentrations of fluoride and sulfate in shallow groundwater persist in this area. There is groundwater mounding within the capped area as evidenced by the groundwater water-level elevation pattern. MW-1 is located east of the ESI. The material in well MW-1 is characterized by a few low-level exceedances of groundwater screening levels. However, because the nature and quantity of the purple/pink material remains unclear, further evaluation is recommended.	**Yes**

Table 4-1
Areas of Concern (AOC) Major Findings and Recommendation Summary
Columbia Gorge Aluminum Smelter Site, Goldendale, Washington
(Page 2 of 2)

Area of Concern (AOC)	Major RI Findings Summary	RI Recommendation	FS Evaluation (Yes/No)
Wetlands	• In general, PAH concentrations exceeded ecological soil screening levels for wildlife protection of 1.1 mg/kg as total HMW PAHs at several wetland locations. At Wetland K, soil samples exceed MTCA Method B screening levels of 0.1 mg/kg for TTEC that were used for screening levels in this open space zoned area. • Wetland springs are characterized by fluoride concentrations above MTCA Method B groundwater screening level of 0.96 mg/L over a widespread area and exceed the MCL of 4.0 mg/L in a few locations. • At Wetland D, elevated PAH, arsenic, and sulfate soil concentrations in soil coincide with former location of the Duck Pond based on historical aerial photograph review. • At Wetland K, elevated PAH concentrations are widespread and occur in both channel and non-channel areas. • Based on a review of historical aerial photographs, the wetlands were created during plant construction and historical operations and do not appear to represent natural features that pre-date the period of plant operations.	The Wetlands AOC will be included in the FS based the soil chemical results including Wetlands D, E, G, H, I, J, K, and L. Of site contaminants, only low concentrations selenium (maximum of 1.4 mg/kg) that exceeded terrestrial ecological soil screening level for wildlife protection of 0.3 mg/kg were detected in soils at Wetlands F and M. The selenium concentrations in wetland areas will be further evaluated in the FS to determine if inclusion of these wetlands in the FS is warranted. In addition, discharges of contaminated groundwater through springs at Wetland D, K, F, the NESI wetland, and Cliffs Spring 07 will be addressed, as appropriate, as part of the GWAOC, the Stormwater Pond and Appurtenant Facilities (SWMU 32), and SWMU 31 NESI FS evaluations.	**Yes**

a The application of industrial soil cleanup levels for the site is appropriate based on future land use considerations as discussed in Volume 1, Section 5 of this report. Although no further action is recommended for portions of AOCs, the application of MTCA Method C for site cleanup requires consideration of appropriate institutional controls to be implemented in accordance with the Washington Administrative Code (WAC) 173-340-440. The FS will include evaluation of institutional controls where no further remedial action is recommended.

COPC – Chemicals of Potential Concern
ESI – East Surface Impoundment
ft bgs – feet below ground surface
FS – Feasibility Study
GWAOC – Groundwater Area of Concern
HMW – High molecular weight PAH
LMW – Low molecular weight PAH
MCL –Maximum Contaminant Level for drinking water
mg/kg – Milligrams per kilogram
mg/L – Milligrams per liter
MTCA – Model Toxics Control Act
NESI – North of the East Surface Impoundment
NPDES – National Pollutant Discharge Elimination System
PAH –Polynuclear Aromatic Hydrocarbons
PCB – Polychlorinated Biphenyls
SE – Scrubber Effluent Line
SWMU – Solid Waste Management Unit
TPH– Total Petroleum Hydrocarbon
µg/L – Micrograms per liter
UST – Underground storage tank
WPA – Work Plan Addendum