Remedial Investigation Report

CFAC Facility
2000 Aluminum Drive
Columbia Falls, Montana

February 21, 2020

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Acronym List

Acronym	Definition
%	Percent
ºC	Degrees Celsius
ºF	Degrees Fahrenheit
ADI	Average Daily Intake
AGI	Amplified Geochemical Imaging, LLC
AOC	Administrative Order on Consent
ATV	All-Terrain Vehicle
AVS	Acid Volatile Sulfide
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BRAWP	Baseline Risk Assessment Work Plan
BTV	Background Threshold Value
BUU	Below Upper Hydrogeologic Unit
C	Contaminant Concentration
C	Solute Concentration
CaF_2	Fluorite/Calcium Fluoride
$Ca_{5(}PO_4)_3F$	Apatite
CARB	California Air Resources Board
CCC	Criterion Continuous Concentration
CEM	Conceptual Exposure Model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFAC	Columbia Falls Aluminum Company, LLC
CFS	Cubic Feet Per Second
CM^3	Cubic Centimeters
CO_2	Carbon Dioxide
COC	Contaminants of Concern
COPC	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
Cr(III)	Trivalent Chromium
Cr(VI)	Hexavalent Chromium
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
dC/dx	Concentration Gradient
dh/dl	Hydraulic Gradient
DI	Dissolved (Filtered)
DO	Dissolved Oxygen
DQO	Data Quality Objective
DU	Decision Unit
EC	Exposure Concentration
ECSM	Ecological Conceptual Site Model
EDD	Estimated Daily Dose
EHS	EHS Support, LLC
ELCR	Excess Lifetime Cancer Risk

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Acronym	Definition
EPC	Exposure Point Concentration
ER	Electrical Resistivity
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESV	Ecological Screening Value
F	Mass Flux
FIPS2500	Montana State Plane Coordinate System
FNU	Formazin Nephelometric Units
FS	Feasibility Study
FT	Feet
FT^3	Cubic Feet
FT-AMSL	Feet Above Mean Sea Level
FT-BLS	Feet Below Land Surface
f_{oc}	Fraction of Soil Organic Carbon
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GW	Groundwater
HCN	Hydrogen Cyanide
HI	Hazard Index
HMW	High Molecular Weight
HQ	Hazard Quotient
I_H	Horizontal Hydraulic Gradient
IP	Induced Polarization
IRIS	Integrated Risk Information System
ISM	Incremental Sample Methodology
ITRC	Interstate Technology & Regulatory Council
IUR	Inhalation Unit Risk
J	Contaminant Mass Flux
K	Hydraulic Conductivity
K_d	Relative Mobility of a Chemical in the Environment
K_{oc}	Soil Adsorption Coefficient
K_{oc}	Organic Carbon Partitioning Coefficient
K_{ow}	Octanol-Water Partitioning Coefficient
KF	Potassium Fluoride
KG	Kilograms
L	Liter
LADI	Lifetime Average Daily Intake
LANL	Los Alamos National Laboratory
LiDAR	Light Detection and Ranging
LMW	Low Molecular Weight
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration
MAIC	Montana Alumina Investors Corporation
MATC	Maximum Acceptable Toxicant Concentration
MBMG	Montana Bureau of Mines and Geology
MCL	Maximum Contaminant Level

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Acronym	Definition
MDEQ	Montana Department of Environmental Quality
MDL	Method Detection Limit
MG	Milligrams
MI^2	Square Miles
MPDES	Montana Pollutant Discharge Elimination System
MSW	Municipal Solid Waste
n	Soil Porosity
n_e	Effective Porosity
Na_3AlF_6	Cryolite
NAD83	North American Datum 1983
NaF	Sodium Fluoride
$NaHCO_3$	Sodium Bicarbonate
NAVD88	North American Vertical Datum 1988
NHD	National Hydrography Dataset
NM	Not Measured
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NRWQC	National Recommended Water Quality Criteria
NTU	Nephelometric Turbidity Unit
ORNL	Oak Ridge National Laboratory
ORP	Oxygen Reduction Potential
ρ	Bulk Density of the Soil
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
pE	Redox Potential
PID	Photoionization Detector
PLM	Polarized Light Microscopy
PPRTV	Provisional Peer-Reviewed Reference Toxicity Value
PRAO	Preliminary Remedial Action Objective
PRG	Preliminary Remediation Goals
q_0	Groundwater Flux/Discharge
QA	Quality Assurance
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RAO	Remedial Action Objective
RBSSL	Risk Based Soil Screening Level
R_f	Retardation Factor
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RI	Remedial Investigation
RIR	Remedial Investigation Report

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Acronym	Definition
RSL	Regional Screening Level
SAB	Suspended and Bedded Sediment
SAJ&AE	Shari A. Johnson & Associates Engineering, PLLC
SAP	Sampling and Analysis Plan
SEM	Simultaneously Extracted Metals
SC	Site Characterization
SLERA	Screening Level Ecological Risk Assessment
SMDP	Scientific Management Decision Point
SOP	Standard Operating Procedure
SPL	Spent Potliner
SVOC	Semivolatile Organic Compounds
SW	Surface Water
T	Total (Unfiltered)
TEF	Toxicity Equivalency Factor
TEQ	Toxic Equivalency
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
µg	Microgram
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UU	Upper Hydrogeologic Unit
v	Seepage Velocity
V	Specific Discharge/Darcy Velocity
v	Effective Velocity of the Groundwater
v_c	Velocity of the Contaminant
VOC	Volatile Organic Compound
WET	Whole Effluent Toxicity
WP	Work Plan

Executive Summary

Introduction

On behalf of Columbia Falls Aluminum Company, LLC (CFAC), Roux Environmental Engineering and Geology, D.P.C. (Roux), has prepared this Remedial Investigation Report (RIR) as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) of the Superfund Site referred to as Anaconda Aluminum Co. Columbia Falls Reduction Plant, located two miles north-east of Columbia Falls in Flathead County, Montana (hereinafter, "the Site"). The RI/FS is being conducted pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) dated November 30, 2015, between CFAC and the United States Environmental Protection Agency (USEPA) (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 08-2016-0002).

The purpose of this RIR is to present the results of the multiple phases of the Remedial Investigation (RI), including the Phase I Site Characterization (SC), the Supplemental South Pond Assessment, and the Phase II SC completed at the Site from April 2016 through November 2018; and also to summarize the scope and results of the Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA) prepared for the Site. The results each phase of the RI are included in the following reports and are included as appendices to this RIR: Phase I SC Data Summary Report (Appendix A), Groundwater and Surface Water (GW/SW) Data Summary Report (Appendix B), Phase II SC Data Summary Report (Appendix C), BHHRA (Appendix D), and BERA (Appendix E). Collectively, the information presented in this RIR provides the foundation to support the development and evaluation of remedial alternatives in the Feasibility Study (FS).

As described in Section 1 of the RI/FS Work Plan (Roux, 2015), the RI/FS was designed to meet the following study objectives:

- Objective 1: Identify and characterize sources of contaminants of potential concern (COPCs);
- Objective 2: Determine the nature and extent of Site-related COPCs in environmental media at the Site (i.e., soil, groundwater, surface water, sediment, and sediment porewater);
- Objective 3: Understand the fate and transport of COPCs in environmental media at the Site;
- Objective 4: Identify any complete or potentially complete exposure pathways (considering current and also potential future land use);
- Objective 5: Evaluate current and potential future human health and ecological risks posed by the COPCs present at the Site; and
- Objective 6: Conduct an evaluation of remedial alternatives for the Site.

Objectives 1 through 5 have been achieved through the performance of the RI, as documented in subsequent sections of this RIR. Objective 6 will be the focus of the upcoming FS, for which a FS Work Plan (FSWP) is currently being prepared.

Site Background

The Site is located at 2000 Aluminum Drive near Columbia Falls, Flathead County, Montana. The Site is approximately two miles north-east from the center of Columbia Falls and is accessed by Aluminum Drive via North Fork Road (County Road 486). The boundaries of the Site were defined in the RI/FS Work Plan (Roux, 2015a) and are depicted on Figure 1. The Site consists of approximately 1,340 acres bounded by

Cedar Creek Reservoir to the north, Teakettle Mountain to the east, Flathead River to the south, and Cedar Creek to the west.

The Site was operated as a primary aluminum reduction facility (commonly referred to as an aluminum smelter) from 1955 until 2009. A description of the ownership and operational history is provided in Section 1.3.2. Buildings and industrial facilities associated with former operations remaining at the Site at the start of the RI/FS in 2016 included offices, warehouses, laboratories, mechanical shops, a paste plant, coal tar pitch tanks, pump houses, a casting garage, and the potline facility. Decommissioning of the industrial facilities was completed in the third quarter of 2019.

The Site also includes seven closed landfills, one open landfill that hasn't been used since 2009, material loading and unloading areas, two closed leachate ponds, and several percolation ponds. A map showing the locations of these and other Site features is provided for reference on Figure 2. The south end of the Site includes the switch yard (Rectifier Yard) jointly owned by CFAC and Bonneville Power Administration and the mainline of the Burlington Northern Santa Fe Railway. A description of the various Site features is provided in Section 1.3.4.

There are no ongoing manufacturing or commercial activities at the Site. A definitive future land use plan has not been developed for the Site; however, the former production area of the Site is anticipated to be used for industrial/commercial purposes. CFAC maintains a limited on-Site staff that is responsible for the maintenance of the remaining buildings and infrastructure at the Site, as well as maintenance associated with existing landfills and stormwater management system.

The Flathead River, which forms the southern border of the Site, is used for recreational activities, including: boating, floating, kayaking, hunting, fishing, and bird-watching water activities. In addition, it has been documented that trespassers also may utilize other portions of the Site for recreational purposes, including all-terrain vehicle (ATV) riding, hunting, and fishing.

The nearest residences are located adjacent to the south-west Site boundary, approximately 0.80 miles west of the historical footprint of Site operations, in a neighborhood referred to as Aluminum City. The nearest groundwater wells used for drinking water are located within the Aluminum City neighborhood.

Several production wells historically pumped groundwater that was used both for industrial operations and for potable water. However, electric power to these wells was terminated as part of Site decommissioning activities. Therefore, existing on-Site wells are non-operational, and they are not currently used for potable water.

Remedial Investigation Activities Summary

The following provides an overview of environmental investigations performed at the Site related to the RI/FS. A detailed description of the results of the investigations are provided in the respective reports and are summarized together in the Phase II SC Data Summary Report. The results of the BERA and BHHRA are described in their respective reports. The scope of work and results of each report are described in more detail throughout the various sections of this RIR.

Phase I SC Data Summary Report – 2017

CFAC and Roux completed a Phase I SC from April 2016 through July 2017, which included the collection and laboratory analysis of soil, sediment, groundwater, and surface water samples from within and around

Site features. The Phase I SC activities were performed in accordance with the USEPA-approved Phase I Sampling and Analysis Plan (SAP) and SAP Addendum (Roux, 2015b; 2016a). The results of these field activities are provided in the Phase I SC Data Summary Report.

<u>Screening Level Ecological Risk Assessment (SLERA) – 2017</u>

The SLERA, completed by Roux and CFAC, provided an assessment of potential risks to ecological receptors that may be exposed to constituents from the Site. The SLERA evaluated the aspects of the Site that could influence potential exposures and risks to ecological receptors.

Based on the review of the historical processes and data collected during the SLERA, preliminary contaminants of potential ecological concern (COPECs) were identified in surface water, sediment, and surface soil to which ecological receptors could potentially be exposed. Based on these results, it was determined that the conclusions of the SLERA are insufficient to dismiss potential ecological risk, and further data gathering, or data analyses was recommended to better understand the risk.

<u>GW/SW Data Summary Report – 2018</u>

The GW/SW Data Summary Report, completed by Roux, summarizes the results of groundwater and surface water investigations that were completed from August 2016 through July 2017 to achieve the Phase I SC objectives listed in the RI/FS Work Plan (Roux, 2015a).

<u>Phase II SC Data Summary Report – 2019</u>

The Phase II SC program, completed by Roux, was designed to address any outstanding data gaps in order to conduct a risk assessment and complete the RI. CFAC and Roux completed a Phase II SC from June 2018 through October 2018, which included the collection and laboratory analysis of soil, sediment, groundwater, surface water, and porewater samples from within and around Site features. Within the same time period, a Background Investigation was conducted which included collection and laboratory analysis of soil, sediment, and surface water samples from reference areas outside of the Site boundaries. The Phase II SC activities were performed in accordance with the USEPA-approved Phase II SAP and the Background Investigation SAP (Roux, 2018c; 2018d). The results of the Phase II SC and Background Investigation field activities are provided in Sections 4 and 5 of the Phase II SC Data Summary Report, respectively. The Phase II SC Data Summary Report also summarizes the Supplemental South Pond Assessment sampling that was completed under the Expedited Risk Assessment SAP (Roux, 2017c).

<u>BHHRA – 2019</u>

The objective of the BHHRA, completed by EHS Support, LLC (EHS) was to characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action based on the conceptual investigation framework presented in the BHHRA Work Plan (EHS Support, 2018a). The BHHRA provides the basis for determining whether remedial action is necessary to address potential risk to human health in the various exposure areas identified at the Site, as well as the extent of remedial action required. The BHHRA supports the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to contaminants of concern (COCs).

<u>BERA – 2019</u>

The overall purpose of the BERA, completed by EHS, was to evaluate whether environmental conditions associated with historical operations at the Site pose an unacceptable risk to ecological receptors based on the conceptual investigation framework presented in the BERA Work Plan (EHS Support, 2018b). Similar to the BHHRA, the BERA provides the basis for determining whether remedial action is necessary to address potential risk to ecological receptors in the various exposure areas identified at the Site, as well as the extent of remedial action required.

Nature and Extent of Contamination

Multiple phases of investigation were completed as part of the RI in order to generate a comprehensive dataset for the Study Area. A summary of the scope of work for each investigation phase of the RI, including the Phase I SC, Supplemental South Pond Assessment, Phase II SC, and the Background Investigation, is provided in Section 2.

Approximately 39 chemicals were retained as COPCS for evaluation in the BHHRA and approximately 40 chemicals were retained as COPCs for evaluation in the BERA. However, the results of the risk assessments indicated that only a subset of COPCs contribute to risk estimates that exceed *de minimis* levels for potential human health risk (i.e., excess lifetime cancer risk of 1E-6 for carcinogens; or hazard quotient of 1 for non-carcinogens) or pose moderate risk from the ecological perspective[1]. Thus, these COCs contributing to risk exceeding *de minimis* levels were the focus for in-depth evaluation within the nature and extent of contamination sections of this RIR. In addition, although cyanide and fluoride are not risk drivers with respect to soil, both of these primary COCs were retained for in-depth evaluation of their nature and extent in soil due to their prevalence in groundwater and surface water.

Nature and Extent of Cyanide and Fluoride

Based on review of the box and whisker plots and statistical summary tables (Appendices Q1 and Q2 and Tables 11 and 12), cyanide concentrations in soil across the Site ranged from <0.02 to 137 mg/kg. The highest concentrations of cyanide in soil were generally found in the former industrial and operational areas of the Site including the Central Landfills Area, Main Plant Area, and North Percolation Ponds; as well as the South Percolation Ponds and Backwater Seep Sampling Area. Concentrations of cyanide in the South Percolation Ponds are higher than those in the Main Plant Area and Central Landfills Area but are generally within the same order of magnitude. Outside of the Former Drum Storage Area, concentrations of cyanide in soil in the Central Landfills Area were generally similar to or less than those observed in the other industrial areas of the Site. Concentrations of cyanide observed in the undeveloped areas of the Site, the Industrial Landfill Area, and the Flathead River Area are similar to the range of background concentrations. As described in the Phase II Data Summary Report and BHHRA, concentrations of COCs generally decrease with increasing depth. The surface soil interval (0 to 0.5 feet below land surface [ft-bls]) generally has the greatest concentrations of COCs.

Based on review of the box and whisker plots and statistical summary tables (Appendix Q3 and Tables 11 and 12), fluoride concentrations in soil across the Site ranged from <0.014 to 810 mg/kg, with the highest

[1] BERA Soil COC selection criteria:
Med-Large Home Range Wildlife: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Small Home Range Wildlife: Sample points exceeding LOAEL-based back calculated value;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance);
ISM samples: localized exceedance was not justification for removal based on averaged EPC across DU;
PAH direct contact exposure selected based on exposure areas with points exceeding MATC.
BERA Sediment/Porewater selection criteria:
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance).

concentrations in the Main Plant, North Percolation Ponds, and Central Landfill Area; and a single high detection in the Industrial Landfill Area. Outside these areas, fluoride concentrations within the Site were less than those observed in the industrial areas, and typically ranged between 1 to 20 mg/kg. Concentrations of fluoride in background areas were generally less than concentrations on-Site, with the exception of Background Reference Area #4 which is within the same order of magnitude (i.e., 1 to 10 mg/kg) as the undeveloped areas, Flathead River Area, South Percolation Ponds, and the majority of the Industrial Landfill Area. The average concentration of fluoride generally decreased with increasing depth.

Cyanide and fluoride are identified as the primary COCs in groundwater based upon the frequency of detection and exceedance of water quality standards, as well as based upon contribution to estimated risks at the Site. Concentrations are highest adjacent to the primary source areas within the Plume Core Area, (footprint of elevated concentrations of cyanide and fluoride in upper hydrogeologic unit groundwater), including the West Landfill and Wet Scrubber Sludge Pond. Groundwater statistical summary tables are included in Table 4. Cyanide and fluoride emanate from this source area (as described further in Section 8.2) and migrate in south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the Plume Core Area were less than one-half of the MCL in all six rounds of sampling and are typically non-detect or at background concentrations[2] adjacent to Aluminum City.

Based on review of the box and whisker plots and statistical summary tables (Appendices R1, R2, R3, and R4 and Table 15), cyanide concentrations in surface water ranged from <2 to 630 µg/L, with the majority of the highest concentrations in the Backwater Seep Sampling Area and Riparian Sampling Area, followed by the South Percolation Ponds and North Percolation Ponds. The distribution of free cyanide was similar to total cyanide, but at lower concentrations. The hydrogeologic studies (i.e., groundwater and surface water elevation data) indicate that groundwater discharges to the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; and ultimately to the Flathead River. Thus, the source of elevated cyanide concentrations in these Site features is groundwater. Concentrations of cyanide in the remaining surface water features (Flathead River, Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and Northern Surface Water Feature) were mostly non-detect (i.e., <2 µg/L).

Based on review of the box and whisker plots and statistical summary tables (Appendices S1 and S2 and Table 16), cyanide concentrations in sediment ranged from <0.067 to 8.5 mg/kg, with the highest concentrations occurring in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds). Concentrations in the Flathead River, Cedar Creek, and the Northern Surface Water Feature were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as cyanide concentrations in background sediment.

Based on review of the box and whisker plots and statistical summary tables (Appendix R5 and Table 15), fluoride concentrations in surface water ranged from <12 to 22,400 µg/L, with the highest concentrations in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds. Concentrations in the Flathead River, Cedar Creek, the Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature were markedly lower and generally within the same order of magnitude as fluoride concentrations in background surface water.

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2 Within the western and northern portions of the Site, the detections of fluoride in groundwater are similar to the average 160 µg/l concentration measured in public and community water supply wells.

Based on review of the box and whisker plots and statistical summary tables (Appendix S3 and Table 16), fluoride concentrations in sediment ranged from <0.17 to 219 mg/kg, with the maximum concentration in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area. Concentrations of fluoride in the Northern Surface Water Feature were less than those in the North Percolation Ponds and the Backwater Seep Sampling Area/Riparian Sampling Area, but at concentrations higher than background sediment. Concentrations in the Flathead River and Cedar Creek were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as concentrations in background sediment.

<u>Nature and Extent of Polycyclic Aromatic Hydrocarbons (PAHs)</u>

For presentation purposes, benzo(a)pyrene was selected as an indicator analyte for PAHs because it was the most frequently detected at elevated concentrations, and it is the PAH that contributes most to estimated risk in each exposure area.

Based on review of the box and whisker plots and statistical summary tables (Appendix Q4 and Tables 11 and 12), benzo(a)pyrene concentrations in soil range from <0.001 to 2,000 mg/kg, with the highest concentrations in the North-Percolation Ponds and Main Plant Area. Concentrations of benzo(a)pyrene were generally similar throughout the Central Landfills Area, Industrial Landfill Area, South Percolation Ponds, and Eastern Undeveloped Area, with the exception of a few high concentrations in the Central Landfills Area and Industrial Landfill Area. Benzo(a)pyrene concentrations were lowest within the North-Central and Western Undeveloped Areas, the Flathead River Area, and the Backwater Seep Sampling Area. Within these areas, concentrations were similar to, or within the same order of magnitude, as background reference areas. The average concentration of benzo(a)pyrene generally decreased with increasing depth.

Semivolatile organic compounds (SVOCs) were detected in less than 6% of groundwater samples collected from monitoring wells screened in the upper hydrogeologic unit throughout the RI (Table 14a of the Phase II SC Data Summary Report). Groundwater statistical summary tables are included in Tables 13 and 14. In general, SVOCs are not impacting groundwater quality across the Site, with the exception of isolated detections in a few monitoring wells.

The results of the RI indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of PAHs in sediment, followed by the effluent ditch, and the North-West Percolation Pond. The soils/sediments within the North Percolation Pond appear to be the source of the PAHs in the pond surface water (as described further in Section 8.2). As presented in the box and whisker plots and statistical summary tables (Appendices R7 and S4 and Tables 15 and 16), concentrations of benzo(a)pyrene in sediment and surface water are highest in the North Percolation Ponds, followed by the Backwater Seep Sampling Area.

<u>Nature and Extent of Metals</u>

The areal distribution of the detected metals is widespread across the Site. Sixteen different metals were detected at frequencies between 90% and 100% of the samples collected. It should be noted that all of the metals detected can be found as naturally occurring substances in the environment. Based on their frequency of detection and magnitude of concentrations, select metals are indicative of naturally occurring substances in the environment, as documented via the Background Investigation included as Section 4.4.2.3 within the Phase II SC Data Summary Report. However, the areal distribution of metal detections and the magnitude of metal concentrations around certain Site features indicate that concentrations of some metals are in part a result of the former operations. This is most evident for the North Percolation Pond Area, and to a lesser extent for soil samples from within the Main Plant, Central Landfill, and Industrial Landfill Areas. Concentrations of metals driving risk are presented in a soil statistical summary, included in Tables 11 and 12, and soil box plots, included in Appendices Q6 through Q14.

The results of the RI confirmed that many metals, which can naturally occur in the environment, were detected frequently in groundwater samples. The most commonly detected metals in groundwater in all six sampling rounds were barium, calcium, potassium, and sodium, which were detected in 100% of groundwater samples. The highest concentrations of these metals were limited to monitoring wells located downgradient of the West Landfill and Wet Scrubber Sludge Pond.

Total concentrations of antimony, arsenic, barium, lead, mercury, and thallium were detected at elevated concentrations in surface water samples. As presented in Table 15, elevated concentrations of metals in surface water were most commonly observed in the North and South Percolation Ponds and Riparian Sampling Area.

Thirteen different metals were detected in 100% of sediment samples collected during the RI. Aluminum and arsenic were detected at the highest concentrations in sediment. A single elevated concentration of aluminum occurred in the sediment sample collected from CFSDP-024 within the North-East Percolation Pond; while elevated arsenic was wide-spread throughout the sediment samples, but were highest in the North Percolation Ponds, Backwater Seep Sampling Area, and Riparian Sampling Area.

Nature and Extent of Polychlorinated Biphenyls (PCBs)

PCBs were detected in 2% of all soil samples. The most commonly detected type of PCB was Aroclor 1254. Aroclor 1254 was observed in one surficial soil sample (CFSB-227 in the Central Landfill Area with a concentration of 1.2 mg/kg) and in four samples (shallow sample collected from CFSB-224, surface and shallow sample collected from CFSB-227, and shallow sample collected from CFSB-229), all in the Central Landfill Area within the footprint of the Operational Area, south of the West Scrubber Sludge Pond. Aroclor 1254 was also detected in three surface samples and one shallow sample collected west of the West Rectifier Yard within the Main Plant Area. As presented in the box and whisker plots and statistical summary tables (Appendix Q5 and Tables 11 and 12), aroclor 1254 was not detected in any other exposure areas. PCBs were not detected in any sediment samples.

Detailed Discussion of Individual COCs

A discussion of individual COCs contributing to risk at the Site is provided below. The discussion addresses ranges of concentration, vertical and horizontal extent of contamination, and spatial patterns of contamination within the Site, and (where applicable) comparison to BTVs to assess if hot spots or areas of elevated concentrations relative to background concentrations are present. Comparisons to human health and ecological screening criteria are not included in the discussion below; all comparisons to screening levels are discussed in Section 7 and provided in the Phase II SC Data Summary Report.

Sources of COCs in Site Media

The RIR identified the following Site features as potential source areas:

- Main Plant Area;
- Landfills;
- Percolation Ponds; and

- Former Drum Storage Area.

A summary of each potential source area is provided below.

Main Plant Area

The findings from the RI indicate that concentrations of PAHs, cyanide, and fluoride are the primary COCs present in soil throughout the Main Plant Area based upon the frequency and magnitude of exceedances of screening levels. However, these concentrations in soil do not appear to be a significant source of cyanide and fluoride in groundwater. Despite the widespread occurrence of PAHs in soil across the area and the exceedances of various screening criteria, PAHs are generally non-detect in groundwater in all sampling rounds. The concentrations of cyanide and fluoride in groundwater within and downgradient (south) of the Main Plant Area are less than those measured in wells upgradient (north) of the Main Plant Area near the landfills, suggesting that the Main Plant soils are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the soils were a significant source, an increase in cyanide and fluoride concentrations would be expected).

Landfills

The West Landfill and Wet Scrubber Sludge Pond are the primary sources of cyanide and fluoride in groundwater at the Site. The iso-concentration maps indicate that the highest cyanide and fluoride concentrations in groundwater appear to originate at the Wet Scrubber Sludge Pond and the West Landfill consistently during all six rounds of sampling. Adjacent to the West Landfill and Wet Scrubber Sludge Pond, groundwater elevations in the upper hydrogeologic unit can fluctuate more than 70 feet seasonally. Cyanide and fluoride emanate from this source area and migrate in south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the Plume Core Area were less than one-half of the USEPA MCL in all six rounds of sampling and are typically non-detect or at background concentrations adjacent to Aluminum City.

The Center Landfill is likely a secondary source area for the observed elevated cyanide and fluoride concentrations in groundwater, based on the elevated concentrations in groundwater adjacent to the landfill.

The results of the RI indicated that the Industrial Landfill, East Landfill, and Sanitary Landfill are not significant contributing sources to the cyanide and fluoride in groundwater.

Percolation Ponds

The results of the RI indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of cyanide and PAHs in soil and sediment, followed by the effluent ditch, and the North-West Percolation Pond. However, concentrations of cyanide and fluoride in groundwater downgradient (south) of the North Percolation Ponds are less than those measured in wells upgradient of the ponds. This continued decrease in concentrations as groundwater flows beneath the ponds suggests that the ponds are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the ponds were a significant source, an increase in cyanide and fluoride concentrations would be expected). Additionally, although SVOCs were detected frequently in North Percolation Pond soil, they were not detected in any groundwater monitoring wells immediately downgradient from the North Percolation Ponds, indicating that the SVOCs in soil are not a source to groundwater. However, it’s likely that the soils/sediments within the North Percolation Pond are the source of the COCs in the surface water from the pond.

The results of the RI indicate that the South Percolation Ponds are not a source of contamination at the Site, but as discussed below in Section 8.3, groundwater seepage and the migration of water from South Percolation Ponds could potentially impact surface water, sediment, sediment porewater within the Flathead River.

Former Drum Storage Area

In the Former Drum Storage Area, cyanide and fluoride were detected at elevated concentrations in surface and shallow samples but decreased by an order of magnitude with increasing depth. Based on this finding, this feature may be a contributing source to the elevated cyanide and fluoride concentrations in groundwater that appear to originate beneath this area and the West Landfill and Wet Scrubber Sludge Pond. However, the decrease in concentrations with depth and the absence of any observed waste materials suggest that any contribution from this area to groundwater contamination are much less than the contribution from the adjacent landfills.

Contaminant Fate and Transport

An evaluation of the fate and transport of COCs at the Site was conducted based upon knowledge of the Site physical characteristics, the concentrations and extent of COCs in various media, and source area characteristics. The evaluation considered the physicochemical characteristics of the COCs and various physical, chemical, and biological processes that influence contaminant fate and transport. The fate and transport analysis focused on contaminants that were identified as primary COCs through the risk assessment process, as described in Section 7. A summary of the fate and transport evaluation is provided below.

Migration of COCs from Source Areas

The results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective. All other primary COCs identified in soil, sediment, or surface water samples within the source areas appear to be stable and not migrating at levels of concern based upon risk assessment results.

The six rounds of groundwater sampling conducted during the RI indicate that the West Landfill and Wet Scrubber Sludge Pond appear to be the primary sources of the cyanide and fluoride in groundwater. The Center Landfill and Former Drum Storage Area appear to be potentially contributing sources, but to a lesser degree than the West Landfill and Wet Scrubber Sludge Pond.

A consistent pattern was observed during all six rounds of groundwater sampling; cyanide and fluoride migrates in a south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the contours shown on Plate 18 and Plate 19are less than one-half of the USEPA MCL in all six rounds of sampling. Cyanide concentrations are typically non-detect in the north, west, and south-west portions of the Site (e.g., near Aluminum City) during all rounds of sampling. These data, as well as the six rounds of groundwater flow data, indicate that migration of the cyanide and fluoride is not in the direction towards Aluminum City, but rather follows the southerly groundwater flow patterns towards the Flathead River. The findings also indicate that there is limited vertical migration and cyanide and fluoride are primarily migrating horizontally within the upper hydrogeologic unit.

The hydrogeologic studies (i.e., groundwater elevation data and surface water elevation data) indicate that groundwater discharges to the Flathead River. The Backwater Seep Sampling Area, the Riparian Sampling Area, and the South Percolation Pond Area are all located within the extent of the "Seep Area" where groundwater is expressed from the upper hydrogeologic unit to the Flathead River. Elevated concentrations of cyanide in sediment and sediment porewater are present in the Backwater Seep Sampling Area and Riparian Sampling Area. Elevated concentrations of fluoride in sediment porewater are present in the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; though fluoride was not detected at elevated concentrations in sediment in these features. These concentrations, along with the groundwater flow, indicate the groundwater is the primary source of the cyanide and fluoride concentrations in surface water, sediment, and sediment porewater measured in these areas. Concentrations of cyanide in surface water, sediment, and sediment porewater up-river in the Flathead River were typically non-detect, further supporting that groundwater discharge is the primary source of the cyanide in the sediment and surface water of the Backwater Seep Sampling Area and Riparian Sampling Area. In addition, direct discharges into the South Percolation Ponds could have contributed to surface water and sediment impacts in this area.

All surface water, sediment, and sediment porewater samples collected within the main stem of the Flathead River downgradient of the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds during all six rounds of sampling were generally non-detect for total cyanide. Fluoride was generally detected in surface water and sediment samples collected within the main stem of the Flathead River downgradient of these areas, but at concentrations below screening levels; fluoride was typically not detected in sediment porewater samples. These findings confirmed that the elevated levels of cyanide and fluoride found in groundwater and in the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Pond, are not measurably impacting surface water, sediment, or sediment porewater quality within the main channel of the Flathead River.

Cyanide and Fluoride Flux

The results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective. Results of subsurface characterization and analytical laboratory testing were utilized to estimate the mass flux of cyanide and fluoride in the affected media (i.e., upper hydrogeologic unit groundwater). The purpose of the assessment was to evaluate the general areas of the Site where most of the groundwater COCs are located as a basis for evaluating potential future Site impacts and to focus on areas for evaluating potential remediation alternatives in the FS. Contaminant characteristics and physicochemical properties including leaching, advection and dispersion, diffusion, precipitation/dissolution, partitioning and adsorption, biological degradation and transformation, dilution, photolysis, and volatilization were considered as part of the fate and transport analysis.

The evaluations were conducted for areas directly downgradient of the primary source areas (i.e., landfills) and in areas south of the landfills along the groundwater flow path toward the Flathead River. Plate 20 and Plate 21 present the locations of groundwater flow transects and sub-transects that were evaluated for cyanide and fluoride in groundwater, respectively. In general, the transects cover the extent of the Plume Core Area and in some cases, extend outside the Plume Core Area. Groundwater velocity, contaminant velocity, and mass flux estimates were developed based on a number of interpretations and assumptions; therefore, the quantities presented should be considered approximate, order of magnitude estimates.

The results of the cyanide and fluoride mass flux is provided in Section 6.4. Data inputs and assumptions for calculations to generate these estimates, including Darcy velocity/specific discharge, groundwater effective velocity, and contaminant velocity are provided in Section 6.4.

The evaluation indicates that mass flux of cyanide and fluoride are highest immediately downgradient of the landfills, which is consistent with the understanding that the landfills are the primary source of cyanide and fluoride in groundwater. Contaminant flux decreases with increasing distance from the landfills. With respect to cyanide, the decrease in flux with increasing distance from the landfills is likely due to various attenuation process such as biodegradation and sorption.

Fluoride flux decreases by an order of magnitude downgradient of the landfills and north of the Main Plant Area. A potential explanation for this decrease in concentration is the precipitation of fluoride out of groundwater immediately outside and downgradient of the primary source area as described in Section 6.3.4.

The findings indicate that the cyanide and fluoride groundwater flux estimated just north of Flathead River is not measurably impacting the surface water quality of the main channel of the Flathead River. The observations noted above (i.e., cyanide and fluoride not measurably impacting Flathead River) were further evaluated by calculating the maximum concentration that could be expected in the river based upon the groundwater flux estimates previously described, assuming all the groundwater discharged to the river. The data inputs and assumptions for this estimate is provided in Section 6.4.3.

Baseline Human Health Risk Assessment

The BHHRA evaluated potential human health risks to receptors at the Site. Data collected during the RI investigation activities within each exposure area were used to characterize potential risks. The receptors evaluated in the current and future scenarios, as appropriate, included industrial workers (industrial worker, landfill management worker, stormwater management worker), construction workers, recreational trespassers (ATV rider and hunter), adolescent trespassers, adolescent and adult recreationist (boaters, floaters, and fisher), and residents (adult and child). The BHHRA included the evaluation of potential exposures to COPCs in soil, surface water, sediment, and groundwater, as well as the potential exposure to COPCs in fish (i.e., uptake of COPCs in surface water) by the recreationist (fisher) and exposure to COPCs in venison (i.e., uptake of COPCs in soil) by recreational trespassers (hunter). Default and Site-specific exposure assumptions were developed for these receptors.

Table 9-1 through Table 9-35 and Appendix I and Appendix J of the BHHRA presented the calculated cumulative risks for each receptor by COPC in each potentially complete exposure scenario identified in the Conceptual Exposure Model (CEM). Table 27 of this RIR (Table 9-36 of the BHHRA) presents a summary of the cumulative excess lifetime cancer risk (ELCR) and hazard index (HI) for each receptor.

Based on the evaluation of the BHHRA results, the following general conclusions can be drawn regarding human health risks at the Site.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

The conditions in the following exposure areas at the Site do not pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs. These exposure areas include:

- North-Central Undeveloped Area;
- Eastern Undeveloped Area;
- Western Undeveloped Area;
- South Percolation Pond Area;
- Flathead River Area; and
- Backwater Seep Sampling Area.

As shown in Table 27, it is noted that risk characterization results for the three undeveloped areas (i.e., Eastern, Western, and North-Central Undeveloped Areas) indicate a ELCR above 1E-06 or a non-cancer risk (HI >1) for exposure to surface soil. However in each case, the risk was due to the presence of arsenic or manganese in soil, both of which were found in background soil samples at comparable concentrations. Therefore, these are not attributable to Site-related contamination, but rather to naturally occurring background conditions.

In addition, it is noted in the Western Undeveloped Area that one isolated detection of bis(2-ethylhexyl) phthalate in groundwater, at a concentration of 73 µg/L at monitoring well CFMW-069 during the October 2018 sampling event resulted in a calculated risk of 1E-05 for drinking water exposure under the hypothetical future residential scenario evaluated for this area. The prior sample collected at this location in June 2018 was non-detect, with an MDL of 4.4 µg/L. Bis(2-ethylhexyl) phthalate is not a contaminant associated with historical operations at the Site, and it has not been identified at levels of concern anywhere on the Site. Given these factors and that bis(2-ethylhexyl) phthalate is recognized as common field and lab contaminant (associated with plasticware), the calculated risk appears overestimated and unrelated to Site-related contamination.

Exposure Areas That Pose Risks Due to Site-Related Contamination

The conditions in the following exposure areas at the Site pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs:

- North Percolation Pond Area;
- Main Plant Area;
- Central Landfills Area: and
- Industrial Landfill Area.

In addition, groundwater within the Plume Core Area poses risk based upon a hypothetical future residential drinking water scenario.

The key conclusions with respect to each of the above areas are presented below.

North Percolation Pond Area: This area presents high potential risk within the Site, with a calculated cumulative ELCR of 1E-04 for a stormwater management work scenario and 5E-05 for a trespasser scenario. In each case, the risk driver is exposure to PAHs within the pond. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the North Percolation Pond Area.

Main Plant Area: Risk in the Main Plant Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 8E-06 for the industrial worker scenario. Discrete samples were collected across the entirety of the Main Plant Area (i.e., 290 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the construction worker and trespasser scenarios to 2E-05 for the industrial worker scenario. The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the ELCR within the Main Plant Area. This area also exhibits some potential non-cancer effects with the HI of 4 (developmental, nervous, and thyroid target organ systems) for both the industrial and construction worker.

Central Landfills Area: Risk in the Central Landfills Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 1E-05 for the landfill management worker scenario. Discrete samples were collected across the entirety of the Central Landfills Area (i.e., 128 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the trespasser scenario to 3E-05 for the landfill management worker. The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the Central Landfills Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Central Landfill Area.

Industrial Landfill Area: The calculated cumulative ELCRs range from 2E-06 for the trespasser scenario to 1E-05 for the landfill management worker scenario. PAHs in soil are the primary risk driver for the Industrial Landfill Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Industrial Landfill Area.

Groundwater Plume Core Area: As noted within the BHHRA, CFAC intends to prohibit the use of groundwater beneath the Site for potable use. However, as required by USEPA, the BHHRA evaluated risk associated with exposure to groundwater within the Plume Core Area under a residential exposure scenario[3] to provide a conservative evaluation of potential health risk in the absence of any controls.

The Plume Core Area was defined based upon evaluation of the cyanide and fluoride extents in groundwater within the upper hydrogeologic unit as described in Section 3.1. Within this area, the calculated HIs for future adult exposure to cyanide, free cyanide, and fluoride are 7E+01, 2E+00, and 5E+00, respectively; and cumulative HI is 8E+01. The calculated HIs for future child exposure to cyanide, free cyanide, and fluoride are 1E+02, 4E+00, and 9E+00, respectively, and cumulative HI is 1E+02. The results indicate potential for non-cancer effects if groundwater within the Plume Core Area is to be used as a source of drinking water.

In addition to the non-cancer effects, the results of the BHHRA indicate a calculated cumulative ELCR of 2E-04 for lifetime exposure (i.e. including exposure as a child, adolescent, and adult) to arsenic in groundwater under a future residential exposure scenario. Review of the data indicates that the EPC of 9.8 µg/L is primarily driven by elevated concentrations measured in two wells (CFMW-012 and CFMW-015), where maximum concentrations were approximately 92 µg/L. The vast majority of wells within the Plume Core Area are non-detect for arsenic, with the typical MDL less than 1 µg/L.

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3 The BHHRA evaluated residential exposure in the Western Undeveloped Area including an assessment of the cumulative potential residential risks from exposure to soils and upper hydrogeologic groundwater (see BHHRA: Section 6.1.7 Western Undeveloped Area). In addition, the BHHRA assessed the cumulative potential residential risks from exposure to the plume core area groundwater as well as site-wide groundwater in the below upper hydrogeologic unit (see BHHRA: Section 6.1.13 Additional Groundwater Evaluation).

The objective of the BHHRA was to conservatively characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action. The BHHRA met this objective and provides the risk managers with the necessary information to support the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to COCs.

Baseline Ecological Risk Assessment

The findings of the BERA are summarized below to clearly identify the assessment procedures used, the potential risks identified, and the uncertainties associated with the conclusions. The BERA findings are evaluated for each ecological exposure area to support area-specific recommendations to guide risk management decision-making for the Site.

Terrestrial Exposure Areas

The overall results of the BERA for the terrestrial exposure areas are presented in Table 28 of this RIR (Table 8-1 of the BERA) and are summarized below.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

Current conditions in the following terrestrial exposure areas at the Site are not likely to result in adverse ecological effects resulting from exposure to Site-related COCs:

- the Eastern Undeveloped Area;
- the North-Central Undeveloped Area;
- the Western Undeveloped Area; and
- the Flathead River Riparian Area.

For the Eastern Undeveloped Area, North-Central Undeveloped Area, and Western Undeveloped Area, some sampling locations were identified with concentrations of barium or manganese that exceeded lowest observed effect concentration (LOECs) for terrestrial plants. However, these metals were present at concentrations consistent with background concentrations, and their presence was not attributed to Site-related pathways. Bis(2-ethylhexyl) phthalate in the Eastern Undeveloped Area exceeded a HQ_{NOAEL} (hazard quotient) of 1 for the yellow-billed cuckoo, a special status species that is evaluated based only no observed adverse effect levels (NOAEL) endpoints. However, as discussed in Section 7.1.7 of the BERA, bis(2-ethylhexyl) phthalate is not related to historical Site operations and is a common laboratory contaminant. Furthermore, it is not likely that yellow-billed cuckoo would be present at the Site due to its rarity in Montana and the absence of basic habitat requirements at the Site.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Current conditions in the following terrestrial exposure areas at the Site have the potential to result in adverse effects to terrestrial receptors:

- Main Plant Area;
- Central Landfills Area;
- Incremental Sampling Methodology Grid; and
- Industrial Landfill Area.

The key conclusions with respect to each of the above areas are presented below.

Main Plant Area

Risk estimates for the Main Plant Area, particularly in the north-central portion of this exposure area, indicate the potential for adverse effects associated with exposure to PAHs in soil within localized areas proximal to former operations. Direct contact exposure to PAHs in the Main Plant Area may result in adverse direct contact effects to terrestrial invertebrates in these localized areas. Exposure estimates for PAHs in soil resulted in wildlife ingestion HQ_{LOAEL} (lowest observed adverse effect levels) values that exceeded 1 for two avian receptors (the American woodcock and yellow-billed cuckoo), primarily due to the modeled ingestion of terrestrial invertebrates. In the northern portion of the Main Plant Area within the Operational Area footprint, there is potential for adverse effects for small mammals including the short-tailed shrew (exposure > HQ_{LOAEL} at 5 of 90 stations) and meadow vole (exposure > HQ_{LOAEL} at 9 of 90 stations).

Central Landfills Area

Risk estimates for the Central Landfills Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals, including copper, in soil within localized areas near the former Wet Scrubber Sludge Pond. The direct contact evaluation indicates that potential risk to soil invertebrates and terrestrial plants is low, although localized areas of PAHs and one elevated copper result at CFSB-002 (7,260 mg/kg) resulted in some NOEC and LOEC exceedances. Wildlife ingestion models indicate the potential for adverse effects to two avian receptors (the American woodcock and yellow-billed cuckoo) and short-tailed shrew associated with exposure to copper, PAHs, and aroclor 1254 assuming conservative exposure assumptions. However, wildlife exposure to copper was largely attributable to the anomalously high concentration at CFSB-002; EPCs for PAHs were also influenced by localized stations with elevated concentrations. Similar to the Main Plant Area, it is not likely that yellow-billed cuckoo would be exposed at estimated doses due to its rarity in Montana and the absence of basic habitat requirements in the Central Landfills Area. The modeled ingestion of terrestrial invertebrate prey items was the critical exposure pathway for wildlife receptors.

Incremental Sampling Methodology (ISM) Grid

Ecological risk estimates for the ISM Grid (i.e., Operational Area) were similar to risk estimates for overlapping areas within the Main Plant Area and Central Landfills Area. Direct contact exposure estimates indicate moderate risk to soil invertebrates and terrestrial plants based on soil exposure to PAHs and select metals, including copper, selenium (plants only), and zinc. Several of the DUs, particularly in the central third of the ISM Grid within the Central Landfills Area, contained concentrations of constituents that exceeded LOAEL-based benchmarks protective of small range receptors. Exceedances of LOAEL-based benchmarks in these DUs were primarily associated with LMW and HMW PAH exposure to the short-tailed shrew.

Industrial Landfill Area

Risk estimates for the Industrial Landfill Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals in soil. Risk estimates for the Industrial Landfill Area indicate limited potential for adverse effects associated with direct contact exposure to soil invertebrates and terrestrial plants. Wildlife ingestion models indicate estimated doses of nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) resulting in HQ_{LOAEL} values from 1 to 5 in the Industrial Landfill Area, primarily due to the modeled ingestion of terrestrial invertebrate prey items. As a result, nickel and PAHs in soil at the Industrial Landfills Area represent a moderate risk to ecological receptors due to direct contact and indirect ingestion exposure pathways.

Based on these findings, the potential for adverse effects to ecological receptors exposed to soil in localized areas of the Main Plant Area, Central Landfills Area, ISM Grid, and Industrial Landfill Area cannot be entirely dismissed under current conditions. Concern regarding ecological exposure is limited to small bird and mammal populations that may use modified and disturbed habitats in developed areas of the Site. However, concerns regarding exposure to receptors representing other trophic groups is reduced due to the low-quality habitat available in these areas under current, developed conditions relative to the undeveloped portions of the Site.

Transitional Exposure Areas

Transitional exposure areas were evaluated assuming both dry (terrestrial) and inundated (semi-aquatic/aquatic) conditions. The overall results of the BERA for the transitional exposure areas are presented in Table 29 of this RIR (Table 8-2 of the BERA; terrestrial scenario) and Table 30 of this RIR (Table 8-3 of the BERA; aquatic scenario) and are summarized below.

<u>Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination</u>

Current conditions in the following transitional exposure areas at the Site are not likely to result in adverse ecological effects resulting from the exposure to Site-related COCs:

- Cedar Creek Reservoir Overflow Ditch; and
- Northern Surface Water Feature.

Risk estimates for the Cedar Creek Reservoir Overflow Ditch indicate minimal risks to ecological receptors under dry and inundated scenarios. During periods of inundation, direct contact risk associated with surface water and sediment in the Cedar Creek Reservoir Overflow Ditch is expected to be minimal. Some exceedances of NOECs and LOECs in sediment and surface water were noted; however, consideration of BTVs, concentration gradients, the low magnitude and frequency of exceedances, and other factors indicate that Site-related toxicity related to these constituents is unlikely. For times of the year when inundation does not occur, direct contact risk to terrestrial organisms is expected to be negligible relative to background risk. Wildlife risks associated with direct and indirect ingestion pathways to exposure media within the Cedar Creek Reservoir Overflow Ditch were negligible. The small-range receptor evaluation indicated that a single sample in this exposure area had concentrations that exceeded only the NOAEL benchmark; however, no LOAEL-based benchmarks were exceeded. Therefore, no constituents in media associated with the Cedar Creek Reservoir Overflow Ditch are considered to be of concern for direct or indirect ingestion by wildlife receptors.

The potential for adverse effects associated with constituents in media at the Northern Surface Water Feature Area is considered minimal under both dry and inundated scenarios. During periods of inundation, direct contact exposure to COCs in surface water and sediment is expected to be limited to background exposure. During dry periods, risks to soil invertebrates and terrestrial plants are negligible. Wildlife ingestion modeling results indicated HQ_{LOAEL} values slightly exceeding 1 for barium and selenium exposure to American dipper. However, this risk estimate is likely overestimated because inundation is seasonal and varies interannually and likely does not support a permanent benthic invertebrate community to provide a forage base for American dipper.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Current conditions in the following transitional exposure areas at the Site have the potential to result in adverse effects to ecological receptors:

- North Percolation Pond Area; and
- South Percolation Pond Area.

The key conclusions with respect to each of the above areas are presented below.

North Percolation Pond Area

Risk estimates for the North Percolation Pond Area indicate the potential for adverse effects based on exposure through direct contact and wildlife ingestion pathways. The greatest potential for adverse direct contact effects is associated with exposure to cyanide, fluoride, metals, and PAHs during inundated conditions in the North-East Pond. Under dry scenarios, exposure to PAHs in soil exceeded NOEC values protective of soil invertebrates. Elevated risks associated with direct and indirect ingestion by wildlife receptors were also observed in the North Percolation Pond based on the results of the food chain modeling.

The North Percolation Ponds represent low quality habitat for terrestrial or aquatic receptors, based on their use as a former wastewater management structure. Based on the degraded habitat function and value of the North Percolation Ponds, exposure pathways may be more limited than the exposure assumptions used in direct contact and ingestion pathway evaluations. However, based on the risk estimates presented in the BERA, exposure to waste related COCs in multiple media in the North Percolation Ponds has the potential to adversely affect ecological receptors. Further actions should be considered to reduce or further study the elevated ecological risk at this exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond until the future uses of the North Percolation Pond are determined.

South Percolation Pond Area

The potential for adverse effects associated with constituents in media at the South Percolation Pond Area is considered minimal under dry scenarios, but moderate under inundated scenarios due to potential adverse effects associated with direct contact with cyanide, metals, and PAHs in surface water. During periods of inundation, exposure to cyanide and select metals in surface water has the greatest potential for adverse effects to temporary aquatic communities via direct contact exposure pathways. Risk associated with direct and indirect ingestion by wildlife receptors in South Percolation Pond media is minimal based on the results of the food chain modeling.

Aquatic Exposure Areas

The overall results of the BERA for the aquatic exposure areas are presented in Table 31 of this RIR (Table 8-4 of the BERA) and are summarized in this section.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

The conditions in one aquatic exposure area and a portion of another do not pose significant potential for adverse ecological effects resulting from the presence of Site-related COCs. These exposure areas include:

- Flathead River (excluding the Backwater Seep Sampling Area); and
- Cedar Creek.

For the portion of the Flathead River outside of the Backwater Seep Sampling Area, risk to ecological receptors is expected to be minimal. Outside of stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations were below NOEC benchmarks based on National Recommended Water Quality Criteria (NRWQC) criterion continuous concentration (CCC) and MDEQ chronic criteria, respectively. Filtered aluminum concentrations were below MDEQ chronic criteria. Barium concentrations in surface water outside of the Backwater Seep Sampling Area are consistent with regional conditions. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Flathead River main channel.

Potential risks associated with direct contact with surface water and sediment and wildlife ingestion pathways in Cedar Creek are considered to be negligible. Direct contact EPCs are generally below NOECs, with the exception of barium. However, barium concentrations in surface water and sediment porewater are consistent upgradient to downgradient, indicating that concentrations are representative of upgradient/background conditions. Potential exposure to wildlife foraging in Cedar Creek is not considered to exceed background exposure.

<u>Exposure Areas That Pose Risks Due to Site-Related Contamination</u>

Exposure conditions in two aquatic exposure areas indicate the potential for adverse ecological effects due to direct contact pathways:

- Flathead River – Backwater Seep Sampling Area; and
- Flathead River Riparian Area Channel.

The key conclusions with respect to these areas are presented below.

<u>Flathead River – Backwater Seep Sampling Area</u>

The evaluation of Flathead River sediment, sediment porewater, and surface water data indicate that the greatest potential for ecological exposure to Site-related constituents is associated with direct contact exposure within the Backwater Seep Sampling Area, and areas where groundwater containing cyanide and fluoride discharges to surface water. Surface water exposure was greatest to cyanide (total and free), barium, and aluminum, with greater concentrations observed in the Backwater Seep Sampling Area and adjacent stations immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028). Attenuation of surface water concentrations occurs rapidly with increasing distance from the Backwater Seep Sampling Area, particularly during periods of elevated discharge within the Flathead River. Outside of the stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations did not exceed chronic NRWQC- and DEQ-7-based benchmarks, respectively, in multiple rounds of surface water sampling events. This finding indicates that the potential area of exposure to aquatic receptors at concentrations exceeding NOECs and LOECs based on NRWQC (free cyanide) and MDEQ (total cyanide) benchmarks is spatially-limited to a groundwater-surface water mixing zone along the shoreline within and immediately adjacent to the Backwater Seep Sampling Area. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Backwater Seep Sampling Area. Further evaluation of chronic, direct contact exposure to cyanide in surface water and sediment porewater in the Backwater Seep Sampling Area/Flathead River Riparian Area may be warranted.

Flathead River Riparian Area Channel

The evaluation of sediment and surface water data in the Flathead River Riparian Area Channel indicate the potential for adverse effects associated with direct contact exposure of aquatic receptors to cyanide (total and free), fluoride, and metals in surface water. Surface water data indicate potential exposure to COCs may be influenced by groundwater discharge associated with the Backwater Seep Sampling Area and surface discharge from the South Percolation Pond Area. A temporal analysis of COC concentrations in surface water indicate that the greatest chronic exposure to cyanide in the Flathead River Riparian Area Channel likely occurs during periods of elevated discharge within the Flathead River.

Recommended Preliminary Remedial Action Objectives (PRAOs)

RAOs are qualitative statements that describe what a remedial action is intended to accomplish at a Site. RAOs can be specific to certain COCs, environmental media, and the exposure pathways and receptors to be protected. RAOs can take into consideration both current and future land use, as well as groundwater and surface water beneficial use designations. For the RIR, RAOs are considered preliminary (PRAOs) and are subject to change as a result of stakeholder discussion and development of the FS.

Based on the findings of the BHHRA and BERA, it is recommended that the following exposure areas be carried forward for evaluation of remedial alternatives in the FS:

- Main Plant Area;
- Central Landfills Area;
- Industrial Landfill Area;
- North Percolation Pond Area;
- South Percolation Pond Area;
- Backwater Seep Sampling Area and Riparian Sampling Area; and
- Groundwater (Plume Core Area).

The following exposure areas generally exhibit *de minimis* risk to human health and ecological receptors and, as such, are not proposed for further evaluation in the FS:

- Western Undeveloped Area;
- North-Central Undeveloped Area (including the Northern Surface Water Feature);
- Eastern Undeveloped Area; and
- Flathead River (outside of the Backwater Seep Sampling Area).

The FSWP will specify the RAOs for each of the aforementioned areas and also develop preliminary remediation goals (PRGs) for various media in each area, as appropriate. PRGs specify concentrations of COCs in various media that are protective of human health and ecological receptors. Therefore, PRGs can be used to help define the area and volume of environmental media that need to be addressed by a remedial action. PRGs also are used to assist in the screening of technologies and development of remedial action alternatives that precede the detailed analysis of alternatives in the FS.

Based upon the results of the BHHRA and BERA, the following are recommended PRAOs to be considered, and potentially further refined or expanded upon, during preparation of the FSWP. These PRAOs are based upon reasonable anticipated future use of each exposure area as outlined in the BHHRA and BERA. It is also noted that the approach for developing and applying the PRGs referenced below will be presented in the FSWP.

- PRAO #1: Protect future Site workers and trespassers by reducing potential for direct contact exposure to the COCs exceeding PRGs. Based upon BHHRA results, PRAO #1 is applicable to the Main Plant Area, Central Landfills Area, Industrial Landfill Area, and the North Percolation Pond Area. PAHs are the primary risk driver in these areas.
- PRAO #2: Protect terrestrial ecological receptor communities by reducing potential for direct contact exposure to the COCs exceeding PRGs in the Main Plant Area, Central Landfills Area, and Industrial Landfill Area. Based upon the BERA results, PAHs are a primary risk driver in each area, as well as select metals in Central Landfills Area and Industrial Landfill Area.
- PRAO #3: Protect transitional ecological receptor communities by reducing potential for direct contact and wildlife ingestion exposures to COCs exceeding PRGs in the North and South Percolation Pond Areas. PAHs, cyanide, and metals are risk drivers in these areas.
- PRAO #4: Protect aquatic ecological receptor communities by reducing potential for direct contact exposure to COCs exceeding PRGs in the Backwater Seep Sampling Area and the Riparian Sampling Area.
- PRAO #5: Improve and protect groundwater quality by reducing the migration of COCs from identified source areas.
- PRAO #6: Improve groundwater and surface water quality towards promulgated water quality standards to the extent practicable.

1. Introduction

On behalf of Columbia Falls Aluminum Company, LLC (CFAC), Roux Environmental Engineering and Geology, D.P.C. (Roux), has prepared this Remedial Investigation Report (RIR) as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) of the Superfund Site referred to as Anaconda Aluminum Co. Columbia Falls Reduction Plant, located two miles north-east of Columbia Falls in Flathead County, Montana (hereinafter, "the Site"). The RI/FS is being conducted pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) dated November 30, 2015, between CFAC and the United States Environmental Protection Agency (USEPA) (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 08-2016-0002).

1.1 Purpose of Report and RI/FS Objectives

The purpose of this RIR is to present the results of the multiple phases of the Remedial Investigation (RI), including the Phase I Site Characterization (SC), the Supplemental South Pond Assessment, and the Phase II SC completed at the Site from April 2016 through November 2018; and also to summarize the scope and results of the Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA) prepared for the Site. The results each phase of the RI are included in the following reports and are included as appendices to this RIR: Phase I SC Data Summary Report (Appendix A), Groundwater and Surface Water (GW/SW) Data Summary Report (Appendix B), Phase II SC Data Summary Report (Appendix C), BHHRA (Appendix D), and BERA (Appendix E). Collectively, the information presented in this RIR provides the foundation to support the development and evaluation of remedial alternatives in the Feasibility Study (FS).

As described in Section 1 of the RI/FS Work Plan (Roux, 2015), the RI/FS was designed to meet the following study objectives:

- Objective 1: Identify and characterize sources of contaminants of potential concern (COPCs);
- Objective 2: Determine the nature and extent of Site-related COPCs in environmental media at the Site (i.e., soil, groundwater, surface water, sediment, and sediment porewater);
- Objective 3: Understand the fate and transport of COPCs in environmental media at the Site;
- Objective 4: Identify any complete or potentially complete exposure pathways (considering current and also potential future land use);
- Objective 5: Evaluate current and potential future human health and ecological risks posed by the COPCs present at the Site; and
- Objective 6: Conduct an evaluation of remedial alternatives for the Site.

Objectives 1 through 5 have been achieved through the performance of the RI, as documented in subsequent sections of this RIR. Objective 6 will be the focus of the upcoming FS, for which a FS Work Plan (FSWP) is currently being prepared.

1.2 Report Organization

This RIR was prepared in general accordance with the format outlined in the "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988). The remaining sections of this report include the following information.

Sections 1.3 and 1.4 – Site Background and Previous Investigations

Section 1.3 provides a description of the Site and a review of the historical manufacturing and waste disposal activities that have occurred at the Site. Section 1.4 provides a review of the previous investigations that took place prior to the RI/FS.

Section 2 – Remedial Investigation Activities Summary

Section 2 provides a summary of the investigation activities that took place during the multiple phases of the RI/FS program. Phase I SC of the RI was conducted between April 2016 and July 2017 and was intended to broadly characterize key chemical and physical features of the Site. The Supplemental South Pond Assessment was conducted in October and November 2017 to collect additional data needed to evaluate human health and ecological risk within the South Percolation Pond Area prior to the completion of the Phase II SC. Phase II SC of the RI was conducted between June 2018 and October 2018 to fill data gaps and collect additional data needed to support the risk assessment and FS.

Section 3 – Physical Characteristics of Study Area

Section 3 describes the physical environment of the Study Area including human influences and land use. Site stratigraphy, groundwater hydrology, and surface water hydrology are also discussed.

Section 4 – Nature and Extent of Contamination

Section 4 describes the nature and extent of contamination in soil, groundwater, surface water, sediment, and sediment porewater. While many contaminants are present in the Study Area, the contaminants of concern (COCs) determined to be the drivers of ecological and human health risk include cyanide, fluoride, polycyclic aromatic hydrocarbons (PAHs), select metals, and polychlorinated biphenyls (PCBs). The RI focuses on this subset of COCs to help describe, represent, and understand the nature and extent of contamination, its fate and transport, and the overall Conceptual Site Model (CSM).

Section 5 – Sources of COCs in Site Media

Section 5 provides a more in-depth discussion of specific Site features that have been identified as the primary sources of COCs observed in the various environmental media at the Site.

Section 6 – Contaminant Fate and Transport

Section 6 provides a discussion of the physical and chemical processes that govern the migration of COCs in various Site media and includes an evaluation of contaminant flux in groundwater.

Section 7 – Baseline Risk Assessment

Section 7 provides a summary of the scope and results of the BHHRA and BERA.

Section 8 – Summary and Conclusions

Section 8 presents a summary of the information and conclusions in this RIR.

Section 9 – References

Section 9 lists references included in this RIR.

1.3 Site Background

The Site background information provided in the following sections includes:

- a general Site description;
- ownership and operational history;
- description of the environmental setting; and
- descriptions of Site features and exposure areas.

1.3.1 Site Description

The Site is located at 2000 Aluminum Drive near Columbia Falls, Flathead County, Montana. The Site is approximately two miles north-east from the center of Columbia Falls and is accessed by Aluminum Drive via North Fork Road (County Road 486). The boundaries of the Site were defined in the RI/FS Work Plan (Roux, 2015a) and are depicted on Figure 1. The Site consists of approximately 1,340 acres bounded by Cedar Creek Reservoir to the north, Teakettle Mountain to the east, Flathead River to the south, and Cedar Creek to the west.

The Site was operated as a primary aluminum reduction facility (commonly referred to as an aluminum smelter) from 1955 until 2009. A description of the ownership and operational history is provided in Section 1.3.2. Buildings and industrial facilities associated with former operations remaining at the Site at the start of the RI/FS in 2016 included offices, warehouses, laboratories, mechanical shops, a paste plant, coal tar pitch tanks, pump houses, a casting garage, and the potline facility. Decommissioning of the industrial facilities was completed in the third quarter of 2019.

The Site also includes seven closed landfills, one open landfill that hasn't been used since 2009, material loading and unloading areas, two closed leachate ponds, and several percolation ponds. A map showing the locations of these and other Site features is provided for reference on Figure 2. The south end of the Site includes the switch yard (Rectifier Yard) jointly owned by CFAC and Bonneville Power Administration and the mainline of the Burlington Northern Santa Fe Railway. A description of the various Site features is provided in Section 1.3.4.

There are no ongoing manufacturing or commercial activities at the Site. A definitive future land use plan has not been developed for the Site; however, the former production area of the Site is anticipated to be used for industrial/commercial purposes. CFAC maintains a limited on-Site staff that is responsible for the maintenance of the remaining buildings and infrastructure at the Site, as well as maintenance associated with existing landfills.

The Flathead River, which forms the southern border of the Site, is used for recreational activities, including: boating, floating, kayaking, hunting, fishing, and bird-watching water activities. In addition, it has been documented that trespassers also may utilize other portions of the Site for recreational purposes, including all-terrain vehicle (ATV) riding, hunting, and fishing.

The nearest residences are located adjacent to the south-west Site boundary, approximately 0.80 miles west of the historical footprint of Site operations, in a neighborhood referred to as Aluminum City. The nearest groundwater wells used for drinking water are located within the Aluminum City neighborhood.

Several production wells historically pumped groundwater that was used both for industrial operations and for potable water. However, electric power to these wells was terminated as part of Site decommissioning activities. Therefore, existing on-Site wells are non-operational, and they are not currently used for potable water.

1.3.2 Site History

This section provides an overview of the ownership and operational history of the Site.

1.3.2.1 Site Ownership History

According to available resources, the earliest noted developments at the Site were agricultural and residential. Industrial development began in the 1950s, when the Anaconda Copper Mining Company purchased the property in 1951 and built the aluminum reduction facility. The industrial ownership timeline for the Site is as follows:

- 1951 to 1978: Anaconda Aluminum Company
- 1978 to 1985: Atlantic Richfield Company
- 1985 to 1999: Montana Aluminum Investor's Corporation
- 1999 to present: Columbia Falls Aluminum Company, LLC

CFAC currently owns all land within the Site boundary except for the switch yard jointly owned by CFAC and Bonneville Power Administration and the mainline of the Burlington Northern Santa Fe Railway.

1.3.2.2 Site Operational History

The Site was operated as a primary aluminum reduction facility from 1955 until 2009. A detailed description of the operational history at the Site was provided in Section 2.7.2 of the RI/FS Work Plan (Roux, 2015a).

Aluminum was produced at the Site from 1955 to 2009. The facility began with two potlines in 1955 and an annual capacity of 67,500 tons per year (using 120 pots per potline). A third potline was added in 1965, and a fourth and fifth potline were added in 1968, increasing total aluminum production capacity at the Site to 180,000 tons per year. The plant expanded to 10 pot rooms in the late 1960s. Aluminum production at the Site was suspended in 2009 due to a downturn in aluminum market conditions, and CFAC announced the permanent closure of the facility in March 2015.

During aluminum production, the Hall- Héroult process and the Vertical Stud Soderburg technology was used to reduce alumina into aluminum. In the Hall- Héroult process, aluminum oxide was dissolved into a sodium fluoride (cryolite) bath in a carbon-lined pot heated to 960 degrees Celsius. Electric current ran through a carbon anode made of petroleum coke and pitch, to a carbon cathode (a steel pot, firebrick liner, and a layer of carbon paste), reducing the aluminum ion to aluminum metal. The anode was consumed during the reaction and molten aluminum formed at the bottom of the pot. The molten aluminum was tapped from the pot and transported to the Cast House where it was cast into ingots for off-Site shipment. Over the years, as part of the casting process, various alloys and ingots have been produced at the facility.

The aluminum production process generated several waste products, most notably spent potliner (SPL). During the process, the sodium in the cryolite bath gradually penetrated the carbon paste lining of the pot, causing the carbon to swell and eventually fail. The typical lifespan of the carbon cathode was 5 to 7 years. To re-use the pot, the carbon lining of the pot (i.e., potliner) was removed and replaced with a new carbon lining. The SPL consisted of the thick layer of carbon bonded to an insulating brick layer containing fluoride, sodium, aluminum, and small amounts of cyanide. The fluoride and sodium in the SPL were from the sodium fluoride (cryolite) bath and the cyanide formed in the cathode as a side chemical reaction during aluminum production.

The aluminum production process generated air emissions, including particulate fluoride, hydrogen fluoride, and PAHs. The main sources of air emissions were typically the Paste Plant and the aluminum reduction facility (i.e., potline buildings; USEPA, 1998). Air pollution from the smelting process was controlled using wet scrubbers until 1976, and air pollution from the Paste Plant also used a wet scrubber from 1955 to 1999. Waste water from the paste plant wet scrubber was discharged to the North Percolation Ponds (CFAC, 2003). The aluminum reduction facility wet scrubbers were replaced with dry scrubbers in 1976, and an analysis of the sludge by the Columbia Falls Reduction Plant laboratory staff indicated that the sludge was approximately 80 percent (%) calcium fluoride on a dry weight basis, and also contained calcium oxide, magnesium oxide, sodium oxide, and iron oxide (Hydrometrics, 1993). The sludge generated from the aluminum reduction facility wet scrubbers was landfilled on-Site at the Wet Scrubber Sludge Pond.

Raw materials were delivered to the Site predominantly by rail and included aluminum oxide (i.e., alumina), petroleum coke, coal tar pitch, and fluoride/cryolite. Alumina was delivered to the off-loading buildings where the alumina was transferred to the silos between the potlines. Petroleum coke and coal tar pitch were delivered to the north-west side of the plant and mixed in the Paste Plant to form briquettes to be used as anodes.

Solid waste generated by the aluminum production process was primarily disposed in on-Site landfills until 1990, after which SPL was shipped off-Site for disposal as hazardous waste. In addition to SPL and wet scrubber sludge, the on-Site landfills were reportedly used to dispose of other wastes such as: dross, solvents, potliner refractory wastes (non-hazardous; likely the scrap calcined petroleum coke, ore, cryolite, aluminum fluoride, bath, brick, concrete), scrap metal, wood, used oil, and municipal solid waste (MSW). A summary of the years of operation and types of wastes reportedly disposed of at each landfill over time is provided in Section 2.7.2 of the RI/FS Work Plan (Roux, 2015a) and in Section 5.2 of this RIR.

Liquid waste generated as a result of the aluminum reduction process and stormwater were discharged to several percolation ponds. The facility discharged to the percolation ponds in accordance with a Montana Pollutant Discharge Elimination System (MPDES) permit, first issued in 1994. A summary of the liquid waste disposal areas is provided in Section 2.7.2 of the RI/FS Work Plan (Roux, 2015a).

During historical facility operations, wastewater generated as a result of the aluminum reduction process was discharged indirectly to groundwater. Ground Water Pollution Control System Permit Number MGWPCS0005 was issued by the State of Montana on September 17, 1984. The plant was permitted to discharge indirectly to the groundwater. In 1993, Montana Alumina Investors Corporation (MAIC) applied for a MPDES permit for the groundwater, contaminated by historical SPL disposal practices, released via a seep to the Flathead River. Permit MT-0030066 was issued in 1994 authorizing MAIC to discharge process wastewater from its aluminum reduction plant to groundwater discharging to the Flathead River. The permit included special conditions requiring MAIC to cap the SPL landfill and investigate Site hydrology to track the cyanide concentration in groundwater from the landfill to the Flathead River. On February 1, 1999, the State of Montana re-issued MPDES Permit No. MT-0030066. The Site MPDES Permit was terminated effective April 17, 2019 due to the permanent plant closure and the elimination of discharges controlled by the permit.

1.3.3 Environmental Setting

Background information regarding the regional environmental setting is provided below.

1.3.3.1 Site Topography

Plate 1 presents a topographic map of the Site that was prepared based upon a detailed photogrammetric survey completed on May 22, 2018. The land surface elevation at the Site varies from approximately 3,020 to 3,535 feet above mean sea level (ft-amsl). On a Site-wide scale, the general slope is in the south to south-west direction towards the Flathead River.

Where it borders the Site, the Flathead River is present at an elevation of approximately 3,020 ft-amsl. Adjacent to the Flathead River is an area of land that contains the South Percolation Ponds, where the land surface in this area generally ranges between 3,020 and 3,040 ft-amsl. Immediately to the north of this area is a narrow steep slope that rises to an elevation of approximately 3,120 ft-amsl.

North of the steep slope is the Main Plant Area, where the topography is generally flat with an increase in elevation of approximately 5 feet from west to east across the plant. The area immediately east of the Main Plant increases at a slope and reaches elevations above 3,250 ft-amsl. East of this area, the elevation fluctuates by approximately 60 feet locally around Site landfill features and the Cedar Creek Reservoir Overflow Ditch. East of the Cedar Creek Reservoir Overflow Ditch, the elevation increases to about 3,535 ft-amsl at the Site boundary, adjacent to the base of Teakettle Mountain. The Site is bordered by Teakettle Mountain to the east, which reaches elevations greater than 5,000 ft-amsl.

In the area north and north-east of the Main Plant, the Site elevations vary locally around Site landfill features and the local slopes can vary significantly. In general, within the north-eastern area of the Site the elevations range from approximately 3,110 ft-amsl to 3,225 ft-amsl. The East Landfill, located on the north-eastern border of the Site, reaches elevations of 3,255 ft-amsl and is the highest elevated local feature on the Site. In the north-western area of the Site, the elevations range from approximately 3,095 ft-amsl to 3,175 ft-amsl.

1.3.3.2 Regional Climate Conditions

The Site is located at a latitude of 48º 23’ N. Its mid-hemisphere latitude and intermontane setting results in wide seasonal climatic swings. Average annual precipitation in the region ranges from about 10-inches to 21-inches depending on the year. Greater precipitation at higher elevations is common; much of the precipitation is stored as snow. The regional climate is considered modified maritime (i.e., much of the precipitation regime is influenced by moist air masses from the Pacific Ocean traveling from west to east). Dry, cold air masses often move in the north to south direction from Canada. Mean annual temperature for nearby Kalispell, Montana is 43.95 ºF (6.64 ºC).

A meteorological data station is located at the Glacier Park International Airport. Climate data were downloaded from each station for the time period from 2005 through 2018 through the Phase II SC. The table below summarizes the average annual temperatures and precipitation observed at the station.

October 2005 – December 2018	Glacier International Airport
Average Daily Temperature (°F)	43.95
Average Daily Maximum Temperature (°F)	55.97
Average Daily Minimum Temperature (°F)	31.53
Average Annual Total Precipitation (inches)	16.19

Monthly data collected from the Glacier International Airport station indicates that most precipitation occurs in the early winter and late spring seasons. As discussed in Section 4.1.2.2.2 of the Phase II SC Data Summary Report (and Appendix L3 of the Phase II SC Data Summary Report), the maximum monthly precipitation over the past eleven years (from 2008 to 2018) most frequently occurred in June (six of eleven years) during high-water season and the minimum monthly precipitation most frequently occurred in August (four of eleven years) during low-water season. July through September were the driest months over the last eleven-year period and June was the wettest month over the last eleven-year period.

Based on data collected by the Western Regional Climate Center (WRCC, 2018), prevailing winds in the area, as measured at Glacier Park International Airport, are generally from the south and south-east. A wind rose diagram depicting the wind patterns was generated from Midwestern Regional Climate Center for Kalispell/Glacier Park Airport (Mean Wind Direction, 1948 – 2018) and is provided as Figure 4 of the Background Investigation Sampling and Analysis Plan (SAP) (Roux, 2018d).

1.3.3.3 Regional Geology

The Site is located within the north-east section of the Kalispell Valley, which is part of the larger Northern Rocky Mountain Physiographic Province (Fennemen, 1931). The Kalispell Valley runs north-west to south-east and is approximately 15 miles wide in the northern section near the Site. The Kalispell Valley was formed by late Paleocene to Eocene folding and thrust faulting combined with shaping of the valley by the middle Wisconsin Cordilleran and Alpine Glaciation (Konizeski et al., 1968). The Cordilleran Ice Sheet advanced south into the Kalispell Valley from the north-west corner near Whitefish, MT and combined with the Flathead Alpine Glacier originating in Glacier National Park east of the Site. Glacial recession resulted in the formation of glacial features in the valley including the Flathead River within the unconsolidated glacial drift.

The mountains bordering the Kalispell Valley are comprised predominantly of metamorphosed Precambrian sedimentary rock of the Ravalli group, lower belt series (Konizeski et al., 1968). The rock is typically gray to greenish-gray argillite and light gray quartzite. Based on interpretation of the well logs from the Site, depth to bedrock is estimated to vary from 150 feet to greater than 300 feet across the majority of the Site depending on the proximity to the neighboring mountains and the Flathead River. In areas to the east of the Site near Teakettle Mountain, depth to bedrock is likely less than 150 ft. In the southern portion of the Site near the Flathead River, depth to bedrock may be significantly deeper than 300 feet. On a Site-wide scale, the general slope is in the south-south west direction towards the Flathead River.

The Site is situated approximately 0.5 miles northwest of Badrock Canyon, through which the Flathead River flows west and then south towards Flathead Lake. Teakettle Mountain is located on the east border of the Site and is comprised of primarily Precambrian sedimentary strata of the Ravalli Group. The stratigraphy immediately beneath the Site varies locally due to the heterogeneous nature of glacial and alluvial deposits. Alden (Alden, 1953) suggests the area near Columbia Falls is underlain by primarily glacial till and lake sediments deposited by the Cordilleran Ice Sheet. In addition to these deposits, many valleys in western Montana contain glacial deposits derived from smaller, local glaciers (Hydrometrics, 1985). These deposits generally result in various mixtures of clay, sand, silt, cobbles and boulders.

As described in the Background Investigation SAP (Roux, 2018d), surficial geologic maps were reviewed to refine the understanding of the Flathead Valley geologic formations and surficial soil types and how they relate to the Site. Figure 5 of the Background Investigation SAP presented a geologic map of the Flathead Valley in the vicinity of the Site. This map was generated based on the Geologic and Structure Maps of the

Kalispell Quadrangle, Montana, and Alberta and British Columbia (Harrison, et al., 1992). Figure 5 of the Background Investigation SAP also presented the Site boundary in reference to surficial geology in the Flathead Valley. Consistent with the findings from the Phase I Site Characterization, the geologic formations occurring at land surface across the Site include mostly: 1) glacial and fluvioglacial deposits (Pleistocene) (Qgr); 2) alluvial deposits (Holocene) (Qal); and 3) the Revett Formation (Middle Proterozoic) (Yr) which is expressed at the surface as Teakettle Mountain.

Surficial soil types within the Flathead Valley were also reviewed using the United States Department of Agriculture Natural Resources Conservation Service Web Soil Service (https://websoilsurvey.nrcs.usda.gov). Figure 6 of the Background Investigation SAP presented the surface soil type map of the Flathead Valley in the vicinity of the Site. Based on the soil survey map and consistent with the Phase I Site Characterization findings, three major soil types are present at the Site: 1) glacial till (27-7), alluvium, and outwash as gravelly loam (Mh); 2) fluvial deposits and riverwash (Rc); and 3) partially mountainous land combined with glacial till (Mr and 75).

The majority of the soil at the Site has been designated as glacial till and alluvium (presented as Qgr on Figure 5 and 27-7 and Mh based on Figure 6 of the Background Investigation SAP). This soil type extends from the base of Teakettle Mountain along the eastern boundary of the Site through the western boundary of the Site. Fluvial deposits occur along the southern boundary of the Site and within the floodplain of the Flathead River. The mountainous land and glacial till is apparent along Teakettle Mountain on the eastern boundary of the Site.

A more detailed description of the regional geology can be found in the RI/FS Work Plan (Roux, 2015a), Phase I SC Data Summary Report, Phase II SC Data Summary Report, and the Background Investigation SAP (Roux, 2018d). A description of the Site stratigraphy is provided in Section 3.1.

1.3.3.4 Regional Hydrogeology

The Site is located within the Flathead River-Columbia Falls watershed. The Site is bordered by surface water features on each side, including the Flathead River to the south, Cedar Creek to the west, Cedar Creek Reservoir to the north, and Cedar Creek Reservoir Overflow Ditch to the east.

The Flathead River is a tributary to the Columbia River, which flows into the Pacific Ocean. The North Fork of the Flathead River originates in the province of British Columbia, Canada. The Middle Fork of the Flathead River originates in the Bob Marshall Wilderness located south of Glacier National Park. The confluence of the North Fork and Middle Fork of the Flathead River is approximately 10 miles upstream of the Site, north of Coram, Montana. The South Fork joins the main stem of the Flathead River at the entrance of Badrock Canyon located approximately 2 miles upstream of the Site. The Flathead River flows west through Badrock Canyon towards the City of Columbia Falls where its course is then southerly toward Flathead Lake (E&E, 1988). At the Site, the drainage area of the Flathead River is approximately 4,470 square miles (mi^2), which includes the drainage area of Cedar Creek to the west.

The United States Geological Survey (USGS) maintains three gauging stations on the Flathead River in the general vicinity of the Site. The closest station is located approximately three miles south-west of the Site near Columbia Falls (USGS Station #12363000). Two stations are located approximately ten miles north/north-east of the Site, (i.e., the north fork station on the Flathead River and the middle fork station immediately west of Glacier National Park [USGS Stations #12355500 and #12358500, respectively]). For the time period of 2008 to 2018 at the Columbia Falls USGS station, the average minimum yearly discharge was 3,317 cubic feet per second (cfs), and the minimum yearly discharge occurred most often in October and January. For the time period of 2008 to 2018 at the Columbia Falls USGS station, the average maximum yearly discharge was 44,509 cfs and the maximum yearly discharge occurred most often in May and June. Variability in the flow rates of the Flathead River are discussed in more detail in Section 4.1.2.2.2 the Phase II SC Data Summary Report.

Groundwater in the region is typically recharged from the surface water sources within the watershed including numerous reservoirs, ponds, streams, and lakes and additionally through infiltration of precipitation. Groundwater in the region may also discharge to surface water bodies. For example, during spring, the snowmelt and increased seasonal precipitation causes high flow in the Flathead River. This results in the Flathead River recharging groundwater and acting as a losing stream. In contrast, in the late summer, the dry weather results in a decrease in river stage so that the Flathead River becomes a gaining stream (Konizeski et al., 1968).

Cedar Creek originates north of the Site in the area contributing to the Cedar Creek Reservoir. At the outlet of the Cedar Creek Reservoir, the upgradient catchment area is 12.5 mi^2. From the reservoir outlet, Cedar Creek flows approximately 3 miles south-west towards the City of Columbia Falls. The elevation of Cedar Creek is higher than groundwater elevations within the Site, indicating that Cedar Creek is a losing stream rather than a gaining stream. According to the USGS National Hydrography Dataset (NHD), a tributary to Cedar Creek is mapped that bisects the northern area of the Site. This intermittent feature is shown to be situated along the eastern side of the Industrial Landfill and joins Cedar Creek approximately 0.5 mile to the south-west of the Industrial Landfill. This feature was not observed during Site investigation activities; however, surface water ponding and wetland vegetation were observed in the area south and south-east of the Industrial Landfill. Based on field observations, the source of the ponding was attributed to seeps in the nearby cliff. This feature was generally mapped by Roux field personnel and is identified on Figure 2 as the Northern Surface Water Feature. At the western Site boundary, Cedar Creek drains an additional 1.5 mi^2, predominately from the western two-thirds of the Site.

The Cedar Creek Reservoir Overflow Ditch flows intermittently in the spring and regulates flow for Cedar Creek and the Cedar Creek Reservoir (Hydrometrics, 1985). Based upon proximity and land surface topography, some surface water runoff from the eastern side of the Site, originating from the East Landfill and the Sanitary Landfill, as well as runoff from the western flank of Teakettle Mountain, flows to the Cedar Creek Reservoir Overflow. Excluding potential upgradient contributions from the Cedar Creek Reservoir, the Cedar Creek Reservoir Overflow Ditch has a catchment area of approximately 2.0 mi^2. About 20% of this catchment area originates on-Site and the remaining catchment extends to the peak of Teakettle Mountain to the east. Like Cedar Creek, the elevation of Cedar Creek Reservoir Overflow Ditch is higher than surrounding groundwater elevations within the Site, indicating that the Cedar Creek Reservoir Overflow Ditch is a losing stream.

1.3.3.5 Description of Aquatic, Terrestrial, and Transitional Habitat

Aquatic, terrestrial, and transitional habitats are present within the Site. This section describes the general physical, hydrological, or vegetative characteristics that describe habitats within the Stillwater Swan Wooded Valley ecoregion where the Site is located in Montana (Woods et al., 2002). The habitat types described for the Site are used as the basis for identifying ecological exposure areas for the BERA.

Aquatic habitats are characterized by perennial or near-perennial inundation with water and physical habitats that can support aquatic receptor species. In lotic aquatic habitats (flowing streams and rivers), flow conditions are suitable for the establishment of fish and invertebrate communities, as well as semi-aquatic birds or mammals that rely on aquatic flora or fauna as a food resource. Two lotic aquatic habitats exist within and around the Site, including the Flathead River and Cedar Creek. The Flathead River is considered a large river by the Montana Department of Environmental Quality (MDEQ). Large rivers are non-wadeable and almost always seventh-order or higher according to the Strahler stream order index (Strahler, 1964). Key physical habitat features of the Flathead River include cobble or gravel substrate; deep, fast-flowing water; and, depending on valley dimensions, multi-thread channels. In the river reach adjacent to the Site, the Flathead River provides marginal fish habitat for common species, with this section of the river being used as a migration corridor to access areas of more suitable habitat (Stagliano, 2015). Given the absence of extensive agriculture or other non-anthropogenic nutrient sources upgradient, the Flathead River is considered oligotrophic, which means that it lacks macronutrients, such as phosphorus.

Cedar Creek is a small headwater stream that discharges to the Flathead River. Small headwater stream habitats in the region can be distinguished primarily by their hydrologic regime. Montane headwater streams that originate in the high-elevation peaks have characteristically high spring and early summer flows, a spring freshet, due to snow melt. Small headwater systems are also often oligotrophic.

Terrestrial habitats are dry, upland areas that may support aboveground and/or belowground terrestrial flora and fauna. Soils that are considered terrestrial habitat are limited to the vadose, or unsaturated zone, of the soil profile. Vegetation type is another key characteristic of physical terrestrial habitats. There are four primary terrestrial habitats on the Site, which are characterized predominately by the type of vegetation present. These habitats include mixed conifer forest, riparian forest, deciduous shrubland, and open grassland.

Transitional habitats are characterized by intermittent or seasonal surface water inundation. Transitional habitats can potentially support aquatic receptor species during certain life stages (e.g., benthic invertebrates, juvenile herpetofauna), as well as terrestrial species during dry periods (e.g., soil invertebrates, terrestrial plants).

Ecological exposure areas identified based on on-Site habitat types are defined in Section 3.3.1 of the BERA. The evaluation of potential ecological receptors within exposure areas is distinguished based on the presence of aquatic, terrestrial, or transitional habitat characteristics.

1.3.4 Site Features

Several Site features were identified for investigation during the RI based upon review of prior investigations and evaluation of historical information as described in the RI/FS Work Plan. The Site features investigated include landfills and leachate ponds, percolation ponds, buildings and operational areas, and surface water features. The Site features are described in the sections below. The locations of Site features are shown on Figure 2.

1.3.4.1 Landfills

Landfills operated at the Site and were utilized for disposal of a variety of wastes from 1955 to October 2009. Certain landfills were used for disposal of SPL from 1955 to 1990. Other wastes reportedly disposed in landfills include solvents, municipal solid waste, sanitary waste, scrap metal, and construction debris. The landfills are described in the following subsections and in detail in the RI/FS Work Plan (Roux, 2015a). Evaluation of the potential significance of each of these features as potential source areas for COPCs observed in groundwater and surface water at the Site is provided in Section 5.2. Table 1 summarizes details for the landfills including years of operation, type of waste disposed, construction, and localized groundwater ranges.

West Landfill

The West Landfill comprises approximately 7.8 acres, with areal dimensions of approximately 615 feet by 600 feet. The landfill reportedly is unlined, extends approximately 35 feet below surrounding grade (CFAC, 2013), and rises approximately 13 feet above grade on the eastern side of the landfill and over 30 feet above grade from the western side. Groundwater levels in the area of the West Landfill range from approximately 36 feet to 87 feet below surrounding grade. Landfill gas vents are present within the West Landfill.

As noted in the RI/FS Work Plan, historical aerial photographs indicate that the West Landfill appears undeveloped until between 1963 and 1974, later than the 1955 date described in several prior reports (CFAC, 2013; Weston, 2014; RMT, 1997). Minimal disturbance, and only along the southern boundary of the West Landfill, was observed in the 1956 and 1963 aerial photographs; while the majority of the West Landfill appeared to be in use by the time of the 1974 aerial photograph (included as Appendix F). Therefore, based on the historical aerial photographs, use of the West Landfill for SPL disposal commenced between 1963 and 1974. The West Landfill was used to dispose of SPL and other wastes (sanitary, industrial, and reportedly solvents) through 1980, though SPL disposal into the West Landfill reportedly ended in 1970. The landfill was closed in 1981 and capped with a synthetic (hypalon) cap in 1994 (CFAC, 2013).

An Electrical Resistivity/Induced Polarization (ER/IP) geophysical survey was conducted as part of the Phase I SC to approximate the landfill bottom and landfill caps, as discussed in Section 2.5.2. As determined from the ER/IP geophysical survey, an area of low resistivity was identified to approximately 115 feet below the top of the West Landfill. The interpretation of these results suggested the depth of the waste material or impacted soil and groundwater underlying the West Landfill could be as thick as 115 feet; though it should be noted that these types of geophysical surveys are indirect measurements and subject to various interferences. The as-built drawings for the West Landfill cap completed in 1994 (Appendix G1), indicate an average thickness of the waste within the landfill is 30 feet, which is consistent with the reported waste thickness of 35 feet.

Wet Scrubber Sludge Pond

The Wet Scrubber Sludge Pond is a landfill that is approximately 10.8 acres in size with areal dimensions of approximately 750 feet by 580 feet. Based on the historical documents reviewed, the depth of landfilled material is unknown. The ER/IP geophysical survey indicates an approximate thickness between 15-inches and 43-inches of landfill material. Groundwater levels measured in adjacent monitoring wells indicate that during high-water season, groundwater is observed to be approximately 60 feet below land surface (ft-bls); though groundwater levels in CFMW-007 adjacent to the West Landfill were 35.5 ft-bls. During low-water season, groundwater is observed to be approximately 105 ft-bls.

The Wet Scrubber Sludge Pond received waste material from the wet scrubbers at the aluminum reduction plant from 1955 until 1980, at which time the wet scrubbers for the aluminum reduction plant were replaced with dry scrubbers that produce much less waste (RMT, 1997). Review of aerial photographs indicates that the Wet Scrubber Sludge Pond more closely resembled a landfill operation in the 1955 to 1963 photographs; with the pond feature not present until the 1974 photograph. The pond was subsequently capped with an unlined earthen cap in 1981 and vegetated.

Center Landfill

The Center Landfill is approximately 1.8 acres in area, in a circular shape, with an aerial diameter of approximately 330 feet. The Center Landfill was also historically referred to as the carbon mound. Based on the historical documents reviewed, the landfill was constructed above grade and is approximately 15 feet above surrounding grade. The ER/IP geophysical survey indicates an approximate thickness between 15 and 30 feet of landfill material. Water levels in the area of the Center Landfill range from approximately 57 feet to 139 feet below surrounding grade.

The Center Landfill was reportedly unlined. The Center Landfill was reportedly used to dispose of SPL, solvents, sanitary waste, and scrap from 1970 to 1980. The landfill was closed in 1980 and likely capped with a 6-inch clay cap and 18-inches of till.

East Landfill

The East Landfill encompasses an area of approximately 2.4 acres. The aerial dimensions are approximately 330 feet by 730 feet. Based on the historical documents reviewed, the East Landfill was constructed above ground level (CFAC, 2013), and is approximately 30 feet above the surrounding grade. The ER/IP geophysical survey indicates an approximate landfill depth of 40 feet. Groundwater levels in the area of the East Landfill range from approximately 109 feet to 130 feet below surrounding grade.

The East Landfill was reportedly built with a clay liner and capped with a 6-inch thick clay layer, a synthetic cap, and an 18-inch vegetated till cover (Appendix G2). The landfill was also built with two lined leachate collection ponds. The landfill was operated from 1980 to 1990 for disposal of SPL and was closed in 1990.

The North Leachate Pond is located directly north of the East Landfill and is approximately 0.6 acres in size, with aerial dimensions of approximately 250 feet by 115 feet. The North Leachate Pond was lined with a hypalon liner. The leachate pond received stormwater runoff and leachate from the East Landfill and was hydraulically connected to the Wet Scrubber Sludge Pond by a drainage pipe. The pond was also aerated to reduce concentrations of cyanide. The pond was closed in 1994.

The South Leachate Pond is located directly south of the East Landfill and is approximately 0.9 acres in size. The South Leachate Pond received stormwater runoff and leachate from the East Landfill. The South Leachate Pond was lined with hypalon liner. Similar to the North Leachate Pond, the South Leachate Pond was aerated to reduce concentrations of cyanide (CFAC, 1994; CFAC, 2003). The pond was emptied in 1990 and was dried, capped and closed in 1993.

Sanitary Landfill

The Sanitary Landfill is approximately 3.8 acres in size, approximately 330 feet wide by 540 feet long. The ER/IP geophysical survey indicated an approximate thickness between 18 and 55 feet of landfill material. Groundwater levels in the area of the Sanitary Landfill range from approximately 23 feet to 94 feet below surrounding grade.

Based on aerial photography review, the Sanitary Landfill operated in the early 1980s. The landfill was reportedly clay lined, and was used for plant garbage (RMT, 1997). Some sources report solvents and hazardous waste were also buried in the landfill (E&E, 1988). According to the 2014 Site Reassessment Report, the landfill was covered with clean fill and vegetated.

Industrial Landfill

The Industrial Landfill is an inactive, uncovered landfill in the northern portion of the Site, encompassing approximately 12.4 acres. The aerial dimensions of the landfill are approximately 720 feet by 800 feet, though the shape is irregular. ER/IP geophysical survey transects were not completed at the Industrial Landfill. Groundwater levels in the area of the Industrial Landfill range from approximately 19 feet to 31 feet below surrounding grade.

The Industrial Landfill began operations in the 1980s based on aerial photography. The Industrial Landfill received non-hazardous waste and debris (CFAC, 2013) until landfilling operations ceased in October 2009. Details regarding the depth of landfilled material or presence of a liner are unknown.

Asbestos Landfills

As described in the RI/FS Work Plan (Roux, 2015a), two areas were identified as being former asbestos landfills based on historical information. These areas are referred to as the North Asbestos Landfills and the South Asbestos Landfills. The North Asbestos Landfills are located north of the West Landfill and consist of two separate areas (i.e., North-West and North-East Asbestos Landfills); the South Asbestos Landfills are located south of the East Landfill, near the eastern boundary of the Site, and consist of two separate areas (i.e., South-West and South-East Asbestos Landfills). Together, the four landfills are referred to collectively as the Asbestos Landfills. The Asbestos Landfills were constructed as early as the late 1970s or early 1980s and were in use from 1993 to 2009. Details regarding landfill construction are unknown; however, based on observations made during the Phase I SC field reconnaissance and test pitting activities, the landfills have a natural soil cover that overlies the asbestos materials within the landfills. There is no evidence of an engineered cap or liner.

1.3.4.2 Percolation Ponds

Water from Site operations and stormwater discharges to several percolation ponds. Details regarding the percolation ponds are provided in the sections below.

North-East Percolation Pond

The North-East Percolation Pond is approximately 2 acres in size. The depth of the percolation pond is unknown. The North-East Percolation Pond was constructed in 1955, and based on the aerial photography review, the exact size and shape of the North-East Percolation Pond changed slightly over time. This percolation pond received discharges from various operations within the Main Plant Area until manufacturing ceased in 2009. The North-East Percolation Pond is currently operational as a discharge point for stormwater drainage. Groundwater levels in the area of the North-East Percolation Pond range from approximately 30 feet to 73 feet below surrounding grade.

North-West Percolation Pond

The North-West Percolation Pond is approximately 8 acres in size. The North-West Percolation Pond was constructed to receive overflow water from the North-East Percolation Pond. The two ponds were connected by an approximately 1,440-foot-long unlined ditch. Based on the review of aerial photography, the North-West Percolation Pond appears to be in the process of being constructed in 1972. Groundwater levels in the area of the North-West Percolation Pond range from approximately 24 feet to 44 feet below surrounding grade.

West Percolation Pond

The West Percolation Pond is approximately 0.05 acres in size and is located just north of the main parking lot, west of the Main Plant. The West Percolation Pond was first observed on aerial photography from the 1980s. The West Percolation Pond received boiler blowdown from the Fabrication Shop, Warehouse, and Change House and stormwater from the parking lots (2014 Draft MPDES Permit Fact Sheet). Groundwater levels in the area of the West Percolation Pond range from approximately 42 feet to 56 feet below surrounding grade.

South Percolation Ponds

Based on review of historical aerials, the South Percolation Ponds were constructed in the early 1960s. The South Percolation Ponds are a series of three ponds located on the south end of the Site, adjacent to the Flathead River. The ponds are 2.4, 1.2, and 6.6 acres (from west to east) forming a total of 10.2 acres and are connected in series. Wastewater enters the South Percolation Pond system from a concrete pipe located on the west end of the pond system. From the pipe, water flows into the subsequent ponds through an unlined ditch. Groundwater levels in the area of the South Percolation Ponds range from approximately 8 feet to 14 feet below surrounding grade. The water level in the South Percolation Ponds has been observed to correlate closely with surface water elevations in the Flathead River; indicating a hydraulic connection between the two water bodies.

The South Percolation Ponds received water from the sewage treatment plant, the aluminum casting contact chilling water, non-contact cooling water from the rectifier and other equipment, process wastewater from the casting mold cleaning and steam cleaning, non-process wastewater from the fabrication shop steam cleaning, and stormwater (2014 Draft MPDES Permit Fact Sheet).

1.3.4.3 Buildings and Former Operational Areas

The Main Plant Area includes the buildings historically used for production of aluminum and various support buildings, warehouses, and storage areas. The Main Plant Area includes the following Site features:

- The Potline Buildings where the aluminum smelting occurred;
- The casting house, mechanical shops, Paste Plant, Rod Mill, and warehouses adjacent to the potlines; and
- The Rectifier Yards.

Details of these Site features are provided below. Decommissioning of the industrial facilities was completed in the third quarter of 2019.

Potline Buildings

The Main Plant Area is where the production of aluminum occurred. The facility was approximately 47 acres and spanned approximately 1,760 feet by 1,170 feet.

In 1955, the plant began operation with four pot rooms. The plant expanded to ten pot rooms in the 1960s. The potline buildings had courtyards and various support buildings in between the pot rooms. The courtyards contained air ventilation structures including the dry scrubbers. Support buildings include the casting house, offices, garages, and a briquette storage area (Anaconda Aluminum, 1981).

The dry scrubbers in the plant were installed to replace a wet scrubber sludge system, which operated until final installation of the dry scrubbers between 1976 and 1978. Prior to 1978, the cathode soaking pits were used to cool pots. Historical documents suggest these pits were located to the east of Potroom 4, at the northern end of the Main Plant Area potline buildings.

Many raw materials were required for aluminum production and were stored on-Site. Raw materials were delivered to the Site at several transfer stations, located just north of the Main Plant, and adjacent to the railroad. Raw material transfer stations include the Petroleum Coke Building, the Alumina Unloading Stations, and the Lime Unloader station (Roux, 2015a).

Rod Mill

The Rod Mill is approximately 1.2 acres and is located on the south-western portion of the Main Plant Area. This area was used as a Rod Mill during the first decade of plant operation. Afterwards, the Rod Mill was used for storage. During the 1990s, the Rod Mill was used for storage of hazardous waste, including SPL and PCBs (RMT, 1997).

Paste Plant

The Paste Plant manufactured anode briquettes from petroleum coke and coal tar pitch. Once made, the briquettes were sent to the Main Plant Area for use in the pots. Several other buildings were part of the briquette making process, including the petroleum coke unloading building, a petroleum coke silo, a paste plant wet scrubber (replaced by a dry scrubber in 1999), coal tar pitch tanks, and a coal tar pitch unloading shed (RMT, 1997; E&E, 1988; CFAC, 2003).

Rectifier Yards

The Rectifier Yards are located in the south portion of the Main Plant Area and are approximately 18 acres in size. The Rectifier Yards were essential to powering the Site operations. A portion of the Rectifier Yards are owned by Bonneville Power Administration.

Transformers and capacitors in the Rectifier Yards historically used transformer oil containing PCBs. Transformer oil containing PCBs were removed in the 1990s (RMT, 1997).

Operational Area

The Operational Area comprises approximately 43 acres north of the Main Plant Area where aerial photographs indicate historical operations may have been conducted but no known source area exists.

1.3.4.4 Surface Water Features

There are four primary surface water bodies on-Site: Flathead River, Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature. These primary surface water bodies are described above in Section 1.3.4.4 and are summarized below. Surface water features specific to the Flathead River, including the "Seep Area[4]", Backwater Seep Sampling Area, and the Riparian Sampling Area are also described below.

[4] The "Seep Area" is where groundwater is expressed from the upper hydrogeologic unit to the Flathead River.

Cedar Creek

Cedar Creek is fairly shallow and, based on elevation of the groundwater table, groundwater from the Site does not recharge into Cedar Creek. A tributary to Cedar Creek flows, or has flown, historically east of the Industrial Landfill and to the south-west, joining Cedar Creek approximately one-half mile to the south-west of the landfill.

Cedar Creek Reservoir Overflow Ditch

The Cedar Creek Reservoir Overflow Ditch runs from the Cedar Creek Reservoir to the Flathead River. The Cedar Creek Reservoir Overflow Ditch runs alongside the Sanitary Landfill, Center Landfill, the southern Asbestos Landfill, and the East Landfill and associated leachate ponds before discharging into the Flathead River.

Northern Surface Water Feature

The Northern Surface Water Feature is a seasonal ponding area located between Cedar Creek and the Cedar Creek Reservoir Overflow Ditch, just south of the Industrial Landfill. It is believed that during the spring, the snowmelt and increased seasonal precipitation creates a localized elevated or perched water table which feed the seeps. The substrate of the feature is predominantly grass covered with areas of channelization which help direct the groundwater from the seeps in the nearby cliff to the feature.

Flathead River

The Flathead River runs along the southern border of the Site. Groundwater from the Site discharges to the Flathead River along the “Seep Area,” as described below.

Seep Area

The “Seep Area” is a documented groundwater discharge point to the Flathead River. Due to the steep banks along the Flathead River, some of the Site groundwater discharges from the cliffs and flows down to the Flathead River. Flowing seeps have been observed and documented along the Flathead River for over 1,000 feet.

Backwater Seep Sampling Area

Along the length of the “Seep Area”, groundwater discharges to a backwater area of the Flathead River, referred to as the Backwater Seep Sampling Area, located approximately 0.25 miles downstream of the South Percolation Ponds.

Riparian Sampling Area

The Riparian Sampling Area is vegetated with a riparian forest and is located north of the Flathead River between the South Percolation Pond Area and the Backwater Seep Sampling Area. The Riparian Sampling Area contains a backchannel from the Flathead River.

1.3.4.5 Exposure Areas

The Site was divided into exposure areas for conducting the BHHRA and BERA as part of the RI. The exposure areas for the BHHRA were defined considering both the current and reasonable anticipated future land use for the various areas of the Site. The boundaries of each BHHRA exposure area were determined using professional judgement considering Site characteristics, current and potential future receptors, and the distribution of COPCs identified during the Phase I SC. The ecological exposure areas defined for the BERA are similar to the BHHRA exposure areas; but slightly modified and further subdivided as appropriate to represent primary habitat types and receptor groups that may be exposed to COPCs.

The BHHRA and BERA exposure areas are shown in Figures 3 and 4, respectively. A brief description of each exposure area is provided below. Additional information regarding the foreseeable future of each exposure area and the habitats present is provided in Section 7.

- **Main Plant Area** – includes the area of historical manufacturing operations including the former Main Plant, associated buildings and infrastructure, and the former Rod Mill. The Main Plant Area is covered by impervious surfaces and there are no areas of significant vegetation other than weeds common to roadsides and disturbed areas.
- **North Percolation Pond Area** – is a water management area of historical wastewater discharge and consists of two ponds (North-East and North-West) connected by an approximately 1,440-foot-long unlined influent and overflow ditch.
- **Central Landfill Area** – consists of 12 distinct Site features (as shown on Figure 2) associated with waste management and disposal activities.
- **Industrial Landfill Area** – an inactive, uncapped landfill in the northern portion of the Site that received non-hazardous waste and debris.
- **Eastern Undeveloped Area** – undeveloped and vegetated with forest and shrubland, except for the area that includes the Borrow Pit Area. There were no operational activities conducted within this area.
- **North-Central Undeveloped Area** – undeveloped, vegetated, and includes roadways in the northern portion of the Site. There were no operational activities conducted within this area.
- **Western Undeveloped Area** – includes roadways and mixed vegetation in the western third of the Site. Cedar Creek transects the area along the north-western border from north to south. The south-western portion of this area is adjacent to the off-Site residential area referred to as Aluminum City. There were no operational activities conducted within this area.
- **South Percolation Pond Area** – includes a series of three water management ponds and the surrounding vegetated area located on the south end of the Site adjacent to the Flathead River.
- **Flathead River Area** – The portion of Flathead River which runs along the southern border of the Site.
- **Backwater Seep Sampling Area** – a backwater area of the Flathead River west of the South Percolation Pond Area along the southern border of the Site that is documented as receiving groundwater discharge.
- **Cedar Creek, Cedar Creek Reservoir Overflow Ditch, Riparian Sampling Area, and Northern Surface Water Feature** – these four surface water features (previously described above) are treated as separate exposure areas within the BERA based upon the types of habitats present.

1.4 Previous Investigations

A detailed description and summary of results from previous environmental investigations and cleanup actions performed at the Site prior to the RI/FS was provided within the RI/FS Work Plan. Prior to preparing the RI/FS Work Plan (Roux, 2015a), all previous investigation reports noted below were reviewed by Roux and considered when developing the scope of work for the RI/FS. A tabular summary of the prior investigations is provided below.

Previous Investigation	Author	Year
Site Location and Evaluation for Disposal of Hazardous Wastes at Columbia Falls Reduction Plant	Hydrometrics, Inc (Hydrometrics)	1980
Preliminary Site Assessment	Ecology and Environment, Inc.	1984
Hydrogeological Evaluation	Hydrometrics, Inc	1985
Site Investigation Analytical Results Report	Ecology and Environment, Inc.	1988
CECRA Priority List	MDEQ	1989
PCB Remediation in Rectifier Yard	Olympus Environmental	1991
Hydrological Data Summary Report	Hydrometrics, Inc	1992
Assessment of Hydrological Conditions Associated with the Closed Landfill, Calcium Fluoride Pond and Production Well Number 5 at the Columbia Falls Aluminum Plant	Hydrometrics, Inc	1993
Second PCB Remediation in Rectifier Yard	Olympus Environmental	1994
USEPA Investigation	USEPA and MDEQ Water Quality Bureau	1996
Suspected SPL Removal from Wet Scrubber Sludge Pond Landfill	CFAC (MAIC)	1998
Waste Characterization Investigation	USEPA and MDEQ	2001
CFAC Environmental Issues Investigation	Hydrometrics, Inc	2003
Site Reassessment for Columbia Falls Aluminum Company Aluminum Smelter Facility	Weston	2014
Residential Water Well Sampling	Hydrometrics, Inc	2014-2015
Whole Effluent Toxicity (WET) Testing	CFAC	2014-2018

2. Remedial Investigation Activities Summary

This section summarizes the field activities scope of work completed as part of the RI.

2.1 RI/FS Investigations

The following provides an overview of environmental investigations performed at the Site related to the RI/FS and the associated RI/FS reports documenting those investigations. A detailed description of the results of the investigations are provided in their respective reports and are summarized together in the Phase II SC Data Summary Report. The results of the BERA and BHHRA are also described in their respective reports. The scope of work and results of each report are described in more detail throughout the various sections of this RIR.

Phase I SC Data Summary Report – 2017

The Phase I SC program, completed by Roux in 2017, included the collection and laboratory analysis of soil, sediment, groundwater, and surface water samples collected from within and around Site features. The objectives of the Phase I SC, as outlined in the RI/FS Work Plan, Phase I SAP, and SAP Addendum (Roux, 2015a; 2015b; 2016a), included:

- Evaluate the conditions at all identified RI areas and Site features to determine which RI areas and Site features require further investigation and/or quantitative evaluation in the Baseline Risk Assessment;
- Refine the list of COPCs requiring further investigation at various RI areas and Site features so lists of laboratory analyses can be reduced during subsequent phases of investigation;
- Refine the understanding of groundwater flow and groundwater quality beneath the Site, particularly in the vicinity of potential receptors;
- Develop a more detailed understanding of bedrock topography and the depths, thicknesses, and extents of the various hydrogeologic units which may influence groundwater flow and the distribution of COPCs in the subsurface;
- Begin to evaluate seasonal influences on groundwater/surface water interactions and contaminant concentrations in groundwater and surface water;
- Develop data to support the preparation of the Baseline Risk Assessment Work Plans; and
- Develop data to support identification and screening of remedial technologies as part of the FS.

Screening Level Ecological Risk Assessment (SLERA) – 2017

The SLERA, completed by Roux, provided an assessment of potential risks to ecological receptors that may be exposed to constituents from the Site. The SLERA evaluated the aspects of the Site that could influence potential exposures and risks to ecological receptors, including:

- The environmental setting;
- Potential sources and release mechanisms of constituents to environmental media; and
- Fate and transport processes that may have contributed to existing conditions.

Based on the review of the historical processes and data collected during the SLERA, preliminary constituents of potential ecological concern (COPECs) were identified in surface water, sediment, and surface soil to which ecological receptors could potentially be exposed. Based on these results, it was determined that the conclusions of the SLERA are insufficient to dismiss potential ecological risk, and further data gathering or data analyses was recommended to better understand the risk.

GW/SW Data Summary Report – 2018

The GW/SW Data Summary Report, completed by Roux, summarized the results of groundwater and surface water investigations that were completed from August 2016 through July 2017 to achieve the Phase I SC objectives listed in the RI/FS Work Plan (Roux, 2015a).

Phase II SC Data Summary Report – 2019

The Phase II SC program, completed by Roux, was designed to address any outstanding data gaps in order to conduct a risk assessment and complete the RI. Based on the understanding of the Site conditions, the updated CSM following the completion of the Phase I SC, and the data gaps identified during preparation of the BHHRA WP and BERA WP (EHS Support, 2018a; 2018b), the following objectives were established for the Phase II SC:

- Refine the understanding of the nature and extent of COPCs around Site features investigated during the Phase I SC and collect all data required for quantitative evaluation in the baseline risk assessment;
- Collect additional data to support the evaluation and refinement of COPCs for the development of the baseline risk assessments;
- Evaluate conditions at RI areas/Site features and/or conditions within media that were not investigated during the Phase I SC, were identified as a data gap during the Phase I SC, or were discussed with USEPA;
- Address the data gaps identified in the BHHRA WP and BERA WP (EHS Support, 2018a; 2018b);
- Refine data to support identification and screening of remedial technologies as part of the FS; and
- Develop an understanding of the frequency of detection and concentrations of COPCs in off-Site background reference areas.

In addition to documenting the above objectives, the Phase II SC Data Summary Report also summarized the Supplemental South Pond Assessment sampling that was completed under the Expedited Risk Assessment SAP (Roux, 2017c).

BHHRA – 2019

The objective of the BHHRA, completed by EHS Support, was to characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action based on the conceptual investigation framework presented in the BHHRA Work Plan (EHS Support, 2018a). The BHHRA provided the basis for determining whether remedial action is necessary to address potential risk to human health in the various exposure areas identified at the Site, as well as the extent of remedial action required. The BHHRA supports the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to COCs.

BERA – 2019

The overall purpose of the BERA, completed by EHS Support, was to evaluate whether environmental conditions associated with historical operations at the Site pose an unacceptable risk to ecological receptors based on the conceptual investigation framework presented in the BERA Work Plan (EHS Support, 2018b). Specific objectives of the BERA included:

- Refine the screening-level problem formulation in the context of new information and findings of analyses conducted as part of the Phase I SC, Phase II SC, and the SLERA;

- Refine the Ecological Conceptual Site Model (ECSM) of the Site;
- Refine the list of COPECs identified in the SLERA to identify COPECs that are most likely to drive risk management decision-making for the Site to focus and streamline the BERA risk analysis;
- Develop screening-level and baseline ecological exposure estimates for complete exposure pathways identified in the refined ECSM for ecological exposure areas identified in the BERA Work Plan;
- Characterize risk based on baseline exposure estimates to support Scientific Management Decision Points (SMDPs) for identified ecological exposure areas;
- Evaluate uncertainties in the exposure estimates and risk characterizations and the potential influence of uncertainties on risk conclusions; and
- Identify potential data gaps based on the uncertainty analysis.

2.2 Overview of Field Activities

The RI field activities were performed in three main phases: a Phase I SC, Supplemental South Pond Assessment, and Phase II SC (including a Background Investigation). These field activities are summarized below and detailed in Table 2.

Phase I SC

Roux completed a Phase I SC in from April 2016 through July 2017, which included the collection and laboratory analysis of soil, sediment, groundwater, and surface water samples from within and around Site features. The Phase I SC activities were performed in accordance with the USEPA-approved Phase I SAP and SAP Addendum (Roux, 2051b; 2016a). The results of these field activities are provided in the Phase I SC Data Summary Report.

Supplemental South Pond Assessment

CFAC proposed expedited fieldwork and risk assessment activities in the South Percolation Pond Area in a letter to the USEPA dated September 6, 2017. The purpose of expediting the field activities in this area was to collect the additional data needed to evaluate human health and ecological risk within the South Percolation Pond Area prior to the completion of the Phase II SC fieldwork and the Site-wide risk assessment activities.

Roux conducted soil, sediment, and surface water sampling activities in and around the South Percolation Ponds, Backwater Seep Sampling Area, and Riparian Sampling Area to complete the characterization of these areas and to meet the data quality objectives (DQOs) outlined the Expedited Risk Assessment SAP (Roux, 2017c) in October and November 2017.

Phase II SC and Background Investigation

Roux completed a Phase II SC from June 2018 through October 2018, which included the collection and laboratory analysis of soil, sediment, groundwater, surface water, and porewater samples from within and around Site features. Within the same time period, a Background Investigation was conducted which included collection and laboratory analysis of soil, sediment, and surface water samples from reference areas outside of the Site boundaries. The Phase II SC activities were performed in accordance with the USEPA-approved Phase II SAP and the Background Investigation SAP (Roux, 2018c; 2018d). The results of the Phase II SC and Background Investigation field activities are provided in Section 4 and 5 of the Phase II SC Data Summary Report, respectively.

The following sections describe the areas investigated and work completed as part of the RI.

2.3 Pre-Intrusive Investigation Activities

Pre-intrusive investigation activities were conducted prior to, and in preparation for, intrusive activities as part of the RI field programs (i.e., hand augering or drilling). The objective of the pre-intrusive activities was to gain a better understanding of drilling locations and subsurface conditions prior to implementation of the drilling investigation scope of work. The pre-intrusive activities included Site reconnaissance, topographic surveys, brush clearing, and ground penetrating radar (GPR) utility mark-outs. The following sections summarize these pre-intrusive investigation activities completed during the RI.

2.3.1 Site Reconnaissance

Site reconnaissance activities for the Phase I SC were initiated by Roux on April 4, 2016 and were completed on April 16, 2016. As part of Site reconnaissance, Roux personnel visited each Site feature, all proposed drilling locations, and existing well locations described in the RI/FS Work Plan, Phase I SAP, and Phase I SAP Addendum (Roux, 2015a; 2015b; 2016a). Each location was inspected, and any pertinent observations and location adjustments were noted on field datasheets. A more detailed discussion of the Phase I SC Site reconnaissance is included in Section 2.4.2 of the Phase I SC Data Summary Report.

A habitat assessment was initiated by Roux and EHS on May 2, 2016 and was completed on May 6, 2016. This habitat assessment was conducted to asses habitat value, flora and fauna, and potential exposure pathways; and to identify potential locations for representative sample collection. Each Site feature was assessed by field biologists.

Site reconnaissance activities for the Phase II SC were initiated by Roux on April 25, 2018 and were completed on April 26, 2018. As part of Site reconnaissance, Roux personnel visited proposed drilling locations within vegetated areas of the Site. Each location was inspected to assess potential constraints on access for the Sonic and Geoprobe™ drill rigs and associated equipment. A more detailed discussion of the Phase II SC Site reconnaissance is included in Section 3.2.1 of the Phase II SC Data Summary Report.

2.3.2 Drainage Structure Sampling

Fifteen drainage structures associated with the former plant operations were observed and inspected by Roux personnel from April 12 to April 15, 2016, to screen for the potential presence of COPCs based upon visual observations of staining, or the presence of odors and photo-ionization detector (PID) readings. Observations made as part of the drainage structure evaluation were summarized in Section 2.5 of the Phase I SAP Addendum (Roux, 2016a). In conjunction with the inspection activities, soil samples were collected from four drainage structures that were able to be opened and accessed with hand tools and had soil/sediment accumulations at the bottom of the structure. Results of the drainage structure sampling were summarized in Section 2.5.1 of the Phase I SAP Addendum.

Based on the results of the initial drainage structure sampling activities, the three drainage structures with the highest concentrations of COPCs in soil (CFDS-005, CFDS-007, and CFDS-013), were selected for further investigation as part of the Phase I SC drilling scope of work to evaluate the subsurface soils beneath each structure. Soil borings were completed by Cascade Environmental (Cascade) on July 14 and 15, 2016. At each location, a soil boring was advanced through the bottom of the drainage structure utilizing the Sonic drilling technique, as described in Section 2.6 of the Phase I SC Data Summary Report.

2.3.3 Site Surveying

The various surveys conducted during the RI are described in the sections below.

2.3.3.1 Topographic Survey

Sand Surveying Inc. (Sands) performed a topographic survey of the Site features and landfills using light detection and ranging (LiDAR) fly-over technology on May 22, 2018. The topographic survey included a ground control survey, data processing, and mapping showing roads, structures, visible utilities, water features, and land surface topography with 1-foot contours. The results of the LiDAR survey are provided in Section 3.3 of the Phase II SC Data Summary Report. The survey will primarily be utilized to evaluate areas of runoff/overland flow, erosional features, anomalies related to differential settlement (if any) within the landfills, horizontal extent of disposal areas, and adequate slope for drainage as part of the FS.

2.3.3.2 Ground Penetrating Radar Utility Mark Outs

Shari A. Johnson & Associates Engineering, PLLC (SAJ&AE) performed utility mark-outs utilizing GPR geophysical survey techniques as part of the Phase I SC during the week of May 9, 2016. The GPR was used to identify potential utilities and/or other subsurface obstructions in the immediate vicinity of each proposed drilling location. The identified utilities were marked in the field with spray paint and were noted by Roux personnel utilizing a hand-held Global Positioning System (GPS; with sub-meter accuracy). Final drilling locations were modified where necessary based on the findings of the survey. A summary of the GPR survey results is provided in Section 2.8 of the Phase I SAP Addendum.

SAJ&AE performed utility mark-outs utilizing GPR geophysical survey techniques during the Phase II SC on April 26, 2018. The GPR was used to identify potential utilities and/or other subsurface obstructions in the immediate vicinity of proposed soil borings outside of the Rectifier Yards. The identified utilities were marked in the field with spray paint and were noted by Roux personnel utilizing a hand-held GPS. No soil boring locations were modified based on the results of the survey. A summary of the GPR survey results is provided in Section 3.2.2 of the Phase II SC Data Summary Report.

2.4 Passive Soil Gas Investigation

A passive soil gas investigation was conducted by Roux from April 18 to April 23, 2016, with the objective of identifying any potential areas where volatile organic compounds (VOCs) may be present. The passive soil gas investigation was conducted using Amplified Geochemical Imaging, LLC (AGI) passive sampling devices at ten locations; including eight locations within the Former Drum Storage Area to the west of the West Landfill, and two locations within the Operational Area (at a former storage area between the Main Plant Area and Wet Scrubber Sludge Pond). A review of the passive soil gas results is provided in Section 2.4.4.2 of the Phase I SC Data Summary Report.

2.5 Landfill Investigations

Various investigations were performed at Site landfills during the RI as discussed in the sections below. Additional details regarding the scope of work included in this section are provided in the Phase I SC Data Summary Report and the Phase II SC Data Summary Report.

2.5.1 Landfill Soil Gas Screening

Roux personnel conducted field screening of soil gas utilizing a landfill gas meter and PID to assess for the presence of methane and other VOCs at five landfill areas across the Site; including: the Wet Scrubber Sludge Pond, West Landfill, Sanitary Landfill, Center Landfill, and Industrial Landfill.

Between April 18 and April 25, 2016, Roux field personnel completed screening by manually installing the soil gas probe to depths of three to five ft-bls at four locations within the Wet Scrubber Sludge Pond and two locations within the Center Landfill. On June 4 and June 5, 2016, Roux utilized a Geoprobe™ direct push rig operated by Cascade to complete the soil gas screening at 14 locations within the West Landfill, Sanitary Landfill, and Industrial Landfill. Additionally, ten existing landfill vents within the West Landfill were screened.

2.5.2 Landfill Electrical Resistivity/Induced Polarization Survey

An ER/IP geophysical survey conducted by Spectrum Geophysics was utilized in an effort to approximate the depth of landfill bottoms and landfill caps.

Spectrum Geophysics performed the ER/IP geophysical survey as part of the Phase I SC from April 18, 2016 through April 22, 2016. The survey was conducted across six transects at the Site in accordance with the Geophysical Work Plan prepared by Spectrum Geophysics dated March 23, 2016. The objective of the ER/IP geophysical survey was to develop a preliminary understanding of approximate depth to bedrock, approximate depth to groundwater, approximate depth of landfills, potential changes in subsurface hydrogeological conditions, and potentially other subsurface anomalies that may contribute to the delineation of potential source areas. The results of the ER/IP geophysical survey were summarized in a summary report prepared by Spectrum Geophysics and submitted to the USEPA on July 21, 2016. The results are discussed in Section 3.2.3.1 of the Phase I SC Data Summary Report.

2.5.3 Asbestos Landfill Investigations

The investigations performed within the Asbestos Landfills during the RI are described below. Details of the locations and construction of the Asbestos Landfills are included in Section 1.3.4.1 above.

Asbestos Landfill Test Pitting

Cascade, under Roux oversight, conducted test pitting activities from August 15 through August 18, 2016 within the Asbestos Landfills in order to further define the extent and contents of the landfills. A certified asbestos inspector provided by Hydrometrics was present throughout the duration of the test pit activities. The test pitting consisted of seven test pits excavated to approximately 10 ft-bls within the South Asbestos Landfill and eight test pits excavated to approximately 10 ft-bls within the North Asbestos Landfill.

At each test pit location, Roux personnel, in consultation with the asbestos inspector, recorded visual observations in a field notebook. The presence, or lack thereof, of visual asbestos was noted at each test pit location. The presence of other materials was also noted where present in the test pits. After visual inspections, the excavated materials were placed back in the excavation.

Asbestos Landfill Surface Sampling

The historical knowledge of Asbestos Landfill operations at the Site and previous Site reconnaissance and test pitting activities indicated that asbestos containing materials were buried in the landfills underneath a soil cover. However, it could not be determined from visual field inspection if asbestos was present in the surface soil. Therefore, surficial soil sampling was conducted to determine the presence, or lack thereof, of asbestos in the surface soil, and the extent of the asbestos, if present.

Roux conducted surface soil sampling from July 31 through August 10, 2017 within the Asbestos Landfills in order to assess for the presence of asbestos. A certified asbestos inspector provided by Hydrometrics was present throughout the duration of the sampling activities. A total of 56 grid cells were sampled across the four landfills. The sampling was conducted at the frequency of 30 surface soil sub-samples per grid cell (approximately 3,000 square feet per cell). Surface soil samples were collected from each grid and samples were analyzed via the California Air Resources Board (CARB) 435 method using polarized light microscopy (PLM). The laboratory analytical results were summarized in the Surficial Soil Sampling Results from Asbestos Landfills letter sent to USEPA on October 19, 2017 and also included in the BHHRA Work Plan.

2.5.4 Landfill Cover Investigation

Soil borings were advanced within landfill cover materials at landfills for which there are no design drawings or as-built drawings; specifically, the Sanitary Landfill, Center Landfill, Wet Scrubber Sludge Pond, and Industrial Landfill. The landfill samples were collected to characterize the nature of the landfill covers and to evaluate the geotechnical parameters of the landfill covers for use in the FS.

Eighteen soil borings were advanced with hand augers to a total depth of 2 ft-bls. Two soil samples were collected for laboratory analysis from each of the 18 soil borings, including a discrete surface soil sample from the interval of 0-0.5 ft-bls and a discrete shallow soil sample from the interval of 0.5-2 ft-bls.

2.5.5 Landfill Groundwater Investigation

As described in Section 2.7.1 below, monitoring wells were installed adjacent to and downgradient of each landfill to assess groundwater quality, groundwater elevations, and groundwater flow in the vicinity of each landfill. These monitoring wells were required to evaluate groundwater quality in potential source areas.

2.6 Site-Wide Soil Investigations

This section describes the Site-wide soil investigations completed as part of the RI. Details regarding the scope of work included in this section are provided in the Phase I SC Data Summary Report and the Phase II SC Data Summary Report. Table 3 summarizes the number, general location, depth intervals, and analyses of the soil samples collected during the RI. Plate 2 and Plate 3 present the location and designations for all soil borings completed during the RI.

2.6.1 Site-Wide Soil Borings and Soil Sampling

The rationale behind the various soil sampling activities completed during the RI is briefly described below.

- **Characterization of Nature and Extent of COPCs in Soil in/around Site Features** – During the Phase I SC, soil borings were advanced within Site features to confirm potential source areas identified in the preliminary CSM presented in the RI/FS Work Plan (Roux, 2015a) and to identify any potential additional source areas. During the Phase II SC, select soil borings were advanced to refine the understanding of the nature and extent of COPCs identified during the Phase I SC. These soil borings were typically within the boundaries of the Site feature being investigated, or along the perimeter of features to assess for impacts to the adjacent areas, and at depth intervals necessary to vertically characterize and/or delineate the soil conditions beneath the feature.

- **Main Plant Borings** – Soil borings were advanced within the former footprint of the Main Plant Building to characterize the soil beneath the former potroom basements and to investigate soil quality surrounding the Main Plant utility tunnel.
- **Delineation of PCBs in Soil** – Discrete soil borings were advanced within the Operational Area of the Site to refine the horizontal and vertical extent of the PCBs detected during the Phase I SC Operational Area sampling.
- **Dioxin and Furan Compounds outside the Rectifier Yards** – The Phase I SC soil results identified localized detections of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) (together as dioxin and furan compounds) in surficial and shallow soils collected in the Rectifier Yards. As part of the Phase II SC, surficial and shallow soil samples were collected from eight soil borings outside the Rectifier Yards to delineate the extent of dioxin and furan compounds and to determine if those compounds are confined to the Rectifier Yards. Based upon the results of the dioxin and furan compounds outside of the Rectifier Yards, and as described in Field Modification #2 of the Phase II SC Data Summary Report, additional samples were collected within the Main Plant Area and Western Undeveloped Area to develop a better understanding of the distribution and concentrations of dioxin and furan compounds at the Site.
- **Characterization of Chromium in Soil** – As part of the Phase I SC soil sampling program, Roux collected soil samples for total chromium analysis to characterize the nature and extent of chromium at the Site. In an effort to characterize the valence state of chromium in soil at the Site, soil samples were collected from locations surrounding the Main Plant Area and analyzed for total chromium and hexavalent chromium (Cr[VI]).
- **Characterization of Site Boundary Soil** – The Phase I SC results identified detections of COPCs, specifically PAHs, cyanide, fluoride, and select metals in areas of the Site where former Site operations did not occur, and in the samples that were farthest from the areas of Site operations. In an effort to vertically and horizontally delineate these COPCs, a series of soil borings were advanced along the extent of the western and eastern Site boundary.
- **Characterization of Spatial Variability in Soil for Risk Assessment** – As identified in the risk assessment data gaps in the Phase II SAP (Roux, 2018c), additional soil samples were collected during the Phase II SC to support assessment of potential ecological and human health risk at the Site. The objective of this sampling was to increase the spatial density of sampling locations within exposure areas where limited sampling occurred during the Phase I SC or to characterize undeveloped areas of the Site where historical Site operations did not occur (i.e., North-Central Undeveloped Area and Western Undeveloped Area). Additional samples were also collected within exposure areas that were more densely sampled during the Phase I SC (e.g., Main Plant Area and Central Landfill Area) to support the calculation of statistically valid Exposure Point Concentrations (EPCs) in the risk assessment, as described in the Phase II SAP (Roux, 2018c).

2.6.2 Operational Area Soil Investigation

An incremental sampling methodology (ISM) investigation was conducted within the Operational Area during the Phase I SC to assess whether any potential source areas were present in this area.

The Phase I SC Operational Area soil investigation was conducted from June 14, 2016 through July 26, 2016. The Operational Area was divided into 43 grid cells, also referred to as Decision Units (DUs); each approximately one acre in size. Each incremental soil sample consisted of 32 discrete grab samples that were randomly distributed within the four quadrants of each grid (i.e., eight samples per quadrant). The coordinates of the random locations were established using GIS and a random number generator. Field personnel utilized a hand-held GPS to navigate to each of the 32 sample locations within each grid for sample collection.

Samples from the first 15 DUs (designated CFISS-001 through CFISS-015) were collected using ISM field processing methods. As documented in Field Modification #4 of the Phase I SC, field processing by Roux/Hydrometrics was discontinued at the request of USEPA since the field processing method did not include drying and breaking up of soil aggregates and/or sieving, as would be done in the lab processing of incremental soil samples.

Samples from the remaining 28 DUs were instead collected using the "wedge" approach as defined in the Interstate Technology and Regulatory Council (ITRC) February 2012 guidance document titled "Incremental Sampling Methodology" and discussed in the Roux Standard Operating Procedure (SOP) 5.12 titled Incremental Soil Sampling. As part of this modification, three DUs (DU-002, 006, and 008) were re-sampled to allow for a comparison of the results from the two methods (field processing vs. laboratory processing), and for assessment of whether or not the initial field processing approach yielded different results relative to the laboratory processing methods, thus whether re-sampling should potentially occur in the 12 DUs not re-sampled.

Due to the variability of the results in the three resampled DUs, as documented in the Phase I SC Data Summary Report, all 12 DUs were proposed for re-sampling utilizing the lab processing protocols in accordance with the ITRC ISM guidance as part of the Phase II SC.

The Phase II SC Operational Area soil investigation was conducted from May 15, 2018 through May 23, 2018. The 12 DUs with boundaries that were previously determined during the Phase I SC, each approximately one acre in size, were sampled using the ISM "wedge" soil sampling procedure described above during the Phase II SC. In addition to the ISM soil sampling conducted in the 12 DUs, replicate sampling (as described in the ITRC Guidance (ITRC, 2012) was conducted in four of the DUs (DU-001, 004, 011, and 015) to provide an estimate of variability between replicates.

2.7 Hydrogeological Investigations

This section describes the monitoring well installation, groundwater elevation monitoring, and slug testing performed as part of the hydrogeological investigations. Details regarding the scope of work summarized in this section are provided in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and the Phase II SC Data Summary Report.

There are two hydrogeologic units discussed in the RI. The coarse-grained glacial outwash and alluvium deposits found above the glacial till are collectively referred to as the "upper hydrogeologic unit" at the Site. While the upper hydrogeologic unit appears to be continuous across the Site, the groundwater within the upper hydrogeologic unit appears to exist under perched water-table conditions. Glacial tills found "below the upper hydrogeologic" unit were typically characterized as containing a higher percentage of fines, and as denser and drier than the overlying outwash and alluvium deposits. These observations indicate the till deposits likely have a lower hydraulic conductivity than the overlying outwash and alluvium deposits, which is supported by observations during monitoring well development where the new, deep wells screened within the tills typically yielded less water than wells screened in the outwash deposits.

The stratigraphic units underlying the Site form a complex hydrogeologic framework that influences groundwater elevations, groundwater flow, and potential COPC migration beneath the Site. A detailed description of the hydrogeologic units at the Site is provided in Section 3.2.

2.7.1 Monitoring Well Installation and Survey

During the Phase I SC, Cascade installed 44 monitoring wells; including 28 monitoring wells screened in the upper hydrogeologic unit and 16 deeper monitoring wells screened below the upper hydrogeologic unit. During the Phase II SC, Cascade installed an additional eight monitoring wells in the upper hydrogeologic unit. The new monitoring well locations were selected to supplement the network of 20 monitoring wells that existed at the Site prior to the RI/FS to support further evaluation of groundwater quality in potential source areas and in areas that had not previously been monitored, while also helping to refine the understanding of Site groundwater flow.

Monitoring wells in the upper hydrogeologic unit were typically installed with the top of the screened interval located approximately 5 to 10 feet below the observed groundwater table at the time of drilling to account for seasonal fluctuations in groundwater elevations. Monitoring wells screened below the upper hydrogeologic unit were installed to evaluate the vertical extent of COPCs in groundwater and to evaluate groundwater flow within deeper hydrogeologic units. The screened intervals of the deeper wells were determined by Roux personnel based on field observations made during drilling and were typically set below the first low-permeability unit observed during drilling.

All newly installed monitoring wells were surveyed by Sands for horizontal (North American Datum 1983 [NAD83]) and vertical (North American Vertical Datum 1988 [NAVD88]) coordinates within the Montana State Plane Coordinate System (FIPS2500). In addition, Sands surveyed the top of casing for the five former production wells and all existing wells on-Site. Survey data is included in Table 4 of the Phase II SC Data Summary Report.

Newly-constructed monitoring wells were developed and allowed a minimum of one-week to equilibrate with the surrounding formation prior to sampling. The development was completed by Cascade using a surge block and submersible pump. Temperature, pH, oxidation reduction potential (ORP), dissolved oxygen (DO), specific conductance, and turbidity readings were monitored and pumping proceeded during development of each monitoring well until the discharge water met a field turbidity value of 10 formazin nephelometric units/nephelometric turbidity units (FNU/NTU) or less; or, until the field turbidity did not improve for a period of two hours during active development.

2.7.2 Groundwater Elevation Monitoring

Site-wide groundwater levels were measured by Roux prior to each groundwater sampling event during the RI. The groundwater levels were measured on August 30, 2016, November 29, 2016, March 14/15, 2017, and June 16, 2017 during the Phase I SC; and on June 4/5, 2018 and October 1/2, 2018 during the Phase II SC. Groundwater level measurements were collected to provide a snapshot of the Site-wide groundwater elevations immediately prior to the start of each groundwater and surface water sampling round. Groundwater levels were measured utilizing an electronic water-level meter capable of measuring fluid elevation within an accuracy of 0.01 ft. The groundwater levels were used to create a groundwater contour map for each round of groundwater sampling to represent groundwater level and flow during those rounds. Groundwater levels measured during the RI are included in Table 4 of the Phase II SC Data Summary Report.

As described in the GW/SW Data Summary Report and Phase II SC Data Summary Report, transducers were installed to continuously collect groundwater elevation data in various areas of the Site and around different Site features, with the objective of developing an understanding of groundwater elevation fluctuations in response to precipitation events and longer-term seasonal trends at the Site. Initially, six

In Situ Level Troll 700 pressure transducers were deployed in six pre-RI/FS monitoring wells from April 2016 until March 2017, before the installation of any Phase I SC monitoring wells. The pressure transducers were deployed to continuously record groundwater elevation fluctuations in monitoring wells CFWM-001, 007, 020, and 049 (screened in the upper hydrogeologic unit), and CFMW-044b and 056 (screened in the below upper hydrogeologic unit). The pressure transducer in CFMW-007 was removed in June 2016 and installed in monitoring well CFMW-003, which is also screened in the upper hydrogeologic unit. In March 2017, the six pressure transducers were relocated to six different monitoring wells at the Site, as part of the Phase I SC. The pressure transducers were deployed to continuously collect groundwater elevation fluctuations in nested monitoring wells CFWM-016, 016a, 019, 019a, 053, and 053a located around the West and Center Landfills, and near the Flathead River downgradient of the Central Landfill Area.

As part of the Phase II SC, three new pressure transducers were deployed in new Phase II SC monitoring wells, CFMW-065, CFMW-066, and CFMW-069, around the Western Undeveloped area and Industrial Landfill in June 2018. The data obtained from these transducers was utilized in conjunction with the existing pressure transducer network and the Site-wide gauging data to facilitate comprehensive understanding of Site-wide groundwater fluctuations. The pressure transducers were programed to collect automated measurements every 30 minutes.

Roux also continued to monitor the Montana State Bureau of Mines pressure transducer deployed in existing monitoring well CFMW-007/TW 3 (identified ID 87873 in the Montana Bureau of Mines and Geology [MBMG] website well database [MBMG, 2017]).

2.7.3 Slug Testing

Roux conducted slug testing on all 52 new 2-inch diameter monitoring wells installed as part of the RI in July 2017 and June 2018. Slug tests were performed via one of two methods: pneumatic or mechanical slug testing. The pneumatic slug test method was the preferred testing method for most wells due to the level of accuracy able to be achieved in high conductivity settings. Pneumatic slug testing methods were used at locations where the entire length of screen of the monitoring well was submerged beneath the level of standing water in the well. If the water level was below the top of the screen, mechanical slug testing was performed.

The Phase I SC slug tests were performed from July 10 through July 27, 2017 and the Phase II SC slug tests were performed following the first groundwater and surface water sampling event during the high-water season, from June 19 through June 21, 2018. The slug testing activities were conducted to understand the hydraulic conductivity in the subsurface across the Site and the *in-situ* permeability contrast between various hydrogeologic units beneath the Site.

In accordance with the procedures outlined in the Phase II SAP (Roux, 2018c), four tests were generally completed at each location: two 1-foot displacement tests; and two 2-foot displacement tests. Two tests were conducted at each displacement level to assess the reproducibility of the data for consecutive tests.

All pneumatic tests were conducted in accordance with the procedures outlined in SOP 4.8 entitled “Conducting a Pneumatic Slug Test” included in the Phase II SAP. Pneumatic slug tests were conducted using compressed air as the displacing (slug) volume. The water column within the well casing was depressed by increasing the air pressure in the casing above the water column. When the water level was depressed to a predetermined level and the air pressure stabilized within the test interval, the air pressure within the well casing was rapidly released. The instantaneous release of air pressure from the well casing initiated a pneumatic slug withdrawal test, which was recorded using a pressure transducer data logger.

All mechanical tests were conducted in accordance with the procedures outlined in SOP 4.9 entitled "Conducting a Mechanical Slug Test." Mechanical slug tests were conducted within using a solid cylinder (slug). Due to the fact that mechanical slug tests were being performed on wells screened near the water table, the testing was limited to "slug-out" tests. As part of the "slug-out test," the water column within the well casing was decreased by rapidly removing the solid slug from the water column. All changes in water levels were recorded using a pressure transducer data logger.

Hydraulic conductivity values determined from the slug testing data and analysis are discussed in Section3.2.3.

2.8 Groundwater Quality Investigations

This section summarizes the Site-wide groundwater monitoring and residential well monitoring that was completed as part of the RI. Details regarding these monitoring activities are provided in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and the Phase II SC Data Summary Report. A total of 390 groundwater samples were collected during the RI; 242 groundwater samples were collected during the four rounds of the Phase I SC and 148 groundwater samples were collected during the two rounds of the Phase II SC. Table 4 details the number and analyses of the groundwater samples collected during each round of the RI. Plate 4 presents the location and designations for all groundwater monitoring wells sampled during the RI.

2.8.1 Site-Wide Groundwater Monitoring

During the Phase I SC, groundwater samples were collected quarterly from the Site-wide monitoring wells in September 2016, December 2016, March 2017, and June 2017 to capture seasonal variability in groundwater quality. During the Phase II SC, groundwater samples were collected from the Site-wide monitoring wells during June 2018 to capture high-water groundwater conditions and October 2018 to capture low-water groundwater conditions.

Each round of sampling was approximately three weeks in duration. Groundwater samples were collected using the methods described in the USEPA guidance document entitled "Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling" (USEPA, 2010), and in accordance with the applicable Roux SOPs provided in the Phase I SAP (Roux, 2015b), Phase I SAP Addendum (Roux, 2016a), and the Phase II SAP (Roux, 2018c). During groundwater sampling, a water quality meter was used to monitor water quality indicator parameters such as pH, conductivity, DO, ORP, temperature, and turbidity.

2.8.2 Residential Well Monitoring

In 2013, Weston Solutions, Inc. (Weston) completed an investigation at the Site on behalf of USEPA. The results were summarized in the April 2014 report titled "Site Reassessment for Columbia Falls Aluminum Company Aluminum Smelter Facility, Columbia Falls, Flathead County, Montana prepared for United States Environmental Protection Agency Region 8" (Weston, 2013). Four rounds of residential groundwater sampling were conducted as part of the Site Reassessment. A summary of the results of this investigation is included in the RI/FS Work Plan (Roux, 2015a).

After the rounds of sampling described above, CFAC offered to conduct quarterly sampling of water supply wells for any Aluminum City residents that desired additional sampling of their well locations. As a result, sampling events were completed quarterly by Hydrometrics on behalf of CFAC from June 2015 through September 2018. A maximum of 14 monitoring well locations were sampled within a single sampling round. A total of 165 groundwater samples were collected from June 2015 through September 2018. Quarterly sampling conducted by CFAC was completed in September 2018. CFAC will continue to conduct residential well sampling twice annually, in the fall and spring of each year to coincide with high-water and low-water seasons. A summary of the results of this investigation is included in Appendix EE of the Phase II SC Data Summary Report.

2.9 Surface Water Quality Investigations

This section summarizes the surface water discharge monitoring and Site-wide surface water quality monitoring completed during the RI. Details regarding these activities are provided in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and the Phase II SC Data Summary Report. A total of 189 surface water samples were collected during the RI; 87 surface water samples were collected during the four rounds of the Phase I SC, 13 surface water samples were collected during the Supplemental South Pond Assessment, and 89 surface water samples were collected during the two rounds of the Phase II SC. Table 5 details the number, general location, and analyses of the surface water samples collected during each round of the RI. Plate 5 presents the location and designations for all surface water samples collected during the RI.

2.9.1 Surface Water Discharge Monitoring

As part of the six surface water sampling events performed during the Phase I and Phase II SC, the discharge of Cedar Creek and Cedar Creek Reservoir Overflow Ditch were measured utilizing a mechanical current-meter method in accordance with Roux SOP 6.7 titled, “Measuring Stream Discharge” provided in the Phase I SAP (Roux, 2015b), Phase I SAP Addendum (Roux, 2016a), and the Phase II SAP (Roux, 2018c). To collect the measurements, the stream channel cross-section was divided into equal vertical subsections. In each subsection, the area was calculated by measuring the width and depth of the subsection, and the water velocity was determined using a current flow meter. The discharge in each subsection was computed by multiplying the subsection area by the measured velocity and the total discharge was determined by summing the discharge of each subsection. Surface water discharge was not measured for the Flathead River since data was reviewed from the nearest USGS monitoring station (Station No. 12363000) located approximately three miles downstream of the Site. The results of the discharge monitoring are provided in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and Phase II SC Data Summary Report.

2.9.2 Site-Wide Surface Water Monitoring

During the Phase I SC, surface water samples were collected quarterly from on-Site surface water features in September 2016, December 2016, March 2017, and June 2017 to capture seasonal variability in the surface water quality. During the Supplemental South Pond Assessment, surface water samples were collected from the South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area to better define the surface water quality within these surface water features. During the Phase II SC, surface water samples were collected from on-Site surface water features during June 2018 to capture high-water conditions and October 2018 to capture low-water conditions. Additional surface water sample locations were added during the Phase II SC to refine the understanding of surface water quality in these features.

Surface water samples were collected as grab samples from within the Site feature by Roux personnel. All surface water samples were collected at a depth of approximately 60% of the total water column depth in accordance with the Roux SOP 4.5 entitled "Surface Water Sampling." Roux collected surface water samples from the Flathead River with the use of a boat provided by Kennedy/Jenks Consulting (Kennedy/Jenks) from Whitefish, Montana. A captain from Kennedy/Jenks steered the boat through the river, and surface water samples were collected from the boat by collecting a grab sample directly from the waterbody using the sample collection container for each analysis.

As part of the sample collection activities within the surface water bodies, the surface water was field screened with a water quality meter to evaluate surface water quality parameters including: pH, conductivity, DO, ORP, temperature, and turbidity. The water quality meter was placed directly in the surface water body and monitored until stable readings were observed.

2.10 Sediment Quality Investigations

During the Phase I SC, sediment samples were collected from on-Site surface water features in September 2016 to refine the understanding of sediment quality. During the Supplemental South Pond Assessment, sediment samples were collected from the South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area to better define the sediment quality within these surface water features. During the Phase II SC, sediment samples were collected from on-Site surface water features in June 2018 and October 2018. Additional sediment sample locations were added during the Phase II SC to refine the understanding of sediment quality in these features. Details regarding these activities are provided in the Phase I SC Data Summary Report and the Phase II SC Data Summary Report. A total of 72 sediment samples were collected during the RI; 12 sediment samples were collected during the Phase I SC, 16 sediment samples were collected during the Supplemental South Pond Assessment, and 44 sediment samples were collected during the Phase II SC. Table 6 details the number, general location, and analyses of the sediment samples collected during each phase of the RI. Plate 5 presents the location and designations for all sediment samples collected during the RI.

As discussed in Section 2.5 of the Phase II SAP (Roux, 2018c), the total recoverable concentrations of inorganic and non-volatile organic COPECs in bulk sediment within aquatic and transitional habitats are not expected to vary seasonally. As such, only one round of sediment data was collected within select surface water features when the surface water features were expected to be wet.

2.11 Sediment Porewater Quality Investigations

Roux performed sediment porewater sampling during both the high-water sampling event in June 2018 and the low-water sampling event in October 2018 coinciding with the surface water sampling events, as part of the Phase II SC. Sediment porewater samples were collected for evaluation of COPEC bioavailability in surface water features. Details regarding the porewater sampling scope of work are provided in the Phase II SC Data Summary Report. Table 7 summarizes the number, general location, and analyses of the sediment porewater samples collected during the Phase II SC. Plate 5 presents the location and designations for all sediment porewater samples collected during the RI.

As discussed in the Phase II SAP (Roux, 2018c), the total recoverable concentrations of inorganic and non-volatile organic COPECs in bulk sediment within aquatic and transitional habitats are not expected to vary seasonally in surface water features that are not connected to the groundwater system (i.e., Cedar Creek, North Percolation Ponds). Within the Flathead River which is subject to groundwater input, variable concentrations, if any, would be expected to be greatest during low-water season when potential COPEC inputs from groundwater are highest. As such, sediment porewater data was collected during the low-water season within select surface water features.

Sediment porewater samples were collected from the same locations as surface water and sediment samples, immediately following the collection of the surface water samples and prior to collection of bulk sediment samples. During each sampling event, Roux collected sediment porewater samples from Site surface water features that were observed to contain water during the respective sampling event.

2.12 Background Investigation

This section describes the Background Investigation conducted as part of the Phase II SC. The purpose of the Background Investigation was to characterize the concentrations of COPCs in areas outside the Site that are unaffected by historical Site operations or other readily identifiable, anthropogenic sources of contamination.

Results of the Phase I SC indicated that cyanide, fluoride, PAHs, metals, and dioxin and furan compounds are potential COPCs found within various media at the Site. Cyanide, fluoride, and PAHs were identified as Site-related COPCs in the Phase I SC based upon knowledge of historical Site operations and the distribution of concentrations observed in the various media around source areas and Site features. Metals were also frequently detected across the Site in most soil, surface water, and sediment samples and identified as potential COPCs. Additionally, dioxin and furan compounds were detected in soil within the Rectifier Yards.

Although cyanide, fluoride, PAHs, some metals, and dioxin and furan compounds were determined to be COPCs, these constituents are often present within the background environment. Therefore, these COPCs were evaluated in Background Reference Areas to determine background concentrations to allow for the proper framing of the risk assessment results. Details regarding the Background Investigation scope of work are provided in the Phase II SC Data Summary Report. Table 8 summarizes the number, general location, and analyses of background soil, surface water, and sediment samples collected during the Background Investigation.

2.12.1 Background Soil Investigation

Four soil background reference areas were selected for soil sampling as part of the Background Investigation. Soil type and soils derived from similar geologic sources were the primary consideration for selecting soil background reference areas, as described in the Background SAP (Roux, 2018d). The four soil background reference areas sampled are listed below:

- **Soil Background Reference Area #1: Glacial Till and Alluvium –** located approximately three-quarters of a mile south of the Site boundary and over one mile from the Main Plant Area;
- **Soil Background Reference Area #2: Fluvial Deposits and Riverwash –** located downstream of the Site within State of Montana Fish and Game Commission Property;
- **Soil Background Reference Area #3: Fluvial Deposits and Riverwash –** located in an area north-east and upstream of the Site, near Blankenship Bridge; and
- **Soil Background Reference Area #4: Mountainous Land with Glacial Deposits –** located approximately one-half mile south-east of the Site boundary and three-quarters of a mile south-east of the Main Plant area.

Figure 5 includes the locations of the background soil reference areas. The background soil investigation was completed in September 2018. A total of 40 surface soil samples were collected from the four background soil reference areas (ten samples per reference area), in accordance with the Background SAP (Roux, 2018d). The sampling locations were randomly distributed within each reference area.

2.12.2 Background Surface Water Investigation

Two surface water background reference areas were selected for surface water and sediment sampling as part of the Background Investigation. Surface water features comparable to the on-Site surface water features was the primary consideration for selecting surface water background reference areas. The two surface water background reference areas sampled are listed below:

- **Surface Water Background Reference Area #1: Flathead River Reference Area** – area upstream of the Site within the Flathead River; and
- **Surface Water Background Reference Area #2: Cedar Creek Reference Area –** located more than two miles upgradient of the Site and north of Cedar Creek Reservoir.

Figure 5 includes the locations of the background surface water reference areas. The background surface water investigation took place in June and October 2018, concurrent with the Phase II SC on-Site surface water sampling events. Background surface water sampling followed the same procedures as the Site surface water sampling.

During both background surface water sampling events, the discharge of the stream in Background Surface Water Reference Area #2, along Cedar Creek, was measured utilizing a mechanical current-meter method in accordance with Roux SOP 6.7 titled, “Measuring Stream Discharge.” The discharge in the headwaters of Cedar Creek was measured at multiple points to compare discharge between the background reference area and Cedar Creek on-Site.

2.12.3 Background Sediment Investigation

Background sediment sampling was conducted during the 2018 low-water season, in accordance with the Background SAP (Roux, 2018d). Sediment samples were collected from the two background surface water and sediment reference areas. Background sediment samples were collected from the same locations as surface water samples immediately following the collection of surface water samples. Background sediment sampling followed the same procedures as the on-Site sediment sampling.

2.13 Project Data Verification and Validation Summary of Findings

Data verification and validation were performed to confirm that the project data met the DQOs outlined in the RI/FS Work Plan (Roux, 2015a), Phase I SAP (Roux, 2015b), Phase I SAP Addendum (Roux, 2016a), Phase II SAP (Roux, 2018c), and Background Investigation SAP (Roux, 2018d). The following section describes the verification and validation procedures performed as part of the RI sampling.

Data verification was performed by Roux to evaluate the completeness, correctness, and conformance/compliance of data against the specifications outlined in the various project SAPs; and to evaluate how closely the procedures outlined in the various SAPs were followed during data generation. Personnel involved in the collection of samples and generation of data, including field samplers and subcontractors, conducted initial verification of field data. Field data verification included ensuring that data was properly collected and handled according to the sampling procedures described in the SAPs and the

SOPs. Documents outlining project procedures and task-specific SOPs were readily available to all project personnel for the duration of the RI sampling. All records were verified with multiple tiers of review by field staff, the RI Project Manager, and Quality Assurance (QA) Officer, including, but not limited to, chains of custody, field notebooks, field forms, and daily reports.

Prior to data validation, sample receipts, sample logins, and sample analysis methods were reviewed and verified. Laboratory data were reviewed by Laboratory Data Consultants, Inc. of Carlsbad, California, a qualified, third-party data validator. Validation of laboratory data was performed in accordance with the following USEPA guidance:

- National Functional Guidelines for Organic Data Review (USEPA, 2017a);
- National Functional Guidelines for Inorganic Data Review (USEPA, 2017b); and
- Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (USEPA, 2009).

All laboratory data packages were verified and validated using a Stage 4 validation to evaluate whether the data met the performance and acceptance criteria. The Stage 4 validation was performed on 100% of the laboratory chemical data generated during the RI/FS. As described in the guidance (USEPA, 2009), the Stage 4 verification and validation included completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, recalculation checks, and the review of actual instrument outputs. The analytical results were evaluated with respect to the following data quality indicators: precision, accuracy, representativeness, completeness, sensitivity, and comparability.

The data validator documented all findings by adding appropriate validation qualifiers (as necessary) to the sample results in the laboratory data packages based on the various verification and validation tasks. The following qualifiers were applied to the data where applicable to identify data limitations identified during validation:

J+ .... (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however, the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.

J- .... (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however, the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.

J .... (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however, the reported concentration is estimated due to it being below the laboratory quantitation limit or due to non-conformances discovered during data validation. Bias is indeterminate.

U .... (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however, the compound or analyte should be considered non-detect at the reported concentration due to the presence of contaminants detected in the associated blank(s).

UJ .... (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however, the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.

R .... (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.

NA .... (Not Applicable): The non-conformances discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant a qualification of the data.

Additionally, flags classified as P (Protocol) or A (Advisory) were applied to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

2.13.1 Summary of Data Verification and Validation Results

Sample counts proposed in the Phase I SAP (Roux, 2015b), Phase I SAP Addendum (Roux, 2016a), Phase II SAP (Roux, 2018c), Background Investigation SAP (Roux, 2018d), and the Expedited Risk Assessment SAP (Roux, 2017c) were compared to the count for samples collected during the RI. A summary count of all samples collected (not including field duplicates or Quality Assurance/Quality Control [QA/QC] samples) and a summary of any deviations from the proposed sample count are included in their respective data summary reports, including the Phase I SC Data Summary Report, the GW/SW Data Summary Report, and the Phase II SC Data Summary Report.

Approximately 341 laboratory sample delivery groups were submitted to Laboratory Data Consultants, Inc. for review as part of the data validation process for samples collected during the RI. The results of the data validation were produced by Laboratory Data Consultants, Inc. and are provided in the respective data summary reports. Data qualifiers added as a result of the data validation processes were imported to the CFAC RI/FS database and are included in the data summary tables of each data summary report.

A review of the data validation reports was completed by Roux to evaluate the completeness of the data in accordance with the applicable project SAP QA/QC procedures. Overall, approximately 490 analyses were rejected out of an estimated 438,538 analyses (approximately 0.001%) performed as part of the sampling activities summarized in this RIR. A summary of the data that was described in the data validation reports as rejected during the validation process was also provided in the respective data summary reports. The data suggested that the overall dataset generated during the work was usable and complete. Based on the evaluation of the data rejections, no gaps were identified in the data.

2.13.2 Evaluation of Method Detection Limits

A review of analytical method detection limits (MDLs) achieved by the laboratory in samples that were non-detect during the RI was performed to evaluate the adequacy of the MDLs relative to the minimum human health and ecological screening criteria. Tables providing minimum, maximum, mean, and median detection limits for all non-detect analytes in soil, groundwater, surface water, sediment, and sediment porewater compared to the minimum screening criteria are provided in Appendix WW of the Phase II SC Data Summary Report. The tables also identify the minimum human health and ecological screening criteria for each media.

Overall, the evaluation of MDLs indicates that the MDL for non-detect results are sometimes above the lowest screening criteria (i.e., USEPA Protection of Groundwater Risk Based Soil Screening Levels [RBSSLs], USEPA Tapwater Regional Screening Levels [RSLs], or Minimum Ecological Screening Values [ESVs]), for multiple analytes. As noted above, these RSLs are designed to be conservative screening levels, and these RSLs are often not attainable in the laboratory. However, the MDLs are almost always adequate for the other screening levels evaluated during the multiple rounds of sampling. It should be noted that during scoping of the RI/FS, CFAC and Roux required that each laboratory being considered for use on the project provide a list of attainable MDLs. During the analytical laboratory selection process, Roux evaluated the proposed MDLs against the desired limits based on the screening criteria. This information was provided in the Phase I SAP (Roux, 2015b), Phase I SAP Addendum (Roux, 2016a), and Phase II SAP (Roux, 2018c). TestAmerica Laboratories, Inc. was selected to be the primary analytical laboratory mainly because of their ability to achieve the most desired detection limits of all laboratories considered.

3. Physical Characteristics of Study Area

This section summarizes the physical characteristics of the Site and the surrounding region. Site stratigraphy, groundwater hydrology, and surface water hydrology are discussed in the sections below.

3.1 Site Stratigraphy

A summary of regional and Site geology was provided in Section 2.4 of the RI/FS Work Plan (Roux, 2015a) based on previous investigations at the Site and published literature for the Kalispell Valley region. One of the objectives of the RI drilling program was to refine the understanding of local Site geology and evaluate the influence of local geology and Site features on groundwater flow and potential COPC fate and transport.

Lithologic data collected from soil borings completed as monitoring wells during the RI were utilized to generate hydrogeologic cross-sections depicting the stratigraphy beneath the Site. Plate 6 presents the locations for four generalized hydrogeologic cross-sections, including:

- Section A-A' (Plate 7) oriented south-west to north-east and perpendicular to Teakettle Mountain, extending from the western boundary of the Site across the West Landfill;
- Section B-B' (Plate 8) oriented west to east across the southern portion of the Site, extending from the western boundary of the Site to the eastern boundary of the Site;
- Section C-C' (Plate 9) oriented north-west to south-east and parallel to Teakettle Mountain, extending from the western side of the Industrial Landfill to the Flathead River; and
- Section D-D' (Plate 10) oriented west to east, extending across the Former Drum Storage Area, Wet Scrubber Sludge Pond, and the East Landfill.

The generalized geologic cross sections indicate three major stratigraphic units underlying the Site. The three stratigraphic units consist primarily, from land surface down, of:

- A layer of glaciofluvial and alluvial coarse-grained deposits, varying in vertical extent and grain size, depending on vicinity to Site features (i.e., Teakettle Mountain, Flathead River, etc.);
- A layer of dense, poorly sorted glacial till with interbedded deposits of glaciolacustrine clays and silts; and
- Bedrock.

In addition to the generalized geologic cross-sections, detailed cross-sections depicting lithologic changes in the glaciofluvial and alluvial coarse-grained deposits (i.e., upper hydrogeologic unit as defined in Section 3.2.1.1) were developed to evaluate the potential for preferential groundwater pathways adjacent to and downgradient of potential source areas. The detailed cross-sections depict the lithology from surface to the top of the glacial till from transects located within the cyanide and fluoride Plume Core Area[5]. The level of lithologic detail for individual borings is greater on the detailed cross-sections as compared to the generalized cross-sections. However, based upon the observed lithologic heterogeneity of the individual borings, the known depositional environmental (i.e., outwash deposits), and the distance between borings (typically greater than 300 feet between borings); it was determined that extrapolation of the detailed lithology between borings in the detailed cross-sections was not technically appropriate. In addition to the geology, the detailed cross-sections depict the minimum and maximum concentrations of total cyanide and fluoride observed

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[5] The "Plume Core Area" for cyanide is identified as the area where monitoring wells had detected concentrations of total cyanide of greater than 300 µg/l in any of the six sampling rounds. The "Plume Core Area" for fluoride is identified as the area where monitoring wells had detected concentrations of fluoride of greater than 2,000 µg/l in any of the six sampling rounds.

during the six rounds of groundwater sampling, as well as the minimum and maximum groundwater elevations across the six rounds of groundwater sampling. Hydraulic conductivity values from slug testing performed at select monitoring wells are also depicted. Plate 11 presents the locations for the five detailed geologic cross-sections, including:

- Section A-A' (Plate 12) oriented north-west to south-east, is situated downgradient (south-west) of the West Landfill and extends through the south-west corner Wet Scrubber Sludge Pond, extending into the Operational Area. This transect intersects with Section B-B';
- Section B-B' (Plate 13) oriented north-west to south-east parallel with Teakettle Mountain, is situated downgradient (on the west side) of the West Landfill and Wet Scrubber Sludge Pond, extending through the Former Drum Storage Area and Operational Area. This transect intersects with Section A-A';
- Section C-C' (Plate 14) oriented north-west to south-east, is situated north of the Main Plant Area and extends through the North-East Percolation Pond and Cedar Creek Reservoir Overflow Ditch. This transect intersects with Section D-D';
- Section D-D' (Plate 15) oriented south-west to north-east, is situated north of the Main Plant Area and extends from the North-East Percolation Pond through the Operational Area. This transect intersects with Section C-C'; and
- Section E-E' (Plate 16) oriented south-west to north-east, is situated south of the Main Plant Area, extending through the Former Rod Mill and Rectifier Yards.

A description of the three stratigraphic units observed on the generalized and detailed cross-sections is provided below.

- The glacial outwash and alluvium layer typically contain coarse grained deposits (varying amounts of sand, gravel, and cobbles) with varying degrees of sorting and with lesser amounts of fines. The glacial outwash layer is encountered at the surface across most of the Site, with recent alluvial deposits present primarily near the southern border of the Site in the vicinity of the Flathead River. The cross sections indicate that the glacial outwash vertical thickness appears to be relatively consistent in areas north and west of the Main Plant Area, with average thicknesses ranging from 50 to 80 feet thick. The glacial outwash north of the Main Plant Area reaches maximum vertical thickness in the areas beneath the Former Drum Storage Area, West Landfill, Wet Scrubber Sludge Pond, and Center Landfill; where thickness was typically observed to range from 125 to 150 feet. The thickness tends to decrease close to Teakettle Mountain where bedrock elevations are shallower. Near the Flathead River, the vertical extent of the alluvial deposits is approximately 100 feet thick along the western/central southern boundary of the river.
- Glacial till was observed in the subsurface across most of the Site, typically beneath the coarse-grained outwash deposits. The glacial till layer is a dense, poorly-sorted deposit, consisting of varying amounts of sand, gravel, cobbles, silt, and clay. Based on field observations, the till was typically noted to be drier and denser than the overlying coarse-grained deposits. The maximum vertical extent of the glacial till is unknown in the areas to the north, west, and south of the Site, as the next lithologic layer was not encountered during drilling. This indicates that the till is typically at least 200 feet thick or greater in these areas.
- Based on regional geologic literature, beneath the unconsolidated glacial deposits are pre-Cambrian aged bedrock. The literature indicates that the depth to bedrock increases in a south-western direction across the Site, as you increase in distance from Teakettle Mountain. This was confirmed during the Phase I SC. Bedrock was encountered in soil boring CFMW-023a, which is located to the east of the Site near Teakettle Mountain, at an approximate depth of 150 ft-bls. Weathered bedrock was also encountered in soil boring CFMW-008a (also located to the east of the Site near Teakettle Mountain) at approximately 130 ft-bls, and a more competent bedrock within the same boring at approximately 245 ft-bls. Bedrock was not encountered in any of the other deep soil borings

completed at the Site, indicating that depth to bedrock is greater than 300 ft-bls across most of the Site.

Review of the detailed cross-sections indicate that the lithology within the glacial outwash and alluvium layer above the glacial till (i.e., upper hydrogeologic unit) is largely gravelly sand and poorly graded sand within the upper 150 ft-bls. Sandy gravel was also frequently noted within the upper 150 ft-bls. Silt and clay were observed infrequently throughout the lithology of the soil borings within the upper 100 ft-bls. An increasing amount of silty clay was noted in a few soil borings closer to the start of the glacial till (roughly 150 ft-bls).

Hydraulic conductivity values were included on the detailed cross-sections for the upper hydrogeologic unit monitoring wells where slug tests were conducted. Hydraulic conductivity is generally within the anticipated literature range of the various geology for the screened interval, ranging from 0.13 feet per day (ft/day) in CFMW-035 to 930.91 ft/day in CFMW-070.

The maximum and minimum cyanide and fluoride concentrations for monitoring wells screened within the upper hydrogeologic unit are presented on the detailed cross-sections. Concentrations of cyanide and fluoride within nested wells presented on the cross-sections typically decrease with depth within the upper hydrogeologic unit. As presented on Plate 14 and Plate 15 (detailed hydrogeologic cross sections C-C' and D-D', respectively), upper hydrogeologic unit monitoring well CFMW-028, screened from 50 to 60 ft-bls, has a cyanide concentration of 389 micrograms per liter (µg/L), while CFMW-028a, screened from 110 to 120 ft-bls, has a cyanide concentration of 7.3 µg/L. Similarly, CFMW-028 has a fluoride concentration of 4,400 µg/L, while CFMW-028a has a fluoride concentration of 1,020 µg/L. As described in the fate and transport section below (Section 6), it is likely that the majority of contaminant mass resides and migrates within the upper half of the upper hydrogeologic unit.

Although groundwater concentrations for wells screened below the upper hydrogeologic unit are not shown on the detailed cross-sections, the concentrations are generally non-detect or orders of magnitude lower than the concentrations within the upper hydrogeologic unit. As described in Section 4.3.2 of the Phase II SC Data Summary Report, there is limited vertical connection between the upper and below upper hydrogeologic units.

To assess for potential preferential pathways in the subsurface, the detailed cross-sections were evaluated for any relationships with lithology, hydraulic conductivity, and concentration distributions of cyanide and fluoride. As described above, extrapolation of lithology between borings in the detailed cross-sections was not possible due to the largely heterogeneous nature of the soil within the upper hydrogeologic unit and the distances between the borings Though migration may be preferential through high conductivity zones, there are no specific preferential pathways that be identified based upon evaluation of the data as presented in the detailed cross-sections.

3.2 Groundwater Hydrology

This section describes the regional hydrogeology, hydrogeologic units, groundwater flow, hydraulic conductivity, and the groundwater/surface water relationship at the Site. Roux also evaluated temporal variability of the hydrologic data (i.e., elevation, discharge, precipitation) for groundwater and surface water features at the Site. Additional details regarding the groundwater hydrology and temporal variability (including additional tables and graphs) can be found in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and Phase II SC Data Summary Report.

3.2.1 Hydrogeologic Units

The stratigraphic units underlying the Site form a complex hydrogeologic framework that influences groundwater elevations, groundwater flow, and potential COPC migration beneath the Site. There are two hydrogeologic units discussed in the RI; these units are referred to as the upper hydrogeologic unit and the below upper hydrogeologic unit. The two hydrogeologic units and their characteristics are described in detail in the sections below.

3.2.1.1 Upper Hydrogeologic Unit

The coarse-grained glacial outwash and alluvium deposits that are found above the glacial till are collectively referred to as the upper hydrogeologic unit at the Site. During drilling, the glacial deposits comprising the upper hydrogeologic unit were typically observed to be loose and wet when water was encountered at the water table. Based upon relatively consistent elevations at which groundwater was encountered within the upper hydrogeologic unit and the occurrence of groundwater at all drilling locations, it appears that the unit is horizontally continuous across the investigated area. The continuity of the upper hydrogeologic unit is also confirmed by hydraulic flow directions and gradients measured during monitoring well water level gauging.

While the upper hydrogeologic unit appears to be continuous across the Site, the groundwater within the upper hydrogeologic unit appears to exist under perched water table conditions. Perched zones have been documented to occur at various locations throughout the Kalispell Valley and have historically been referred to in regional literature as the Pleistocene perched aquifers (Konizeski et al., 1968). The perched conditions are supported by the lithology and the rapid and pronounced response to precipitation/seasonal changes that are observed around the Central Landfill Area and Main Plant Area. The saturated thickness of the upper hydrogeologic unit varies across the Site depending upon the depth to underlying glacial till and proximity to Teakettle Mountain. Saturated thickness was observed to be less near Teakettle Mountain when compared to areas beneath the landfills and west of the landfills.

3.2.1.2 Below Upper Hydrogeologic Unit

During drilling, the glacial till found below the upper hydrogeologic unit were typically characterized as containing a higher percentage of fines, and as denser and drier, than the overlying outwash and alluvium deposits. The till deposits were often characterized as stiff and moist or dry; in contrast to the overlying outwash and alluvium that was typically characterized as loose and wet. These observations indicate that the till deposits likely have a lower hydraulic conductivity than the overlying outwash and alluvium deposits. This is supported by observations during monitoring well development, where the deep wells screened within the tills typically yielded much less water than wells screened in the outwash deposits. This is also supported by slug testing data which was collected from monitoring wells screened in the glacial till.

Based upon the CSM, bedrock is considered to define the bottom of the hydrogeologic system beneath the Site.

3.2.2 Groundwater Elevation and Flow

During the RI, the water level elevation data indicated that groundwater elevations fluctuate seasonally at varying magnitudes depending on the area of the Site. The table below summarizes average groundwater elevations in three general areas of the Site for wells within the upper hydrogeologic unit during each gauging round.

Remedial Investigation Average Groundwater Elevations (ft-amsl)							
Location	Wells Utilized	Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
Teakettle Mountain/ Landfill Area	CFMW-002 CFMW-010 CFMW-012 CFMW-014 CFMW-015 CFMW-016 CFMW-019 CFMW-020 CFMW-021	3065.76	3065.87	3063.78	3079.88	3087.95	3063.06
Center of the Site (Between Main Plant and Landfills)	CFMW-026 CFMW-027 CFMW-028 CFMW-029 CFMW-031 CFMW-032 CFMW-033 CFMW-034 CFMW-035 CFMW-043 CFMW-044 CFMW-070	3063.3	3060.64	3058.27	3071.05	3075.08	3061.23
Southern Area (Between Main Plant and Flathead River)	CFMW-037 CFMW-038 CFMW-040 CFMW-042 CFMW-045 CFMW-047 CFMW-049 CFMW-050 CFMW-053 CFMW-054 CFMW-071	3032.49	3026.59	3023.87	3041.49	3040.22	3031.27

Remedial Investigation Average Groundwater Depth (ft-bls)							
Location	Wells Utilized	Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
Teakettle Mountain/ Landfill Area	CFMW-002 CFMW-010 CFMW-012 CFMW-014 CFMW-015 CFMW-016 CFMW-019 CFMW-020 CFMW-021	81.95	81.84	84.2	67.83	59.75	82.28
Center of the Site (Between Main Plant and Landfills)	CFMW-026 CFMW-027 CFMW-028 CFMW-029 CFMW-031 CFMW-032 CFMW-033 CFMW-034 CFMW-035	47.4	50.06	52.69	39.65	35.68	49.34

Remedial Investigation Average Groundwater Depth (ft-bls)							
Location	Wells Utilized	Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
	CFMW-043 CFMW-044 CFMW-070						
Southern Area (Between Main Plant and Flathead River)	CFMW-037 CFMW-038 CFMW-040 CFMW-042 CFMW-045 CFMW-047 CFMW-049 CFMW-050 CFMW-053 CFMW-054 CFMW-071	82.72	89.16	91.88	73.7	75.69	84.65

The data above indicate that near Teakettle Mountain and the Central Landfill Area, average water levels fluctuated by approximately 25 feet during the RI; with the lowest levels occurring in October 2018 and the highest in June 2018. In the center of the Site, average water levels fluctuated by approximately 17 feet; with the lowest levels in March 2017 and the highest in June 2018. In the southern area of the Site, average water levels fluctuated by approximately 18 feet; with the lowest levels in March 2017 and the highest in June 2017.

The groundwater depth and groundwater elevations from monitoring wells screened in the upper hydrogeologic unit were utilized to create groundwater contour maps and to evaluate groundwater flow. The groundwater contour maps from the RI are provided on Plate 17. Groundwater typically flows south-west away from Teakettle Mountain toward the Landfill Area. From the Landfill Area, groundwater continues to flow south-west until it reaches the center of the Site, where topography is relatively flat, and then flows south. Groundwater flows south from the center of the Site toward the Flathead River. In the Western Undeveloped Area, groundwater flows south-east, away from Aluminum City, and toward the Flathead River. Overall, the groundwater flow patterns described above remained consistent during all six rounds of water level gauging for the RI.

3.2.2.1 Hydraulic Gradients

The groundwater flow maps (Plate 17) indicate that the hydraulic gradients are consistent across all six rounds of the RI and can generally be divided into three distinct areas. Near Teakettle Mountain and in the Central Landfill Area, the groundwater hydraulic gradient is steep and generally mirrors the steeper topography in that portion of the Site. Groundwater elevations in the center of the Site (near the North Percolation Ponds, former Operational Area, and northern half of the Main Plant Area) typically vary by less than three feet across long distances (i.e., over 1,000 feet), indicating a relatively flat groundwater hydraulic gradient across the center of the Site (i.e., generally an order of magnitude less than near the Central Landfill Area). The gradient then increases in the southern area of the Site between the Main Plant Area and the Flathead River (which is also consistent with the steep drop in topography between the railroad and the river). The table below summarizes the average hydraulic gradients in the three general areas of the Site during each gauging round:

Location	Remedial Investigation Hydraulic Gradient (ft/ft)					
	Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
Teakettle Mountain/Landfill Area	0.0280	0.0433	0.0536	0.0719	0.0494	0.0602
Center of the Site (Between Main Plant and Landfills)	0.0013	0.0028	0.0030	0.0034	0.0050	0.0014
Southern Area (Between Main Plant and Flathead River)	0.0131	0.0078	0.0053	0.0199	0.0091	0.0107

3.2.2.2 Vertical Gradients

The table below shows the elevations measured in monitoring well clusters during all six gauging events, where there is a well screened within the upper hydrogeologic unit and an adjacent deep well screened below the upper hydrogeologic unit. The table below also includes the elevations measured in monitoring well clusters CFMW-016/CFMW-016a, CFMW-028/CFMW-028a, CFMW-045/CFMW-045a, and CFMW-049/CFMW-049a, which are monitoring well locations where both monitoring wells are screened in the upper hydrogeologic unit.

Monitoring Well Location ID	Geologic Unit	Remedial Investigation Groundwater Elevations (ft-amsl)					
		Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
Monitoring Well Clusters with an Upper Hydrogeologic Unit and Below Upper Hydrogeologic Unit Well							
CFMW-003	Upper	3121.48	3122.83	3123.35	3126.10	3125.64	3121.59
CFMW-003a	Below Upper	2994.17	2996.23	2997.36	3001.89	3000.57	2996.86
CFMW-011	Upper	3064.99	3063.39	3060.18	3075.00	3081.09	3062.84
CFMW-011a	Below Upper	3003.10	3003.78	3004.95	3011.60	3010.8	3004.84
CFMW-012	Upper	3066.78	3065.42	3062.17	3076.98	3083.93	3063.63
CFMW-012a	Below Upper	2997.42	2999.05	3000.11	3006.02	3004.92	2999.50
CFMW-019	Upper	3064.43	3062.70	3059.87	3073.25	3077.79	3062.34
CFMW-019a	Below Upper	2997.48	2999.07	3000.11	3006.71	3004.98	2999.55
CFMW-025	Upper	DRY	3077.09	3079.10	3076.89	3077.11	3076.69
CFMW-025b	Upper	3068.84	3069.73	3069.50	3073.76	3076.96	3067.88
CFMW-025a	Below Upper	3055.65	3047.52	3048.53	3064.61	3067.19	3049.44
CFMW-032	Upper	3064.59	3062.48	3059.61	3073.51	3078.27	3062.62
CFMW-032a	Below Upper	3003.59	3004.68	3005.01	3012.52	3021.29	3010.81
CFMW-044	Upper	3060.02	3056.41	DRY	3066.39	3067.93	3058.38

Monitoring Well Location ID	Geologic Unit	Remedial Investigation Groundwater Elevations (ft-amsl)					
		Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018
Monitoring Well Clusters with an Upper Hydrogeologic Unit and Below Upper Hydrogeologic Unit Well							
CFMW-044a	Upper	3056.40	3052.88	3049.87	3062.87	3063.93	3054.77
CFMW-044b	Below Upper	3044.03	3051.38	3039.81	3051.20	3052.04	3042.54
CFMW-053	Upper	3052.45	3038.58	3035.14	3063.43	3065.00	3045.50
CFMW-053a	Below Upper	3023.76	3021.97	3020.41	3028.56	3029.81	3022.98
CFMW-056b	Upper	3067.50	3065.93	3065.96	3073.82	3075.04	3067.78
CFMW-056a	Below Upper	3021.12	3022.38	3023.73	3032.37	3031.10	3025.52
CFMW-056	Below Upper	3014.79	3015.92	3017.50	3026.29	3024.51	3019.12
CFMW-057b	Upper	Not Installed	Not Installed	Not Installed	Not Installed	3076.82	3070.18
CFMW-057a	Below Upper	3016.22	3017.49	3018.95	3028.25	3025.96	3021.61
CFMW-057	Below Upper	3011.13	3012.68	3014.43	3023.44	3021.04	3016.01
Monitoring Well Clusters with both wells screened in the Upper Hydrogeologic Unit							
CFMW-016	Upper	3068.89	3073.30	3072.66	3094.73	3109.39	DRY
CFMW-016a	Upper	3066.78	3073.32	3072.67	3094.62	3109.24	3063.95
CFMW-028	Upper	3064.24	3062.31	3059.52	3072.38	3076.16	3062.20
CFMW-028a	Upper	3064.35	3062.40	3059.68	3072.56	3076.57	3062.25
CFMW-045	Upper	3029.97	3025.20	3022.33	3039.20	3037.31	3027.26
CFMW-045a	Upper	3024.37	3022.88	3020.73	3031.33	3030.05	3023.97
CFMW-049	Upper	3017.79	3019.44	3018.19	3029.71	3036.77	3017.57
CFMW-049a	Upper	3017.69	3019.51	3018.34	3030.05	3037.41	3018.46

As shown above, in all cases the elevations measured in deep wells screened below the upper hydrogeologic unit are lower than the elevations in adjacent wells screened within the upper hydrogeologic unit. The differences in elevations between the upper hydrogeologic unit wells and the wells screened below the upper hydrogeologic unit is typically greater than 25 feet, and in some cases, exceed 50 feet. This large difference is indicative of limited (if any) hydraulic connectivity between the two water bearing zones. The groundwater elevations measured in monitoring well clusters where both monitoring wells are screened in the upper hydrogeologic unit typically differ by less than 0.3 feet; and often by less than 0.1 feet, suggesting that at most locations there is limited vertical migration of water within the upper hydrogeologic unit.

Vertical gradients for each nested well pair for each gauging event and the geometric mean for all events are provided in the table below:

Monitoring Well Location ID	Geologic Unit	Remedial Investigation Groundwater Vertical Gradient (ft/ft)						Geometric Mean
		Phase I Round 1 Aug 30, 2016	Phase I Round 2 Nov 29, 2016	Phase I Round 3 Mar 14/15, 2017	Phase I Round 4 June 16, 2017	Phase II Round 1 June 4/5, 2018	Phase II Round 2 Oct 1/2, 2018	All Rounds
CFMW-003	Upper	0.884	0.879	0.875	0.863	0.869	0.866	0.865
CFMW-003a	Below Upper							
CFMW-011	Upper	0.534	0.514	0.476	0.547	0.606	0.500	0.528
CFMW-011a	Below Upper							
CFMW-012	Upper	0.534	0.511	0.477	0.546	0.608	0.493	0.526
CFMW-012a	Below Upper							
CFMW-019	Upper	0.507	0.482	0.453	0.504	0.552	0.476	0.495
CFMW-019a	Below Upper							
CFMW-025b	Upper	0.330	0.555	0.524	0.229	0.244	0.461	0.368
CFMW-025a	Below Upper							
CFMW-032	Upper	0.407	0.385	0.364	0.407	0.380	0.345	0.381
CFMW-032a	Below Upper							
CFMW-044a	Upper	0.124	0.015	0.101	0.117	0.119	0.122	0.083
CFMW-044b	Below Upper							
CFMW-053	Upper	0.279	0.161	0.143	0.339	0.342	0.219	0.234
CFMW-053a	Below Upper							
CFMW-056b	Upper	0.546	0.512	0.497	0.488	0.382	0.367	0.460
CFMW-056a	Below Upper							
CFMW-016	Upper	0.059	-0.001	0.000	0.003	0.004	DRY	0.013
CFMW-016a	Upper							
CFMW-028	Upper	-0.002	-0.002	-0.003	-0.003	-0.007	-0.001	-0.003
CFMW-028a	Upper							
CFMW-045	Upper	0.087	0.036	0.023	0.123	0.113	0.051	0.061
CFMW-045a	Upper							
CFMW-049	Upper	0.003	-0.002	-0.004	-0.009	-0.017	-0.023	-0.009
CFMW-049a	Upper							

The magnitude of the vertical gradients between the upper hydrogeologic unit and below the upper hydrogeologic unit vary depending on the location of the well cluster within the Site. The vertical gradients between the two units also show variation temporally, where the lowest gradients were observed during lower water levels (i.e., March 2017 and October 2018).

The vertical gradients calculated for clusters within the upper hydrogeologic unit confirm that there is a limited vertical gradient, and that the direction of the gradient (upward or downward) may vary temporally at individual well clusters. The only well with a consistently downward gradient was CFMW-045/045a.

In addition to the monitoring well gauging events discussed above, Roux reviewed groundwater elevation data collected from a MBMG transducer and additional transducers installed by Roux throughout the RI, as discussed in Section 2.7.2. The MBMG transducer is deployed in existing monitoring well CFMW-007/TW-3 located on the west side of the West Landfill. It is noted that water levels from 1996 to 2009 are representative of water levels under pumping conditions during operation of the CFAC plant, and water levels from 2009 to present are generally based on non-pumping conditions. These changes in pumping conditions could also have an impact on historical water levels.

The data from the CFMW-007 MBMG transducer was used to create a hydrograph that illustrates minimum and maximum groundwater fluctuations and the seasonal changes in groundwater elevation for the upper hydrogeologic unit over the last twenty years, as shown in Appendix J of the Phase II SC Data Summary Report. In addition, the graph presents the daily precipitation data from 1996 through 2018, recorded by the weather station at Glacier Park International Airport (Kalispell, Montana). The yellow brackets on the graph show the time frame of the Phase I SC sampling period in 2016 and 2017, the Supplemental South Pond Assessment sampling period in 2017, and the Phase II SC sampling period in 2018. Review of the hydrograph indicates that the highest groundwater water levels at the Site consistently occur in May/June, and the lowest Site water levels are observed in October through February.

As described in Section 3.5.3 of the Phase II SC Data Summary Report, six pressure transducers were installed in nested well locations (i.e., CFMW-016/16a, CFMW-019/19a, and CFMW-053/53a) as part of the Phase I SC and continued to record groundwater elevation data throughout the Phase II SC. Data from March 2017 through October 2018 were utilized to evaluate groundwater elevation fluctuations at locations around and downgradient of the landfills, and to evaluate differences in groundwater elevation fluctuations in the upper hydrogeologic unit and below the upper hydrogeologic unit. Note that monitoring wells CFMW-016 and CFMW-016a are both screened in the upper hydrogeologic unit, and therefore were not used to compare differences between the two hydrogeologic units. As part of the Phase II SC, three new pressure transducers were deployed in June 2018 in new Phase II SC monitoring wells, CFMW-065, CFMW-066, and CFMW-069, within the Western Undeveloped Area and adjacent to the Industrial Landfill.

Groundwater elevations obtained from pressure transducers were plotted over time to produce hydrographs for these nine well locations. The hydrographs in Appendix K of the Phase II SC Data Summary Report indicate that the highest Site water levels during this period were observed in May 2018 and the lowest water levels were observed in October 2017 through February 2018. The magnitude of groundwater elevation fluctuations was dependent on the location within the Site and the well screen depth.

The data from monitoring wells CFMW-016 and 019 (both screened in the upper hydrogeologic unit near the Wet Scrubber Sludge Pond) indicate that the highest Site water levels in 2017 were observed in late March/early April 2017, after which the groundwater elevation levels trended downward to the lowest elevation (below the depth of the pressure transducer in CFMW-016) through the end of 2017 and continued into March 2018. The highest Site water levels in 2018 were observed in May 2018, after which the groundwater elevation levels trended downward through October 2018. Groundwater elevation changes were greater than 50 feet in CFMW-016 (located on the eastern boundary of the Wet Scrubber Sludge Pond) and groundwater elevation changes were greater than 25 feet in monitoring well CFMW-019 (located on the southern boundary of the Wet Scrubber Sludge Pond). Elevation fluctuations of greater than 50 feet were also observed at CFMW-007 (graph included in Appendix J of the Phase II SC Data Summary Report; located on the western boundary of the West Landfill) during the same time frame. The fluctuations in these upper hydrogeologic unit monitoring wells corresponded with spring thaw and snow melt and seasonal precipitation.

Groundwater elevation data from wells screened below the upper hydrogeologic unit (Appendix K of the Phase II SC Data Summary Report) did not show large fluctuations like the wells screened in the upper hydrogeologic unit. Monitoring wells CFMW-019a and CFMW-053a fluctuated by less than ten feet between March 2017 and October 2018. The slower, gradual responses observed in wells screened below the upper hydrogeologic unit monitoring wells in nested wells CFMW-053/-053a and CFMW-019/-019a further suggests limited connectivity between the two units proximal to these well pairs.

Groundwater elevation data from CFMW-065, CFMW-066, and CFMW-069 wells screened in the upper hydrogeologic unit showed a decrease by less than ten feet from June 2018 through October 2018. These data indicate that groundwater elevation fluctuations in these wells are less than in wells within the Central Landfill Area and adjacent to Teakettle Mountain.

3.2.3 Hydraulic Conductivity

Slug testing results from the RI were used to determine the hydraulic conductivity at the upper hydrogeologic unit and below the upper hydrogeologic unit monitoring well locations.

The table below provides a summary of the minimum, maximum, and geometric mean hydraulic conductivity values from slug tests of wells screened the two hydrogeologic units. The results indicate that the geometric mean hydraulic conductivity of the upper hydrogeologic unit is higher than the geometric mean hydraulic conductivity of the materials below the upper hydrogeologic unit. These hydraulic conductivity values are consistent with geologic observations recorded in boring logs during drilling, which generally indicate wells below the upper hydrogeologic unit are screened in finer grained materials. Additionally, the wide range of estimated hydraulic conductivity values is indicative of the heterogeneous geological conditions that are encountered beneath the Site.

The geometric mean in the table below are reflective of geometric means from all displacement intervals at the respective monitoring well locations.

Hydrogeologic Unit	Minimum Estimated Hydraulic Conductivity *(ft/day)*	Maximum Estimated Hydraulic Conductivity *(ft/day)*	Median Estimated Hydraulic Conductivity *(ft/day)*	Geometric Mean Estimated Hydraulic Conductivity *(ft/day)*
Upper Hydrogeologic Unit	0.11	1476.58	15.63	13.35
Below the Upper Hydrogeologic Unit	0.004	113.60	0.05	0.27

3.2.4 Groundwater/Surface Water Relationships

A groundwater seep was identified along the Flathead River in the Backwater Seep Sampling Area of the Site (Figure 2). The “Seep Area,” as defined in the MPDES permit, encompasses a greater length of the Flathead River shoreline than just the Backwater Seep Sampling Area. Groundwater from the upper hydrogeologic unit is expressed to the sediment porewater and surface water located within the extent of the "Seep Area." Historically, groundwater has consistently been observed to discharge from the banks of the Backwater Seep Sampling Area and was sampled as part of the requirements for the Site MPDES Permit (#MT00300066). The Site MPDES Permit was terminated effective April 17, 2019 due to the permanent plant closure at CFAC and the elimination of discharges controlled by the permit. The hydrogeologic studies (i.e., groundwater elevation data and surface water elevation data) indicate that groundwater from the upper hydrogeologic unit discharges to Flathead River.

There is no evidence that suggests that groundwater discharges to Cedar Creek, Cedar Creek Reservoir Overflow Ditch, or the Northern Surface Water Feature. The elevation of Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature is higher than groundwater elevations within the Site, indicating that these Site features are losing water to the subsurface rather than gaining.

3.3 Surface Water Hydrology

The discharge and hydrology of Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and the Flathead River were evaluated during the RI. Figure 2 depicts the locations of these surface water features. This section describes the surface water flow patterns and discharge and the effect of seasonal variability on flow patterns and discharge. Additional details regarding the surface water hydrology (including additional data tables and graphs) can be found in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and Phase II SC Data Summary Report.

The Northern Surface Water Feature was determined not to be impacted by groundwater. It is an intermittent seasonal ponding area fed by snowmelt and increased seasonal precipitation during the spring and is dry with a grass covered area during the rest of the year.

Surface water discharge data for the Flathead River was reviewed during the RI from the nearest USGS monitoring station (Station No. 12363000) located approximately three miles downstream of the Site. The USGS monitoring station results showed that Phase I Round 4 (June 2017) and Phase II Round 1 (June 2018) captured high-water conditions of the Flathead River; and Phase I Round 1 (September 2016), Supplemental South Ponds Assessment activities (November 2017), and Phase II Round 2 (October 2018) captured low-water conditions of the Flathead River. These data also indicate that the dates for maximum Flathead River discharge over the last eleven years are typically within May and June, and dates of minimum discharge over the last eleven years range from October to March. These data indicate that the RI maximum and minimum discharge events occurred within a representative timeframe consistent with historical data and that the high-water and low-water sampling periods of the RI were well timed to coincide with the high-water and low-water conditions.

At the western Site boundary, Cedar Creek drains an additional 1.5 mi^2, predominately from the western two thirds of the Site. The Cedar Creek Reservoir Overflow Ditch flows intermittently in the spring and regulates flow for Cedar Creek and the Cedar Creek Reservoir (Hydrometrics, 1985). Based upon proximity and land surface topography, some surface water runoff from the eastern side of the Site, originating from the East Landfill and the Sanitary Landfill, as well as runoff from the western flank of Teakettle Mountain, flows to Cedar Creek Reservoir Overflow Ditch. Excluding potential upgradient contributions from the Cedar Creek Reservoir, the Cedar Creek Reservoir Overflow Ditch has a catchment area of approximately 2 mi^2. About 20% of this catchment area originates on-Site and the remaining catchment extends to the peak of Teakettle Mountain to the east. Like Cedar Creek, the elevation of Cedar Creek Reservoir Overflow Ditch is higher than surrounding groundwater elevations within the Site, indicating that Cedar Creek Reservoir Overflow Ditch is a losing stream.

Discharge of Cedar Creek and Cedar Creek Reservoir Overflow Ditch were measured utilizing a mechanical current-meter method as described in Section 2.9.1 above. Results of the discharge calculations are summarized in Appendix L4 of the Phase II SC Data Summary Report. Cedar Creek Reservoir Overflow Ditch was dry throughout most of the field program. The discharge was evaluated at multiple points along the surface water bodies in an effort to confirm the CSM; that both Cedar Creek and Cedar Creek Reservoir Overflow Ditch are acting as losing streams as they flow through the Site. In Cedar Creek Reservoir Overflow Ditch, the discharge measured at locations on the northern end of the Site were typically higher than the locations at the southern end of the Site. These data indicate that the ditch was acting as a losing stream throughout the entire year (when wet) and thus losing water infiltration into the groundwater system. These data are also supported by visual field observations throughout the program where the northern end of Cedar Creek Reservoir Overflow Ditch was observed to be wet, while the southern end of the ditch was dry at the same time.

In Cedar Creek, the stream discharge did not decrease consistently from upstream to downstream measurement locations. The increases could be attributed to local surface water inputs from the west and/or could be within the margin of error of the field measurement method. As documented within the Phase I SC Data Summary Report, the creek bed of Cedar Creek is located above the water table in the upper hydrogeologic unit; indicating that it is not a groundwater discharge location.

4. Nature and Extent of Contamination

This section presents the results of the RI as it relates to the nature and extent of COPCs in soil, groundwater, surface water, sediment, and sediment porewater.

4.1 Data Used in the Evaluations

Multiple phases of investigation were completed as part of the RI in order to generate a comprehensive dataset for the Site. A summary of the scope of work for each investigation phase of the RI is described in Section 2.2 above. Detailed descriptions of the scope of work and results of the investigations are included in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and the Phase II SC Data Summary Report. In each of these reports, the data is summarized in tables, figures, and plates, and COPCs are evaluated utilizing various human health and ecological screening levels, as discussed in Section 7 below, in accordance with the RI/FS Work Plan and the various project SAPs.

4.2 Comparison of Analytical Results to Screening Levels

The analytical results for all constituents were compared to the screening criteria identified within the RI/FS Work Plan to develop an understanding of the nature and extent of contamination present at the Site and to determine which constituents were potential COPCs that required evaluation within the BHHRA and BERA. The screening criteria used in this evaluation are outlined below for soil, groundwater, surface water, sediment, and sediment porewater, respectively.

Soil Screening Levels

Human Health Screening Levels[6]:

- USEPA Residential Soil RSLs (USEPA, November 2019)
- USEPA Industrial Soil RSLs (USEPA, November 2019)
- USEPA Protection of Groundwater RBSSLs (USEPA, November 2019)

ESVs:

- Minimum ESV gathered from the following sources:
    - USEPA Ecological Soil Screening Levels (USEPA, 2003b)
    - Los Alamos National Laboratory (LANL) ECORISK Database (LANL, 2017)
    - Toxicological Benchmarks for Screening COPCs for Effects on Terrestrial Plants (Efroymson et al., 1997a)[7]
    - Toxicological Benchmarks for Screening COPCs for Effects on Soil Invertebrates (Efroymson et al., 1997b)[8]
    - Toxicological Benchmarks for Wildlife (Sample et al., 1996)
    - Region 5 RCRA Ecological Screening Levels (USEPA, 2003c)

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[6] Human Health RSLs provided in the EPA Risk-Based Screening Tables are based on a target risk level for cancer of 1E-06 and non-cancer target hazard quotient of 0.1 as noted in the RI/FS Work Plan and Phase II SAP.
[7] ORNL Risk Assessment Information System (RAIS)
[8] ORNL RAIS

Groundwater Screening Levels

Human Health Screening Levels:

- MDEQ Circular DEQ-7, Human Health Numeric Water Quality Standards (MDEQ, June 2019)
- USEPA Drinking Water Maximum Contaminant Levels (MCLs; USEPA, November 2019)
- USEPA Tapwater RSLs (USEPA, November 2019)

Surface Water Screening Levels

Human Health Screening Levels:

- MDEQ Circular DEQ-7, Human Health Numeric Water Quality Standards (MDEQ, June 2019)
- USEPA Drinking Water MCLs (USEPA, November 2019)
- USEPA Tapwater RSLs (USEPA, November 2019)

ESVs:

- Minimum ESV gathered from the following sources:
    - MDEQ Circular DEQ-7 Acute Aquatic Life Standards (MDEQ, June 2019)
    - MDEQ Circular DEQ-7 Chronic Aquatic Life Standards (MDEQ, June 2019)
    - USEPA National Recommended Water Quality Criteria (USEPA, 2004)
    - Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: (Suter and Tsao, 1996)
    - Suter and Tsao, 1996. GLWQI Tier II SAV/SCVs and Oak Ridge National Laboratory (ORNL) LCVs provided in Table 1 and ORNL Population EC20s provided in Table 2
    - USEPA Region 3 Freshwater Screening Benchmark (USEPA, 2006)
    - Canadian Water Quality Guidelines, Summary Table (CCME, 2008)

Sediment Screening Levels

Human Health Screening Levels:

- USEPA Residential Soil RSLs (USEPA, November 2019)
- USEPA Industrial Soil RSLs (USEPA, November 2019)
- USEPA Protection of Groundwater RBSSLs (USEPA, November 2019)

ESVs:

Minimum ESV gathered from the following sources:

- Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. (MacDonald et al., 2000)
- USEPA Region 3 Freshwater Sediment Screening Benchmarks (USEPA, 2006)
- Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius;* (Ingersoll et al., 1996)
- Region 5 RCRA Ecological Screening Levels, (USEPA, 2003c)

Sediment Porewater Screening Levels

<u>ESVs</u>:

- Minimum ESV gathered from the following sources:
  - MDEQ Circular DEQ-7 Acute Aquatic Life Standards (MDEQ, June 2019)
  - MDEQ Circular DEQ-7 Chronic Aquatic Life Standards (MDEQ, June 2019)
  - USEPA National Recommended Water Quality Criteria (USEPA, 2004)
  - Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: (Suter and Tsao, 1996)
  - GLWQI Tier II SAV/SCVs and ORNL LCVs provided in Table 1 and ORNL Population EC20s provided in Table 2 (Suter and Tsao, 1996)
  - USEPA Region 3 Freshwater Screening Benchmark (USEPA, 2006b)
  - Canadian Water Quality Guidelines, Summary Table (CCME, 2008)

The Phase II SC Data Summary Report contains comprehensive data tables and statistical data summary tables that are inclusive of all data collected during all phases of the RI. For most constituents that exceeded any of the screening criteria, the Phase II SC Data Summary Report also contains thematic dot maps that provide a visual representation of where exceedances of screening criteria occurred within environmental media at the Site. An evaluation of MDLs achieved related to the screening criteria was also provided for all media in the Phase I and Phase II SC Data Summary Reports.

As described in the Phase II SC Data Summary Report, the presence of an analyte in media at concentrations exceeding screening criteria did not indicate that a risk exists, but rather, that further evaluation of that particular analyte and exposure scenario was warranted in either the BHHRA or BERA as applicable based upon the type of screening criteria exceedance (i.e., human health or ecological criteria, or both).

As described in Section 7, the final screening of COPCs and identification of which COPCs for each media were retained for further evaluation in the risk assessment was provided in the BHHRA and BERA. COPCs were retained for evaluation in the risk assessments if the maximum concentration of an analyte within an exposure area media exceeded the minimum screening criteria derived from the sources listed above. These COPCs are described in detail in the following section.

4.3 Selection of COCs for In-Depth Evaluation

Based upon the screening process described above and in Sections 7.1 and 7.2, approximately 39 chemicals were retained as COPCS for evaluation in the BHHRA and approximately 40 chemicals were retained as COPCs for evaluation in the BERA. However, the results of the risk assessments indicate that only a subset of COPCs contribute to risk estimates that exceed *de minimis* levels for potential human health risk (i.e., excess lifetime cancer risk of 1E-6 for carcinogens; or hazard quotient of 1 for non-carcinogens) or pose moderate risk from the ecological perspective[9]. Thus, these COCs contributing to risk exceeding *de minimis*

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[9] COCs on this list were derived from the following sets of tables and the criteria listed below:
<u>BERA Soil COC selection criteria:</u>
Med-Large Home Range Wildlife: $HQ_{LOAEL} > 1$ based on refined exposure evaluation;
Small Home Range Wildlife: Sample points exceeding LOAEL-based back calculated value;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance);

levels will be the focus for in-depth evaluation within the subsequent sections of this RIR. In addition, although cyanide and fluoride are not risk drivers with respect to soil, both of these primary COCs have been retained for in-depth evaluation of their nature and extent in soil due to their prevalence in groundwater and surface water. The COCs identified to drive risk at the Site for each media type and exposure area based on the results of BHHRA and BERA are summarized in the table below. Tables 9 and 10 detail the exposure areas in which each of these COCs were identified and the selection criteria for the BHHRA and BERA COCs, respectively. Details regarding the risk assessment methodology and results is provided in the BERA and BHHRA and is summarized in Section 7.

COCs Contributing to Risk	Soil	Groundwater (UU)	Groundwater (BUU)	Sediment	Surface Water	Porewater
BHHRA COCs	arsenic manganese benzo(a)anthracene benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene dibenz(a,h)anthracene indeno(1,2,3-c,d)pyrene* PCB-1254 (Aroclor 1254)	total cyanide free cyanide arsenic bis(2-ehtylhexyl)phthalate fluoride	arsenic antimony	arsenic benzo(a)pyrene benzo(b)fluoranthene* dibenz(a,h)anthracene* indeno(1,2,3-c,d)pyrene*	NA	NA
BERA COCs	barium copper nickel selenium thallium* vanadium zinc HMW PAHs LMW PAHs PCB-1254 (Aroclor 1254)	NA	NA	barium cadmium* copper total cyanide free cyanide lead* nickel* selenium* vanadium* zinc* HMW PAHs* LMW PAHs*	aluminum barium cadmium* copper total cyanide free cyanide iron zinc* fluoride* Multiple PAH compounds*	barium copper total cyanide free cyanide

4.4 Nature and Extent of COCs Contributing to Risk

The nature and extent of the COCs contributing to risk identified above in Section 4.3 are evaluated in the following sections. First, an overview of the nature and extent of these COCs in various media is provided to frame the general distribution of CPCs across the Site as determined based upon the results of the RI. This is followed by specific sections discussing each COC and/or class of COCs contributing to risk in detail with respect to its occurrence and extent in various media across the Site.

4.4.1 Description of Presentation Tools

The nature and extent evaluations are presented using four primary types of tables and figures which are described in this subsection. In addition, other types of graphics are used, as appropriate, for specific media and are described in the appropriate places in this RIR. The four primary types of presentation tools are briefly described as follows:

ISM samples: localized exceedance was not justification for removal based on averaged EPC across DU; PAH direct contact exposure selected based on exposure areas with points exceeding maximum acceptable toxicant concentration (MATC).
<u>BERA Sediment/Porewater selection criteria:</u>
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance).
*Only present within the North Percolation Ponds; co-located with COCs contributing to risk.

- **Tables 11 through 20 (soil, Operational Area soil, upper hydrogeologic unit groundwater, below upper hydrogeologic unit groundwater, surface water, sediment, and sediment porewater, respectively) -** Tables presenting summary statistics by exposure area or Background Reference Area are provided for each media and COC contributing to risk. In the text, concentration ranges and averages are provided in summary bullets by exposure area in the distribution of contaminants subsections throughout Section 4.4.2. Statistical summary tables for each of the sampled media provide the frequency that the measured concentration of each COC exceeded the various screening criteria per exposure area.
- **Appendices H through M (soil, Operational Area soil, groundwater, surface water, sediment, and sediment porewater, respectively) -** Plan view thematic dot maps (i.e., color-coded dot maps) show data at individual sampling locations. Their primary purpose is to show the spatial patterns of the data. Thematic dot maps depict the relative concentrations of select COCs contributing to risk and facilitate the identification of locations where the analyte was detected, the locations where analyte concentrations exceed the human health and ecological screening criteria, and the relative magnitude of the exceedances. Samples collected during the Phase I SC are presented as circles, samples collected during the Supplemental South Pond Assessment are presented as triangles, and samples collected during the Phase II SC are presented as squares.
- **Appendices N through P (soil, surface water, and sediment, respectively) -** Background threshold value (BTV) thematic dot maps show data at individual sampling locations and depict the relative concentrations of select COCs contributing to risk for relevant media exceeding Site-specific background criteria (i.e., non-detect, <BTV, >BTV, and 10-times the BTV). BTVs representative of the primary soil types or surface water features identified on-Site were compared to corresponding human health and ecological exposure areas on-Site, as presented in Figures 3 and 4, respectively. These maps facilitate the identification of locations or potential hot spots where concentrations are elevated compared to surrounding concentrations (i.e., exceed 10-times the BTV). While USEPA and MDEQ do not have specific numeric guidance for identification of hot spots, other regulatory agencies have used the 10-times criterion to identify potential hot spot locations (NJDEP, 2018; ODEP, 1998; USEPA, 1996; USEPA, 2002d).
- **Appendices Q through S (soil, surface water, and sediment, respectively) -** Box and whisker plots present the data grouped according to each respective exposure area and the Background Reference Areas. Their primary purpose is to show the distribution of data within an exposure area or Background Reference Area and facilitate comparison among these areas. The boxes present the data from each exposure area or Background Reference Area individually for each media and COC contributing to risk. The boxes span the 25th and 75th percentiles of the data (i.e., the interquartile range). The horizontal line through each box indicates the median. Whiskers extend beyond the boxes to the 10th and 90th percentiles. All individual data values beyond the 10th and 90th percentiles are presented as individual symbols. Sample counts for each exposure area are posted at the top of each box and whisker plot. The maximum and median MDLs are also plotted on the box and whisker plots. Non-detect concentrations were plotted using full MDLs. Only the results of the parent sample (and not duplicate samples) were used for this statistical analysis. It should be noted that if box and whisker plots are not presented for an exposure area or media, there were not enough samples to present the distribution.

4.4.2 Overview of Nature and Extent of COCs Contributing to Risk

This section provides an overview of the nature and extent of the COCs contributing to risk in various media listed in Section 4.3 to frame the general distribution of constituents across the Site as determined based upon the results of the RI. The highest concentrations of these constituents were typically found in the exposure areas which correspond to former industrial areas of the Site, including: the Main Plant Area, the North Percolation Ponds, and the Central Landfill Area.

Nature and Extent of Cyanide and Fluoride

Based on review of the box and whisker plots and statistical summary tables (Appendices Q1 and Q2 and Tables 11 and 12), cyanide concentrations in soil across the Site ranged from <0.02 to 137 milligrams per kilogram (mg/kg). The highest concentrations of cyanide in soil were generally found in the former industrial and operational areas of the Site including the Central Landfills Area, Main Plant Area, and North Percolation Ponds; as well as the South Percolation Ponds and Backwater Seep Sampling Area. Concentrations of cyanide in the South Percolation Ponds are higher than those in the Main Plant Area and Central Landfills Area but are generally within the same order of magnitude. Outside of the Former Drum Storage Area, concentrations of cyanide in soil in the Central Landfills Area were generally similar to or less than those observed in the other industrial areas of the Site. Concentrations of cyanide observed in the undeveloped areas of the Site, the Industrial Landfill Area, and the Flathead River Area are similar to the range of background concentrations.

As described in the Phase II SC Data Summary Report, BHHRA, and BERA, concentrations of COCs generally decrease with increasing depth. The surface soil interval (0 to 0.5 ft-bls) generally has the greatest COC concentrations. The average concentration of total cyanide generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals (17-22 and >22 ft-bls) were generally collected to delineate hot spots identified in the Phase I SC, and, therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average cyanide concentration of 1.31 mg/kg
- 0.5-2 ft-bls – average cyanide concentration of 1.30 mg/kg
- 2-10 ft-bls – average cyanide concentration of 0.77 mg/kg
- 10-17 ft-bls – average cyanide concentration of 0.08 mg/kg
- 17-22 ft-bls – average cyanide concentration of 0.08 mg/kg
- >22 ft-bls – average cyanide concentration of 0.09 mg/kg

Based on review of the box and whisker plots and statistical summary tables (Appendix Q3 and Tables 11 and 12), fluoride concentrations in soil across the Site ranged from <0.014 to 810 mg/kg, with the highest concentrations in the Main Plant, North Percolation Ponds, and Central Landfill Area; and a single high detection in the Industrial Landfill Area. Outside these areas, fluoride concentrations within the Site were less than those observed in the industrial areas, and typically ranged between 1 to 20 mg/kg. Concentrations of fluoride in background areas were generally less than concentrations on-Site, with the exception of Background Reference Area #4 which is within the same order of magnitude (i.e., 1 to 10 mg/kg) as the undeveloped areas, Flathead River Area, South Percolation Ponds, and the majority of the Industrial Landfill Area.

The average concentration of fluoride generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals (17-22 and >22 ft-bls) were generally collected to delineate hot spots identified in the Phase I SC, and therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average fluoride concentration of 43.45 mg/kg
- 0.5-2 ft-bls – average fluoride concentration of 35.53 mg/kg
- 2-10 ft-bls – average fluoride concentration of 27.57 mg/kg
- 10-17 ft-bls – average fluoride concentration of 16.80 mg/kg

- 17-22 ft-bls – average fluoride concentration of 20.07 mg/kg
- >22 ft-bls – average fluoride concentration of 8.19 mg/kg

Cyanide and fluoride are identified as the primary COCs in groundwater based upon the frequency of detection and exceedance of water quality standards, as well as based upon contribution to estimated risks at the Site. Concentrations are highest adjacent to the primary source areas within the Plume Core Area, (footprint of elevated concentrations of cyanide and fluoride in upper hydrogeologic unit groundwater), including the West Landfill and Wet Scrubber Sludge Pond. Groundwater statistical summary tables are included in Table 4. Cyanide and fluoride emanate from this source area (as described further in Section 8.2) and migrate in south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the Plume Core Area were less than one-half of the MCL in all six rounds of sampling and are typically non-detect or at background concentrations[10] adjacent to Aluminum City.

Based on review of the box and whisker plots and statistical summary tables (Appendices R1, R2, R3, and R4 and Table 15), cyanide concentrations in surface water ranged from <2 to 630 µg/L, with the majority of the highest concentrations in the Backwater Seep Sampling Area and Riparian Sampling Area, followed by the South Percolation Ponds and North Percolation Ponds. The distribution of free cyanide was similar to total cyanide, but at lower concentrations. The hydrogeologic studies (i.e., groundwater and surface water elevation data) indicate that groundwater discharges to the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; and ultimately to the Flathead River. Thus, the source of elevated cyanide concentrations in these Site features is groundwater. Concentrations of cyanide in the remaining surface water features (Flathead River, Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and Northern Surface Water Feature) were mostly non-detect (i.e., <2 µg/L).

Based on review of the box and whisker plots and statistical summary tables (Appendices S1 and S2 and Table 16), cyanide concentrations in sediment ranged from <0.067 to 8.5 mg/kg, with the highest concentrations occurring in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds). Concentrations in the Flathead River, Cedar Creek, and the Northern Surface Water Feature were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as cyanide concentrations in background sediment.

Based on review of the box and whisker plots and statistical summary tables (Appendix R5 and Table 15), fluoride concentrations in surface water ranged from <12 to 22,400 µg/L, with the highest concentrations in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds. Concentrations in the Flathead River, Cedar Creek, the Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature were markedly lower and generally within the same order of magnitude as fluoride concentrations in background surface water.

Based on review of the box and whisker plots and statistical summary tables (Appendix S3 and Table 16), fluoride concentrations in sediment ranged from <0.17 to 219 mg/kg, with the maximum concentration in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area. Concentrations of fluoride in the Northern Surface Water Feature were less than those in the North

[10] Within the western and northern portions of the Site, the detections of fluoride in groundwater are similar to the average 160 µg/l concentration measured in public and community water supply wells.

Percolation Ponds and the Backwater Seep Sampling Area/Riparian Sampling Area, but at concentrations higher than background sediment. Concentrations in the Flathead River and Cedar Creek were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as concentrations in background sediment.

Nature and Extent of PAHs

For presentation purposes, benzo(a)pyrene was selected as an indicator analyte for PAHs because it was the most frequently detected at elevated concentrations, and it is the PAH that contributes most to estimated risk in each exposure area.

Based on review of the box and whisker plots and statistical summary tables (Appendix Q4 and Tables 11 and 12), benzo(a)pyrene concentrations in soil range from <0.001 to 2,000 mg/kg, with the highest concentrations in the North-Percolation Ponds and Main Plant Area. Concentrations of benzo(a)pyrene were generally similar throughout the Central Landfills Area, Industrial Landfill Area, South Percolation Ponds, and Eastern Undeveloped Area, with the exception of a few high concentrations in the Central Landfills Area and Industrial Landfill Area. Benzo(a)pyrene concentrations were lowest within the North-Central and Western Undeveloped Areas, the Flathead River Area, and the Backwater Seep Sampling Area. Within these areas, concentrations were similar to, or within the same order of magnitude, as background reference areas.

The average concentration of benzo(a)pyrene generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals were generally collected to delineate hot spots identified in the Phase I SC, and therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average benzo(a)pyrene concentration of 15.59 mg/kg
- 0.5-2 ft-bls – average benzo(a)pyrene concentration of 6.91 mg/kg
- 2-10 ft-bls – average benzo(a)pyrene concentration of 18.41 mg/kg
- 10-17 ft-bls – average benzo(a)pyrene concentration of 0.46 mg/kg
- 17-22 ft-bls – average benzo(a)pyrene concentration of 0.91 mg/kg
- >22 ft-bls – benzo(a)pyrene was non-detect

Semivolatile organic compounds (SVOCs) were detected in less than 6% of groundwater samples collected from monitoring wells screened in the upper hydrogeologic unit throughout the RI (Table 14a of the Phase II SC Data Summary Report). Groundwater statistical summary tables are included in Tables 13 and 14. In general, SVOCs are not impacting groundwater quality across the Site, with the exception of isolated detections in a few monitoring wells.

The results of the RI indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of PAHs in sediment, followed by the effluent ditch, and the North-West Percolation Pond. The soils/sediments within the North Percolation Pond appear to be the source of the PAHs in the pond surface water (as described further in Section 8.2). As presented in the box and whisker plots and statistical summary tables (Appendices R7 and S4 and Tables 15 and 16), concentrations of benzo(a)pyrene in sediment and surface water are highest in the North Percolation Ponds, followed by the Backwater Seep Sampling Area.

Nature and Extent of Metals

The areal distribution of the detected metals is widespread across the Site. Sixteen different metals were detected at frequencies between 90% and 100% of the samples collected. It should be noted that all of the metals detected can be found as naturally occurring substances in the environment. Based on their frequency of detection and magnitude of concentrations, select metals are indicative of naturally occurring substances in the environment, as documented via the Background Investigation included as Section 4.4.2.3 within the Phase II SC Data Summary Report. However, the areal distribution of metal detections and the magnitude of metal concentrations around certain Site features indicate that concentrations of some metals are in part a result of the former operations. This is most evident for the North Percolation Pond Area, and to a lesser extent for soil samples from within the Main Plant, Central Landfill, and Industrial Landfill Areas. Concentrations of metals driving risk are presented in a soil statistical summary, included in Tables 11 and 12, and soil box plots, included in Appendices Q6 through Q14.

The results of the RI confirmed that many metals, which can naturally occur in the environment, were detected frequently in groundwater samples. The most commonly detected metals in groundwater in all six sampling rounds were barium, calcium, potassium, and sodium, which were detected in 100% of groundwater samples. The highest concentrations of these metals were limited to monitoring wells located downgradient of the West Landfill and Wet Scrubber Sludge Pond.

Total concentrations of antimony, arsenic, barium, lead, mercury, and thallium were detected at elevated concentrations in surface water samples. As presented in Table 15, elevated concentrations of metals in surface water were most commonly observed in the North and South Percolation Ponds and Riparian Sampling Area.

Thirteen different metals were detected in 100% of sediment samples collected during the RI. Aluminum and arsenic were detected at the highest concentrations in sediment. A single elevated concentration of aluminum occurred in the sediment sample collected from CFSDP-024 within the North-East Percolation Pond; while elevated arsenic was wide-spread throughout the sediment samples, but were highest in the North Percolation Ponds, Backwater Seep Sampling Area, and Riparian Sampling Area.

Nature and Extent of PCBs

PCBs were detected in 2% of all soil samples. The most commonly detected type of PCB was Aroclor 1254. Aroclor 1254 was observed in one surficial soil sample (CFSB-227 in the Central Landfill Area with a concentration of 1.2 mg/kg) and in four samples (shallow sample collected from CFSB-224, surface and shallow sample collected from CFSB-227, and shallow sample collected from CFSB-229), all in the Central Landfill Area within the footprint of the Operational Area, south of the West Scrubber Sludge Pond. Aroclor 1254 was also detected in three surface samples and one shallow sample collected west of the West Rectifier Yard within the Main Plant Area. As presented in the box and whisker plots and statistical summary tables (Appendix Q5 and Tables 11 and 12), aroclor 1254 was not detected in any other exposure areas. PCBs were not detected in any sediment samples.

Detailed Discussion of Individual COCs

A discussion of individual COCs contributing to risk at the Site is provided below. The discussion addresses ranges of concentration, vertical and horizontal extent of contamination, and spatial patterns of contamination within the Site, and (where applicable) comparison to BTVs to assess if hot spots or areas of elevated concentrations relative to background concentrations are present. Comparisons to human health and ecological screening criteria are not included in the discussion below; all comparisons to screening levels are discussed in Section 7 and provided in the Phase II SC Data Summary Report.

4.4.2.1 Distribution of Cyanide

The distribution of cyanide at the Site and in background is summarized in Tables 11 through 20 for Site-wide soil, Operational Area soil, upper unit groundwater, below upper unit groundwater, surface water, sediment, sediment porewater, background soil, background surface water, and background sediment samples, respectively. Thematic maps presenting cyanide data are provided in Appendices H1 and H2, I1, J1 through J4 and J18 through J21, K1 through K4, L1 and L2, and M1 and M2 (Site-wide soil, Operational Area soil, groundwater, surface water, sediment, and sediment porewater, respectively). BTV thematic dot maps presenting cyanide data are provided in Appendices N1, O1 and O2, and P1 (soil, surface water, and sediment, respectively). Box plots presenting cyanide data are provided in Appendices Q1 and Q2, R1 through R4, and S1 and S2 (soil, surface water, and sediment, respectively).

The range and arithmetic average for each exposure area and notable patterns in the data are as follows (if patterns are not discussed, it infers that no notable patterns were observed):

Cyanide in Soil

- Main Plant Area – total cyanide concentrations in soil ranged from <0.014 to 15.3 mg/kg, with the maximum concentration in the 2-10 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 2-10 ft-bls depth interval at a concentration of 1.14 mg/kg. Concentrations were highest near the former Cathode Soaking Pits. Excluding the Cathode Soaking Pits, the maximum concentration is within the 0.5-2 ft-bls depth interval at a concentration of 2.4 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.24 mg/kg. Concentrations of cyanide in the Main Plant Area sporadically exceeded the respective BTV of 0.273 mg/kg, most frequently around the former Cathode Soaking Pits/Paste Plant/Operational Area[11], but were generally less than the BTV.
- North Percolation Pond Area – total cyanide concentrations in soil ranged from <0.02 to 137 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 14.1 mg/kg. Concentrations were highest in the North-East Percolation Pond. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.105 mg/kg. Concentrations of cyanide in the North Percolation Ponds generally exceeded the BTV of 0.273 mg/kg and 10-times the BTV in surface and shallow samples. Concentrations decreased with increasing depth such that cyanide in the 10-17 ft-bls depth intervals only sporadically exceeded the BTV but were generally less than the BTV or non-detect.
- Central Landfill Area – total cyanide concentrations in soil ranged from <0.015 to 13 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 0.423 mg/kg. Concentrations were highest in the Former Drum Storage Area. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.046 mg/kg. Concentrations of cyanide in Central Landfill Area exceeded the BTV of 0.273 mg/kg and 10-times the BTV in samples within the Former Drum Storage Area and the Operational Area. Concentrations of total cyanide only exceeded the BTV outside of the Former Drum Storage Area and the Operational Area in the surface soil samples.
- Industrial Landfill Area – total cyanide concentrations in soil ranged from <0.017 to 0.42 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of

[11] Discrete samples only; Operational Area ISM samples discussed separately.

all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.095 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.022 mg/kg. The maximum concentration (0.42 mg/kg) was the only concentration that exceeded the BTV of 0.273 mg/kg.

- South Percolation Pond Area – total cyanide concentrations in soil ranged from <0.017 to 16.4 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 1.03 mg/kg. Concentrations were highest in the western-most South Percolation Pond. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.071 mg/kg. Most of the samples in the western-most pond exceeded the BTV of 0.178 mg/kg, and one sample exceeded 10-times the BTV.
- Flathead River[12] – total cyanide concentrations in soil ranged from <0.033 to 0.67 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.029 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (0.5-2 ft-bls) was non-detect. Samples were generally non-detect, with the exception of one sample collected along the river south of the percolation ponds. There were no exceedances of the BTV.
- Backwater Seep Sampling Area – total cyanide concentrations in soil ranged from <0.071 to 3.7 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval in the eastern-most sample closest to the Riparian Sampling Area. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 1.41 mg/kg. Concentrations were highest in soil samples collected from the northern side of Backwater Seep Sampling Area, where most concentrations exceeded the BTV of 0.178 mg/kg and some concentrations exceeded 10-times the BTV.
- Eastern Undeveloped Area – total cyanide concentrations in soil ranged from <0.056 to 0.64 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.218 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.1 mg/kg. Concentrations in the Eastern Undeveloped Area were typically non-detect and always less than the BTV. No concentrations exceeded the BTV of 0.793 mg/kg.
- North-Central Undeveloped Area – total cyanide concentrations in soil ranged from <0.017 to 1.5 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.201 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.023 mg/kg. Concentrations of cyanide in the North-Central Undeveloped Area sporadically exceeded the BTV of 0.273 mg/kg in surface and shallow samples. Concentrations decreased with increasing depth such that cyanide below the 2 ft-bls depth did not exceed the BTV.
- Western Undeveloped Area – total cyanide concentrations in soil ranged from <0.017 to 2.2 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.225 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.017 mg/kg. Concentrations of cyanide in the Western Undeveloped Area sporadically exceeded the respective BTV of 0.273 mg/kg but were generally less than the BTV. No concentrations exceeded 10-times the BTV.
- Operational Area ISM – total cyanide concentrations in soil ranged from <0.064 to 18.2 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-002 located within the Former

12 Flathead River exposure area discusses concentrations within the Flathead River only. The Backwater Seep Sampling Area is discussed as a separate exposure area for this analysis.

Drum Storage Area portion of the Operational Area grid. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 1.24 mg/kg.

- Background Reference Areas[13] – total cyanide concentrations in soil ranged from <0.055 to 2.4 mg/kg with the maximum concentration in Reference Area #3. The highest average concentration of all reference areas occurred in Reference Area #2 at a concentration of 0.359 mg/kg.
- Based upon the comparison of analytical results for Site-wide soil exposure areas, a statistical evaluation of Site versus background was conducted to determine which COCs in soil are potentially Site-related. This soil comparison is discussed in Section 5.5.1 of the Phase II SC Data Summary Report. Total cyanide was determined to be potentially Site-related within the North Percolation Pond Area, the South Percolation Pond Area, and the Backwater Seep Sampling Area.
- The Site-wide thematic maps and the summary statistic tables show that there is a distinct decrease in total cyanide concentrations between the 0-2 ft-bls and deeper depth intervals. The average concentrations of total cyanide within the top 2 ft-bls are at least one order of magnitude greater than the average concentrations of samples collected between 2 and 22 ft-bls. Concentrations of cyanide typically decreased with increasing depth, such that only one sample exceeded 10-times the BTV (2.73 mg/kg) in intermediate depth intervals (10-17 ft-bls) within the former cathode soaking pit.

Cyanide in Groundwater

- During all six rounds of sampling, the cyanide concentrations in groundwater decrease with screened depth within the upper hydrogeologic unit, and concentrations were generally non-detect in monitoring wells screened below the upper hydrogeologic unit (as discussed in Section 4.3.2 of the Phase II SC Data Summary Report. These non-detect findings indicate there is limited vertical migration and that COCs in groundwater, specifically cyanide, are primarily migrating horizontally within the upper hydrogeologic unit. These findings are consistent with observed hydrogeologic conditions described in Section 4.1.2 of the Phase II SC Data Summary Report, which indicate that there is only limited, if any, hydraulic connectivity between the upper hydrogeologic unit and the water bearing zones screened in the underlying glacial till.
- Upper Unit – total cyanide concentrations in groundwater ranged from <2 to 10,800 µg/L with the highest average concentration of 1,149.6 µg/L (in the Central Landfills Area). Dissolved total cyanide ranged from <2 to 11,500 µg/L with the highest average concentration of 1,048. µg/L (in the Central Landfills Area). Free cyanide concentrations ranged from ranged from <1.5 to 306 µg/L with the highest average concentration of 31.4 µg/L (in the North Percolation Ponds Area). Dissolved free cyanide ranged from <1.5 to 150 µg/L with the highest average concentration of 23.9 µg/L (in the North Percolation Pond Area).
- Below Upper Unit – total cyanide concentrations in groundwater ranged from <2 to 13.9 µg/L with the highest average concentration of 3.66 µg/L (in the Main Plant Area). Dissolved total cyanide ranged from <2 to 13.3 µg/L with the highest average concentration of 4.11 µg/L (in the Main Plant Area). Free total cyanide concentrations ranged from ranged from <1.5 to 3.9 µg/L with the highest average concentration of 1.44 µg/L (in the North-Central Undeveloped Area). Dissolved free cyanide ranged from <1.5 to 4.8 µg/L with the highest average concentration of 1.88 µg/L (in the Central Landfills Area).

Cyanide in Surface Water

- North Percolation Ponds – total cyanide concentrations in surface water ranged from <2 to 7.6 µg/L with an average concentration of 4.3 µg/L. Dissolved total cyanide was non-detect in all samples. Concentrations were highest in the North-East Percolation Pond during Phase I Round 3 (March 2017) and exceeded the BTV of 2 µg/L.
- South Percolation Ponds – total cyanide concentrations in surface water ranged from <2 to 139 µg/L with an average concentration of 15.7 µg/L. Dissolved total cyanide concentrations ranged from <2

[13] Background Soil Reference Area #1 - Glacial Till and Alluvium; Background Soil Reference Area #2/3 - Fluvial Deposits and Riverwash; Background Soil Reference Area #4 - Mountainous Land with Glacial Deposits.

to 68.2 µg/L with an average concentration of 26.99 µg/L. Concentrations most often exceeded the BTV of 2 µg/L and 10-times the BTV during Phase II Round 1 (June 2018). Total free cyanide concentrations ranged from <1.5 to 10 µg/L with an average concentration of 3.7 µg/L. Dissolved free cyanide concentrations ranged from 1.7 to 4.9 µg/L with an average concentration of 3.0 µg/L. Concentrations of total free cyanide generally exceeded the BTV of 1.834 µg/L.

- Flathead River – total cyanide concentrations in surface water ranged from <2 to 3.2 µg/L. Dissolved total cyanide was non-detect in all samples. Flathead River samples were generally non-detect, with the exception of one detection at a concentration of 3.2 µg/L during Phase I Round 1 (September 2016); this was the only exceedance of the BTV of 2 µg/L. Total free cyanide concentrations ranged from <1.5 to 1.8 µg/L with an average concentration of 0.99 µg/L. Dissolved free cyanide was only analyzed in one sample with a concentration of 1.6 µg/L. Concentrations of total and dissolved free cyanide did not exceed the BTV of 1.834 µg/L.
- Backwater Seep Sampling Area – total cyanide concentrations in surface water ranged from <2 to 378 µg/L with an average concentration of 100.77 µg/L. Dissolved total cyanide concentrations ranged from 11.7 to 328 µg/L with an average concentration of 108.7 µg/L. Concentrations frequently exceeded the BTV of 2 µg/L and 10-times the BTV across the sampling rounds. The maximum concentration (378 µg/L) occurred at CFSWP-004 during Phase II Round 2 (October 2018). Total free cyanide concentrations ranged from <1.5 to 139 µg/L with an average concentration of 20.7 µg/L. Dissolved free cyanide concentrations ranged from 1.6 to 42.2 µg/L with an average concentration of 11.2 µg/L. Concentrations of total free cyanide generally exceeded the BTV of 1.834 µg/L and sporadically exceeded 10-times the BTV.
- Riparian Sampling Area – total cyanide concentrations in surface water ranged from 5.1 to 630 µg/L with an average concentration of 169 µg/L. Dissolved total cyanide concentrations ranged from 9.9 to 245 µg/L with an average concentration of 95.44 µg/L. Concentrations exceeded the BTV of 2 µg/L in all samples and 10-times the BTV frequently across the sampling rounds. The maximum concentration (630 µg/L) occurred at CFSWP-030 during Phase II Round 1 (June 2018). Total free cyanide concentrations ranged from <1.5 to 140 µg/L with an average concentration of 27.1 µg/L. Dissolved free cyanide concentrations ranged from 1.8 to 63.5 µg/L with an average concentration of 19.4 µg/L. Concentrations of total free cyanide generally exceeded the BTV of 1.834 µg/L and sporadically exceeded 10-times the BTV.
- Cedar Creek – total cyanide concentrations in surface water ranged from <2 to 15.3 µg/L. Dissolved total cyanide was non-detect in all samples. Cedar Creek samples were generally non-detect with sporadic exceedances of the BTV (2 µg/L) throughout the sampling rounds. There were no exceedances of 10-times the BTV. The maximum concentration (15.3 µg/L) occurred at CFSWP-014 during Phase I Round 2 (December 2016). Total free cyanide concentrations ranged from <1.5 to 7.7 µg/L. Dissolved free cyanide was non-detect in all samples. Total free cyanide concentrations only exceeded the BTV of 1.834 µg/L in two samples during Phase II Round 1 (June 2018) and Phase II Round 2 (October 2018).
- Cedar Creek Reservoir Overflow Ditch – total cyanide and dissolved cyanide concentrations in surface water were non-detect in all samples. Total free cyanide concentrations ranged from <1.5 µg/L to 5.8 µg/L with an average concentration of 1.4; however, total cyanide was non-detect.
- Northern Surface Water Feature – total cyanide concentrations in surface water ranged from <2 to 4.4 µg/L. Dissolved total cyanide was non-detect in all samples. The maximum concentration 4.4 µg/L) was the only concentration that exceeded the BTV of 2 µg/L. Total free cyanide concentrations ranged from <1.5 to 4.1 µg/L with an average concentration of 2 µg/L. Total free cyanide concentrations exceeded the BTV of 1.834 µg/L in approximately half of the samples.
- Background Reference Areas[14] – total cyanide concentrations in background surface water were non-detect in all samples. Free cyanide concentrations ranged from <1.5 to 2.4 µg/L with the

[14] Background Surface Water Reference Area #1 - Background Flathead River; Background Surface Water Reference Area #2 - Background Cedar Creek.

maximum concentration in Reference Area #1. The highest average concentration occurred in Reference Area #1 at a concentration of 0.9 µg/L.L.

- Based upon the comparison of analytical results for Site-wide surface water features, a statistical evaluation of Site versus background was conducted to determine which COCs in surface water are potentially Site-related. This surface water comparison is discussed in Section 5.5.2 of the Phase II SC Data Summary Report. Total cyanide was determined to be potentially Site-related in Cedar Creek, the Northern Surface Water Feature, Flathead River, the Backwater Seep/Riparian Sampling Area, and the South Percolation Ponds. Free cyanide was determined to be potentially Site-related in the Backwater Seep/Riparian Sampling Area and the South Percolation Ponds.
- The Site-wide thematic maps and the summary statistic tables for total cyanide do not show a clear seasonal trend due to the large percentage of non-detect results, with the exception of the highest concentrations occurring in the Backwater Seep Area and the Riparian Sampling Area during low-water conditions and the lowest concentrations during high-water conditions. Site-wide concentrations were typically less than the BTV, with the exception of the South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area.

Cyanide in Sediment

- North Percolation Ponds – total cyanide concentrations in sediment ranged from 0.096 to 7.8 mg/kg with an average concentration of 3.95 mg/kg. Concentrations were highest in the North-East Percolation Pond and exceeded 10-times the BTV of 0.116 mg/kg.
- South Percolation Ponds – total cyanide concentrations in sediment ranged from <0.1 to 8.5 mg/kg with an average concentration of 1.19 mg/kg. Concentrations frequently exceed the BTV of 0.116 mg/kg and 10-times the BTV. The single sample analyzed for free cyanide in the South Percolation Pond had a concentration of 0.89 mg/kg.
- Flathead River – total cyanide concentrations in sediment ranged from <0.067 to 0.087 mg/kg. Flathead River samples were generally non-detect. There was one detection at a concentration of 0.087 mg/kg in the western-most downgradient sample location. There were no exceedances of the BTV (0.116 mg/kg).
- Backwater Seep Sampling Area – total cyanide concentrations in sediment ranged from 0.35 to 8.3 mg/kg with an average concentration of 1.80 mg/kg. Concentrations frequently exceeded the BTV of 0.116 mg/kg and 10-times the BTV. Free cyanide was non-detect.
- Riparian Sampling Area – total cyanide concentrations in sediment ranged from 0.27 to 1.7 mg/kg with an average concentration of 0.815 mg/kg. Concentrations frequently exceeded the BTV of 0.116 mg/kg and sporadically exceeded 10-times the BTV. Free cyanide was non-detect.
- Cedar Creek – total cyanide concentrations in sediment ranged from <0.075 to 0.24 mg/kg with an average concentration of 0.104 mg/kg. All concentrations during the Phase I exceeded the BTV of 0.116 mg/kg. All concentrations were non-detect or below the BTV of 0.116 mg/kg during the Phase II.
- Northern Surface Water Feature – total cyanide concentrations in sediment ranged from <0.07 to 0.6 mg/kg with an average concentration of 0.202 mg/kg. Concentrations exceeded the BTV of 0.116 mg/kg in the northern portion of the Northern Surface Water Feature.
- Background Reference Areas – total cyanide concentrations in sediment ranged from <0.067 to 0.13 mg/kg with the maximum concentration in Reference Area #2. The highest average concentration occurred in Reference Area #2 at a concentration of 0.069 mg/kg.
- Based upon the comparison of analytical results for Site-wide surface water features, a statistical evaluation of Site versus background was conducted to determine which COCs in sediment are potentially Site-related. This sediment comparison is discussed in Section 5.5.3 of the Phase II SC Data Summary Report. Total cyanide was determined to be potentially Site-related for sediment in Cedar Creek, the Northern Surface Water Feature, Backwater Seep Sampling Area//Riparian Sampling Area, and the South Percolation Ponds.

- The Site-wide thematic maps and the summary statistic tables show that Site-wide concentrations in sediment were typically less than the BTV, with the exception of the South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area.

Cyanide in Sediment Porewater

- South Percolation Ponds – dissolved total cyanide concentrations in sediment porewater ranged from <2 to 129 µg/L with an average concentration of 38.7 µg/L. Dissolved free cyanide concentrations were non-detect.
- Flathead River – dissolved total cyanide in sediment porewater was non-detect in all samples. Dissolved free cyanide concentrations ranged from <1.5 to 3.6 µg/L with an average concentration of 1.2 µg/L. Flathead River samples were generally non-detect. The maximum concentration of dissolved free cyanide (3.6 µg/L) was the only detection.
- Backwater Seep Sampling Area – dissolved total cyanide concentrations in sediment porewater ranged from 38.8 to 491 µg/L with an average concentration of 262.1 µg/L. Dissolved free cyanide concentrations ranged from 3.6 to 62.4 µg/L with an average concentration of 23.66 µg/L.
- Riparian Sampling Area – dissolved total cyanide concentrations in sediment porewater ranged from 52.7 to 429 µg/L with an average concentration of 238.3 µg/L. Dissolved free cyanide concentrations ranged from 2.4 to 38.7 µg/L with an average concentration of 19.9 µg/L.
- Cedar Creek – dissolved total cyanide and dissolved free cyanide concentrations in sediment porewater were non-detect.
- Northern Surface Water Feature – dissolved total cyanide concentrations in sediment porewater ranged from <2 to 4.1 µg/L with an average concentration of 1.7 µg/L. Dissolved free cyanide concentrations ranged from <1.5 to 8.3 µg/L with an average concentration of 1.99 µg/L.
- The Site-wide thematic maps and the summary statistic tables show that generally the detections of cyanide in sediment porewater were in the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Ponds.

4.4.2.2 Distribution of Fluoride

The distribution of fluoride at the Site and in background is summarized in Tables 11 through 20 for soil, Operational Area soil, upper unit groundwater, below upper unit groundwater, surface water, sediment, sediment porewater, background soil, background surface water, and background sediment samples, respectively. Thematic maps presenting fluoride data are provided in Appendices H3, I2, J5 and J6 and J22 and J23, K5 and K6, L3, and M3 (soil, Operational Area soil, groundwater, surface water, sediment, and sediment porewater, respectively). BTV thematic dot maps presenting cyanide data are provided in Appendices N2, O3, and P2 (soil, surface water, and sediment, respectively). Box plots presenting cyanide data are provided in Appendices Q3, R5 and R6, and S3 (soil, surface water, and sediment, respectively).

The range and arithmetic average for each exposure area and notable patterns in the data are as follows (if patterns are not discussed, it infers that no notable patterns were observed):

Fluoride in Soil

- Main Plant Area – fluoride concentrations in soil ranged from <0.16 to 571 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 67.35 mg/kg. Concentrations were highest near the former Paste Plant and to the east of the Main Plant. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 8.17 mg/kg. Concentrations of fluoride in the Main Plant Area frequently exceeded the BTV of 4.171 mg/kg and 10-times the BTV in the surface and shallow samples, and generally exceeded the BTV at greater depths but only sporadically exceeded 10-times the BTV.

- North Percolation Pond Area – fluoride concentrations in soil ranged from 0.87 to 306 mg/kg, with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 91.91 mg/kg. Concentrations were highest in the North-East Percolation Pond. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was 19.33 mg/kg. Concentrations of fluoride in the North Percolation Ponds generally exceeded the BTV of 4.171 mg/kg and 10-times the BTV in surface and shallow samples. Concentrations within the North-West Percolation Pond decreased with increasing depth such that fluoride in the 10-17 ft-bls depth intervals only sporadically exceeded the BTV but were generally less than the BTV or non-detect. Concentrations within the North-East Percolation Pond still generally exceeded the BTV of 4.171 mg/kg and 10-times the BTV in deeper samples.
- Central Landfills Area – fluoride concentrations in soil ranged from 0.28 to 796 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 58.5 mg/kg. Concentrations were highest in the Former Drum Storage Area. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 2.49 mg/kg. Concentrations of fluoride in Central Landfills Area frequently exceeded the BTV of 4.171 mg/kg and 10-times the BTV in samples throughout the exposure area in the surface, shallow, and intermediate sample intervals. Concentrations of fluoride did not exceed 10-times BTV in the deep samples.
- Industrial Landfill Area – fluoride concentrations in soil ranged from <0.17 to 810 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 83.97 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.34 mg/kg. Concentrations of fluoride in the Industrial Landfill Area frequently exceeded the BTV of 4.171 mg/kg and sporadically exceeded 10-times the BTV in samples throughout the exposure area in the surface and shallow sample intervals. Concentrations of fluoride did not exceed the BTV or 10-times the BTV in the deeper sample intervals.
- South Percolation Pond Area – fluoride concentrations in soil ranged from 0.8 to 44.1 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 14.19 mg/kg. Concentrations were highest in the western-most pond. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 5.18 mg/kg. Most of the samples in the western-most pond exceeded the BTV of 2.68 mg/kg with sporadic samples in the remainder of the South Percolation Ponds exceeding the BTV. Four samples within the western-most pond exceeded 10-times the BTV.
- Flathead River Area – fluoride concentrations in soil ranged from 0.36 to 15.3 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 12 mg/kg. There were no exceedances of the BTV (2.68 mg/kg).
- Backwater Seep Sampling Area – fluoride concentrations in soil ranged from 1.58 to 32.7 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval in the eastern-most sample closest to the Riparian Sampling Area. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 20.19 mg/kg. Concentrations were highest in soil samples collected from the northern side of the Backwater Seep Sampling Area, where most concentrations exceeded the BTV of 2.68 mg/kg, with only one exceedance of 10-times the BTV in the eastern-most sample closest to the Riparian Sampling Area.
- Eastern Undeveloped Area – fluoride concentrations in soil ranged from 0.69 to 41.3 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 14.64 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 1.28 mg/kg. Concentrations in the Eastern Undeveloped

Area typically only exceeded the BTV of 11.29 mg/kg along the eastern Site boundary. No concentrations exceeded the 10-times the BTV.

- North-Central Undeveloped Area – fluoride concentrations in soil ranged from 0.54 to 27.6 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 8.42 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 2.08 mg/kg. Concentrations of fluoride in the North-Central Undeveloped Area sporadically exceeded the BTV of 4.171 mg/kg but did not exceed 10-times the BTV.
- Western Undeveloped Area – fluoride concentrations in soil ranged from <0.21 to 15.4 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 5.22 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 1.45 mg/kg. Concentrations of fluoride in the Western Undeveloped Area sporadically exceeded the BTV of 4.171 mg/kg in surface and shallow samples. Concentrations decreased with increasing depth such that there was only one fluoride exceedance above the BTV below the 2 ft-bls depth interval.
- Operational Area ISM – fluoride concentrations in soil ranged from 16.6 to 976 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-002 located within the Former Drum Storage Area portion of the Operational Area grid. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 283.21 mg/kg.
- Background Reference Areas – fluoride concentrations in soil ranged from <0.15 to 9.41 mg/kg with the maximum concentration in Reference Area #4. The highest average concentration of all reference areas occurred in Reference Area #4 at a concentration of 3.59 mg/kg.
- Based upon the comparison of analytical results for Site-wide exposure areas, a statistical evaluation of Site versus background was conducted to determine which COCs in soil are potentially Site-related. This soil comparison is discussed in Section 5.5.1 of the Phase II SC Data Summary Report. Fluoride was determined to be potentially Site-related for soil in the Main Plant Area, the North Percolation Pond Area, the Central Landfill Area, the Industrial Landfill Area, the North-Central Undeveloped Area, the Western Undeveloped Area, the South Percolation Pond Area, the Flathead River Area, the Backwater Seep Sampling Area, and the Eastern Undeveloped Area.
- The Site-wide thematic maps and the summary statistic tables show that there is a decrease in fluoride concentrations in soil between the 0-2 ft-bls and deeper depth intervals. In all exposure areas, the average concentrations of fluoride within the top 2 ft-bls are greater than the average concentrations of samples collected between 2 and 22 ft-bls.

Fluoride in Groundwater

- During all six rounds of sampling, the fluoride concentrations in groundwater decrease with screened depth within the upper hydrogeologic unit, and concentrations were generally non-detect in monitoring wells screened below the upper hydrogeologic unit (as discussed in Section 4.3.2.2 of the Phase II SC Data Summary Report). These non-detect findings indicate there is limited vertical migration and that the fluoride is primarily migrating horizontally within the upper hydrogeologic unit. These findings are consistent with observed hydrogeologic conditions described in Section 4.1.2 of the Phase II SC Data Summary Report, which indicate that there is only limited, if any, hydraulic connectivity between the upper hydrogeologic unit and the water bearing zones screened in the underlying glacial till.
- Upper Unit – fluoride concentrations in groundwater ranged from ranged from <12 to 52,900 µg/L with the highest average concentration of 5,813.9 µg/L (in the Central Landfills Area). Dissolved fluoride ranged from <60 to 55,300 µg/L with the highest average concentration of 6,455.4 µg/L (in the Central Landfills Area).
- Below Upper Unit – fluoride concentrations in groundwater ranged from ranged from <12 to 762 µg/L with the highest average concentration of 278.7 µg/L (in the Industrial Landfill Area). Dissolved

fluoride ranged from 90.2 to 649 μg/L with the highest average concentration of 331.5 μg/L (in the Main Plant Area).

Fluoride in Surface Water

- North Percolation Ponds – fluoride concentrations in surface water ranged from 2,150 to 22,400 μg/L with an average concentration of 12,275 μg/L. The single sample analyzed for dissolved fluoride had a concentration was 21,500 μg/L. All concentrations exceeded the BTV of 130.2 and 10-times the BTV.
- South Percolation Ponds – fluoride concentrations in surface water ranged from 250 to 9,240 μg/L with an average concentration of 1,037 μg/L. Dissolved fluoride concentrations ranged from 289 to 1,860 μg/L with an average concentration of 817.7 μg/L. Concentrations exceeded the BTV of 29.8 μg/L in all samples and frequently exceeded 10-times the BTV.
- Flathead River – fluoride concentrations in surface water ranged from <12 to 547 μg/L with an average concentration of 71.9 μg/L. Dissolved fluoride concentrations ranged from 109 to 119 μg/L with an average concentration of 116.7 μg/L. Fluoride concentrations in the Flathead River exceeded the BTV of 29.8 in all samples during the Phase I with the maximum concentration exceeding 10-times the BTV. Concentrations generally exceeded the BTV during Phase II Round 1 and all concentrations were non-detect during Phase II Round 2.
- Backwater Seep Sampling Area – fluoride concentrations in surface water ranged from 40.2 to 2,570 μg/L with an average concentration of 868.7 μg/L. Dissolved fluoride concentrations ranged from 167 to 558 μg/L with an average concentration of 303.3 μg/L. Fluoride concentrations in the Flathead River exceeded the BTV of 29.8 in all samples during the Phase I with frequent exceedances of 10-times the BTV.
- Riparian Sampling Area – fluoride concentrations in surface water ranged from 1,920 to 3,640 μg/L with an average concentration of 2,394 μg/L. Concentrations exceeded 10-times the BTV (29.8 μg/L) in all samples across all sampling rounds.
- Cedar Creek – fluoride concentrations in surface water ranged from <12 to 137 μg/L with an average concentration of 90.8 μg/L. Dissolved fluoride concentrations ranged from 121 to 131 μg/L with an average concentration of 128 μg/L. Cedar Creek samples were generally below the BTV (130.2 μg/L). There was one exceedance of the BTV in Phase I Round 3 and all samples exceeded the BTV during Phase I Round 4. There were no exceedances of 10-times the BTV.
- Cedar Creek Reservoir Overflow Ditch – fluoride concentrations in surface water ranged from 38.7 to 2,600 μg/L with an average concentration of 220.2 μg/L. Dissolved fluoride concentrations ranged from 126 to 185 μg/L with an average concentration of 149 μg/L. Cedar Creek Reservoir Overflow Ditch samples were generally below the BTV (130.2 μg/L). There were sporadic exceedances of the BTV during the various sampling rounds and all samples exceeded the BTV during Phase I Round 4. The maximum concentration (2,600 μg/L) was the only concentration that exceeded 10-times the BTV.
- Northern Surface Water Feature – fluoride concentrations in surface water ranged from 166 to 301 μg/L with an average concentration of 214.7 μg/L. The single sample analyzed for dissolved fluoride had a concentration of 188 μg/L. Northern Surface Water Feature samples all exceeded the BTV (130.2 μg/L). There were no exceedances of 10-times the BTV.
- Background Reference Areas – fluoride concentrations in background surface water ranged from <12 to 3,500 μg/L with the maximum concentration in Reference Area #1. The highest average concentration also occurred in Reference Area #1 at a concentration of 218.1 mg/kg.
- Based upon the comparison of analytical results for Site-wide surface water features, a statistical evaluation of Site versus background was conducted to determine which COCs in surface water are potentially Site-related. This surface water comparison is discussed in Section 5.5.2 of the Phase II SC Data Summary Report. Fluoride was determined to be potentially Site-related for surface water in Cedar Creek, the Northern Surface Water Feature, Cedar Creek Reservoir Overflow Ditch,

Flathead River, Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds.

- The Site-wide thematic maps and the summary statistic tables indicate the minimum concentrations for detected samples most often occurred during Phase I Round 1 (September 2016, low-water) and Phase II Round 2 (October 2018, low-water), and the maximum concentrations most often occurred during Phase I Round 4 (June 2017, high-water) and Phase II Round 2 (June 2018, high-water). The notable exceptions to this trend were the samples from Backwater Seep Sampling Area and the Riparian Sampling Area. Site-wide concentrations were typically less than the BTV, with the exception of the Northern Percolation Ponds, South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area.

Fluoride in Sediment

- North Percolation Ponds – fluoride concentrations in sediment ranged from 56.6 to 219 mg/kg with an average concentration of 137.8 mg/kg. Concentrations in the North Percolation Ponds exceeded 10-times the BTV of 0.44 mg/kg.
- South Percolation Ponds – fluoride concentrations in sediment ranged from <0.31 to 93.7 mg/kg with an average concentration of 23.84 mg/kg. Concentrations frequently exceed 10-times the BTV of 0.44 mg/kg.
- Flathead River – fluoride concentrations in sediment ranged from <0.17 to 2.93 mg/kg with an average concentration of 0.43 mg/kg. There were two samples within this Site feature with concentrations above the BTV of 0.44 mg/kg.
- Backwater Seep Sampling Area – fluoride concentrations in sediment ranged from 2.23 to 69.2 mg/kg with an average concentration of 16.43 µg/L. Concentrations frequently exceeded the BTV of 0.44 mg/kg and 10-times the BTV.
- Riparian Sampling Area – fluoride concentrations in sediment ranged from 1.91 to 22.2 mg/kg with an average concentration of 12.54 mg/kg. Concentrations frequently exceeded the BTV of 0.44 mg/kg and sporadically exceeded 10-times the BTV.
- Cedar Creek – fluoride concentrations in sediment ranged from <0.2 to 1.71 mg/kg with an average concentration of 0.63 mg/kg. All concentrations during the Phase I exceeded the BTV of 0.44 mg/kg. All concentrations were non-detect during the Phase II.
- Northern Surface Water Feature – fluoride concentrations in sediment ranged from 1.14 to 9.59 mg/kg with an average concentration of 3.78 mg/kg. Concentrations exceeded the BTV of 0.44 mg/kg in all samples and exceeded 10-times the BTV in the two samples in the northern portion of the Northern Surface Water Feature.
- Background Reference Areas – fluoride concentrations in sediment were non-detect in all background samples.
- Based upon the comparison of analytical results for Site-wide surface water features, a statistical evaluation of Site versus background was conducted to determine which COCs in sediment are potentially Site-related. This sediment comparison is discussed in Section 5.5.3 of the Phase II SC Data Summary Report. Fluoride was determined to be potentially Site-related for sediment in Cedar Creek, the Northern Surface Water Feature, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds.
- The Site-wide thematic maps and the summary statistic tables show that Site-wide concentrations in sediment were typically less than the BTV, with the exception of the Northern Percolation Ponds, South Percolation Ponds, the Backwater Seep Sampling Area, and the Riparian Sampling Area.

Fluoride in Sediment Porewater

- South Percolation Ponds – fluoride concentrations in sediment porewater ranged from 275 to 2,210 µg/L with an average concentration of 869.5 µg/L.

- Flathead River – fluoride concentrations in sediment porewater ranged from <12 to 113 µg/L. The average concentration was non-detect.
- Backwater Seep Sampling Area – fluoride concentrations in sediment porewater ranged from 782 to 3,140 µg/L with an average concentration of 1,852 µg/L.
- Riparian Sampling Area – fluoride concentrations in sediment porewater ranged from 1,650 to 2,410 µg/L with an average concentration of 2,002 µg/L.
- Cedar Creek – fluoride concentrations in sediment porewater were non-detect in all samples.
- Northern Surface Water Feature – fluoride concentrations in sediment porewater ranged from 172 to 256 µg/L with an average concentration of 208.7 µg/L.
- The Site-wide thematic maps and the summary statistic tables show highest concentrations in sediment porewater within the Backwater Seep Sampling Area, the South Percolation Ponds, the Northern Surface Water Feature, and the Riparian Sampling Area.

4.4.2.3 Distribution of PAHs

PAHs are found to be present in soil across the Site and are primary drivers for risk in most exposure areas where risk estimates exceed *de minimis* levels. For presentation purposes, benzo(a)pyrene was selected as an indicator analyte for PAHs because it was the most frequently detected at concentrations exceeding various RSLs and ESVs at the Site, and it is the PAH that contributes most to estimated risk in each exposure area. As such, the discussions below pertain to benzo(a)pyrene.

The distribution of benzo(a)pyrene at the Site and in background is summarized in Tables 11 through 20 for soil, Operational Area soil, upper unit groundwater, below upper unit groundwater, surface water, sediment, sediment porewater, background soil, background surface water, and background sediment samples, respectively. Thematic maps presenting benzo(a)pyrene data are provided in Appendices H4, I3, J7, K7, L4, and M4 (soil, Operational Area soil, groundwater, surface water, sediment, and sediment porewater, respectively). BTV thematic dot maps presenting benzo(a)pyrene data are provided in Appendices N3, O4, and P3 (soil, surface water, and sediment, respectively). Box plots presenting benzo(a)pyrene data are provided in Appendices Q4, R7, and S4 (soil, surface water, and sediment, respectively).

The range and arithmetic average for each exposure area and notable patterns in the data are as follows (if patterns are not discussed, it infers that no notable patterns were observed):

Benzo(a)pyrene in Soil

- Main Plant Area – benzo(a)pyrene concentrations in soil ranged from <0.001 to 450 mg/kg, with the maximum concentration in the 2-10 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 2-10 ft-bls depth interval at a concentration of 32.73 mg/kg. Concentrations were highest near the former Cathode Soaking Pits. Excluding the Cathode Soaking Pit samples, the maximum concentration is within the 0-0.5 ft-bls depth interval at a concentration of 130 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 0.25 mg/kg. Concentrations of benzo(a)pyrene in the Main Plant Area sporadically exceeded the BTV of 0.0317 mg/kg and 10-times the BTV.
- North Percolation Pond Area – benzo(a)pyrene concentrations in soil ranged from <0.002 to 2,000 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 175.03 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was 0.32 mg/kg. Concentrations of

benzo(a)pyrene in the North Percolation Ponds generally exceeded the BTV of 0.0317 mg/kg and 10-times the BTV in samples above 10 ft-bls.

- Central Landfills Area – benzo(a)pyrene concentrations in soil ranged from 0.003 to 100 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 2.66 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was non-detect. Concentrations of benzo(a)pyrene in the Central Landfills Area generally exceeded the BTV of 0.0317 mg/kg and 10-times the BTV in samples above 10 ft-bls and only sporadically exceeded the BTV and 10-times the BTV below 10 ft-bls.
- Industrial Landfill Area – benzo(a)pyrene concentrations in soil ranged from <0.002 to 53 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 4.76 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was non-detect. Concentrations of benzo(a)pyrene in the Industrial Landfill Area generally exceeded the BTV of 0.0317 mg/kg and 10-times the BTV in samples above 2 ft-bls. Concentrations of benzo(a)pyrene did not exceed the BTV in sample intervals below 2 ft-bls.
- South Percolation Pond Area – benzo(a)pyrene concentrations in soil ranged from <0.01 to 4 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.25 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.009 mg/kg. Concentrations of benzo(a)pyrene in the South Percolation Pond Area generally exceeded the BTV of 0.0205 mg/kg and sporadically exceeded 10-times the BTV in samples above 10 ft-bls. There were no exceedances above the BTV below 10 ft-bls.
- Flathead River Area – benzo(a)pyrene concentrations in soil were all non-detect.
- Backwater Seep Sampling Area – benzo(a)pyrene concentrations in soil ranged from <0.011 to 0.036 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.015 mg/kg. Concentrations of benzo(a)pyrene in the Backwater Seep Sampling Area were generally non-detect and exceeded 10-times the BTV in three samples.
- Eastern Undeveloped Area – benzo(a)pyrene concentrations in soil ranged from <0.002 to 1.9 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.45 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.002 mg/kg. There are exceedances of the BTV of 0.0317 mg/kg within the 0-0.5 ft-bls interval. There were no exceedances above the BTV below 0.5 ft-bls.
- North-Central Undeveloped Area – benzo(a)pyrene concentrations in soil ranged from <0.002 to 0.22 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.056 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.008 mg/kg. Concentrations of benzo(a)pyrene in the North-Central Undeveloped Area sporadically exceeded the BTV of 0.0317 mg/kg in the surface and shallow soil sample intervals. There was only one exceedance of the BTV below 2 ft-bls. There were no exceedances above 10-times the BTV.
- Western Undeveloped Area – benzo(a)pyrene concentrations in soil ranged from <0.002 to 0.27 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.042 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 0.005 mg/kg. Concentrations of benzo(a)pyrene in the Western Undeveloped Area sporadically exceeded the BTV of 0.0317 mg/kg in the surface and soil sample interval. There was only one exceedance of the BTV below 0.5 ft-bls. There were no exceedances above 10-times the BTV.

- Operational Area ISM – benzo(a)pyrene concentrations in soil ranged from <0.01 to 240 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval at CFISS-013 located downgradient of the Wet Scrubber Sludge Pond. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 16.59 mg/kg.
- Background Reference Areas – benzo(a)pyrene concentrations in background soil ranged from <0.004 to 0.21 mg/kg with the maximum concentration in Reference Area #4. The highest average concentration of all reference areas occurred in Reference Area #4 at a concentration of 0.065 mg/kg.
- Based upon the comparison of analytical results for Site-wide exposure areas, a statistical evaluation of Site versus background was conducted to determine which COCs in soil are potentially Site-related. This soil comparison is discussed in Section 5.5.1 of the Phase II SC Data Summary Report. Benzo(a)pyrene was determined to be potentially Site-related for soil in the Main Plant Area, the North Percolation Pond Area, the Central Landfill Area, the Industrial Landfill Area, the North-Central Undeveloped Area, the Western Undeveloped Area, the South Percolation Pond Area, and the Eastern Undeveloped Area.
- The Site-wide thematic maps and the summary statistic tables show that there is a decrease in benzo(a)pyrene concentrations in soil between the 0-2 ft-bls and deeper depth intervals. The exceedances of the BTVs are generally in the surface and shallow soil intervals within the industrial areas of the Site (Main Plant Area, Northern Percolation Pond Area, Central Landfills Area, and the Industrial Landfills Area).

Benzo(a)pyrene in Surface Water

- North Percolation Ponds – the benzo(a)pyrene concentration in the single surface water sample collected in the North-East Percolation Pond during Phase I Round 4 was 3.9 µg/L. This concentration exceeded 10-times the BTV (0.6 µg/L).
- South Percolation Ponds – benzo(a)pyrene concentrations in surface water ranged from <0.2 to 0.4 µg/L with an average concentration of 0.1 µg/L. Concentrations exceeded the BTV of 0.06 µg/L in one sample, located in the eastern-most pond. Concentrations did not exceed 10-times the BTV.
- Flathead River – benzo(a)pyrene was non-detect in all surface water samples.
- Backwater Seep Sampling Area – benzo(a)pyrene concentrations in surface water ranged from <0.05 to 0.3 µg/L. Concentrations exceeded the BTV of 0.06 µg/L in one the western-most sample. Concentrations did not exceed 10-times the BTV.
- Riparian Sampling Area – benzo(a)pyrene was non-detect in all surface water samples.
- Background Reference Areas – benzo(a)pyrene was non-detect in all surface water samples.
- Based upon the comparison of analytical results for Site-wide surface water features, a statistical evaluation of Site versus background was conducted to determine which COCs in surface water are potentially Site-related. This surface water comparison is discussed in Section 5.5.2 of the Phase II SC Data Summary Report. Benzo(a)pyrene was determined to be potentially Site-related for surface water in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds.
- The Site-wide thematic maps, BTV maps, and the summary statistic tables show that concentrations of benzo(a)pyrene in surface water were typically non-detect, with the exception of one sample in the South Percolation Ponds, one sample in the Backwater Seep Sampling Area, and one sample in the North-East Percolation Pond.

Benzo(a)pyrene in Sediment

- North Percolation Ponds – benzo(a)pyrene concentrations in sediment ranged from 19 to 100 mg/kg with an average concentration of 59.5 mg/kg. Concentrations exceeded 10-times the BTV of 0.025 mg/kg in both samples.

- South Percolation Ponds – benzo(a)pyrene concentrations in sediment ranged from 0.11 to 0.86 mg/kg with an average concentration of 0.35 mg/kg. Concentrations exceeded the BTV of 0.025 mg/kg in all samples and sporadically exceeded 10-times the BTV throughout the various phases of sampling.
- Flathead River – benzo(a)pyrene concentrations in sediment ranged from <0.0009 to 0.99 mg/kg with an average concentration of 0.088 mg/kg. The maximum concentration was the only sample to exceed the BTV of 0.25 mg/kg.
- Backwater Seep Sampling Area – benzo(a)pyrene concentrations in sediment ranged from <0.002 to 1.2 mg/kg with an average concentration of 0.22 mg/kg. Concentrations sporadically exceeded the BTV of 0.025 mg/kg and 10-times the BTV in samples throughout the various phases of sampling.
- Riparian Sampling Area – benzo(a)pyrene concentrations in sediment ranged from <0.014 to 0.091 mg/kg with an average concentration of 0.036 mg/kg. Concentrations sporadically exceeded the BTV of 0.025 mg/kg in samples collected during the Supplemental South Pond Assessment and the Phase II. Concentrations did not exceed 10-times the BTV.
- Cedar Creek – benzo(a)pyrene concentrations in sediment ranged from <0.002 to 0.094 mg/kg with an average concentration of 0.039 mg/kg. Concentrations generally exceeded the BTV of 0.025 mg/kg. There were no exceedances of 10-times the BTV.
- Northern Surface Water Feature – benzo(a)pyrene concentrations in sediment ranged from <0.002 to 0.086 mg/kg with an average concentration of 0.44 mg/kg. Concentrations generally exceeded the BTV of 0.025 mg/kg. There were no exceedances of 10-times the BTV.
- Background Reference Areas – benzo(a)pyrene concentrations in sediment ranged from <0.0007 to 0.004 mg/kg with the maximum concentration in Reference Area #1.
- Based upon the comparison of analytical results for Site-wide exposure areas, a statistical evaluation of Site versus background was conducted to determine which COCs in sediment are potentially Site-related. This sediment comparison is discussed in Section 5.5.3 of the Phase II SC Data Summary Report. Benzo(a)pyrene was determined to be potentially Site-related for sediment in Cedar Creek, the Northern Surface Water Feature, the Backwater Seep/Riparian Sampling Area, and the South Percolation Ponds.
- The Site-wide thematic maps, BTV maps, and the summary statistic tables show that concentrations in sediment were typically detect and sporadically exceeded the BTV of 0.025 mg/kg throughout the phases of sampling. Concentrations exceeding 10-times the BTV were limited to the South Percolation Ponds, the Backwater Seep Sampling Area, the Riparian Sampling Area, and the Northern Percolation Ponds.

Benzo(a)pyrene in Sediment Porewater

- South Percolation Ponds – dissolved benzo(a)pyrene concentrations in sediment porewater were non-detect in all samples.
- Flathead River – dissolved benzo(a)pyrene concentrations in sediment porewater were non-detect in all samples.
- Backwater Seep Sampling Area – dissolved benzo(a)pyrene concentrations in sediment porewater ranged from <0.05 to 0.1 µg/L with an average concentration of 0.04 µg/L.
- Riparian Sampling Area – dissolved benzo(a)pyrene concentrations in sediment porewater ranged from <0.05 to 0.1 µg/L with an average concentration of 0.03 µg/L.
- Cedar Creek – dissolved benzo(a)pyrene concentrations in sediment porewater were non-detect in all samples.
- The Site-wide thematic maps and the summary statistic tables showed the highest concentrations in sediment porewater within the Backwater Seep Sampling Area and the Riparian Sampling Area.

4.4.2.4 Distribution of Metals

Tables 9 and 10 shows the identification of metals contributing to risk by media and exposure area. A statistical summary of the data for these metals COCs is provided in Tables 11 through 20 for soil, Operational Area soil, upper unit groundwater, below upper unit groundwater, surface water, sediment, sediment porewater, background soil, background surface water, and background sediment samples, respectively. Thematic maps presenting metals COC data are provided in Appendices H6 through H14, I5 through I13, J10 through J15 and J24 through J30, K14 through K33, L5 through L13, and M5 through M7 (soil, Operational Area soil, groundwater, surface water, sediment, and sediment porewater, respectively). BTV thematic dot maps presenting metals COC data are provided in Appendices N4 through N12, O5 through O16, and P4 through P12 (soil, surface water, and sediment, respectively). Box plots presenting metals COC data are provided in Appendices Q6 through 14, R8 through 19, and S5 through S13 (soil, surface water, and sediment, respectively).

A description of the occurrence and distribution of these metals is provided below. The range and arithmetic average for each exposure area or surface water feature and notable patterns in the data are as follows (if patterns are not discussed, it infers that no notable patterns were observed).

In addition, the results of the hypothesis testing from the comparison of background to Site data are discussed for each metal, as appropriate. Details of the hypothesis testing were included in Section 5.5.1 (soil), Section 5.5.2 (surface water), and Section 5.5.3 (sediment) of the Phase II Data Summary Report.

4.4.2.4.1 Arsenic

The concentrations and distribution of arsenic are discussed for all exposure areas in all media.

Arsenic in Soil

- Main Plant Area – arsenic concentrations in soil ranged from 1.6 to 34.2 mg/kg, with the maximum concentration in the 2-10 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 2-10 ft-bls depth interval at a concentration of 6.21 mg/kg. Concentrations were highest near the former Operational Area and Paste Plant. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 3.75 mg/kg. Concentrations of arsenic in the Main Plant Area only exceeded the BTV of 6.291 mg/kg in a few sporadic samples. Samples below 17 ft-bls only exceeded the BTV within the Main Plaint Building. There were no exceedances above 10-times the BTV.
- North Percolation Pond Area – arsenic concentrations in soil ranged from 1.3 to 34.1 mg/kg, with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 11.5 mg/kg. Concentrations were highest in the North-East Percolation Pond. Concentrations generally decrease with increasing depth, such that the average concentration in the deepest depth interval (17-22 ft-bls) was 5.1 mg/kg. Concentrations of arsenic in the North Percolation Ponds generally exceeded the BTV of 6.291 mg/kg in surface and shallow samples. Concentrations within the North Percolation Ponds decreased with increasing depth such that cyanide below 2 ft-bls only sporadically exceeded the BTV. There were no exceedances above 10-times the BTV.
- Central Landfills Area – arsenic concentrations in soil ranged from 2.8 to 17.9 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 6.30 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 4.6 mg/kg. Concentrations of arsenic in the Central Landfills Area frequently exceeded the BTV of 6.291 mg/kg in samples throughout the exposure area in the

surface and shallow sample intervals. Concentrations only sporadically exceeded the BTV in the samples below 2 ft-bls. There were no exceedances above 10-times the BTV.

- Industrial Landfill Area – arsenic concentrations in soil ranged from 3.5 to 23.5 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 6.79 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 5.5 mg/kg. Concentrations of arsenic in the Industrial Landfill Area exceeded the BTV of 6.291 mg/kg generally in samples on the eastern side of the exposure area in the surface and shallow sample intervals. Concentrations of arsenic did not exceed the BTV in sample intervals below 2 ft-bls. There were no exceedances above 10-times the BTV.
- South Percolation Pond Area – arsenic concentrations in soil ranged from <0.7 to 8.4 mg/kg with the maximum concentration in the 10-17 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 10-17 ft-bls depth interval at a concentration of 3.77 mg/kg. Only two samples, one within the 0.5-2 ft-bls interval and one within the 10-17 ft-bls interval, exceeded the BTV of 6.291. There were no exceedances above 10-times the BTV.
- Flathead River Area – arsenic concentrations in soil ranged from 3.5 to 5.6 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 5.6 mg/kg. There were no exceedances of the BTV (6.291 mg/kg).
- Backwater Seep Sampling Area – arsenic concentrations in soil ranged from 1.9 to 5.4 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 4.97 mg/kg. There were no exceedances of the BTV (6.291 mg/kg).
- Eastern Undeveloped Area – arsenic concentrations in soil ranged from 2.0 to 12.4 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 6.12 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 5.17 mg/kg. There were no exceedances of the BTV (112.1 mg/kg).
- North-Central Undeveloped Area – arsenic concentrations in soil ranged from 2.0 to 15.8 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 10-17 ft-bls depth interval at a concentration of 6.87 mg/kg. Concentrations of arsenic in the North-Central Undeveloped Area sporadically exceeded the BTV of 6.291 mg/kg but did not exceed 10-times the BTV.
- Western Undeveloped Area – arsenic concentrations in soil ranged from 2.0 to 10.8 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 5.04 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 4.27 mg/kg. Concentrations of fluoride in the Western Undeveloped Area sporadically exceeded the BTV of 4.171 mg/kg in surface and shallow samples. Concentrations decreased with increasing depth such that there was only one arsenic exceedance above the BTV below the 2 ft-bls depth interval.
- Operational Area ISM – arsenic concentrations in soil ranged from 4.1 to 31.3 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-002 located within the Main Plant portion of the Operational Area grid. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 9.43 mg/kg.
- Background Reference Areas – arsenic concentrations in soil ranged from 2.4 to 53.7 mg/kg with the maximum concentration in Reference Area #4. The highest average concentration of all reference areas occurred in Reference Area #4 at a concentration of 18.35 mg/kg.

- Based on the results of hypothesis testing as discussed in previous sections, arsenic was determined to be potentially Site-related for soil in the North Percolation Pond Area, the Central Landfill Area, the Industrial Landfill Area, and the North-Central Undeveloped Area.
- The Site-wide thematic maps and the summary statistic tables show that there is a decrease in arsenic concentrations in soil between the 0-2 ft-bls and deeper depth intervals. The exceedances of the BTVs are generally in the developed areas of the Site (Northern Percolation Ponds, Central Landfill Area, and Industrial Landfill Area).

Arsenic in Groundwater

- During all six rounds of sampling, the arsenic concentrations in groundwater are lower in the below upper hydrogeologic unit than the upper hydrogeologic unit (as discussed in Section 4.3.2.3 of the Phase II SC Data Summary Report). These findings indicate that there is only limited, if any, hydraulic connectivity between the upper hydrogeologic unit and the water bearing zones screened in the underlying glacial till.
- Upper Unit – total arsenic concentrations in groundwater ranged from <0.8 to 82.1 µg/L with the highest average concentration of 8.4 µg/L (in the Central Landfills Area). Dissolved arsenic ranged from <0.6 to 92.6 µg/L with the highest average concentration of 6.8 µg/L (in the Central Landfills Area).
- Below Upper Unit – total arsenic concentrations in groundwater ranged from <0.8 to 6.2 µg/L with the highest average concentration of 4.5 µg/L (in the Industrial Landfill Area). Dissolved arsenic ranged from <0.6 to 8.3 µg/L with the highest average concentration of 4.0 µg/L (in the Industrial Landfill Area).

Arsenic in Surface Water

- North Percolation Ponds – total arsenic concentrations in surface water ranged from <0.6 to 2.4 µg/L with an average concentration of 1.4 µg/L. Dissolved arsenic was only analyzed in the single surface water sample collected and had a concentration of 1.0 µg/L.
- South Percolation Ponds – total arsenic concentrations in surface water ranged from <0.8 to 4.4 µg/L with an average concentration of 0.8 µg/L. Dissolved arsenic concentrations ranged from <0.8 to 2.9 µg/L with an average concentration of 0.8 µg/L.
- Flathead River – total arsenic concentrations in surface water ranged from <0.8 to 0.9 µg/L. Dissolved arsenic was non-detect in all samples.
- Backwater Seep Sampling Area – total arsenic concentrations in surface water ranged from <0.8 to 1.0 µg/L. Dissolved arsenic was non-detect in all samples.
- Riparian Sampling Area – total arsenic concentrations in surface water ranged from <0.8 to 18.5 µg/L with an average concentration of 3.6 µg/L. Dissolved arsenic concentrations ranged from <0.8 to 5.5 µg/L with an average concentration of 1.7 µg/L.
- Cedar Creek – total and dissolved arsenic concentrations in surface water were non-detect in all samples.
- Cedar Creek Reservoir Overflow Ditch – total arsenic concentrations in surface water ranged from <0.8 to 2.2 µg/L with an average concentration of 0.5 µg/L. Dissolved arsenic concentrations ranged from <0.8 to 0.7 µg/L.
- Northern Surface Water Feature – total arsenic concentrations in surface water ranged from <0.6 to 3.7 µg/L with an average concentration of 0.9 µg/L. Dissolved arsenic concentrations in surface water ranged from <0.8 to 1.5 µg/L with an average concentration of 0.6 µg/L.
- Background Reference Areas – total arsenic concentrations in background surface water ranged from <0.8 to 1.5 µg/L with the maximum concentration in Reference Area #2. Dissolved arsenic

concentrations ranged from <0.7778 to 1.6 µg/L with the maximum concentration in Reference Area #2.

- Based on the results of hypothesis testing as discussed in prior sections, dissolved arsenic was determined to be potentially Site-related for surface water in the Cedar Creek Reservoir Overflow Ditch.

Arsenic in Sediment

- North Percolation Ponds – arsenic concentrations in sediment ranged from 7.6 to 26.4 mg/kg with an average concentration of 17 mg/kg. One concentration in the North-East Percolation Pond exceeded the BTV of 9.879 mg/kg. Concentrations did not exceed 10-times the BTV.
- South Percolation Ponds – arsenic concentrations in sediment ranged from <0.65 to 2.6 mg/kg with an average concentration of 1.5 mg/kg. No concentrations exceeded the BTV of 7.277 mg/kg.
- Flathead River – arsenic concentrations in sediment ranged from 2.7 to 4.2 mg/kg with an average concentration of 3.34 mg/kg. Concentrations were all detect but there were no exceedances of the BTV of 7.277 mg/kg.
- Backwater Seep Sampling Area – arsenic concentrations in sediment ranged from 2.8 to 6.2 mg/kg with an average concentration of 4.11 mg/kg. No concentrations exceeded the BTV of 7.277 mg/kg.
- Riparian Sampling Area – arsenic concentrations in sediment ranged from 2.5 to 6.1 mg/kg with an average concentration of 4.04 mg/kg. No concentrations exceeded the BTV of 7.277 mg/kg.
- Cedar Creek – arsenic concentrations in sediment ranged from 1.8 to 4.2 mg/kg with an average concentration of 2.59 mg/kg. No concentrations exceeded the BTV of 9.879 mg/kg.
- Northern Surface Water Feature – arsenic concentrations in sediment ranged from 3.2 to 14.5 mg/kg with an average concentration of 7.48 mg/kg. Concentrations exceeded the BTV of 9.879 mg/kg in the two northern-most samples. There were no exceedances of 10-times the BTV.
- Background Reference Areas – arsenic concentrations in sediment ranged from 1.7 to 7 mg/kg with the maximum concentration in Reference Area #2. The highest average concentration occurred in Reference Area #2 at a concentration of 5.02 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, total arsenic was determined to be potentially Site-related for sediment in the Northern Surface Water Feature.
- The Site-wide thematic maps, BTV maps, and the summary statistic tables show that concentrations in sediment were all mostly detect but exceedances of the BTV were limited to the North-East Percolation Pond and the Northern Surface Water Feature.

Arsenic in Sediment Porewater

- South Percolation Ponds – dissolved arsenic concentrations in sediment porewater ranged from <0.8 to 1.4 µg/L with an average concentration of 0.6 µg/L.
- Flathead River – dissolved arsenic concentrations in sediment porewater were non-detect in all samples.
- Backwater Seep Sampling Area – dissolved arsenic concentrations in sediment porewater were non-detect in all samples.
- Riparian Sampling Area – dissolved arsenic concentrations in sediment porewater ranged from <0.058 to 3.9 µg/L with an average concentration of 1.3 µg/L.
- Cedar Creek – dissolved arsenic concentrations in sediment porewater ranged from <.8 to 1.0 µg/L with an average concentration of 0.7 µg/L.

4.4.2.4.2 Aluminum

The concentrations and distribution of aluminum in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (surface water), South Percolation Ponds (surface water), Flathead River (surface water), Backwater Seep Sampling Area (surface water), and Riparian Sampling Area (surface water).

Aluminum in Surface Water

- North Percolation Ponds – total aluminum concentrations in surface water ranged from 109 to 8,630 µg/L with an average concentration of 4,369.5 µg/L. Dissolved aluminum was only analyzed in one sample at a concentration of 4,780 µg/L. The total aluminum concentration in the North-West Percolation Pond during Phase I Round 3 (March 2017) exceeded the BTV of 33.91 µg/L and the total aluminum concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) exceeded 10-times the BTV of 33.91 µg/L. The one dissolved aluminum concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) exceeded 10-times the BTV of 15.8 µg/L.
- South Percolation Ponds – total aluminum concentrations in surface water ranged from <13.5 to 24,500 µg/L, with the maximum concentration in sample CFSWP-020 collected during the Supplemental South Pond Assessment, with an average concentration of 1,491 µg/L. Excluding the CFSWP-020 sample, the maximum concentration is in sample CFSWP-019 collected during the Supplemental South Pond Assessment at a concentration of 4,330 µg/L. Dissolved aluminum concentrations ranged from <15 to 2,360 µg/L with an average concentration of 259.3 µg/L. Total aluminum concentrations generally exceeded the BTV of 15.8 µg/L during Phase II Round 2 (October 2018) and concentrations exceeded either the BTV of 15.8 µg/L or 10-times the BTV in both samples collected during the Supplemental South Pond Assessment (November 2017). Dissolved aluminum concentrations exceeded either the BTV of 15.8 µg/L and 10-times the BTV in all samples during Phase II Round 2 (October 2018) and only one sample exceeded the BTV of 15.8 µg/L during Phase II Round 1 (June 2018).
- Flathead River – total aluminum concentrations in surface water ranged from <15 to 1,540 µg/L with an average concentration of 269.5 µg/L. Dissolved aluminum concentrations ranged from <15 to 44.8 µg/L with an average concentration of 12.5 µg/L. Total aluminum concentrations sporadically exceeded the BTV of 683.2 µg/L during Phase I Round 3 (March 2017), Phase I Round 4 (June 2017), and Phase II Round 2 (October 2018). There were no exceedances above 10-times the BTV. Dissolved aluminum concentrations exceeded the BTV of 15.8 µg/L during Phase II Round 1 (June 2018). There were no exceedances above 10-times the BTV.
- Backwater Seep Sampling Area – total aluminum concentrations in surface water ranged from <15 to 1,180 µg/L with an average concentration of 366.2 µg/L. Dissolved aluminum concentrations ranged from <15 to 75.3 µg/L with an average concentration of 16.7 µg/L. Total aluminum concentrations sporadically exceeded the BTV of 683.2 µg/L during Phase I Round 3 (March 2017), Phase I Round 4 (June 2017), the Supplemental South Pond Assessment (November 2017), and Phase II Round 2 (October 2018). There were no exceedances above 10-times the BTV. Dissolved aluminum concentrations exceeded the BTV of 15.8 µg/L during Phase II Round 1 (June 2018) and Phase II Round 2 (October 2018). There were no exceedances above 10-times the BTV.
- Riparian Sampling Area – total aluminum concentrations in surface water ranged from 53.1 to 32,000 µg/L, with the maximum concentration in sample CFSWP-032 collected during the Supplemental South Pond Assessment, and an average concentration of 3,591.6 µg/L. Excluding the CFSWP-032 sample, the maximum concentration was from sample CFSWP-030 collected during the Supplemental South Pond Assessment at a concentration of 11,800 µg/L. Dissolved aluminum concentrations ranged from <15 to 614 µg/L with an average concentration of 183.9 µg/L. Total aluminum concentrations sporadically exceeded the BTV of 683.2 µg/L and exceeded 10-times the BTV during the Supplemental South Pond Assessment (November 2017). Dissolved aluminum concentrations sporadically exceeded the BTV of 15.8 µg/L and exceeded 10-times the BTV during Phase II Round 2 (October 2018).

- Based on the results of hypothesis testing as discussed in prior sections, total aluminum was determined to be potentially Site-related for surface water in Cedar Creek, the Northern Surface Water Feature, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds. Dissolved aluminum was determined to be potentially Site-related for surface water in the Flathead River, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds.

4.4.2.4.3 Antimony

The concentrations and distribution of antimony in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Below Upper Unit (groundwater).

Antimony in Groundwater

- Below Upper Unit – total antimony concentrations in groundwater ranged from <0.6 to 70.7 µg/L with the highest average concentration of 12.3 µg/L (in the Main Plant Area). Dissolved antimony ranged from <0.6 to 84.5 µg/L with the highest average concentration of 6.8 µg/L (in the Main Plant Area).

4.4.2.4.4 Barium

The concentrations and distribution of barium in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (soil/surface water/sediment), South Percolation Ponds (soil/surface water/sediment/sediment porewater), and Riparian Sampling Area (surface water/sediment/sediment porewater).

Barium in Soil

- North Percolation Pond Area – barium concentrations in soil ranged from 19.6 to 1,560 mg/kg, with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 227.26 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the deepest depth interval (17-22 ft-bls) was 79.9 mg/kg. Concentrations of barium in the North Percolation Ponds sporadically exceeded the BTV of 299.5 mg/kg in samples above 10 ft-bls. There were no exceedances above the BTV below 10 ft-bls. There were no exceedances above 10-times the BTV.
- South Percolation Pond Area – barium concentrations in soil ranged from 34.1 to 972 mg/kg with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 285.52 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 57.65 mg/kg. Samples within the western-most pond generally exceeded the BTV of 299.5 mg/kg and two samples within the eastern pond. There was only one exceedance of the BTV below 0.5 ft-bls. There were no exceedances above 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, barium was determined to be potentially Site-related for soil in the North-Central Undeveloped Area, the Western Undeveloped Area, the South Percolation Pond Area, and the Eastern Undeveloped Area.

Barium in Surface Water

- North Percolation Ponds – total barium concentrations ranged from 43.4 to 234 µg/L with an average concentration of 138.7 µg/L. Dissolved barium was only collected in one surface water sample at a concentration of 26.4 µg/L. Concentrations were highest in the North-East Percolation Pond during Phase I Round 3 (March 2017) and exceeded the BTV of 98.63 µg/L.
- South Percolation Ponds – total barium concentrations in surface water ranged from 156 to 2,710 µg/L, with the maximum concentration in the CFSWP-020 sample collected during the Supplemental

South Pond Assessment, with an average concentration of 370.6 µg/L. Excluding the CFSWP-020 sample, the maximum concentration was from sample CFSWP-019 collected during the Supplemental South Pond Assessment at a concentration of 2,710 µg/L. Dissolved barium concentrations ranged from 119 to 527 µg/L with an average concentration of 259.2 µg/L. Concentrations most often exceeded the BTV of 130.3 µg/L and 10-times the BTV during Phase II Round 1 (June 2018).

- Riparian Sampling Area – total barium concentrations in surface water ranged from 122 to 1,230 µg/L with an average concentration of 327.8 µg/L. Dissolved barium concentrations ranged from 117 to 401 µg/L with an average concentration of 230.5 µg/L. Total and dissolved barium concentrations generally exceeded the BTV of 130.3 µg/L across the sampling rounds. There were no concentrations above 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, total and dissolved barium was determined to be potentially Site-related for surface water in Cedar Creek, the Northern Surface Water Feature, Cedar Creek Reservoir Overflow Ditch, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds.

Barium in Sediment

- North Percolation Ponds – barium concentrations in sediment ranged from 317 to 539 mg/kg with an average concentration of 428 mg/kg. Concentrations exceeded the BTV of 239 mg/kg in both samples. Concentrations did not exceed 10-times the BTV.
- South Percolation Ponds – barium concentrations in sediment ranged from 234 to 969 mg/kg with an average concentration of 639 mg/kg. Concentrations exceeded the BTV of 239 mg/kg in all but one sample. Concentrations did not exceed 10-times the BTV.
- Riparian Sampling Area – barium concentrations in sediment ranged from 83.9 to 208 mg/kg with an average concentration of 135.67 mg/kg. Concentrations were all detect but there were no exceedances of the BTV of 239 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, barium was determined to be potentially Site-related for sediment in the Northern Surface Water Feature and South Percolation Ponds.

Barium in Sediment Porewater

- South Percolation Ponds – dissolved barium concentrations in sediment porewater ranged from 173 to 421 µg/L with an average concentration of 286.7 µg/L.
- Riparian Sampling Area – dissolved barium concentrations in sediment porewater ranged from 154 to 394 µg/L with an average concentration of 287.8 µg/L.

4.4.2.4.5 Cadmium

The concentrations and distribution of copper in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (surface water/sediment).

Cadmium in Surface Water

- North Percolation Ponds – total cadmium concentrations in surface water ranged from <0.7 to 3 µg/L with an average concentration of 1.7 µg/L. Dissolved cadmium was only analyzed in one sample at a concentration of 2.5 µg/L. The total cadmium concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) was the only sample to exceed the BTV of 0.61U µg/L. The one total cadmium concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) exceeded the BTV of 0.61 U µg/L (i.e., non-detect).
- Based on the results of hypothesis testing as discussed in prior sections, total cadmium was determined to be potentially Site-related related for surface water in the Backwater Seep Sampling

Area/Riparian Sampling Area and the South Percolation Ponds. Dissolved cadmium was determined not to be potentially Site-related for surface water.

Cadmium in Sediment

- North Percolation Ponds – cadmium concentrations in sediment ranged from 2.7 to 8 mg/kg with an average concentration of 5.35 mg/kg. The cadmium concentration in the North-West Pond exceeded the BTV of 0.73U mg/kg and the cadmium concentration in the North-East Pond exceeded 10-times the BTV of 0.73U mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, total cadmium was determined to be potentially Site-related for sediment in the South Percolation Ponds.

4.4.2.4.6 Copper

The concentrations and distribution of copper in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (surface water), South Percolation Ponds (surface water/sediment/sediment porewater), Central Landfill Area (soil), and Operational Area ISM (soil).

Copper in Soil

- Central Landfills Area – copper concentrations in soil ranged from 5.9 to 7,260 mg/kg, with the maximum concentration in sample CFSB-002 within the 0-0.5 ft-bls depth interval. Excluding the CFSB-002 sample, the maximum concentration was from the 0-0.5 ft-bls depth interval at CFSB-152 at a concentration of 206 mg/kg. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 136.25 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 10.4 mg/kg. Concentrations of copper in the Central Landfills Area sporadically exceeded the BTV of 17.93 mg/kg in samples from intervals above 17 ft-bls. There were only two exceedances above 10-times the BTV.
- Operational Area ISM – copper concentrations in soil ranged from 14.1 to 887 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-038 located within the Main Plant Area portion of the Operational Area grid. Excluding the two maximum concentrations (CFISS-038 and CFISS-006), the maximum concentration is in the 0-0.5 ft-bls depth interval at CFISS-037 at a concentration of 477 mg/kg. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 153.91 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, copper was determined to be potentially Site-related for soil in the Main Plant Area, the North Percolation Pond Area, the Central Landfill Area, the North-Central Undeveloped Area, the Western Undeveloped Area, and the South Percolation Pond Area.

Copper in Surface Water

- North Percolation Ponds – total copper concentrations in surface water ranged from 3.8 to 16.5 µg/L with an average concentration of 10.2 µg/L. Dissolved copper was only collected in one sample at a concentration of 2 µg/L. The total copper concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) was the only sample to exceed the BTV of 5.401 µg/L. The one total copper concentration in the North-East Percolation Pond collected during Phase I Round 4 (June 2017) exceeded the BTV of 5.401 µg/L.
- South Percolation Ponds – total copper concentrations in surface water ranged from <1.9 to 183 µg/L, with the maximum concentration in sample CFSWP-020 collected during the Supplemental South Pond Assessment, and an average concentration of 14.5 µg/L. Excluding the CFSWP-020 sample, the maximum concentration was detected in sample CFSWP-019 collected during the Supplemental South Pond Assessment at a concentration of 75.9 µg/L. Dissolved copper

concentrations ranged from <1.4 to 33.4 µg/L with an average concentration of 3.9 µg/L. Total and dissolved concentrations sporadically exceeded the BTV of 5.401 µg/L and exceeded 10-times the BTV in a few samples.

- Based on the results of hypothesis testing as discussed in prior sections, total copper was determined to be potentially Site-related for surface water in the Northern Surface Water Feature. Dissolved copper was determined to be potentially Site-related for surface water in the Flathead River, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds.

Copper in Sediment

- South Percolation Ponds – copper concentrations in sediment ranged from 20.9 to 143 mg/kg with an average concentration of 57.51 mg/kg. Copper concentrations generally exceeded the BTV of 25.65 mg/kg. Concentrations did not exceed 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, copper was determined to be potentially Site-related for sediment in the Northern Surface Water Feature and the South Percolation Ponds.

Copper in Sediment Porewater

- South Percolation Ponds – dissolved barium concentrations in sediment porewater ranged from <1.9 to 2.9 µg/L with an average concentration of 1.3 µg/L.

4.4.2.4.7 Iron

The concentrations and distribution of iron in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: South Percolation Ponds (surface water).

Iron in Surface Water

- South Percolation Ponds – total iron concentrations in surface water ranged from <42.4 to 22,500 µg/L with an average concentration of 1,423.3 µg/L. Dissolved iron concentrations ranged from <45.7 to 1,430 µg/L with an average concentration of 217.5 µg/L. Total iron concentrations exceeded the BTV of 1,055 µg/L and 10-times the BTV in the Supplemental South Pond Assessment (November 2017) and Phase II Round 2 (October 2018). Dissolved iron concentrations generally exceeded the BTV of 45.7 µg/L and exceeded 10-times the BTV in a few samples.
- Based on the results of hypothesis testing as discussed in prior sections, total and dissolved iron was determined to be potentially Site-related for surface water in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds.

4.4.2.4.8 Lead

The concentrations and distribution of lead in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (sediment).

Lead in Sediment

- North Percolation Ponds – lead concentrations in sediment ranged from 24.8 to 109 mg/kg with an average concentration of 66.9 mg/kg. Concentrations exceeded the BTV of 30.29 mg/kg in both sediment samples (two) collected from the North Percolation Ponds. Concentrations did not exceed 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, lead was determined to be potentially Site-related for sediment in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds.

4.4.2.4.9 Manganese

The concentrations and distribution of manganese in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Main Plant Area (soil) and Eastern Undeveloped Area (soil).

Manganese in Soil

- Main Plant Area – manganese concentrations in soil ranged from 73.4 to 1,270 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 426.67 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 306.42 mg/kg. Concentrations of manganese in the Main Plant Area did not exceed the BTV of 1,838 mg/kg.
- Eastern Undeveloped Area – manganese concentrations in soil ranged from 169 to 3,950 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 1,199.24 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (10-17 ft-bls) was 300 mg/kg. Concentrations of manganese in the Eastern Undeveloped Area exceeded the BTV of 1,838 mg/kg in three samples within the 0-0.5 ft-bls depth interval. There were no exceedances above 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, manganese was determined not to be potentially Site-related for soil.

4.4.2.4.10 Nickel

The concentrations and distribution of nickel in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Central Landfills Area (soil), Industrial Landfill Area (soil) and North Percolation Ponds (soil and sediment).

Nickel in Soil

- Central Landfills Area – nickel concentrations in soil ranged from 4.9 to 534 mg/kg, with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 27.40 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 8.8 mg/kg. Concentrations of nickel in the Central Landfills Area sporadically exceeded the BTV of 17.32 mg/kg in samples in intervals above 17 ft-bls. There were only two exceedances above 10-times the BTV, both in the 0.5-2 ft-bls depth interval.
- Industrial Landfill Area – nickel concentrations in soil ranged from 5.6 to 513 mg/kg, with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 47.06 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (>22 ft-bls) was 7.5 mg/kg. Concentrations of nickel in the Industrial Landfill Area sporadically exceeded the BTV of 17.32 mg/kg in samples in intervals above 2 ft-bls. There were only two exceedances above 10-times the BTV.
- North Percolation Ponds – nickel concentrations in soil ranged from 6.1 to 1,250 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 215 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was 10.96 mg/kg. Concentrations of nickel in the North Percolation Ponds sporadically exceeded the BTV of 17.32 mg/kg and 10-times the BTV in samples in intervals above 17 ft-bls.

- Based on the results of hypothesis testing as discussed in prior sections, nickel was determined to be potentially Site-related for soil in the Main Plant Area, the North Percolation Pond Area, the Central Landfill Area, and the Eastern Undeveloped Area.

Nickel in Sediment

- North Percolation Ponds – nickel concentrations in sediment ranged from 208 to 771 mg/kg with an average concentration of 489.5 mg/kg. Concentrations exceeded 10-times the BTV of 17.94 mg/kg in both samples.
- Based on the results of hypothesis testing as discussed in prior sections, nickel was determined to be potentially Site-related for sediment in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds.

4.4.2.4.11 Selenium

The concentrations and distribution of selenium in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Operational Area ISM (soil) and North Percolation Ponds (soil and sediment).

Selenium in Soil

- Operational Area ISM – selenium concentrations in soil ranged from 0.18 to 13.3 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-022. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 1.83 mg/kg.
- North Percolation Ponds – selenium concentrations in soil ranged from <0.23 to 3.3 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 0.823 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was non-detect. Concentrations of selenium in the North-East Percolation Pond sporadically exceeded the BTV of 1.376 mg/kg in samples in intervals above 10 ft-bls. There were no exceedances above 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, selenium was determined not to be potentially Site-related for soil.

Selenium in Sediment

- North Percolation Ponds – selenium concentrations in sediment ranged from 0.89 to 3.4 mg/kg with an average concentration of 2.15 mg/kg. Concentrations exceeded the BTV of 0.46U mg/kg in both samples. Concentrations did not exceed 10-times the BTV.
- Based on the results of hypothesis testing as discussed in prior sections, selenium was determined to be potentially Site-related for sediment in the South Percolation Ponds.

4.4.2.4.12 Thallium

The concentrations and distribution of thallium in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: North Percolation Ponds (soil).

Thallium in Soil

- North Percolation Ponds – thallium concentrations in soil ranged from <0.099 to 4.6 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 0.856 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was 0.103 mg/kg. Concentrations of thallium in the North

Percolation Ponds and the Overflow Ditch sporadically exceeded the BTV of 0.15U mg/kg. Concentrations of thallium sporadically exceeded 10-times the BTV in the surface and shallow depth intervals only.

- Based on the results of hypothesis testing as discussed in prior sections, thallium was determined to be potentially Site-related for soil in the North Percolation Pond Area, the Central Landfill Area, and the North-Central Undeveloped Area.

4.4.2.4.13 Vanadium

The concentrations and distribution of vanadium in each media is discussed below for the following exposure areas in which it was identified as contributing to risk in the North Percolation Ponds (soil and sediment).

Vanadium in Soil

- North Percolation Ponds – vanadium concentrations in soil ranged from 4.1 to 348 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 69.28 mg/kg. Concentrations generally decrease with increasing depth, such that the average concentration in the lowest depth interval (17-22 ft-bls) was 8.94 mg/kg. Concentrations of vanadium in the North Percolation Ponds and its overflow ditch generally exceeded the BTV of 15.72 mg/kg in depth intervals above 10 ft-bls. There were two exceedances of 10-times the BTV within the North-East Percolation Pond in the surface and shallow depth intervals.
- Based on the results of hypothesis testing as discussed in prior sections, vanadium was determined to be potentially Site-related for soil in the North Percolation Pond Area, the Central Landfill Area, the Industrial Landfill Area, the Flathead River Area, and the Eastern Undeveloped Area.

Vanadium in Sediment

- North Percolation Ponds – vanadium concentrations in sediment ranged from 66.1 to 233 mg/kg with an average concentration of 149.55 mg/kg. The vanadium concentration in the North-West Pond exceeded the BTV of 19.27 mg/kg and the vanadium concentration in the North-East Pond exceeded 10-times the BTV of 19.27 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, vanadium was determined to be potentially Site-related for sediment in the Flathead River.

4.4.2.4.14 Zinc

The concentrations and distribution of zinc in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Operational Area ISM (soil) and North Percolation Ponds (surface water and sediment).

Zinc in Soil

- Operational Area ISM – zinc concentrations in soil ranged from 44.4 to 1,720 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval at CFISS-038 located within the Main Plant Area portion of the Operational Area grid. The highest average concentration of all depth intervals occurred in the 0-0.5 ft-bls depth interval at a concentration of 326.04 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, zinc was determined to be potentially Site-related for soil in the North Percolation Pond Area.

Zinc in Surface Water

- North Percolation Ponds – total zinc concentrations in surface water ranged from <7 to 537 µg/L with an average concentration of 270.3 µg/L. Dissolved zinc was only analyzed in one sample at a concentration of 512 µg/L. The total zinc concentration in the North-East Percolation Pond during

Phase I Round 4 (June 2017) was the only detection and exceeded 10-times the BTV of 7.2 µg/L. The one total zinc concentration in the North-East Percolation Pond during Phase I Round 4 (June 2017) exceeded 10-times the BTV of 14.7 µg/L.

- Based on the results of hypothesis testing as discussed in prior sections, total zinc was determined to be potentially Site-related for surface water in the Cedar Creek Reservoir Overflow Ditch, the Flathead River, the Backwater Seep Sampling Area/Riparian Sampling Area, and the South Percolation Ponds. Dissolved zinc was determined to be potentially Site-related for surface water in Cedar Creek.

Zinc in Sediment

- North Percolation Ponds – zinc concentrations in sediment ranged from 349 to 871 mg/kg with an average concentration of 610 mg/kg. The zinc concentration in the North-West Pond exceeded the BTV of 81.94 mg/kg and the zinc concentration in the North-East Pond exceeded 10-times the BTV of 81.94 mg/kg.
- Based on the results of hypothesis testing as discussed in prior sections, zinc was determined to be potentially Site-related for sediment in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds.

4.4.2.5 Distribution of PCBs

Aroclor 1254 was the only PCB that was indicated as a contributor to risk. Aroclor 1254 was only indicated as a contributor to risk in soil, therefore concentrations and patterns are not discussed for the other sample media. The distribution of aroclor 1254 at the Site is summarized in Tables 11 and 12 for soil and Operational Area soil, respectively. Thematic maps presenting aroclor 1254 soil data are provided in Appendices H5 and I4. Box plots presenting aroclor 1254 soil data are provided in Appendix Q5.

The concentrations and distribution of aroclor 1254 in each media is discussed below for the following exposure areas in which it was identified as contributing to risk: Main Plant Area (soil), Central Landfills Area (soil), and Operational Area ISM (soil).

The range and arithmetic average for each exposure area and notable patterns in the data are as follows (if patterns are not discussed, it infers that no notable patterns were observed):

Aroclor 1254 in Soil

- Main Plant Area – aroclor 1254 concentrations in soil ranged from <0.001 to 0.11 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. All average concentrations were non-detect.
- Central Landfills Area – aroclor 1254 concentrations in soil ranged from <0.001 to 1.2 mg/kg, with the maximum concentration in the 0-0.5 ft-bls depth interval. All average concentrations were non-detect.
- Operational Area ISM – aroclor 1254 concentrations in soil ranged from <0.00009 to 1.3 mg/kg with the maximum concentration in the 0.5-2 ft-bls depth interval. The highest average concentration of all depth intervals occurred in the 0.5-2 ft-bls depth interval at a concentration of 0.11 mg/kg.
- The Site-wide thematic maps and the summary statistic tables show that aroclor 1254 concentrations in soil were generally non-detect. PCBs were not analyzed in background soil samples. The highest concentrations were only within the surface and shallow soil intervals within the Main Plant Area and the Central Landfills Area.

4.4.3 Seasonal Variability of COC Concentrations in Groundwater

Cyanide and fluoride were identified as the primary COCs in Site groundwater as documented above and in the BERA and BHRRA. Therefore, these constituents were selected for detailed review in the evaluation of seasonal variability of concentrations in groundwater samples. A detailed discussion of the seasonal variability of cyanide and fluoride in groundwater can be found in the Phase II SC Data Summary Report. A summary of the seasonal variability discussion is provided below.

The charts in Appendices DD1 and DD2 of the Phase II SC Data Summary Report show that in general there were similar concentration ranges of cyanide and fluoride detections across the six rounds of sampling during the RI. With respect to cyanide, the highest number of maximum concentrations occurred during Phase II Round 2 (October 2018 low-water sampling event), and the lowest number of maximum concentrations occurred during the Phase I Round 2 (December 2016 low-water sampling event). With respect to fluoride, the highest number of maximum concentrations occurred during Phase II Round 1 (June 2018 high-water event), and the lowest number of maximum concentrations occurred during the Phase I Round 2 (December 2016 low-water sampling event).

Concentrations of total cyanide and fluoride from the four groundwater sampling rounds during the Phase I SC and the two groundwater sampling rounds during the Phase II SC were tabulated for comparison with groundwater elevations to further evaluate if Site-wide cyanide and fluoride concentrations varied seasonally. For each monitoring well sampled during the RI, the minimum and maximum detected concentrations of total cyanide and fluoride were identified with their associated sampling round. Additionally, the minimum and maximum groundwater elevations for each monitoring well were identified. This comparison is provided in Appendix DD3 of the Phase II SC Data Summary Report.

As shown in Appendix DD3 of the Phase II SC Data Summary Report, the maximum groundwater elevation in each well most frequently occurred during Phase II Round 1 (June 2018), and the minimum groundwater elevation in each well most frequently occurred during Phase I Round 3 (March/April 2017). The seasonal data for fluoride indicates the minimum concentrations most often occurred during Phase II Round 2 (October 2018, low-water) and the maximum concentrations most often occurred during Phase I Round 3 (March/April 2017, high-water). The seasonal data for cyanide indicates the minimum concentrations most often occurred during Phase I Round 4 (June 2017, high-water) and the maximum concentrations most often occurred during Phase II Round 1 (June 2018, high-water).

Based on the results of the above evaluation for the data collected during the two-year period, the RI dataset provides a representative depiction of the temporal variation in groundwater conditions at the Site. Although the groundwater levels fluctuate seasonally, in general, cyanide and fluoride were detected in the same monitoring well locations during each round of sampling, and the primary source areas of cyanide and fluoride (i.e., the West Landfill and Wet Scrubber Sludge Pond) do not appear to change temporally.

4.4.4 Seasonal Variability of COC Concentrations in Surface Water

Cyanide and fluoride have been identified as the primary COCs in Site surface water, as documented above and in the BERA and BHRRA. Therefore, these constituents were selected for detailed review in the evaluation of seasonal variability of concentrations in surface water samples. A detailed discussion of the seasonal variability of cyanide and fluoride in surface water can be found in the Phase II SC Data Summary Report. A summary of the seasonal variability discussion is provided below.

Appendix HH3 of the Phase II SC Data Summary Report show that the maximum concentrations of cyanide and fluoride occurred during the low-water sampling rounds Phase I Round 1 (September 2016), Supplemental South Ponds Assessment (October 2017), and Phase II Round 2 (October 2018). Concentrations were generally lower during the typically high-water sampling events in Phase I Round 3 (March 2017), Phase I Round 4 (June 2017), and Phase II Round 1 (June 2018).

Concentrations of total cyanide and fluoride at all surface water sampling locations from all rounds were tabulated for comparison in an effort to identify any clear seasonal variations. For each analyte, the minimum and maximum concentrations at each sampling location were highlighted to identify their associated sampling round.

As shown in Appendix HH3 of the Phase II SC Data Summary Report, the seasonal data for fluoride indicate the minimum concentrations for detected samples most often occurred during Phase I Round 1 (September 2016, low-water) and Phase II Round 2 (October 2018, low-water), and the maximum concentrations most often occurred during Phase I Round 4 (June 2017, high-water) and Phase II Round 2 (June 2018, high-water). The notable exceptions to this trend were the samples from Backwater Seep Sampling Area and the Riparian Sampling Area, as previously described above. The data for total cyanide does not show a clear seasonal trend due to the large percentage of non-detect results, with the exception of the highest concentrations occurring in the Backwater Seep Area and the Riparian Sampling Area during low-water conditions and the lowest concentrations during high-water conditions.

4.4.5 Evaluation of Groundwater Relative to MDEQ Standards

The nature and extent of COCs discussion in prior sections of this RIR focused on the COCs that were determined via the risk assessment process to be risk-drivers at the Site. This discussion was not inclusive of all COCs in groundwater that exceed MDEQ Circular DEQ-7 water quality standards. A statistical summary of the data for each COC in groundwater which had a least one exceedance of MDEQ Circular DEQ-7 Human Health Numeric Water Quality Standards is provided below based upon the groundwater quality data from wells screened in the upper hydrogeologic unit and below the upper hydrogeologic unit, respectively. An evaluation of MDLs achieved related to the screening criteria was provided for all media in the Phase I and Phase II SC Data Summary Reports.

Groundwater Results for Monitoring Wells Screened in the Upper Hydrogeologic Unit (Phase I and Phase II)[15]

Analyte	Fraction[16]	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	No. Exceeding	% Exceeding	MDEQ Human Health Standards
Fluoride	DI	50	µg/L	<60	55300	3575.3	1420	49	98	8	16	4000
Fluoride	T	302	µg/L	<12	52900	2981.05	1410	289	95.7	38	12.6	4000
Nitrate Nitrite as N	T	301	µg/L	<100	62800	3973.19	1280	261	86.7	24	7.97	10000
Antimony	DI	302	µg/L	<0.62	8.8	-	-	9	2.98	1	0.33	6
Antimony	T	162	µg/L	<0.62	9.7	0.57	-	30	18.5	1	0.62	6
Arsenic	DI	302	µg/L	<0.64	92.6	2.78	-	60	19.9	14	4.64	10
Arsenic	T	162	µg/L	<0.77	82.1	3.30	-	39	24.1	9	5.56	10

15 Table 14a of the Phase II SC Data Summary Report.

16 Fraction: T indicates a total (unfiltered) result and DI indicates a dissolved (filtered) result.

Groundwater Results for Monitoring Wells Screened in the Upper Hydrogeologic Unit (Phase I and Phase II)[15]												
Analyte	Fraction[16]	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	No. Exceeding	% Exceeding	MDEQ Human Health Standards
Barium	DI	302	µg/L	16.8	1010	206.27	170	302	100	1	0.33	1000
Cyanide, Free	T	200	µg/L	<1.5	306	18.57	4.55	128	64	2	1	200
Cyanide, Total	DI	162	µg/L	<2	11500	468.83	100.5	116	71.6	64	39.5	200
Cyanide, Total	T	302	µg/L	<2	10800	503.49	108	241	79.8	126	41.7	200
Zinc	T	162	µg/L	<5.4	3990	38.52	-	66	40.7	1	0.62	2000
4,6-Dinitro-2-methylphenol	T	170	µg/L	<1.4	2.2	-	-	1	0.59	1	0.59	2
Benzo[a]pyrene	T	170	µg/L	<0.049	0.16	-	-	1	0.59	155	91.2	0.05
Bis(2-ethylhexyl) phthalate	T	170	µg/L	<0.72	73	-	-	9	5.29	2	1.18	6
Dibenz(a,h)anthracene	T	170	µg/L	<0.067	0.64	-	-	1	0.59	1	0.59	0.05

Groundwater Results for Monitoring Wells Screened in the Below Upper Hydrogeologic Unit (Phase I and Phase II)[17]												
Analyte	Fraction	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	No. Exceeding	% Exceeding	DEQ-7 Human Health Standards
Antimony	DI	78	µg/L	<0.62	84.5	2.38	-	12	15.4	3	3.85	6
Antimony	T	39	µg/L	<0.62	70.7	4.24	-	13	33.3	3	7.69	6
Barium	DI	78	µg/L	5.8	4430	325.37	111	78	100	6	7.69	1000
Barium	T	39	µg/L	21	2310	262.79	121	39	100	3	7.69	1000
Lead	T	39	µg/L	<0.37	26.8	1.72	0.63	26	66.7	1	2.56	15

The results of the above comparison indicate that concentrations of total cyanide, free cyanide, fluoride, select metals, nitrate as N, and SVOCs were detected in groundwater above DEQ-7 Human Health Standards. Total cyanide, free cyanide, and fluoride were the COCs detected most frequently at concentrations exceeding MDEQ Circular DEQ-7 Human Health Standards. All of the exceedances for these COCs are in upper hydrogeologic unit wells located within the Plume Core Area as described in Section 4.4.2.

A discussion of the other COCs with exceedances of MDEQ Circular DEQ-7 Human Health Standards is provided below.

- Antimony: Within the upper hydrogeologic unit the only exceedances were at CFMW-008A (adjacent to the former Sanitary Landfill), with total and dissolved antimony in groundwater at concentrations of 9.7 and 8.8 µg/L, respectively. Both detections occurred in the Phase II, Round 1 (June 2018) sampling event. Within the below upper hydrogeologic unit the only exceedances were at CFMW-053a.
- Arsenic: Within the upper hydrogeologic unit all of the exceedances were within Plume Core Area, with the highest concentrations consistently observed in CFMW-012 and CFMW-015 immediately

[17] Table 15a of the Phase II SC Data Summary Report.

adjacent to the West Landfill and Wet Scrubber Sludge Pond. There were no exceedances in the below upper hydrogeologic unit.

- Barium: Within the upper hydrogeologic unit the only exceedance (1,010 µg/L) was at CFMW-049a in the south-east corner of the Main Plant Area (within the Plume Core Area). Within the below upper hydrogeologic unit the only exceedances were at CFMW-053a.
- Zinc: Within the upper hydrogeologic unit the only exceedance (3,990 µg/L) was at CFMW-008 (adjacent to the former Sanitary Landfill). There were no exceedances in the below upper hydrogeologic unit.
- Lead: The only exceedance occurred in the below upper hydrogeologic unit in CFMW-053a (26 µg/L).
- PAHs: Benzo(a)pyrene and dibenz(a,h)anthracene were detected in groundwater at concentrations exceeding their respective DEQ-7 Human Health Standards in upper unit monitoring well CFMW-067, installed during the Phase II SC, on the north-west side of the Industrial Landfill. It is noted that within the Industrial Landfill, the surface and shallow soil show elevated concentrations of PAHs in comparison to the other landfills; and that the Industrial Landfill is not yet capped. Thus, PAH detections in groundwater at the newly installed monitoring well (CFMW-067) may potentially be attributable to the landfill.
- 4,6-Dinitro-2-methylphenol: Within the upper hydrogeologic unit the only exceedance (2.2 µg/L) was in CFMW-023 (downgradient of the East Landfill).
- Bis(2-ethylhexyl) phthalate: Within the upper hydrogeologic unit the two exceedances occurred at CFMW-069 (adjacent to Aluminum Drive within the Western Undeveloped Area) and CFMW-070 within the northern portion of the Main Plant Area. There is no known source of phthalates at the Site, and bis(2-ethylhexyl) phthalate has not been identified previously as a COPC in soil or groundwater. It is noted that although phthalates were not detected in the laboratory method blank associated with the sample, bis(2-ethylhexyl) phthalate is a common laboratory contaminant.
- Nitrate + Nitrite (as nitrogen): Within the upper hydrogeologic unit, concentrations exceeding MDEQ Human Health Standards ranged from 10,100 to 62,800 in monitoring wells CFMW-002, 003, 010, 012, 014, 015, 019, and 054.

As described in the BHHRA and BERA, if a constituent in groundwater exceeded the DEQ-7 Human Health Standard, it was already selected as a COC in the BHHRA because the maximum constituent concentration exceeded the BHHRA screening levels. In addition, the BHHRA evaluated the potential risks and hazards for potential potable use in accordance with both the USEPA and MDEQ screening levels.

4.4.6 Evaluation of Surface Water Relative to MDEQ Standards

As noted above in Section 4.1, the nature and extent of COCs discussion in prior sections of this RIR focused on the COCs that were determined via the risk assessment process to be risk-drivers at the Site. This discussion was not inclusive of all COCs in surface water that exceed MDEQ Circular DEQ-7 water quality standards. A statistical summary of the data for each COC in surface water which had a least one exceedance of MDEQ Circular DEQ-7 Human Health Numeric Water Quality Standards is provided below based upon the surface water quality data from all the surface water features present at the Site.

A statistical summary of the data for COCs with exceedances of MDEQ Circular DEQ-7 surface water standards for protection of human health is provided below. An evaluation of MDLs achieved related to the screening criteria was provided for all media in the Phase I and Phase II SC Data Summary Reports.

Surface Water Exceedances Compared to DEQ-7 Human Health Standards (Phase I and Phase II)												
Analyte	Fraction	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	No. Exceeding	% Exceeding	DEQ-7 Human Health Standards
Alkylated Benzo[a]anthracene	T	6	µg/L	<0.0028	0.071	0.021	0.003	3	50	2	33.3	0.012
Alkylated Benzo[a]pyrene	T	6	µg/L	<0.0024	0.041	0.011	-	2	33	2	33	0.0012
Alkylated Benzo[b]fluoranthene	T	6	µg/L	<0.0042	0.1	0.032	0.004	3	50	2	33.3	0.012
Alkylated Dibenz(a,h)anthracene	T	6	µg/L	<0.005	0.015	0.006	-	2	33	6	100	0.0012
Alkylated Indeno[1,2,3-cd]pyrene	T	6	µg/L	<0.0026	0.04	0.011	-	2	33	2	33.3	0.012
Fluoride	T	190	µg/L	<12	22400	677	136	173	91	2	1.05	4000
Fluoride	DI	23	µg/L	109	21500	1174	130	23	100	1	4.35	4000
Antimony	T	190	µg/L	<0.62	7.7	-	-	18	9.5	1	1	5.6
Antimony	D	125	µg/L	<0.62	7.2	-	-	1	0.8	1	1	5.6
Arsenic	T	190	µg/L	<0.64	18.5	0.77	-	38	20	1	1	10
Barium	T	190	µg/L	43.4	2710	160.9	104	190	100	2	1.05	1000
Cyanide, Free	T	120	µg/L	<1.5	140	8.697	1.55	64	53	34	28.3	4
Cyanide, Free	D	20	µg/L	<1.5	63.5	10.52	4.15	18	90	10	50	4
Cyanide, Total	T	194	µg/L	<2	630	31.63	-	67	35	58	30	4
Cyanide, Total	D	40	µg/L	<2	328	40.27	-	17	43	17	42.5	4
Lead	T	190	µg/L	<0.37	38.5	0.96	-	51	27	2	1	15
Mercury	T	190	µg/L	<0.12	0.26	-	-	2	1.1	190	100	0.05
Thallium	T	190	µg/L	<0.24	0.33	-	-	3	1.6	3	2	0.24
Benzo[a]anthracene	T	23	µg/L	<0.0028	3	-	-	3	13	23	100	0.012
Benzo[a]pyrene	T	23	µg/L	<0.0024	3.9	-	-	3	13	23	100	0.0012
Benzo[b]fluoranthene	T	23	µg/L	<0.0042	10	0.641	-	4	17	23	100	0.012
Benzo[k]fluoranthene	T	23	µg/L	<0.0075	0.46	-	-	1	4.3	1	4	0.12
Bis(2-ethylhexyl) phthalate	T	23	µg/L	<0.72	22	2.124	-	4	17	3	13	3.2
Chrysene	T	23	µg/L	<0.0043	7.6	-	-	3	13	1	4	1.2
Indeno[1,2,3-cd]pyrene	T	23	µg/L	<0.0026	3.1	-	-	2	8.7	23	100	0.012

The results of the comparison indicate that concentrations of total cyanide, free cyanide, fluoride, select metals, and SVOCs in surface water were detected above DEQ-7 Human Health Standards. The distribution of total cyanide, free cyanide, and fluoride at the Site is described above in Section 4.4 above. In addition, a description of the surface water results for cyanide and fluoride compared to DEQ-7 Human Health Standards, as well as USEPA standards, was also provided in Section 4.4.2 of the Phase II SC Data Summary Report. A discussion of metals and SVOCs exceedances of MDEQ Circular DEQ-7 Human Health Standards is provided below.

Total concentrations of antimony, arsenic, barium, lead, mercury, and thallium detected in surface water samples exceeded their respective DEQ-7 Human Health Standard. Exceedances of DEQ-7 Human Health Standards were most commonly observed in the North and South Percolation Ponds and Riparian Sampling Area. Details regarding specific metals are provided below.

- Antimony was detected at a concentration of 7.7 µg/L at CFSWP-024 (North-East Percolation Pond) during the Supplemental South Pond Assessment, which exceeded the DEQ-7 Human Health Standard of 5.6 µg/L.

- Arsenic was detected at a concentration of 18.5 µg/L at CFSWP-032 (Riparian Sampling Area) during the Supplemental South Pond Assessment, which exceeded the DEQ-7 Human Health Standard of 10 µg/L.
- Barium was detected at concentrations of 2,710 µg/L and 1,230 µg/L at CFSWP-020 and 032, respectively (South Percolation Pond and Riparian Sampling Area, respectively) during the Supplemental South Pond Assessment which exceeded the DEQ-7 Human Health Standard of 1,000 µg/L.
- Lead was detected at concentrations of 35.2 µg/L and 38.5 µg/L at CFSWP-020 and 032, respectively (South Percolation Pond and Riparian Sampling Area, respectively) during the Supplemental South Pond Assessment which exceeded the DEQ-7 Human Health Standard of 15 µg/L.
- Mercury was detected at concentrations of 0.26 µg/L and 0.19 µg/L at CFSWP-020 and 032, respectively (South Percolation Pond and Riparian Sampling Area, respectively) during the Supplemental South Pond Assessment which exceeded the DEQ-7 Human Health Standard of 0.05 µg/L.
- Thallium was detected at concentrations of 0.33 µg/L, 0.32 µg/L, and 0.27 µg/L at CFSWP-020, 032, and 024, respectively (South Percolation Pond, Riparian Sampling Area, North-East Percolation Pond, respectively) during the Supplemental South Pond Assessment which exceeded the DEQ-7 Human Health Standard of 0.24 µg/L.

Total concentrations of benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, indeno[1,2,3-cd]pyrene, and bis(2-ethylhexyl) phthalate, detected in surface water samples exceeded their respective DEQ-7 Human Health Standard. Details regarding specific SVOCs are provided below.

- Benzo[a]anthracene was detected at a concentration of 3 µg/L at CFSWP-024 (North-East Percolation Pond) during Phase I Round 4, and at concentrations of 0.63 µg/L, and 0.076 µg/L in CFSWP-026 (Backwater Seep Sampling Area) during the Supplemental South Pond Assessment and Phase II Round 2, respectively.
- Benzo[a]pyrene was detected at a concentration of 3.9 µg/L at CFSWP-024 (North-East Percolation Pond) during Phase I Round 4, a concentration of 0.25 µg/L at CFSWP-026 (Backwater Seep Sampling Area) during the Supplemental South Pond Assessment, and a concentration of 0.36 µg/L at CFSWP-020 (South Percolation Ponds) during the Supplemental South Pond Assessment.
- Benzo[b]fluoranthene was detected at a concentration of 10 µg/L at CFSWP-024 (North-East Percolation Pond) during Phase I Round 4, a concentration of 0.53 µg/L at CFSWP-020 (South Percolation Ponds) during the Supplemental South Pond Assessment, and concentrations of 0.7 µg/L and 0.12 µg/L in CFSWP-026 (Backwater Seep Sampling Area) during the Supplemental South Pond Assessment and Phase II Round 2, respectively.
- Benzo[k]fluoranthene was detected at a concentration of 0.46 µg/L at CFSWP-026 (Backwater Seep Sampling Area) during the Supplemental South Pond Assessment.
- Chrysene was detected at a concentration of 7.6 µg/L in CFSWP-024 (North-East Percolation Pond) during Phase I Round 4.
- Indeno[1,2,3-cd]pyrene was detected at a concentration of 3.1 µg/L in CFSWP-024 (North-East Percolation Pond) during Phase I Round 4, and at a concentration of 0.28 µg/L in CFSWP-020 (South Percolation Ponds) during the Supplemental South Pond Assessment.
- Bis(2-ethylhexyl) phthalate was detected at a concentration of 22 µg/L in CFSWP-035 (Flathead River) during Phase II Round 2, and concentrations of 8.6 µg/L and 4.6 µg/L in CFSWP-027 and CFSWP-028, respectively (Backwater Seep Sampling Area) during Phase II Round 2. As previously described, there is no known source of phthalates at the Site, and bis(2 ethylhexyl) phthalate has not been identified previously as a COPC in soil, groundwater, or surface water. It is noted that although

phthalates were not detected in the laboratory method blank associated with the sample, bis(2-ethylhexyl) phthalate is a common laboratory contaminant.

Surface Water Exceedances Compared to DEQ-7 Acute and Chronic Aquatic Life Standards (Phase I and Phase II)

Analyte	Fraction	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	No. Exceeding	% Exceeding	DEQ-7 Acute	No. Exceeding	% Exceeding	DEQ-7 Chronic
Aluminum	T	190	µg/L	<13.5	32000	715.6	51.85	162	85	25	13.2	750	79	41.6	87
Aluminum	D	125	µg/L	<15	4780	104.1	-	34	27	3	2	750	13	10	87
Cadmium*[18]	T	190	µg/L	<0.61	3	-	-	4	2.1	4	2.11	0.49	190	100	0.25
Cadmium	D	125	µg/L	<0.61	2.5	-	-	1	0.8	1	0.8	0.49	125	100	0.25
Copper*	T	190	µg/L	<1.9	183	4.232	-	74	39	38	20	3.79	45	23.7	2.85
Copper	D	125	µg/L	<1.4	33.4	-	-	13	10	5	4	3.79	8	6	2.85
Cyanide, Free	T	120	µg/L	<1.5	140	8.697	1.55	64	53	12	10	22	29	24.2	5.2
Cyanide, Free	D	20	µg/L	<1.5	63.5	10.52	4.15	18	90	3	15	22	9	45	5.2
Cyanide, Total	T	194	µg/L	<2	630	31.63	-	67	35	35	18	22	55	28.4	5.2
Cyanide, Total	D	40	µg/L	<2	328	40.27	-	17	43	13	32.5	22	17	42.5	5.2
Iron	T	190	µg/L	<42.4	52100	973.6	75.1	106	56	-	-	-	23	12.1	1000
Iron	D	125	µg/L	<42.4	10200	217.7	-	36	29	-	-	-	6	4.8	1000
Lead*	T	190	µg/L	<0.37	38.5	0.96	-	51	27	2	1	13.98	36	19	0.545
Lead	D	125	µg/L	<0.37	5.2	-	-	12	9.6	0	0	13.98	8	6	0.545
Nickel*	T	190	µg/L	<1.3	55.9	-	-	23	12	0	0	145	4	2	16.1
Nickel	D	125	µg/L	<1.3	32.2	-	-	11	8.8	0	0	145	2	1.6	16.1
Zinc*	T	190	µg/L	<5.4	537	10.32	-	33	17	6	3.16	37	6	3.16	37
Zinc	D	125	µg/L	<5.4	512	-	-	10	8	2	2	37	2	2	37

The results of the comparison indicate that concentrations of total cyanide, free cyanide, and select metals in surface water were detected above DEQ-7 Acute Aquatic Life Standards or DEQ-7 Chronic Aquatic Life Standards. A noted above, the distribution of cyanide at the Site is described above in Section 4.4.2.1 above, and also in Section 4.4.2 of the Phase II SC Data Summary Report. A discussion of metals exceedances of MDEQ Circular DEQ-7 Aquatic Life Standards is provided below.

Detected concentrations for dissolved aluminum exceeded the DEQ 7-Acute Aquatic Life Standard of 750 µg/L in three surface water samples and exceeded the DEQ-7 Chronic Aquatic Life Standard of 87 µg/L in 13 surface water samples. Detected concentrations for dissolved iron exceeded the DEQ 7-Chronic Aquatic Life Standard of 1,000 µg/L in six surface water samples. A description of these constituents in surface water compared to DEQ-7 Acute and Chronic Aquatic Life Standards, as well as USEPA standards, was provided in Section 4.4.2 of the Phase II SC Data Summary Report.

Hardness-specific DEQ-7 Acute and Chronic Aquatic Life Standards were generated for select metals, in accordance with MDEQ Circular DEQ-7. Hardness-specific criteria for metals including cadmium, copper, chromium, lead, nickel, silver, and lead were generated based on the sample specific calcium carbonate results. In accordance with the guidance, hardness-specific criteria were only generated for the unfiltered (total) results. The calculated DEQ-7 Acute and Chronic Aquatic Life Standards for these metals are provided in Tables 21 and 22. Comparisons of the surface water results for these select metals to the calculated

18 Unfiltered metals including cadmium, trivalent chromium, copper, lead, nickel, silver, and lead are compared to calculated DEQ-7 Acute and Chronic Aquatic Life Standards based on sample-specific hardness (calcium carbonate) results in accordance with MDEQ Circular-7 (June 2019).

hardness-specific DEQ-7 Acute and Chronic Aquatic Life Standards are provided in Table 23. For the purpose of this evaluation, total chromium results were compared to the trivalent chromium (Cr[III]) hardness-specific standards. A summary of the exceedances is provided below.

Only five samples exhibited concentrations of these metals above the hardness-specific DEQ-7 Acute and Chronic Aquatic Life Standards, as summarized below. Concentrations presented in bold exceeded their respective DEQ-7 Acute Aquatic Life Standards, and concentrations presented in shaded cells exceeded their respective DEQ-7 Chronic Aquatic Life Standards.

Sample Location	Sampling Round	Surface Water Feature	Cadmium	Copper	Lead	Nickel	Zinc
CFSWP-018	P2 R2	South Percolation Pond	0.61 U	**20.1**	4.7	3.6 J	37.4
CFSWP-019	P2 R2	South Percolation Pond	0.66 J	**19.6**	1.9	3.4 J	25.5
CFSWP-020	P2 R2	South Percolation Pond	0.61 U	**12.9**	2.4	3.9 J	12.1 J
CFSWP-024	P1 R4	North-East Percolation Pond	**3**	**16.5**	**7.6**	**55.9**	**537**
CFSWP-027	P2 R2	Backwater Seep Sampling Area	0.61 U	**10.2**	0.37 U	1.3 U	5.4 U

The results of the comparison indicate that unfiltered concentrations of cadmium, copper, and zinc in surface water were detected above their respective hardness-specific DEQ-7 Chronic Aquatic Life Standards. All exceedances for unfiltered metals compared to their respective hardness-specific DEQ-7 Chronic Aquatic Life Standards occurred in one surface water sample, CFSWP-024, located in the North-East Percolation Pond.

The results of the comparison indicate that unfiltered concentrations of cadmium, copper, lead, nickel, and zinc in surface water were detected above their respective hardness-specific DEQ-7 Acute Aquatic Life Standards. Exceedances of for unfiltered metals compared to their respective hardness-specific DEQ-7 Chronic Aquatic Life Standards occurred in the South Percolation Ponds, North-East Percolation Pond, and Backwater Seep Sampling Area.

5. Sources of COCs in Site Media

This section describes the sources and source areas for COCs in soil, groundwater, surface water, sediment, and sediment porewater.

The preliminary CSM presented in the RI/FS Work Plan (Roux, 2015a) and the Phase I SC Data Summary Report identified the following Site features as potential source areas:

- Main Plant Area;
- Landfills;
- Percolation Ponds; and
- Former Drum Storage Area.

A discussion of the RI results relative to each of the above areas is provided below. It should be noted that the following discussions are based on six rounds of sampling which cover a range of temporal and seasonal variability over three years, which provides a representative dataset for the RI.

As described in Section 4.3, the risk assessments indicate that only a subset of COCs contribute to risk estimates that exceed *de minimis* levels for potential human health risk (i.e., excess lifetime cancer risk of 1E-6 for carcinogens; or hazard quotient of 1 for non-carcinogens) or pose moderate risk from the ecological perspective[19]. In addition, although cyanide and fluoride are not risk drivers with respect to soil, both of these COCs were retained for in-depth evaluation due to their prevalence in groundwater and surface water. A summary of these COCs as they relate to the abovementioned source areas is presented below.

Source Area	BERA COCs Contributing to Risk		BHHRA COCs Contributing to Risk
	Soil	Sediment/ Porewater	Soil
Main Plant Area	LMW PAHs HMW PAHS		Arsenic Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene
Central Landfill Area and Former Drum Storage Area	Copper Nickel LMW PAHs HMW PAHs Aroclor 1254		Arsenic Benzo(a)pyrene
Operational Area	Copper		Arsenic

19 BERA Soil COC selection criteria:
Med-Large Home Range Wildlife: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Small Home Range Wildlife: Sample points exceeding LOAEL-based back calculated value;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance);
ISM samples: localized exceedance was not justification for removal based on averaged EPC across DU;
PAH direct contact exposure selected based on exposure areas with points exceeding MATC.
BERA Sediment/Porewater selection criteria:
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance).

Source Area	BERA COCs Contributing to Risk		BHHRA COCs Contributing to Risk
	Soil	Sediment/ Porewater	Soil
	Selenium Zinc LMW PAHs HMW PAHs Aroclor 1254		Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-c,d)pyrene Manganese
North Percolation Ponds	Barium Nickel Selenium Thallium Vanadium LMW PAHs HMW PAHs	Barium Cadmium Lead Nickel Selenium Vanadium Zinc Total Cyanide LMW PAHs HMW PAHs	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-c,d)pyrene
South Percolation Ponds	Barium	Barium Copper	

The potential routes for migration of COCs from source areas are summarized in Section 6.1 as a basis for the detailed evaluation of chemical fate and transport of COCs at the Site.

5.1 Main Plant Area

The Main Plant Area is where manufacturing historically took place at the Site. This area includes the former Main Plant Building (i.e., former potline buildings), the former Paste Plant building, various areas where waste and raw materials were stored and handled during historical Site operations, the plant drainage system, and various underground/aboveground storage tanks located on the north side of the Main Plant. During historical operations, solid waste streams generated in the Main Plant Area were directed to various landfills located north of the Main Plant Area, as further described below in Section 5.2. Likewise, aqueous waste streams were directed to the various percolation ponds as described below in Section 5.3. Although the various waste streams from Site operations were disposed in the landfills and percolation ponds, releases of raw materials or wastes from the features referenced above resulted in impacts to soils throughout the Main Plant Area. In addition, historical plant emissions containing PAHs and fluoride have been identified as a historical source of contamination within the Main Plant Area and other areas of the Site.

With the cessation of manufacturing activities and subsequent demolition of the Main Plant, all raw materials and wastes within the Main Plant Area have been removed down to grade. As a result, there are no ongoing operations or above grade features that are current sources of contamination within the Main Plant Area. It is noted that storm drains from the Main Plant Area still discharge to the North and South Percolation Ponds. MPDES monitoring data prior to termination of the permit (effective April 17, 2019) suggest that these drains may be ongoing sources of fluoride and aluminum to these areas.

The findings from the RI indicate that concentrations of PAHs, cyanide, and fluoride are the primary COCs present in soil throughout the Main Plant Area based upon the frequency and magnitude of exceedances of screening levels. At most locations throughout the Main Plant Area, cyanide and fluoride concentrations in soil exceed the USEPA Protection of Groundwater RBSSLs; however, as described in the Phase I and Phase II SC Data Summary Reports, these concentrations in soil do not appear to be a significant source of cyanide and fluoride in groundwater. The concentrations of cyanide and fluoride in groundwater within and downgradient (south) of the Main Plant Area are less than those measured in wells upgradient (north) of the Main Plant Area near the landfills. While there are some fluctuations in cyanide and fluoride groundwater concentrations within the Main Plant Area, the general decrease in concentrations as groundwater flows beneath the Main Plant Area suggests that the Main Plant Area soils are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the soils were a significant source, an increase in cyanide and fluoride concentrations would be expected).

Concentrations of cyanide and fluoride were below USEPA Industrial RSLs and Residential RSLs at all locations with the exception of two locations: cyanide was present above the USEPA Residential RSL of 2.3 mg/kg in soil boring CFSB-131, beneath the former cathode soaking pit located slightly inside the northern extent of the Main Plant building; and, fluoride was detected in soil boring CFSB-066 on the east side of the Main Plant at a concentration exceeding the USEPA Residential RSL of 310 mg/kg. As described in Section 4.3, cyanide and fluoride in soil do not contribute to risk exceeding *de minimis* levels across the Main Plant Area.

Concentrations of PAHs exceed USEPA Industrial RSLs and Protection of Groundwater RBSSLs in surface soil and shallow soil across the majority of the Main Plant Area (including the materials handling areas and all sampled drainage structures) and across the Operational Area. The widespread distribution of PAHs is attributed to the extensive handling and storage of PAH containing materials, such as petroleum coke and pitch, that were key components of the manufacturing process; as well as the aerial deposition of PAHs from historical plant emissions. The PAH concentrations decreased with depth, but still exceeded USEPA Residential RSLs and USEPA Protection of Groundwater RBSSLs in samples from the 10-17 ft-bls depth interval at the majority of locations to the north, east, and south of the Main Plant. Despite the widespread occurrence of PAHs in soil across the area and the exceedances of various screening criteria, PAHs are generally non-detect in groundwater in all sampling rounds. As described below in Section 6.3, the findings indicate that the PAHs are bound to the soils and not leaching to groundwater.

5.2 Landfills

The landfills were identified as potential sources within the preliminary CSM in the RI/FS Work Plan (Roux, 2015a) due to their historical use as disposal locations for various facility waste streams. Landfills operated at the Site from 1955 to 2009 and were utilized for disposal of a variety of wastes, including SPL from 1955 to 1990. The table below describes the years of operation and types of wastes reportedly disposed of at each landfill over time (CFAC, 2013; E&E, 1988; RMT, Inc., 1997). The location and boundaries of each landfill are shown on Figure 2. Additional discussion of each landfill is provided in Section 6.2.3 and Table 1.

5.2.1 West Landfill, Wet Scrubber Sludge Pond, and Center Landfill

The Phase I SC Data Summary Report and GW/SW Data Summary Report identified that the highest concentrations of cyanide and fluoride in groundwater were observed adjacent to, and/or downgradient of, the West Landfill and the Wet Scrubber Sludge Pond. These data indicated that these Site features are the primary source of the elevated cyanide and fluoride concentrations in groundwater, which would be consistent with the historical use of these features as disposal locations for wastes containing cyanide and fluoride (i.e., cyanide in SPL disposed in the West Landfill; and fluoride within the calcium fluoride sludge disposed in Wet Scrubber Sludge Pond), as well as with current understanding that both landfills are unlined.

As noted in the RI/FS Work Plan, historical aerial photographs indicate that the West Landfill appeared to begin operations later than the 1955 date described in several prior reports (CFAC 2013, Weston, 2014, RMT, 1997). Minimal disturbance, and only along the southern boundary of the West Landfill, was observed in the 1956 and 1963 aerial photographs; while the majority of the West Landfill appeared to be in use by the time of the 1974 aerial photograph (included as Appendix F). Therefore, based on the historical aerial indicate that use of the West Landfill for SPL disposal commenced between 1963 and 1970s.

The West Landfill was used to dispose of SPL and other wastes (sanitary, industrial, and reportedly solvents) through 1981, though SPL disposal reportedly ended in 1970 (CFAC, 2013). The landfill was closed in 1981 and capped with a synthetic (hypalon) cap in 1994 (CFAC, 2013). The landfill reportedly is unlined, extends approximately 35 feet below surrounding grade (CFAC, 2013), and rises approximately 13 feet above grade on the eastern side of the landfill, and over 30 feet above grade from the western side. As determined from the ER/IP geophysical survey conducted during the Phase I SC, an area of low resistivity was identified to approximately 115 feet below the top of the West Landfill. The interpretation of these results suggested the depth of the waste material or impacted soil and groundwater underlying the West Landfill could be as thick as 115 feet; though it should be noted that these types of geophysical surveys are indirect measurements and subject to various interferences. The as-built drawings for the West Landfill cap (Appendix G1), completed in 1994, indicate an average thickness of the waste within the landfill is 30 feet, which is consistent with the approximate reported waste thicknesses.

The Wet Scrubber Sludge Pond reportedly received waste material from the wet scrubbers at the aluminum reduction plant from 1955 until 1980, at which time the wet scrubbers for the aluminum reduction plant were replaced with dry scrubbers which produce much less waste (RMT, 1997). Studies of scrubber sludge indicated that the sludge is 80% calcium fluoride (CaF_2) on a dry weight basis, with small amounts of calcium oxide (CaO), magnesium oxide (MgO), sodium oxide (Na_2O), and iron oxide (Fe_2O_3). The West Scrubber Sludge Pond was subsequently capped with an earthen cap in 1981 and vegetated. Review of aerial photographs indicate that the Wet Scrubber Sludge Pond more closely resembled a landfilling operation in the 1955 to 1963 photographs; with the pond feature not being present until the 1974 photograph.

As discussed in Section 3.2.2, Plate 18 and Plate 19 show contours of cyanide and fluoride concentrations, respectively, in groundwater based on the six rounds of sampling. The iso-concentration maps indicate that highest cyanide and fluoride concentrations in groundwater appear to originate adjacent to and downgradient of the Wet Scrubber Sludge Pond and the West Landfill consistently during all six rounds of sampling. Adjacent to the West Landfill and Wet Scrubber Sludge Pond, groundwater elevations in the upper hydrogeologic unit can fluctuate more than 70 feet seasonally. Groundwater levels manually measured in adjacent monitoring wells indicate that during high-water season, groundwater is observed to have a minimum depth to water of approximately 36 ft-bls; groundwater levels in CFMW-007, continuously monitored with a pressure transducer adjacent to the West Landfill, indicate a minimum depth to water of 35.5 ft-bls. During low-water season, maximum groundwater depth is observed to be approximately 105 ft-bls.

Based upon review of iso-concentration contour maps in Plate 18 and Plate 19, the West Landfill and Wet Scrubber Sludge Pond are the primary sources of cyanide and fluoride in groundwater at the Site. This finding is also supported by contaminant flux calculations as discussed in the fate and transport section

(Section 6). As noted above, although the Wet Scrubber Sludge Pond was not reportedly used for disposal of SPL, it appears to have been the only operating landfill at the Site from 1955 until sometime between 1963 and 1974. Since the Wet Scrubber Sludge Pond was closed in 1981 by capping within an earthen cover, infiltration of precipitation through the cap and the underlying wastes may still be ongoing.

Groundwater samples collected during the RI from monitoring well CFMW-017, located at the Center Landfill, indicate that concentrations of cyanide and fluoride are elevated in groundwater at this well location as compared to the surrounding wells. The elevated concentrations indicate that the Center Landfill (also referred to as the Carbon Mound) is likely a secondary source area for the observed elevated cyanide and fluoride concentrations in groundwater, which is consistent with the historical use of this feature as a disposal location for SPL in the 1970s. The Center Landfill was reportedly built-up from grade without a liner beneath it. The Center Landfill was reportedly closed in 1981 by capping. An undated, untitled drawing indicates the cap consisted of a minimum 6-inch clay seal covered by a minimum of 18-inches of till.

Soil quality around the West Landfill, Wet Scrubber Sludge Pond, and Center Landfill were evaluated during the RI to evaluate if these landfills are a source of COCs in soil around the landfills. The soil boring locations were typically within the boundaries of the Site feature being investigated and along the perimeter of features to assess for impacts to the adjacent areas (i.e., not samples collected from landfill caps or within landfills). The concentrations of COCs in soil adjacent to the landfills were generally similar to or less than those observed in the other industrial areas of the Site (with the exception of the Former Drum Storage Area discussed in Section 5.4 below). At most locations adjacent to landfills throughout the Central Landfill Area, cyanide and fluoride concentrations in soil exceed the USEPA Protection of Groundwater RBSSLs at concentrations similar to those observed across the Main Plant Area. However, as discussed in Section 5.2, these concentrations of cyanide and fluoride in soil do not appear to be a significant source of the cyanide and fluoride in groundwater which is attributable to the landfills. The Phase I SC Data Summary Report stated, "based upon similarity of concentrations to other Site areas and the presence of established vegetative covers across the landfills, it does not appear that the landfills in their current state are the source of the COCs detected in soil." Instead, the soils around the landfills have likely been impacted by the historical waste handling practices.

5.2.2 East Landfill and Sanitary Landfill

As noted in Section 1.3.4.1, the East Landfill was constructed above ground level (30 feet above the surrounding grade; CFAC, 2013) and was reportedly built with a clay liner and capped with a 6-inch thick clay layer, a synthetic cap, and an 18-inch vegetated till cover. The landfill was also built with two lined leachate collection ponds. The landfill was operated from 1980 to 1990 for disposal of SPL (CFAC, 2013) and closed in 1990. Design drawings from 1990 are provided in Appendix G2.

The Sanitary Landfill is reportedly clay lined and was used for disposal of plant garbage (RMT, 1997). Some sources report solvents and hazardous waste were also buried in the landfill (E&E, 1988)

The results of the RI indicated that the East Landfill and Sanitary Landfill are not contributing sources to the cyanide and fluoride in groundwater. As shown in Plate 18 and Plate 19, the cyanide and fluoride concentrations in groundwater to the east and north-east of the West Landfill and Wet Scrubber Sludge Pond, and immediately downgradient of former East Landfill (and its associated leachate ponds) and Sanitary Landfill, are generally orders of magnitude lower than those described above. The maximum cyanide and fluoride concentrations in groundwater immediately downgradient of the East Landfill were 203 µg/L and 736 µg/L, respectively, both in monitoring well CFMW-023. The maximum cyanide and fluoride concentrations immediately downgradient of the Sanitary Landfill were 2.8 µg/L in monitoring well CFMW-008a (estimated concentration) and 777 µg/L in monitoring well CFMW-008, respectively. The concentrations of cyanide and fluoride in these wells are orders of magnitude less than the concentrations observed immediately downgradient of the West Landfill and Wet Scrubber Sludge Pond, where cyanide concentrations ranged from 2,060 µg/L to 11,500 µg/L and fluoride concentrations ranged from 4,110 µg/L to 55,300 µg/L.

These findings are consistent with the construction and historical uses of these landfills (proper lining and capping of the East Landfill preventing cyanide and fluoride leaching to groundwater; and disposal of plant garbage in Sanitary Landfill with lack of corresponding COCs identified in groundwater).

5.2.3 Industrial Landfill

As discussed in Section 1.3.4.1, the Industrial Landfill received non-hazardous waste and debris (CFAC, 2013). Details regarding the depth of landfilled material or presence of a liner are unknown. The Industrial Landfill is not yet capped; thus, the higher concentrations of PAHs within the surface and shallow soil samples are likely reflective of the waste materials within the landfill. PAHs were detected at low concentrations (ranging from 0.2 to 0.6 µg/L) in groundwater adjacent to the Industrial Landfill (CFMW-067). Thus, PAH detections in groundwater may potentially be attributable to the landfill.

The maximum cyanide concentration in upper hydrogeologic unit groundwater immediately downgradient of this feature was 19.1 µg/L in monitoring well CFMW-003. The maximum fluoride concentration was 1,420 µg/L in monitoring well CFMW-066 (below the DEQ-7 Human Health Standard/USEPA MCL of 4,000 µg/L). The results of the RI indicated that Industrial Landfill is not a significant contributing source to the cyanide and fluoride in groundwater.

5.2.4 Asbestos Landfills

The Asbestos Landfills were constructed as early as the late 1970s or early 1980s (CFAC, 2003). Disposal records for the northern asbestos landfill indicate that the landfill was in use from 1993 to 2009 (CFAC, 2009). The results of the RI indicated that soil was non-detect for asbestos in surficial samples collected from the Asbestos Landfills. Based on the lack of asbestos in the surface soil, and the current and future use of the Site, there is no potential for exposure to asbestos by human receptor activity in the Asbestos Landfills. This finding is based only on the surficial sampling of soils. Disturbance of asbestos-containing subsurface soils, if present, may expose receptors to asbestos. In addition, subsurface asbestos-containing building material, if present, may have a tendency to rise in the soil column due to uplift of soil and materials in the soil due to annual freezing and thawing cycles, which may then expose receptors to asbestos.

5.3 Percolation Ponds

The percolation ponds were identified as potential sources within the preliminary CSM in the RI/FS Work Plan (Roux, 2015a) due to their use as wastewater discharge locations and based upon the prior sampling conducted during the USEPA Site Reassessment in 2013 (Weston, 2014).

The North-East Percolation Pond was constructed in 1955. The North-East Percolation Pond is currently operational and a discharge point for stormwater drainage. As described below, this percolation pond received discharges from various operations within the Main Plant area until manufacturing ceased in 2009.

Based on the review of aerial photography, the North-West Percolation Pond appears to be in the process of being constructed by 1972. The North-West Percolation Pond was constructed to receive overflow water from the North-East Percolation Pond. The two ponds are connected by an approximately 1,440-foot-long unlined ditch. While the North Percolation Ponds typically contained water on a continuous basis during historical manufacturing due to continuous discharge of process water, currently and in the absence of operational discharge, the ponds are typically dry with the exception of during the spring thaw period and immediately following precipitation events.

Based on review of historical aerials, the South Percolation Ponds were constructed in the early 1960s. Prior to construction, a channel of the Flathead River flowed east to west throughout the extent of the eastern most pond to the Backwater Seep Sampling Area. The ponds were constructed by filling the channel and installing a dam to obstruct surface water flow. During historical operations, the South Percolation Ponds received process water through an influent ditch located to the west of the three South Percolation Ponds. The South Percolation Ponds received water from the sewage treatment plant, the aluminum casting contact chilling water, non-contact cooling water from the rectifier and other equipment, process wastewater from the casting mold cleaning and steam cleaning, non-process wastewater from the fabrication shop steam cleaning, and stormwater (2014 Draft MPDES Permit Fact Sheet).

A summary of the percolation ponds as sources are described below.

5.3.1 North Percolation Ponds

The results of the Phase I SC indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of cyanide and PAHs in the soil and sediment, followed by the effluent ditch, and the North-West Percolation Pond. The high concentrations of cyanide and PAHs in sediment correspond to a surficial layer of highly viscous to solid black carbonaceous material that exists across the majority of the North-East Percolation Pond, and intermittently across the ditches and North-West Percolation Pond. Based upon soil borings, the maximum thickness of this carbonaceous material is 0.5 ft. Soil samples collected around the perimeter of the ponds confirms the impacts are confined to within the footprint of the ponds and the ditch.

Additional soil sampling completed as part of the Phase II SC confirmed that the highest concentrations of cyanide and PAHs in soil are located in the North Percolation Ponds. Concentrations of cyanide decrease with increasing depth beneath the ponds, such that there are no exceedances of the USEPA Residential RSLs in the 10-17 ft-bls depth interval; however, there are detections of cyanide and thus exceedances of the USEPA Protection of Groundwater RBSSLs. Beneath the North-East Percolation Pond and ditches there are PAHs exceeding the USEPA Industrial RSLs at the 10-17 ft-bls depth interval.

The North Percolation Ponds are located hydraulically downgradient of the West Landfill and Wet Scrubber Sludge Pond source area described above. As shown in Plate 18 and Plate 19, the concentrations of cyanide and fluoride in groundwater downgradient (south) of the North Percolation Ponds are less than those measured in wells upgradient of the ponds. This continued decrease in concentrations as groundwater flows beneath the ponds suggests that the ponds are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the ponds were a significant source, an increase in cyanide and fluoride concentrations would be expected). Additionally, although SVOCs (i.e., common coal tar pitch and petroleum coke constituents) were detected frequently in the North Percolation Pond soil at concentrations exceeding the USEPA Protection of Groundwater RBSSLs, they were not detected in any groundwater monitoring wells immediately downgradient from the North Percolation Ponds (i.e., CFMW-025b, CFMW-26, and CFMW-028).

SVOCs (primarily PAHs) were detected in the surface water sample from the North-East Percolation Pond, at concentrations exceeding the DEQ-7 Human Health Standards and Minimum ESVs. Based on Site reconnaissance and observations during drilling (black, coal tar pitch soil/sediment), and based on the elevated levels of PAHs observed in soil samples, it's likely that the soils/sediments within the North Percolation Pond are the source of the COCs in the surface water from the pond. It should be noted that the North-East and North-West Percolation Ponds were dry during Phase II Rounds 1 and 2 sampling events (high-water and low-water sampling events, respectively), and therefore, additional Phase II surface water, sediment, and sediment porewater samples were not collected.

5.3.2 South Percolation Ponds

In the South Percolation Ponds, COCs similar to those in the North Percolation Ponds were detected; however, the concentrations were in general lower than those observed in the North Percolation Ponds. Concentrations of COCs in surface water (primarily cyanide and fluoride) were generally higher during the low-water sampling events (Supplemental South Pond Assessment and Phase II Round 2), with maximum concentrations in the middle pond (CFSWP-019). The results of the RI indicate that the South Percolation Ponds are not a source of contamination at the Site, but as discussed below in Section 3.2.4, groundwater seepage and the migration of water from South Percolation Ponds could potentially impact surface water, sediment, sediment porewater within the Flathead River.

5.4 Former Drum Storage Area

Based on elevated detections of cyanide and fluoride in soil in both discrete soil borings and in ISM samples, the Phase I SC Data Summary Report identified the Former Drum Storage Area as a Site feature which may be a contributing source to the elevated cyanide and fluoride concentrations in groundwater that appear to originate beneath this area and the West Landfill and Wet Scrubber Sludge Pond. Three additional soil borings were advanced in the Former Drum Storage Area as part of the Phase II SC to refine the understanding of COCs in soil within and around this Site feature. Cyanide and fluoride were detected at concentrations exceeding the USEPA Residential and Industrial RSLs in surface and shallow samples from two of the three borings. Concentrations of cyanide and fluoride decrease by an order of magnitude with increasing depth. The above findings confirm that the Former Drum Storage Area could potentially be a source area. However, the decrease in concentrations with depth and the absence of any observed waste materials suggest that any contribution from this area to groundwater contamination is much less than the contribution from the adjacent landfills.

6. Contaminant Fate and Transport

An evaluation of the fate and transport of COCs at the Site is provided below based upon knowledge of the Site physical characteristics, the concentrations and extent of COCs in various media, and source area characteristics as described above in Sections 3, 4, and 5, respectively. In addition, the evaluation considers the physicochemical characteristics of the COCs and various physical, chemical, and biological processes that influence contaminant fate and transport. The results of the fate and transport evaluation provide important data and insights that will be used in the analysis of remedial alternatives during the FS.

This fate and transport analysis focuses on contaminants that were identified as primary COCs through the risk assessment process, as described in Section 4.3.

6.1 Migration of COCs from Source Areas

The results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective. All other primary COCs identified in soil, sediment, or surface water samples within the source areas appear to be stable and not migrating at levels of concern based upon risk assessment results.

The six rounds of groundwater sampling conducted during the RI indicate that the West Landfill and Wet Scrubber Sludge Pond appear to be the primary sources of the cyanide and fluoride in groundwater. The Center Landfill and Former Drum Storage Area appear to be potentially contributing sources, but to a lesser degree than the West Landfill and Wet Scrubber Sludge Pond. The Northern Percolation Ponds and Main Plant Area do not appear to be potential source areas; to the extent there is any contribution from these areas it is negligible relative to the aforementioned source areas.

A consistent pattern was observed during all six rounds of groundwater sampling; cyanide migrates in a south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the contours shown on Plate 18 and Plate 19 are less than one-half of the USEPA MCL in all six rounds of sampling. Cyanide concentrations are typically non-detect in the north, west, and south-west portions of the Site (e.g., near Aluminum City) during all rounds of sampling.

It should be noted that the average concentrations of fluoride reported for public water and community water supply wells in the in the Flathead Valley is estimated to be approximately 160 µg/L (Roux, 2019). Within the western and northern portions of the Site, the detections of fluoride in groundwater are similar to the average 160 µg/L concentration measured in public and community water supply wells.

As part of the RI, groundwater samples were collected in monitoring wells screened in the upper hydrogeologic unit and below upper hydrogeologic unit. Total cyanide was detected frequently in upper hydrogeologic monitoring wells. Detected concentrations of free cyanide were less than detected concentrations of total cyanide in all upper hydrogeologic unit groundwater samples, and on average comprised less than 8% of the total cyanide. In groundwater samples below upper hydrogeologic unit, total cyanide was generally non-detect.

These data, as well as the six rounds of groundwater flow data, indicate that cyanide and fluoride are not migrating in the direction towards Aluminum City, but rather follows the southerly groundwater flow patterns towards the Flathead River (Plate 18 and Plate 19).

During all six rounds of sampling, the total cyanide and fluoride concentrations in groundwater decrease with depth within the upper hydrogeologic unit. These findings indicate there is limited vertical migration and that the cyanide and fluoride are primarily migrating horizontally within the upper hydrogeologic unit. These findings are consistent with observed hydrogeologic conditions described in Section 3.2.2.2, which indicate that there is only limited, if any, hydraulic connectivity between the upper hydrogeologic unit and the water bearing zones screened in the underlying glacial till.

The cyanide and fluoride contour maps were also utilized to evaluate groundwater quality conditions upgradient and downgradient of the Main Plant Area and the North Percolation Ponds. These data indicate variable concentrations of cyanide downgradient of the West Landfill/Wet Scrubber Sludge Pond in the area located around the North-East Percolation Pond and to the west of the Main Plant buildings. Immediately south and south-west of the North-East Percolation Pond, an area of lower cyanide concentrations is typically observed. The lower concentrations may be attributable to increased recharge to the upper hydrogeologic unit in this area; as storm water from the concrete covered Main Plant Area is directed into the North-East Percolation Pond. The size of the lower concentration area varies from round to round, but appears largest (as delineated by the closed 300 µg/L contour) in the October 2018 sampling event.

Similar to cyanide, the highest concentrations of fluoride were primarily located downgradient of the West Landfill/Wet Scrubber Sludge Pond during all rounds of sampling. The highest detection of fluoride was observed in monitoring well CFMW-015 (located on the western boundary of the Wet Scrubber Sludge Pond and downgradient of the West Landfill). Fluoride concentrations are also elevated north of the Main Plant Area, but decrease with increasing distance away from the West Landfill and Wet Scrubber Sludge Pond.

The hydrogeologic studies (i.e., groundwater elevation data and surface water elevation data) indicate that groundwater discharges to the Flathead River. As shown in Plate 18 and Plate 19, impacted groundwater in the upper hydrogeologic unit appears to generally migrate southward from the source areas, and flow towards the Flathead River. Cyanide concentrations above 200 µg/L (above the USEPA MCL) and fluoride concentrations above 1,000 µg/L extend as far south as the Flathead River during all six rounds. These concentrations of cyanide and fluoride in groundwater are consistent with observed concentrations of cyanide in surface water from the Backwater Seep Sampling Area and Riparian Sampling Area (and to a lesser extent, the South Percolation Ponds). The Backwater Seep Sampling Area, the Riparian Sampling Area, and the South Percolation Pond Area are all located within the extent of the “Seep Area” that was historically a permitted discharge under the Site MPDES Permit (#MT00300066). The “Seep Area” was defined in the permit as the area which has potential to receive groundwater expressed from the upper hydrogeologic unit to the Flathead River. Historically, groundwater in the Backwater Seep Sampling Area has consistently been observed to discharge from the banks and has been sampled as part of the requirements for the Site MPDES Permit (#MT00300066). The Site MPDES Permit was terminated effective April 17, 2019 due to the permanent plant closure and the elimination of discharges controlled by the permit.

Elevated concentrations of cyanide in sediment and sediment porewater are present in the Backwater Seep Sampling Area and Riparian Sampling Area. Elevated concentrations of fluoride in sediment porewater are present in the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; though fluoride was not detected at elevated concentrations in sediment in these features. These concentrations, along with the groundwater flow and quality data described above, indicate the groundwater is the primary source of the cyanide and fluoride concentrations in surface water, sediment, and sediment porewater measured in these areas. Groundwater from the upper hydrogeologic unit is expressed to the sediment porewater and surface water located within the extent of the "Seep Area." Concentrations of cyanide in surface water, sediment, and sediment porewater up-river in the Flathead River were typically non-detect, further supporting that groundwater discharge is the primary source of the cyanide in the sediment and surface water of the Backwater Seep Sampling Area and Riparian Sampling Area. Similarly, concentrations of fluoride in sediment and sediment porewater within the main stem of the Flathead River were typically non-detect, and were present at low concentrations (below USEPA MCL/MDEQ Human Health Standard of 4,000 µg/L) in surface water. In addition, historical direct discharges into the South Percolation Ponds could have contributed to surface water and sediment impacts in this area.

The preliminary CSM in RI/FS Work Plan (Roux, 2015a) indicated that the groundwater seepage and the migration of water from South Percolation Ponds could potentially impact surface water, sediment, and sediment porewater within the Flathead River. The water level in the South Percolation Ponds has been observed to correlate closely with surface water elevations in the Flathead River; indicating a hydraulic connection between the two water bodies and corresponding potential for impacted surface water within the South Percolation Ponds to migrate to the river. Despite this potential, all surface water, sediment, and sediment porewater samples collected within the main stem of the Flathead River downgradient of the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds during all six rounds of sampling were non-detect for total cyanide, with the exception of one surface water sample collected in Phase I Round 1. Fluoride was generally detected in surface water samples collected within the main stem of the Flathead River downgradient of these areas, but at low-level concentrations below screening levels; fluoride was typically not detected in sediment or sediment porewater samples. The Phase II SC confirmed the Phase I SC findings that the elevated levels of cyanide and fluoride found in groundwater and in the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Pond are not measurably impacting surface water, sediment, or sediment porewater quality within the main channel of the Flathead River.

6.2 Characteristics of COC Groups Driving Risk at the Site

The following sections discuss the characteristics of COC groups driving risk at the Site.

6.2.1 Cyanide

Cyanide is a general term that is used to refer to several compounds that contain a carbon-nitrogen functional group where the two atoms are bound together with a triple bond. Cyanide occurs in multiple forms in the environment. In water, cyanide can occur in strong and weak metal-cyanide complexes, as cyanate or thiocyanate, organocyanides, or as free cyanide. In solid phases, cyanides can occur in simple metal cyanide solids, complexes with alkali earth metals, or in complexes with other metals (Jaszczak et al., 2017).

The occurrence and distribution of cyanide at industrial sites and mines has been well studied, most notably by Dzombak et al. (2005). Dzombak has found at aluminum smelter sites that strong iron-cyanide complexes (ferro- and ferricyanide) are the dominant species due to their abundance in the source material (i.e., SPL) as well as due to the abundance of iron that can complex with cyanide. Only 10% or less of the cyanide at smelter sites was found to exist as weak metal-cyanide complexes (e.g., sodium-cyanide) or as free cyanide. At the Site, the observed concentrations of free cyanide on average constitute approximately 8% of the total cyanide present in groundwater which is consistent with that reported by Dzombak.

In general, several studies have shown that iron-cyanide complexes and free cyanide are mobile in groundwater under neutral to alkaline conditions, and in soils with low clay content (such as the soils that comprise the upper hydrogeologic unit beneath the Site). Groundwater in the vicinity of the landfills has been observed to be slightly to highly alkaline, with several wells exhibiting pH greater than 9. Thus, the mobility of cyanide observed at the Site is consistent with the Site-specific geochemical conditions. Acidic pH less than 5, the presence of iron and aluminum oxides, and clay material tend to increase adsorption of metal-cyanide complexes (Dzombak et. al, 2005).

A discussion of the physicochemical processes affecting the fate and transport of cyanide is provided in Section 6.3.

6.2.2 Fluoride

Fluoride is naturally abundant in soils and contained in the minerals apatite ($Ca_5[PO_4]_3F$), fluorite (CaF_2), and cryolite (Na_3AlF_6), as well as micaceous clay materials. Potassium fluoride (KF) and sodium fluoride (NaF) are soluble salts that contain fluoride. Similarly, fluoride is often naturally present in groundwater due to the presence of soil and rocks rich in fluoride. As a result, research has identified water with high concentrations of naturally occurring fluoride is often found near the foot of mountains (Yadav et. al, 2018). As noted in Section 2.12, fluoride, not attributable to any anthropogenic source, is ubiquitous throughout the Flathead Valley water supply wells at an average concentration of 160 µg/L (Roux, 2019).

Na_3AlF_6 and NaF are common feedstocks for aluminum smelters and, as a result, fluoride accumulates within waste materials generated from the smelting process. Studies of wet scrubber sludge indicated that the sludge is 80% calcium fluoride (CaF_2) on a dry weight basis. In addition, one study documented that fluoride comprised between 5 and 11% of SPL by weight (Silveira et. al., 2002).

Fluoride minerals and salts have a wide range of solubilities in water. Calcium fluoride, cryolite, and sodium fluoride have reported solubilities of 16 mg/L, 420 mg/L, and 40,000 mg/L, respectively (Yadav et. al, 2018). These solubilities and the high fluoride content within the SPL and scrubber sludge help to explain why the West Landfill and Wet Scrubber Sludge Pond Landfill are the primary source of fluoride in groundwater at the Site.

A discussion of the physicochemical processes affecting the fate and transport of fluoride is provided in Section 6.3.

6.2.3 PAHs

PAHs are a group of hydrophobic, organic compounds that contain at least two condensed aromatic ring structures. When a PAH has three or less condensed aromatic rings, it is considered a low molecular weight PAH (LMW PAH). When it has four or more aromatic rings, it is considered a high molecular weight PAH (HMW PAH;USEPA, 2007a). During the production of aluminum using the Hall-Héroult process, carbon anodes and cathodes are used to conduct electricity through the alumina to produce molten aluminum. The coal tar pitch and coke used to create carbon anodes and cathodes contain multiple PAH compounds.

Most PAHs do not dissolve in water but, instead, bind to sediment and soil particles. When sediments become suspended in water, PAHs can be transported with the sediment.

PAHs are mainly adsorbed due to their hydrophobicity especially to the soil organic matter (Karickhoff et. al., 2002) and are poorly water soluble. Factors such as the chemical structure, the total concentration and the bioavailability influence the mobility of PAHs in the soil. In general, LMW PAHs have a higher water solubility and are more chemically or microbially degradable. In contrast, HMW PAHs have a higher hydrophobicity and toxicity, a lower solubility and persist therefore longer in the environment (Karickhoff, et.al., 2002). The differences in water solubility and sorption behavior result in a higher potential for mobility of the LMW PAHs (e.g., naphthalene) relative to the potential mobility of HMW PAHs (e.g., benzo[a]pyrene).

At the Site, PAHs are present in throughout soil, and at the highest concentrations in the source areas described above in Section 6.1. However, PAHs were generally non-detect in both groundwater and surface water samples collected throughout the Site as part of the RI, indicating that PAHs are remaining stable in soil and are not migrating in groundwater and surface water pathways. These findings are consistent with characteristics of PAHs described above.

6.2.4 Metals

All soils naturally contain trace levels of metals. The presence of metals in soil is, therefore, not solely indicative of contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed.

Immobilization of metals, by mechanisms of adsorption and precipitation, will often prevent movement of the metals to groundwater. Metal-soil interaction is such that when metals are introduced at the soil surface, downward transportation does not occur to any great extent unless the metal retention capacity of the soil is overloaded, or metal interaction with the associated waste matrix enhances mobility. Changes in soil environmental conditions over time, such as the degradation of the organic waste matrix, changes in pH, redox potential, or soil solution composition, due to various remediation schemes or to natural weathering processes, also may enhance metal mobility.

Metals in the soil solution are subject to mass transfer out of the system by leaching to groundwater, plant uptake, or volatilization. At the same time, metals participate in chemical reactions with the soil solid phase. The concentration of metals in the soil solution, at any given time, is governed by a number of interrelated processes, including inorganic and organic complexation, oxidation/reduction reactions, precipitation/dissolution reactions, and adsorption/desorption reactions (McLean and Bledsoe, 1992).

At the Site, metals were generally not found to be contributing to groundwater impacts with the exception of in the immediate vicinity of the landfills where most exceedances of USEPA/MDEQ groundwater standards occurred.

6.3 Physicochemical Processes Affecting Migration of COCs in Site Media

The fate and transport of Site-related constituents released into the environment depends on the physicochemical properties and processes of the constituent and environmental media, and the physical characteristics of the migration pathway. The following subsections provide brief descriptions of the key properties and processes, and their effect on transport processes.

6.3.1 Leaching

Leaching can occur when soils or waste contact either precipitation (i.e., rainwater) or groundwater, resulting in a liquid known as leachate. Leachate can move downward from a source into the water table and cause groundwater contamination. Leaching is the primary process responsible for the mobilization of cyanide and fluoride from wastes within West Landfill and Wet Scrubber Sludge Pond into the underlying groundwater.

Rates of leaching of contaminants from soil or waste into groundwater depends on the solubility of the chemical, the tightness of binding of the chemical to soil, the amount of water the soil-bound chemical comes in contact with, and the chemical characteristics of the soil and recharging water.

Although the West Landfill was covered with a clay and synthetic cap in 1994 to prevent infiltration of precipitation, the Wet Scrubber Sludge Pond was covered with only an earthen cap. However, the persistence of high concentrations of cyanide and fluoride in groundwater immediately downgradient of these landfills indicates that leaching of contaminants from wastes or highly impacted soils beneath these two landfills is likely ongoing.

In addition, groundwater in the vicinity of the landfills has been observed to be slightly to highly alkaline, with several wells exhibiting pH greater than 9. In general, Dzombak (2005) noted that the mobility of iron-cyanide complexes and free cyanide increases under alkaline conditions and soils with low clay content (such as the soils that comprise the upper hydrogeologic unit beneath the Site). Fluoride mobility in soil is also increased under alkaline conditions because the dissolution rate of fluoride minerals and salts is increased (Yadav, et. al., 2018).

6.3.2 Advection and Dispersion

Advective transport is the term used to describe the transport of a non-reactive, water-soluble chemical in the direction of groundwater flow at an average groundwater velocity (Freeze and Cherry 1979). Advective flow is usually the dominant transport mechanism in aquifer systems. The equation to describe advective flow is:

$$v = K_H \frac{I_H}{n_e}$$

where

v = seepage velocity, in units of length per time
n_e = effective porosity (dimensionless)
K_H = hydraulic conductivity, in units of length per time
I_H = horizontal hydraulic gradient, in units of length per length

The advective flow equation describes the flow velocity in an ideal system (i.e., a system where the seepage velocity depends only on the aquifer properties and the hydraulic gradient). The main application of the advective flow equation is to determine the exact time it would take for a hypothetical drop of water containing dissolved contaminants to reach a certain location. Contaminants transported via advection are traveling at the same rate as the average linear velocity of groundwater. A discussion of groundwater and contaminant velocity at the Site is provided in Sections 6.4.1 and 6.4.2, respectively.

As a contaminated fluid flows through a porous medium, it will mix with non-contaminated groundwater. The result will be a dilution of the contaminant by the process of dispersion. Dispersion describes the longitudinal and transverse spreading of the contaminant plume (Fetter, 2001). Dispersion is caused by variations in flow velocity during advective transport of contaminants. Dispersion results in the three-dimensional mixing of the contaminants, but does not affect the total mass present in the plume. Thus, the lateral spreading of the cyanide and fluoride in groundwater downgradient from the West Landfill and Wet Scrubber Sludge Pond is attributable to dispersion.

Dispersion can result in a spreading of the arrival times of the dissolved contaminant in the water undergoing idealized groundwater flow. The arrival time of the center of mass of the contaminant can be calculated by the advection equation, but some of the contaminant arrives earlier than the center of mass, and some contaminant arrives later.

6.3.3 Diffusion

Diffusion is the process by which both ionic and molecular species dissolved in water move from areas of higher concentration (i.e., chemical activity) to areas of lower concentration. Diffusion of a solute through water is described by Fick's laws (Fetter, 2001). Fick's first law describes the flux of a solute under steady-state conditions:

$$F = -D\, dC \,/\, dx$$

where

F = mass flux of solute per unit time
D = diffusion coefficient (area/time)
C = solute concentration (mass/volume)
dC/dx = concentration gradient (mass/volume/distance)

The negative sign in the formula indicates that the movement is from greater to lesser concentrations. Via diffusion, it is possible for solutes to move through a porous medium, even if groundwater is not flowing.

Diffusion generally is not an important transport process when evaluating contaminant migration at a large scale, such as at the CFAC Site. However, where clay zones have become highly contaminated as a result of diffusion, these low permeability zones can remain as residual sources of contamination within an aquifer after surrounding higher permeability zones have been remediated.

6.3.4 Precipitation/Dissolution

The iron-cyanide solids at aluminum smelter sites are crystalline in nature, where multiple iron-cyanide complexes (ferro- or ferricyanide complexes) are bonded to a central metal cation, most commonly iron due to its natural abundance in the environment (Dzombak et. al, 2005). Dzombak reported on how pH and redox potential (pE) govern the precipitation-dissolution patterns of common iron-cyanide complexes. Aerobic conditions with alkaline pH (>7) were found to be most favorable to dissolution of iron-cyanide complexes; while anaerobic conditions with acidic pH (<7) were favorable for maintaining stability in the solid phase. It has also been reported that dissolution of iron-cyanide complex solids and subsequent vertical migration in the dissolved phase can be followed by re-precipitation of iron-cyanide, resulting in a redistribution of cyanide from original source materials (e.g., waste in a landfill) to soils underlying the landfill.

With respect to fluoride, alkalinity mobilizes fluoride via the dissolution of CaF_2 (fluorite), because the solubility of fluorite increases with an increase in sodium bicarbonate ($NaHCO_3$;Yadav et. al, 2018). As alkaline conditions and high sodium concentrations exist beneath the landfills, this mechanism is likely contributing to the mobilization of fluoride at the Site. Fluoride concentrations immediately adjacent and downgradient of Wet Scrubber Sludge Pond are as high 53,000 µg/L.

Yadav (2018) also notes that in a natural system, water samples in which fluoride concentrations are greater than 5,000 µg/L are oversaturated with regard to fluorite. Thus, it would be expected that fluoride would be removed via precipitation as fluorite as the groundwater migrates away from the source area. This process appears to be occurring at the Site, as concentrations quickly decrease to less than 5,000 µg/L slightly downgradient of the landfill source area.

6.3.5 Partitioning and Adsorption

Partitioning and adsorption are important mechanisms that affect the fate and transport of contaminants. The distribution of chemicals between a solid (soil or sediment), liquid, and gas is described as partitioning. Adsorption refers to the accumulation of a solute on a solid surface (Smith, 1999). Adsorption results in the removal of contaminants from groundwater and the accumulation of the contaminant on the aquifer matrix solids surfaces.

Adsorption and partitioning can be expressed in terms of K_d. The K_d value is the ratio of the concentration of a chemical in a solid phase to the corresponding aqueous-phase concentration. The K_d measures the relative mobility of a chemical in the environment. In general, a high K_d value implies that the contaminant is tightly bound to the soil and will migrate slowly, while a low value implies the opposite.

For organic contaminants, K_d can be typically calculated by using published values for the organic carbon partitioning coefficient (K_{oc}) or the octanol-water partitioning coefficient (K_{ow}), and with knowledge of the total organic carbon (TOC) content of the aquifer matrix. For inorganic compounds, K_d can vary widely based upon site-specific conditions. The most important variables influencing adsorption of inorganics include pH and salinity of the water, grain size and mineralogy of the soil, concentrations of competing ions present, and the organic carbon content of the soil. Important adsorbent materials include iron oxides and hydroxides, manganese oxide, clay minerals, and particulate organic matter. Organic matter may form chelates or ligands with some metals, resulting in greater partitioning to soil with high organic content. The organic material in the soil also may sorb certain metals by other solutes through cation exchange.

The process of adsorption causes dissolved compounds to travel at a rate slower than the average linear groundwater velocity; which is referred to as retardation. The travel rate of dissolved compounds can be estimated by calculating the K_d and retardation factor (Fetter, 2001). A retardation factor of 1 implies that a dissolved compound does not adsorb onto the aquifer matrix, and travels at the same velocity as groundwater. A retardation factor of 2 implies that a dissolved compound adsorbs onto the aquifer matrix, and travels at a rate equal to one-half the velocity of groundwater.

With respect to cyanide, adsorption of free cyanide has been shown to correlate with increasing organic carbon content, similar to organic contaminants. Free cyanide adsorbs weakly, or not at all on oxide minerals. An interrelated complex group of factors governs metal-cyanide species adsorption, and is difficult to form generalizations. However, a number of studies have shown that acidic pH, presence of iron and aluminum oxides, and clay material tend to increase adsorption of metal-cyanide complexes; and on the contrary, high pH and low clay content seemed to increase cyanide mobility (Dzombak et. al, 2005).

At the Site, the aquifer matrix materials of the upper hydrogeologic unit generally contained less than 1.35% TOC. In addition, the pH values are generally near neutral to alkaline and there is limited clay content in the upper hydrogeologic unit. Thus, the observed mobility of both total cyanide (dominated by iron-cyanide complexes) and free cyanide is consistent with the findings from case studies evaluated by Dzombak (2005) and Kjeldsen (1998).

With respect to fluoride, fluoride mobility is highly dependent on the soil's sorption capacity, which varies with pH, salinity, and types of sorbents present in soil. pH is one of the major factors that governs the liberation and mobility of fluoride into groundwater. Fluoride adsorption is greatest in the pH range of 5 to 6.5. At higher pH, as exists at the Site, there is decreased retention of the fluoride ion onto particle surfaces. Under alkaline conditions, hydroxide could exchange with fluoride adsorbed on clay minerals. Adsorption by other anions, including bicarbonate, could cause the desorption of fluoride from mineral/organic matter surfaces within the groundwater system (Habuda-Stanić, Mirna et al., 2014).

Site-specific data for adsorption, as it relates to retardation and contaminant velocity, is described in Section 6.3.5.

6.3.6 Biological Degradation and Transformation

Various naturally-occurring processes can result in the transformation of organic compounds to other compounds of the same type, to products of a different type, or to the ultimate degradation products of organics: carbon dioxide and water (Nyer et al., 1991). Several factors must be considered in the evaluation of these reactions. The biological degradation pathways for a given contaminant may produce different products, and the proportion of these products may vary depending upon the various reaction rates which can vary widely based upon contaminant type and site-specific conditions. Biological degradation depends on the conditions around the microbial colonies in the soil and aquifer matrix. These conditions include pH, ORP, temperature, contaminant type, concentration, and the presence of other nutrients or biological toxins in the soil porewater or groundwater.

Various studies have documented degradation and transformation of various cyanide compounds, including free cyanide and metal-cyanide complexes, by bacteria, fungi and plants. These pathways have involved degradation of the cyanide compounds or their direct assimilation into primary metabolism of the organism (Dzombak, et. al., 2005).

Biological degradation of free cyanide and iron-cyanide complexes in groundwater has been the subject of multiple studies. Most studies have focused on aerobic biodegradation of free cyanide. Under most environmental conditions, free cyanide will degrade to carbon dioxide (CO_2) and the ammonium ion (Dzombak, 2005). Metal-cyanide complexes are generally resistant to degradation. There have been reports of microbial degradation of iron-cyanide complexes; however, some of these studies have been viewed with skepticism because there were not adequate controls to exclude photodissociation as the mechanism responsible for the degradation (Dzombak et. al., 2005; Kjeldsen, 1998).

The various pathways for degradation/transformation of cyanide have given rise to research on various types of bioremediation systems, including phytoremediation (Dzombak, et. al., 2005).

Biodegradation is not considered an important process for fluoride as it is not an organic element.

6.3.7 Dilution

Dilution of contaminant mass may occur along the flow path of plumes through infiltration of recharge from precipitation or recharge from surface water bodies, resulting in dilution of contaminant concentrations along a flow path. In addition, dissolved chemicals leaching from contaminated vadose zone soils may be diluted by unimpacted groundwater underlying the contaminated soils. Dispersion of contaminants within an aquifer also results in the dilution of contaminant concentrations.

6.3.8 Photolysis

Photolysis is the degradation process by which chemical bonds are broken as the result of transfer of light (direct photolysis) or radiant energy (indirect photolysis) to these bonds (Kinerson, 1987). The rate of photolysis, also referred to as photodissociation, depends upon numerous chemical and environmental factors including the light adsorption properties and reactivity of the chemical, and the intensity of solar radiation (Kinerson, 1987).

With respect to cyanide, it has been well documented in literature that iron-cyanide complexes in surface water exposed to sunlight can dissociate to release free cyanide. In some studies, this process has been observed to convert virtually 100% of the total cyanide to free cyanide. In addition, the dissociation process can occur rapidly, with some studies showing complete conversion of iron-cyanide complexes to free cyanide in surface water within 30 minutes of exposure to full sunlight. Photodissociation would be more rapid and pronounced in shallow, clear water, and less pronounced in deeper, turbid waters.

At the Site, total and free cyanide have been observed consistently in the Backwater Seep Sampling Area and Riparian Sampling Area. In these areas, free cyanide was found to comprise, on average, 25% of the total cyanide. This reflects a three-fold increase compared to that observed in groundwater at the Site and is likely attributed to the photodissociation process described above.

Photolysis is not considered a significant degradation pathway for fluoride.

6.3.9 Volatilization

Volatilization is the movement of a constituent from the liquid or solid phase to the gas phase. The potential for volatilization of a compound is typically expressed as either vapor pressure of the compound or as the Henry's law constant. Larger Henry's law constants indicate a greater tendency to escape the water phase and enter soil pore spaces or the atmosphere. Both vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies.

With respect to cyanide, the iron-cyanide complexes which dominate in the groundwater do not exhibit vapor pressures that indicate a tendency for volatilization. However, hydrogen cyanide (HCN), the dominant form of free cyanide in natural aqueous systems, is volatile. Therefore, HCN may volatilize upon discharge to surface water. In addition, HCN formed in surface water from the photodissociation of iron-cyanide complexes (as described in Section 6.3.8), will volatilize into the atmosphere. At the Site, this combination of fate and transport processes is likely occurring within the Backwater Seep Sampling Area and Riparian Sampling Area. As described in Section 6.3.8, the ratio of free cyanide to total cyanide in surface water within the Backwater Seep Sampling Area is higher than within the groundwater discharging to the Backwater Seep Sampling Area. The increase in free cyanide is likely attributable to photolysis of iron-cyanide complexes. The free cyanide within surface water in the Backwater Seep Sampling Area and Riparian Sampling Area would be subject to the volatilization process.

Volatilization is not considered a significant degradation pathway for fluoride.

6.4 Rates of Contaminant Migration and Mass Flux in Groundwater

As described in Section 6.1, the results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective.

The following sections describe the migration and mass flux mathematical evaluations conducted for cyanide and fluoride in upper hydrogeologic unit groundwater at the Site.

Results of subsurface characterization and analytical laboratory testing were utilized to estimate the mass flux of contaminants in the affected media (i.e., upper hydrogeologic unit groundwater). The purpose of the assessment was to evaluate general areas of the Site to determine how the mass flux of cyanide and fluoride varies across the Site. This information can potentially be used to identify which areas are contributing COCs and which areas should be of primary focus when evaluating potential remedial alternatives in the FS. It should be noted that the mass flux estimates presented in this section are based on the available data. A number of interpretations and assumptions were made related to the data in order to complete the estimates, as presented herein. As such, the quantities presented in this section should be considered approximate, order of magnitude estimates.

The evaluations were conducted for areas directly downgradient of the primary source areas (i.e., landfills) and in areas south of the landfills along the groundwater flow path toward the Flathead River. Plate 20 and Plate 21 present the locations of groundwater flow transects that were evaluated for cyanide and fluoride in groundwater within the upper hydrogeologic unit, respectively. In general, the transects cover the extent of the Plume Core Area and in some cases, extend outside the Plume Core Area, as summarized below:

- Transect A - oriented north-west to south-east extending downgradient from the Former Drum Storage Area, West Landfill, Wet Scrubber Sludge Pond, Center Landfill, and Sanitary Landfill;
- Transect B - oriented north-west to south-east extending from just east of the North-West Percolation Pond and north of the North-East Percolation Pond to the South Asbestos Landfill;
- Transect C - oriented north-west to south-east extending across the Main Plant Area, and in general, north of the Main Plant Building; and
- Transect D - oriented west to east across the southern portion of the Site, extending from the Western Undeveloped Area to the Eastern Undeveloped Area.

Each of the above flow transects were divided into sub-transects, as presented on Plate 20 and Plate 21, to better refine the data inputs and subsequent outputs. For example, Transect A for cyanide includes thirteen sub-transects with individual input parameters and mass flux results.

Groundwater elevations and concentrations used in this evaluation were from the June 2018 high-water groundwater sampling event, where groundwater elevations were collected from all monitoring well locations at the Site (i.e., no wells were dry at the time of gauging), and groundwater samples were collected from 76 of the 77 monitoring wells (i.e., the most groundwater samples collected during all six sampling events) to provide the most representative estimates. All data inputs used in this evaluation are described in the sections below and are presented in Tables 24 through 26.

6.4.1 Groundwater Velocity

The aquifer flow velocity is one of the key elements in estimating contaminant fate and transport in groundwater. This section discusses the calculation of velocity utilizing the hydraulic parameters characterized at the Site.

Specific discharge/Darcy velocity for the upper hydrogeologic unit was estimated using a standard Darcy's Law-based analysis:

$$V = K \cdot dh/dl$$

where

V = specific discharge/Darcy velocity (ft/day)
K = hydraulic conductivity (ft/day)
dh/dl = hydraulic gradient (foot per foot [ft/ft])

The following discusses the data inputs for each of these parameters:

- Hydraulic conductivity values (K) were estimated by calculating the average K results from slug testing results for wells in the vicinity of each flow sub-transect.
- To calculate hydraulic gradient (dh/dl), groundwater elevations from monitoring wells upgradient and downgradient of each flow sub-transect were calculated, as well as the distance between the monitoring wells. The hydraulic gradient is the total change in head divided by the distance over which the change occurs.

Tables 24 and 25 presents the data inputs and the calculated V (specific discharge/Darcy velocity) for each sub-transect. The average V for each flow transect was calculated as a weighted average dependent on the width of each sub-transect as a percentage of the total transect. A summary of the average V calculated for each flow transect is provided below.

Flow Transect	Cyanide Plume Average Specific Discharge/Darcy Velocity (V) (ft/day)	Fluoride Plume Average Specific Discharge/Darcy Velocity (V) (ft/day)
A	5.88	6.14
B	0.99	0.94
C	0.60	0.68
D	0.33	0.13

The data suggests that V decreases with increasing distance from Teakettle Mountain toward the Flathead River. This is consistent with the understanding of how the groundwater gradient varies at the Site; near Teakettle Mountain and in the landfill area of the Site, the groundwater hydraulic gradient is steep and generally mirrors the steeper topography in that portion of the Site. Moreover, the saturated thickness of the aquifer near Teakettle Mountain and the landfill area is less than the saturated thickness near Flathead River, thus requiring a steeper gradient to move the groundwater through a thinner aquifer. Groundwater elevations in the center of the Site (near the North Percolation Ponds, former Operational Area, and northern half of the Main Plant Area) are consistent over long distances, indicating a relatively flat groundwater hydraulic gradient across the center of the Site (i.e., generally an order of magnitude less than near the landfill area). The gradient then increases in the southern area of the Site between the Main Plant Area and the Flathead River (which is also consistent with the steep drop in topography between the railroad and the river).

Groundwater effective velocity is dependent upon the specific discharge/Darcy velocity and the effective porosity. Porosity for each sub-transect was estimated utilizing the bulk density of the aquifer material as analyzed in the screened interval of upper hydrogeologic unit monitoring wells; and the particle density of the aquifer material based on literature values (Fetter, 1994). Groundwater effective velocity is used to calculate contaminant velocity as described in the below section (Section 6.4.2). The average groundwater effective velocity for each flow transect was calculated as a weighted average dependent on the width of each sub-transect as a percentage of the total transect. A summary of the average groundwater effective velocity calculated for each flow transect is provided below.

Flow Transect	Cyanide Plume Average Groundwater Effective Velocity (ft/day)	Fluoride Plume Average Groundwater Effective Velocity (ft/day)
A	19.15	14.66
B	2.33	2.31
C	1.63	2.08
D	0.75	0.36

6.4.2 Contaminant Velocity

The transport rate of contaminants in groundwater is affected by the effective groundwater flow velocity in the aquifer, the chemical composition of the aquifer, and the chemical nature of the contaminants. Groundwater flow in the aquifer is described in terms of advective and dispersive flow (see discussion below). The aquifer's organic carbon content and physical properties, along with the distribution coefficient (K_d) of the chemical, are then used to calculate a retardation factor (R_f) for the chemical in the aquifer.

As discussed in Section 6.3.5, both iron-cyanide complexes and free cyanide is correlated with organic carbon. As a result, the retardation of cyanide compounds is strongly influenced by the amount of organic matter in the aquifer matrix. In conditions where dissolved fluoride concentrations are not oversaturated with respect to fluorite, which are downstream of the source areas between transects B and C based on mass flux calculations (see Section 6.4.3), fluoride behaves similar to a conservative tracer ion (i.e., no significant loss to precipitation). Fluoride would then travel at approximately the same velocity as groundwater, so its velocity in groundwater was not estimated as part of this fate and transport analysis. The distribution coefficient, K_d, is calculated prior to determining retardation factors and provides another means of ranking compound mobilities in a specific geologic material. K_d is calculated by the equation:

$$K_d = K_{oc} f_{oc}$$

The following describes the data inputs for each of these parameters:

- Soil adsorption coefficient (K_{oc}) is a literature value which represents the ratio of the amount of chemical adsorbed per unit weight of organic carbon in the soil to the concentration of the chemical in solution at equilibrium (Lyman et al., 1990).
- Fraction of soil organic carbon (f_{oc}) is the fraction of organic carbon in a soil, which is its TOC content analyzed in saturated aquifer soil expressed as a decimal fraction (e.g. 1.0% TOC = 0.010 f_{oc}).

Two K_{oc} values were utilized in the calculations to provide a range of contaminant velocities. The K_{oc} values for cyanide range from 2 L/kg (low[20] K_{oc} for hydrogen cyanide; the dominant form of free cyanide) to 8.93 L/kg (high[21] K_{oc}).

The K_d calculated using the above equation incorporates the chemical characteristics of the contaminant and the aquifer material into one term. The overall retardation characteristics of the aquifer are included in the calculation of R_f by the equation (Freeze and Cherry, 1979):

$$Rf = 1 + \left(\frac{\rho}{n}\right) k_d$$

For each sub-transect, two R_f values were calculated utilizing the low K_{oc} and high K_{oc} to provide a range of contaminant velocity. Utilizing the R_f values, contaminant velocity was calculated as:

$$Rf = \frac{v}{v_c}$$

Where

Rf = retardation factor
ρ = the bulk density of the soil (g/cm^3)
n = the soil porosity (unitless)
v = effective velocity of the groundwater (ft/day)
v_c = the velocity of the contaminant (ft/day)

The following describes the data inputs for each of these parameters:

- Bulk density of the aquifer material (ρ) as analyzed in the screened interval of monitoring wells;
- Soil porosity of the aquifer material (n) as determined by aquifer material bulk density and particle density;
- Groundwater effective velocity (v) is calculated by accounting for effective porosity; and
- Distribution coefficient (K_d) as calculated in the prior equation.

Table 26 presents the results of calculating R_f values for cyanide in upper hydrogeologic unit groundwater. A low estimate and high estimate of R_f values for each sub-transect was calculated utilizing the two K_d values (2 L/kg and 8.93 L/kg, respectively) to provide a range of cyanide retardation. Averages calculated for each transect are summarized below:

Flow Transect	Average Cyanide Rf utilizing Low Range K_d	Average Cyanide Rf utilizing High Range K_d
A	1.20	1.91
B	1.16	1.73

20 USEPA, Technical Appendices for RSEI Version 2.1.2, August 2004, Technical Appendix B, Physicochemical Properties for TRI Chemicals and Chemical Categories.

21 USEPA, Chemistry Dashboard. https://comptox.epa.gov/dashboard/DTXSID6023991 (accessed August 26, 2019), Cyanide.

Flow Transect	Average Cyanide Rf utilizing Low Range K_d	Average Cyanide Rf utilizing High Range K_d
C	1.16	1.72
D	1.09	1.39

As presented above, cyanide has a low-level retardation factor at the Site, ranging from an average of 1.09 to 1.91, suggesting that rate of cyanide migration may range from effective groundwater velocity to approximately one-half the effective groundwater velocity.

Contaminant velocity (ft/day) is then calculated by applying the R_f to the groundwater effective velocity. Similar to the approach for calculating groundwater velocity, the average contaminant velocity for each flow transect was calculated as a weighted average dependent on the width of each sub-transect as a percentage of the total transect. A summary of the average contaminant velocity calculated for each flow transect is provided below:

Flow Transect	Average Cyanide Velocity utilizing Low Range Rf (ft/day)	Average Cyanide Velocity utilizing High Range Rf (ft/day)
A	16.24	10.79
B	2.02	1.40
C	1.40	0.95
D	0.68	0.54

These data indicate that the velocity of cyanide in groundwater decreases with increasing distance away from the landfills toward Flathead River.

6.4.3 Contaminant Mass Flux in Groundwater

The following section describes the evaluation of contaminant mass flux. Mass flux was calculated as a rate measurement (mg/day) specific to each sub-transect across the cyanide and fluoride plumes. For this calculation, mass flux is also presented as a sum of all mass flux measures across the entire plume for each contaminant, and thus represents the total mass of each contaminant solute conveyed by groundwater through a defined plane (ITRC, 2010).

Mathematically, contaminant mass flux is the product of the contaminant concentration in groundwater and the groundwater flux. Thus, contaminant mass flux (J) can be calculated as follows:

$$J = q_0 \cdot C$$

where

q_0 = groundwater flux/discharge (ft^3/day)
C = contaminant concentration (mg/ft^3)

The following discusses the data inputs for each of these parameters:

- Groundwater flux/discharge is dependent on the width of the sub-transect and saturated thickness of the aquifer in the vicinity of the sub-transect, as well as the specific discharge (i.e., Darcy velocity); and
- A representative contaminant concentration was selected for each sub-transect.

As discussed in Section 3.2.2.2, concentrations of cyanide and fluoride in upper hydrogeologic unit groundwater decrease with increasing depth. Therefore, it is assumed that the upper portion of the upper hydrogeologic unit is conveying the majority of the contaminant mass. As a conservative estimate, the mass flux was calculated utilizing two methods: (1) using the full saturated thickness (assuming contaminant mass is flowing through entire aquifer as a conservative estimate), and (2) using one-half the saturated thickness (assuming contaminant mass is flowing through the upper half of the aquifer only).

Contaminant flux for cyanide and fluoride was calculated for each sub-transect. Contaminant flux calculations for each sub-transect are presented in Tables 24 and 25. A summary of the mass flux for each flow transect (sum of mass flux for all respective sub-transects) is provided below. As described above, two estimates of contaminant flux dependent on the saturated thickness are presented to provide a range of flux.

Flow Transect	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
A	5,449,998	2,724,999	25,051,208	12,525,604
B	2,112,737	1,056,369	6,825,376	3,412,688
C	1,669,841	834,920	1,948,292	974,146
D	1,092,460	546,230	1,939,107	969,554

The above evaluation indicates that mass flux of cyanide and fluoride are highest immediately downgradient of the landfills, which is consistent with the understanding that the landfills are the primary source of cyanide and fluoride in groundwater. Contaminant flux decreases with increasing distance from the landfills. With respect to cyanide, the decrease in flux with increasing distance from the landfills is likely due to various attenuation process such as biodegradation and sorption.

Fluoride flux decreases by an order of magnitude in Flow Transects B and C, downgradient of the landfills and north of the Main Plant Area. A potential explanation for this decrease in concentration is the precipitation of fluoride out of groundwater immediately outside and downgradient of the primary source area as described in Section 6.3.4.

Cyanide and fluoride flux continue to decrease with increasing distance from the source area toward Flathead River. As stated in Section 3.2.4, groundwater from the upper hydrogeologic unit is expressed within the extent of the "Seep Area" and then to Flathead River. Based on the data collected during the RI, total cyanide was non-detect in all surface water, sediment, and sediment porewater samples collected within the main stem of the Flathead River downgradient of the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds during all six rounds of sampling, with the exception of one surface water sample collected in Phase I Round 1. Fluoride was generally detected in surface water and sediment samples collected within the main stem of the Flathead River, but at concentrations below screening levels. These findings indicate that the cyanide and groundwater flux estimated in Flow Transect D, just north of Flathead River, is not measurably impacting the surface water quality of the main channel of the Flathead River.

The observations noted above (i.e., cyanide and fluoride not measurably impacting Flathead River) were further evaluated by calculating the maximum hypothetical concentration that could be expected in the river based upon the groundwater flux estimates previously described, assuming all the groundwater discharged to the river. This concentration was calculated using the following formula[22]:

Hypothetical concentration at the Flathead River = Mass Flux/Flathead River Discharge

where

- Mass flux for cyanide and fluoride is the calculated value estimated for Flow Transect D along the Flathead River: 1,092,460 mg/day for cyanide and 1,939,107 mg/day for fluoride. These values were estimated using the full saturated thickness of the aquifer (assuming contaminant mass is flowing through entire aquifer as a conservative estimate, rather than one-half or the upper portion of the aquifer); and
- A mean and minimum discharge value for the Flathead River was used to provide a range of estimated hypothetical cyanide and fluoride concentrations, including: Flathead River mean discharge of 21,625 cfs for June 2018 (high-water event); and Flathead River minimum discharge of 3,300 cfs for the three-year investigation period (2016 through 2018; Appendix L2a of the Phase II SC Data Summary Report). The minimum discharge for the three-year period was utilized to provide a conservative estimate for maximum hypothetical concentrations.

Based upon the results of the calculations, it is estimated that the maximum hypothetical concentration in the Flathead River for cyanide and fluoride utilizing the minimum Flathead River discharge for the three-year period is 0.135 µg/L and 0.240 µg/L, respectively. Utilizing the mean Flathead River discharge for June 2018, the hypothetical concentration in the Flathead River for cyanide and fluoride is 0.021 µg/L and 0.037 µg/L, respectively.

These hypothetical concentrations are below the limits of detection for cyanide and fluoride (detection limit of 2 µg/L and 12 µg/L respectively), which is consistent with the fact that both constituents are typically non-detect within the main stem of the Flathead River. In addition, the hypothetical cyanide and fluoride concentrations are below the most conservative human health and ecological screening criteria (i.e., USEPA Tapwater RSL of 0.15 µg/L and 80 µg/L, respectively).

[22] American Petroleum Institute. Groundwater Remediation Strategies Tool, 2003.

7. Baseline Risk Assessment

The sections below summarize the two Baseline Risk Assessments completed at the Site by EHS Support and Roux. The Baseline Human Health Risk Assessment scope and results are detailed in the BHHRA (Appendix D; EHS Support, 2019b), and the Baseline Ecological Risk Assessment scope and results are detailed in the BERA (Appendix E; EHS Support, 2019c).

CFAC and Roux completed multiple scopes of work as part of the RI to complete the investigations of soil, groundwater, surface water, sediment, and sediment porewater in order to generate a comprehensive dataset to assess human health and ecological risks within the Study Area. The scope of work of each of the different phases of the RI are described in Section 2.2 above. Detailed descriptions of the scope of work and results of the RI investigations are included in the Phase I SC Data Summary Report, GW/SW Data Summary Report, and the Phase II SC Data Summary Report.

A summary of the BHHRA and BERA is provided below.

7.1 Baseline Human Health Risk Assessment

The objective of the BHHRA was to characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action. The BHHRA provides the basis for determining whether remedial action is necessary to address potential risk to human health in the various exposure areas identified at the Site, as well as the extent of remedial action required. The BHHRA supports the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to COCs.

The format for the BHHRA follows the USEPA Risk Assessment Guidance for Superfund (RAGS) Part D (USEPA, 2001). The regulatory guidance for conducting the BHHRA includes RAGS Parts A through F (USEPA, 1989, 1991a, 1991b, 2001, 2004, and 2009), and other guidance documents and procedures that USEPA has issued in addition to the RAGS guidance. The additional guidance and procedures are referenced, as applicable, in the BHHRA Work Plan (EHS Support, 2018a) as well as within the BHHRA (EHS Support, 2019b) where appropriate.

7.1.1 Human Health Exposure Areas and Receptors

Included in the BHHRA is a review of the conceptual exposure models and discussion of exposure pathways for exposure areas. Exposure areas were defined considering both the current and reasonable anticipated future land use for the various areas of the Site and considering the types of habitats present. The boundaries of each exposure area were developed using professional judgement, and considered Site characteristics, current and potential future receptors, and the distribution of COPCs identified in the RI. Section 1.3.4.5 provides a description of each exposure area. Exposure areas are depicted on Figure 3. A summary of the anticipated future use for each area is described below.

- Main Plant Area – based on the remote location from residential areas, flat land, and remaining post-decommissioning infrastructure, the foreseeable future use of this area is industrial or commercial.
- North Percolation Pond – based on the depressed topography, the foreseeable future use of this area is industrial stormwater management.
- Central Landfill Area – based on the existing Site features associated with waste management and disposal activities, the foreseeable future use of the Central Landfill Area is industrial (i.e., landfill management and maintenance activities).

- Industrial Landfill Area – based on the existing Site features associated with waste management and disposal activities, the foreseeable future use of this area is industrial (i.e., landfill management and maintenance).
- Eastern Undeveloped Area – based on limited accessibility (i.e., steep rugged terrain), landfills on the northern portion, Teakettle Mountain eastern portion, main rail line and Flathead River in the southern portion, and the Main Plant Area west of the area, the foreseeable future use of this area is industrial or undeveloped.
- North-Central Undeveloped Area – based on the proximity to landfills and the presence of the Northern Surface Water Feature, the foreseeable future use of this area is industrial or undeveloped.
- Western Undeveloped Area – based on the proximity to existing residential development, existing vegetative habitat, and main rail right-of-way immediately south of the area, the foreseeable future use of this area could be industrial, commercial, residential, or undeveloped for recreational use.
- South Percolation Pond Area – based on the existing operational ponds, riparian vegetation, and adjacent Flathead River, the foreseeable future use of this area is industrial water management or undeveloped.
- Flathead River Area – based on the designated use of the Flathead River as well as local recreational uses, the current and future use of the Flathead River is recreational.
- Backwater Seep Sampling Area and Riparian Sampling Area – based on the presence of the steep relief and the backwater, it is foreseeable that the current and future use of this area will remain undeveloped; however, recreational users of the Flathead River may use the area for recreational purposes.

Based on the current and reasonably foreseeable future use of the Site, and the potential for exposure to affected soil, groundwater, surface water, and sediment, the potential receptors within the overall Site boundary and associated Flathead River were identified for both current Site use and future use scenarios. Current potential receptors evaluated in the BHHRA are trespassers and recreationists. Potential future receptors evaluated include industrial or commercial workers, construction workers, residents, trespassers and recreationists (e.g., hunters and fishers).

It is noted that the potential receptors vary by specific exposure area as detailed within the BHHRA.

7.1.2 Hazard Identification and Selection of COPCs

The purpose of the hazard identification step is to evaluate the environmental data collected during the Site Characterization phase, assess its quality and suitability for use in the risk assessment, and screen the data to determine the COPCs that will be evaluated further in the risk assessment process. The BHHRA evaluated all of the data collected during each RI phase described previously in this RIR. The comprehensive dataset was found to be statistically robust and representative of Site conditions for use in conducting the risk assessment.

The COPC selection process was conducted by utilizing the comprehensive RI dataset and evaluating the data relative to a set of risk-based screening criteria specified by USEPA during preparation of the RI/FS Work Plan. The identification of COPCs was based on comparing the maximum measured COPC concentration by exposure area with the lowest risk-based screening concentration. If the maximum COPC concentration in soil, groundwater, surface water, and sediment exceeded the lowest risk-based screening concentration for that media, the COPC was selected for further assessment in the BHHRA.

As result of the chemical screening process, approximately 39 chemicals were retained as COPCs for quantitative evaluation within the BHHRA. Note that the COPCs retained for further evaluation varied by media and by exposure area. Additional details regarding the selection of COPCs and lists of COPCs by media and exposure area are provided in Section 3.4 of the BHHRA.

7.1.3 Human Health Exposure Assessment

The purpose of the exposure assessment is to predict the magnitude and frequency of potential human exposure to each identified COPC based on the hazard identification. The Conceptual Exposure Model (CEM) presented the potential receptors by potentially complete exposure pathways and environmental media of concern. The following sections summarize key elements of the exposure assessment. The reader is referred to the BHHRA (Appendix D) for additional details.

Exposure Pathways

Exposure pathways were evaluated for both current use and the reasonable anticipated future use of the Site for each exposure area. In general, the medium-specific pathways evaluated for each potential receptor are as follows:

- Trespassers and recreation trespassers (i.e., ATV riders) exposed to soil, surface water, and sediments;
- Industrial or commercial workers exposed to soils and groundwater;
- Construction workers exposed to soils and groundwater;
- Residents exposed to soils and groundwater[23]; and
- Recreationists (e.g., hunters and fishers) exposed to biota, soils, surface water, and sediments.

Additional details regarding pathways and routes of exposure evaluated are provided in Section 2.5 of the BHHRA.

EPCs

Medium-specific EPCs were based on the exposure areas for the Site environmental data for each receptor and exposure pathway. Prior to calculation of EPCs, the technical approaches were detailed in an Interim Deliverable (EHS Support, 2019a) approved by USEPA. The EPC for each environmental media and exposure pathway was typically the 95% upper confidence limit (UCL) on the mean. The 95% UCL of the arithmetic mean was typically calculated using ProUCL Version 5.1 (USEPA, 2016), and was dependent on the distribution of the data. If the 95% UCL of the arithmetic mean exceeded the maximum detected concentration of a COPC, the recommendation provided by the ProUCL software and guidance was used to develop the EPC. In addition, if a sufficient number of data points (i.e., 10 or greater) were not available for the exposure scenario, the maximum detected concentration was selected as the EPC if ProUCL software and guidance did not provide an alternative recommendation. Recommendations provided by the ProUCL software for the evaluation of sample results qualified as below the detection level (non-detect) were followed. Appendix F of the BHHRA provides ProUCL model outputs for each EPC.

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[23] The BHHRA evaluated residential exposure in the Western Undeveloped Area including an assessment of the cumulative potential residential risks from exposure to soils and upper hydrogeologic groundwater (see BHHRA: Section 6.1.7 Western Undeveloped Area). In addition, the BHHRA assessed the cumulative potential residential risks from exposure to the plume core area groundwater as well as site-wide groundwater in the below upper hydrogeologic unit (see BHHRA: Section 6.1.13 Additional Groundwater Evaluation).

Additional details regarding the calculation of EPCs, including descriptions of the EPC calculation process for EPCs across multiple exposure areas, estimated air EPCs for ATV riders, estimated biota tissue EPCs, and biota uptake exposure are provided in Section 4.1 of the BHHRA.

Exposure Assumptions

The exposure assumptions used in the BHHRA were presented in the Interim Deliverable (EHS Support, 2019a). The assumptions were based on USEPA default reasonable maximum exposure (RME) assumptions unless Site-specific RME scenarios were determined to be more appropriate based on professional judgement that included input from individuals knowledgeable of current Site use.. The RME is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway at the Site. Details regarding the exposure assumptions, equations, and models are included as Section 4.2 of the BHHRA.

7.1.4 Toxicity Assessment

The purpose of the toxicity assessment is to determine the relationship between the dose of a COPC taken into the body, and the probability that an adverse effect will result from that dose. The primary sources of toxicity values used in the risk assessment were based on the USEPA Superfund hierarchy of human health toxicity values. Sources of toxicity values in order of preference are as follows:

- USEPA Integrated Risk Information System (IRIS);
- Provisional peer-reviewed reference toxicity values (PPRTVs);
- Agency for Toxic Substances and Disease Registry's Minimal Risk Levels;
- California Environmental Protection Agency Office of Environmental Health Hazard Assessment risk assessment health values; and
- Other sources (screening values from "PPRTV Appendix" sources and other specific individual toxicity values, and the USEPA Superfund program Health Effects Assessment Summary Table).

Quantitative estimates of the toxicity of COPCs include two sets of values; one for carcinogenic effects and one for non-carcinogenic effects. For carcinogenic effects, the USEPA assumes a non-threshold toxicological mechanism that assumes there is no level of exposure that does not pose a probability that an adverse effect will result from that dose. Toxicity criteria for non-carcinogens assume that there is a threshold effects level, below which adverse health effects are not expected to occur. Details regarding the toxicity assessment are included in Section 5 of the BHHRA.

7.1.5 Risk Characterization and Conclusions

The purpose of the risk characterization is to provide a conservative estimate of the potential risk resulting from exposure to COPCs identified in the environmental media at the Site.

Cancer risks were expressed as the upper-bound, increased likelihood of an individual developing cancer because of exposure to a particular COPC. The following equation was used to estimate the excess cancer risk:

$$\text{Cancer Risk} = \text{LADI} \times \text{CSF or EC} \times \text{IUR}$$

Where

- LADI = Lifetime average daily intake (mg/kg-day)

- CSF = Cancer Slope Factor (mg/kg-day)-1
- EC = Exposure concentration (µg/m^3)
- IUR = Inhalation Unit Risk (µg/m^3)-1

For carcinogenic effects, USEPA (USEPA, 2005a) assigns a weight-of-evidence descriptor to each COPC, and if applicable, a cancer slope factor (CSF) or unit risk factor (URF) is subsequently calculated. USEPA determines CSFs for oral exposure and URFs for inhalation exposure for those chemicals that are known or likely human carcinogens. The CSFs and URFs are upper-bound estimates of the excess cancer risk due to continuous exposure to a COPC averaged throughout the course of a 70-year lifetime. A CSF has units of 1/milligram (mg) of COPC/kilogram (kg) of body weight/day, or (mg/kg-day)-1. A URF is expressed in units of 1/microgram (µg) of COPC/cubic meter (m^3) air or (µg/m^3) -1. The basis of CSFs and URFs are data from lifetime animal bioassays, although human data are used when available.

Cancer risk estimates for individual chemicals are summed by media and exposure pathway to generate an estimate of cumulative risk. The National Oil and Hazardous Substances Pollution Contingency Plan states that for carcinogens, acceptable exposure represents an excess upper-bound lifetime cancer risk to an individual between 10-6 and 10-4. Cancer risks less than 10-6 are generally considered *de minimis*. The level of total excess cancer risk that is of concern is a matter of personal, community, and regulatory judgement. In general, the USEPA considers excess cancer risks that are below 10-6 to be negligible, and are generally considered *de minimis;* excess risks above 10-4 are sufficiently large that some sort of intervention or remediation is desirable. Excess cancer risks that range between 10-4 and 10-6 are generally not considered large enough to warrant action under Superfund (USEPA, 1991c), although this is evaluated on a case by case basis and USEPA may determine that risks lower than 10-4 are not sufficiently protective and warrant remedial action. Additionally, the MDEQ considers a cancer risk level of 10-5 allowable.

Noncancer effects from exposure to a COPC are expressed as a hazard quotient (HQ). An HQ is the ratio of the estimated intake or exposure concentration of a COPC to the corresponding COPC-specific reference dose (RfD) or reference concentration (RfC). The following equation is used to estimate the noncancer risk:

$$\text{Hazard Quotient} = \text{ADI/RfD or EC/RfC}$$

Where

- ADI = Average daily intake (mg/kg-day)
- RfD = Reference dose (mg/kg-day)
- EC = Exposure concentration (mg/m^3)
- RfC = Reference concentration (mg/m^3)

The COPC - and pathway-specific HQs are combined as a hazard index (HI), which is then compared to a typically accepted benchmark level of 1. If the HI is less than 1, it is assumed that non-cancer hazards are not above a level of concern. If the HI exceeds 1, then there is a potential for non-cancer adverse effects to result from exposure to Site COPCs under the evaluated receptor scenario(s). If the total HI is greater than 1, separate endpoint-specific HIs were calculated based on target organs (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). If a target-organ-specific HI was greater than 1, there is potential health effects for that target organ and receptor. Table 7-1 through Table 7-35 of the BHHRA present Calculation of Cancer Risks and Non-Cancer Hazards. Table 9-1 through Table 9-35 of the BHHRA summarize the cancer risk and non-cancer hazards for each receptor by medium, exposure medium, exposure route, and exposure point. Table 27 of this RIR (Table 9-36 of the BHHRA) presents a summary of the cumulative excess lifetime cancer risk (ELCR) and the HI for each receptor in each exposure area. The risk characterization incorporates the USEPA risk range of 10-4 and 10-6 and MDEQ management of 10-5 for carcinogens. For non-carcinogens, the risk characterization uses HI of 1 and target organ specific evaluation as applicable.

Evaluation of background risk, and the contribution of background conditions to the Site overall risk, is also discussed in the risk characterization. The contribution of background concentrations of COPCs is evaluated and discussed in Section 6.2 of the BHHRA as applicable to the risk drivers for each complete exposure pathway.

The BHHRA evaluated potential human health risks to receptors at the Site. Data collected during the RI investigation activities within each exposure area were used to characterize potential risks. The receptors evaluated in the current and future scenarios, as appropriate, included industrial workers (industrial worker, landfill management worker, stormwater management worker), construction workers, recreational trespassers (ATV rider and hunter), adolescent trespassers, adolescent and adult recreationist (boaters, floaters, and fisher), and residents (adult and child). The BHHRA included the evaluation of potential exposures to COPCs in soil, surface water, sediment, and groundwater, as well as the potential exposure to COPCs in fish (i.e., uptake of COPCs in surface water) by the recreationist (fisher) and exposure to COPCs in venison (i.e., uptake of COPCs in soil) by recreational trespassers (hunter). Default and Site-specific exposure assumptions were developed for these receptors.

Table 9-1 through Table 9-35 and Appendix I and Appendix J of the BHHRA presented the calculated cumulative risks for each receptor by COPC in each potentially complete exposure scenario identified in the CEM. Table 27 of this RIR (Table 9-36 of the BHHRA) presents a summary of the ELCR and HI for each receptor.

Based on the evaluation of the BHHRA results, the following general conclusions can be drawn regarding human health risks at the Site.

<u>Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination</u>

The conditions in the following exposure areas at the Site do not pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs. These exposure areas include:

- North-Central Undeveloped Area;
- Eastern Undeveloped Area;
- Western Undeveloped Area;
- South Percolation Pond Area;
- Flathead River Area; and
- Backwater Seep Sampling Area.

As shown in Table 27, it is noted that risk characterization results for the three undeveloped areas (i.e., Eastern, Western, and North-Central Undeveloped Areas) indicate a ELCR above 1E-06 or a non-cancer risk (HI >1) for exposure to surface soil. However in each case, the risk was due to the presence of arsenic or manganese in soil, both of which were found in background soil samples at comparable concentrations.

Therefore, these are not attributable to Site-related contamination, but rather to naturally occurring background conditions.

In addition, it is noted in the Western Undeveloped Area that one isolated detection of bis(2-ethylhexyl) phthalate in groundwater, at a concentration of 73 µg/L at monitoring well CFMW-069 during the October 2018 sampling event resulted in a calculated risk of 1E-05 for drinking water exposure under the hypothetical future residential scenario evaluated for this area. The prior sample collected at this location in June 2018 was non-detect, with an MDL of 4.4 µg/L. Bis(2-ethylhexyl) phthalate is not a contaminant associated with historical operations at the Site, and it has not been identified at levels of concern anywhere on the Site. Given these factors and that bis(2-ethylhexyl) phthalate is recognized as common field and lab contaminant (associated with plasticware), the calculated risk appears overestimated and unrelated to Site-related contamination.

<u>Exposure Areas That Pose Risks Due to Site-Related Contamination</u>

The conditions in the following exposure areas at the Site pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs:

- North Percolation Pond Area;
- Main Plant Area;
- Central Landfills Area: and
- Industrial Landfill Area.

In addition, groundwater within the Plume Core Area poses risk based upon a hypothetical future residential drinking water scenario.

The key conclusions with respect to each of the above areas are presented below.

<u>North Percolation Pond Area</u>: This area presents high potential risk within the Site, with a calculated cumulative ELCR of 1E-04 for a stormwater management work scenario and 5E-05 for a trespasser scenario. In each case, the risk driver is exposure to PAHs within the pond. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the North Percolation Pond Area.

<u>Main Plant Area</u>: Risk in the Main Plant Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 8E-06 for the industrial worker scenario. Discrete samples were collected across the entirety of the Main Plant Area (i.e., 290 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the construction worker and trespasser scenario to 2E-05 for the industrial worker scenario. The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the ELCR within the Main Plant Area. This area also exhibits some potential non-cancer effects with the HI of 4 (developmental, nervous, and thyroid target organ systems) for both the industrial and construction worker.

<u>Central Landfills Area</u>: Risk in the Central Landfills Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 1E-05 for the landfill management worker scenario. Discrete samples were collected across the entirety of the Central Landfills Area (i.e., 128 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the trespasser scenario to 3E-05 for the landfill management worker.

The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the Central Landfills Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Central Landfill Area.

Industrial Landfill Area: The calculated cumulative ELCRs range from 2E-06 for the trespasser scenario to 1E-05 for the landfill management worker scenario. PAHs in soil are the primary risk driver for the Industrial Landfill Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Industrial Landfill Area.

Groundwater Plume Core Area: As noted within the BHHRA, CFAC intends to prohibit the use of groundwater beneath the Site for potable use. However, as required by USEPA, the BHHRA evaluated risk associated with exposure to groundwater within the Plume Core Area under a residential exposure scenario[24] to provide a conservative evaluation of potential health risk in the absence of any controls.

The Plume Core Area was defined based upon evaluation of the cyanide and fluoride extents in groundwater within the upper hydrogeologic unit as described in Section 3.1. Within this area, the calculated HIs for future adult exposure to cyanide, free cyanide, and fluoride are 7E+01, 2E+00, and 5E+00, respectively; and cumulative HI is 8E+01. The calculated HIs for future child exposure to cyanide, free cyanide, and fluoride are 1E+02, 4E+00, and 9E+00, respectively, and cumulative HI is 1E+02. The results indicate potential for non-cancer effects if groundwater within the Plume Core Area is to be used as a source of drinking water.

In addition to the non-cancer effects, the results of the BHHRA indicate a calculated cumulative ELCR of 2E-04 for lifetime exposure (i.e. including exposure as a child, adolescent and adult) to arsenic in groundwater under a future residential exposure scenario. Review of the data indicates that the EPC of 9.8 µg/L is primarily driven by elevated concentrations measured in two wells (CFMW-012 and CFMW-015), where maximum concentrations were approximately 92 µg/L. The vast majority of wells within the Plume Core Area are non-detect for arsenic, with the typical MDL less than 1 µg/L.

The objective of the BHHRA was to conservatively characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action. The BHHRA met this objective and provides the risk managers with the necessary information to support the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to COCs.

7.1.6 Uncertainty Analysis

The procedures and assumptions used to assess potential human health risks in the BHHRA were subject to a wide variety of uncertainties. However, the presence of uncertainty is inherent in the risk assessment process, from the sampling and analysis of chemicals in environmental media, to the assessment of exposure and toxicity, and risk characterization. An analysis of uncertainty associated with the risk estimates and characterization was conducted in a semi-quantitative approach and was used to address potential data gaps. Typically, uncertainty exists in characterization of the nature and extent of contamination, in environmental fate and transport modeling, in the magnitude and duration of exposure of various receptors,

[24] The BHHRA evaluated residential exposure in the Western Undeveloped Area including an assessment of the cumulative potential residential risks from exposure to soils and upper hydrogeologic groundwater (see BHHRA: Section 6.1.7 Western Undeveloped Area). In addition, the BHHRA assessed the cumulative potential residential risks from exposure to the plume core area groundwater as well as site-wide groundwater in the below upper hydrogeologic unit (see BHHRA: Section 6.1.13 Additional Groundwater Evaluation).

and in toxicological values used to characterize risks or hazards. Accordingly, Site investigations and evaluations should include a discussion of the likely bias and magnitude of errors associated with uncertainties in estimating the risk. Risk characterization, including a well-performed uncertainty analysis, will place the risk estimates in the proper perspective for informed decision-making.

The BHHRA's approach to presenting the potential risks is consistent with the goal of RME representing the high end of the possible risk distribution, which is generally considered to be greater than the 90th percentile. However, these estimates are based on numerous and often conservative assumptions and, in the absence of definitive information, assumptions are used to ensure that actual Site risks are not underestimated. The cumulative effect of these assumptions can result in an analysis with an overall conservativeness greater than the individual components.

Accordingly, it is important to note that the risks presented in the BHHRA are based on numerous conservative assumptions in order to be protective of human health and to bias risk estimates toward overestimation of risk rather than underestimation. Because of this conservative bias, actual risks are likely to be less than the estimates.

Details regarding the uncertainty analysis are provided in Section 6.3 of the BHHRA.

7.2 Baseline Ecological Risk Assessment

A BERA was conducted as part of the RI to evaluate whether environmental conditions associated with historical operations at the Site pose an unacceptable risk to ecological receptors based on the conceptual investigation framework presented in the BERA Work Plan (EHS Support, 2019c) and two interim deliverables that are presented in Appendix A of the BERA. The BERA was undertaken following the completion of a SLERA which determined that it was not possible to conclude that unacceptable risk does not exist. Rather, the findings of the SLERA indicated that certain COPECs and associated exposure pathways required further evaluation (Roux, 2017b). The complete BERA is provided in Appendix E of this RIR. A summary of the key elements of the BERA process and a summary of the BERA results is provided below.

The BERA was conducted in accordance with USEPA guidance, primarily *Ecological Risk Assessment Guidance for Superfund* (ERAGS), and the BERA Work Plan (EHS Support, 2018b) and interim work plan deliverables (EHS Support, 2019a). The BERA Work Plan outlined the following objectives for the BERA:

- Refine the screening-level problem formulation presented in the SLERA in the context of new information and findings of analyses conducted following the SLERA.
- Refine the ECSM of the Site.
- Refine the list of COPECs identified in the SLERA to identify COPECs that are most likely to drive risk management decision-making for the Site to focus and streamline the BERA risk analysis.
- Develop screening-level and baseline ecological exposure estimates for complete exposure pathways identified in the refined ECSM for ecological exposure areas identified in the BERA Work Plan.
- Characterize risk using baseline exposure estimates to support SMDPs for identified ecological exposure areas.
- Evaluate uncertainties in the exposure estimates and risk characterizations and the potential influence of uncertainties on risk conclusions.

- Identify potential data gaps based on the uncertainty analysis.

7.2.1 ECSM, Exposure Areas, and Receptors

A preliminary ECSM developed during the SLERA was refined and expanded upon as part of the BERA problem formulation. The key elements of the ECSM developed and presented in the BERA include:

- Exposure areas: Ecological exposure areas were defined to represent the habitat types (aquatic, transitional, and terrestrial) and receptor groups that may be present and exposed to Site constituents.
- Ecological receptor categories: Additional ecological receptor categories and representative receptor species, including updated queries of special status species (e.g., rare, threatened, and endangered species), were identified.
- Exposure pathways: Potential exposure pathways were evaluated considering the fate and transport properties of COPECs that may influence mobility and/or exposure routes to receptor categories.
- Bioavailability: The ECSM includes an evaluation of the Site characteristics that may influence the bioavailability of COPECs in Site exposure media.
- Bioaccumulation/biomagnification: The relative importance of COPECs that bioaccumulate or biomagnify were evaluated in the ECSM to identify potential data gaps that may be addressed in the BERA.

Ecological exposure areas were developed and grouped into three broad categories based on habitat types:

- Terrestrial Exposure Areas: Dry, upland areas that may support aboveground and/or belowground terrestrial flora and fauna.
  - Main Plant Area
  - Central Landfills Area
  - Industrial Landfill Area
  - Eastern Undeveloped Area
  - North-Central Undeveloped Area
  - Western Undeveloped Area
  - Flathead River Riparian Area[25]
- Transitional Exposure Areas: Characterized by intermittent or seasonal surface water inundation that may support aquatic or terrestrial receptors, depending on the time of year.
  - North Percolation Pond Area
  - South Percolation Ponds
  - Cedar Creek Reservoir Overflow Ditch
  - Northern Surface Water Feature
- Aquatic Exposure Areas: Characterized by perennial or near-perennial inundation with water and physical habitats that can support aquatic receptor species.
  - Flathead River Area[26]

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[25] The Flathead River Riparian Area is a terrestrial exposure area that includes the terrestrial environmental south of the railroad and up to the Flathead River. This area does not include aquatic exposure areas (i.e., Flathead Riparian Area Channel, Backwater Seep Sampling Area) or transitional exposure areas (i.e., South Percolation Ponds) in the surrounding area.

[26] The Flathead River Area is an aquatic exposure area that includes the main channel of the Flathead River.

- Flathead River Riparian Area Channel[27]
- Cedar Creek Area

The type(s) of impacted environmental media varies among the different ecological exposure areas and associated habitats, and could include surface water, sediment (including porewater), and soil. Ecological receptor exposure pathways to constituents within the impacted environmental media include ingestion (direct and incidental), and to a lesser extent (based on the COPECs identified), direct contact and inhalation.

Aquatic receptors of concern that may use habitats within aquatic and/or transitional exposure areas include plants, invertebrates, fish, herptiles, and semi-aquatic birds and mammals. Terrestrial receptors of concern that may use habitats within transitional and/or terrestrial exposure areas include plants, invertebrates, herptiles, and terrestrial birds and mammals.

Several surrogate species were identified as representative species to evaluate exposure to mammalian and avian receptors based on feeding guild. Representative terrestrial species for each receptor group based on feeding guild are provided below.

Receptor Group	Scientific Name	Common Name
Mammalian Fauna		
Herbivorous Mammal	*Microtus pennsylvanicus*	Meadow Vole
Insectivorous Mammal	*Blarina brevicauda*	Northern Short-tailed Shrew
Carnivorous Mammal	*Mustela frenata*	Long-tailed Weasel
Avian Fauna		
Herbivorous Bird	*Zenaida macroura*	Mourning Dove
Invertivorous Bird	*Scolopax minor*	Woodcock
Carnivorous Bird	*Buteo jamaicensis*	Red-tailed Hawk

Representative aquatic/semi-aquatic species for each receptor group based on feeding guild are provided below.

Receptor Group	Scientific Name	Common Name
Mammalian Fauna		
Piscivorous Mammal	*Mustela vison*	Mink
Avian Fauna		
Invertivorous Bird	*Cinclus mexicanus*	American Dipper
Piscivorous Bird	*Megaceryle alcyon*	Belted Kingfisher

The six federally threatened (or proposed threatened) species identified by USFWS IPaC are presented in the following table, along with general habitat requirements.

[27] The Flathead River Riparian Area Channel is an aquatic exposure area that is surrounded by the Flathead River Riparian Area. This feature is presented in BERA Figure 2-2 and is presented as the Riparian Sampling Area on Figure 2 of this RI Report.

Scientific Name	Common Name	Status	Potential Exposure Area – General Habitat Requirements
Mammals			
Lynx canadensis	Canada Lynx	Threatened	Terrestrial – Moist, boreal spruce-fir forest habitat, particularly dense stands of young conifers.
Ursus arctos horribilis	Grizzly Bear	Threatened	Terrestrial – Relatively undisturbed mountainous habitat ranging from dense forest to subalpine meadows.
Gulo gulo luscus	North American Wolverine	Proposed Threatened	Terrestrial – High elevation habitat near the tree-line, typically in remote areas.
Birds			
Coccyzus americanus	Yellow-billed Cuckoo	Threatened	Terrestrial – Dense, wooded habitats with cover and water nearby, particularly cottonwood-dominated forests canopies.
Fish			
Salvelinus confluentus	Bull trout	Threatened	Aquatic – Cold-water, clean lake and stream habitats, with complex habitat features (e.g., riffles, pools, undercut, banks, structure).
Plants			
Silene spaldingii	Spalding's Catchfly	Threatened	Terrestrial – Bunchgrass grasslands and sagebrush-steppe, and occasionally in open-canopy pine stands.

The USFWS IPaC also indicated that critical habitats for the federally threatened bull trout and eight migratory USFWS Birds of Conservation Concern may occur at the Site.

7.2.2 COPEC Screening Process

The COPEC screening process was conducted in two primary steps. First, the comprehensive dataset for the RI, for each exposure area, was screened against the most conservative ESVs. Second, a refined COPEC screening process was conducted to identify those constituents that are most likely to drive risk management decision-making for the Site. The intent of the refinement step is to focus and streamline the overall ERAGS process. COPEC refinement in the BERA problem formulation is consistent with USEPA *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001a). Specific elements of COPEC refinement include consideration of the following:

- Use of refined ESVs: Alternative ESVs that are protective of chronic exposure but represent a broader range of protective No Observed Effect Concentration (NOEC) endpoints are considered to provide context for the potential ecological risk associated with COPECs identified in the initial screening step, and to focus evaluation of COPECs in the BERA.
- Background concentrations: COPECs in exposure areas at concentrations that are not significantly different from background concentrations may represent regional conditions that are not related to Site activities or are not likely to drive risk in the BERA.
- Frequency of detection: COPECs that are infrequently detected (less than 5%) are not likely to ultimately drive risk management decisions in the BERA process. The magnitude and spatial patterns of exceedances of ESVs and BTVs were considered as part of the refinement of infrequently detected COPECs to ensure hot spots were not overlooked.
- Dietary considerations: COPECs that serve as essential nutrients (e.g., calcium, iron, magnesium, sodium, and potassium) typically pose little threat to ecological receptors when present in

concentrations that allow them to function as nutrients. However, as described in Section 4.4.4 of the BERA, calcium received special consideration due to its potential presence at elevated concentrations due to its generation in historical waste streams at the Site.

Each of these steps and considerations are discussed in greater detail in Section 4.4 of the BERA. Additionally, COPECs retained because they lacked ESVs, or non-detected analytes with MDLs exceeding conservative ESVs were re-evaluated in the refined COPEC screening uncertainty section as part of the BERA Problem Formulation.

7.2.3 Baseline Ecological Risk Analysis

As part of the risk analysis phase, the ecotoxicity review presented in the BERA Problem Formulation was used as the basis to identify receptor-specific benchmarks to estimate the potential ecotoxicological effects of COPECs relevant receptor groups within terrestrial, transitional, and aquatic exposure areas at the Site.

Direct Contact Exposure Pathways

The effects analysis for direct contact pathways was conducted based on literature and guidance reviews to refine direct contact ESVs to represent receptor-specific exposure. Two general tiers of endpoints were identified, as available, to evaluate the potential for adverse effects related to direct contact exposure pathways:

- NOEC: Representative of the central tendency (e.g., geometric mean) of NOEC endpoints identified for relevant test organisms in literature/database studies.
- Lowest Observed Effect Concentration (LOEC): Representative of the low end of the distribution of LOEC endpoints (e.g., 15^{th} percentile or bounded study endpoints) identified for relevant test organisms in literature/database studies.

When available, existing estimates of NOECs and LOECs derived in the literature or guidance based on the geometric mean of no effect endpoints was used in the BERA. If insufficient data were available to establish geometric means, established NOECs and LOECs from literature or guidance were used instead. NOEC and LOEC endpoints for direct contact pathways are presented in Tables 5-1 through 5-3 of the BERA.

Ingestion Exposure Pathways

For ingestion pathways, the effects analysis included a detailed review of toxicity reference values (TRVs) derived from toxicological studies to evaluate the potential for adverse ecological effects associated with the estimated dietary doses. Two tiers of chronic TRVs representing no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) for growth, reproduction, and survival endpoints were identified to evaluate the potential for adverse effects via ingestion pathways:

- Low, NOAEL-based TRV (TRV_{NOAEL}): Represents the geometric mean NOAEL TRV identified in literature studies.
- High, LOAEL-based TRV (TRV_{LOAEL}): Represents a TRV based on chronic exposure, that estimates a geometric mean LOAEL in literature studies.

The two tiers of TRVs were used to evaluate potential wildlife exposure based on estimated daily doses (EDDs) calculated using screening-levels and refined exposure concentrations. TRVs were obtained primarily from peer-reviewed compilations of toxicity data for ecological risk assessment from sources.

Exposure Analysis

Risk estimates were developed in the BERA using data and observational information generated as part of the RI. Risk estimates were based on quantitative comparisons of EPCs to effects thresholds established based on the refined ecological effects analysis discussed in the preceding section. EPCs for mobile receptors were based initially on maximum concentrations, and refined assumptions were used to develop conservative estimates of average concentrations that receptors could be exposed to during their foraging activities. EPCs for risk estimation via direct contact and ingestion pathways were calculated based on UCL_{mean} COPEC concentrations to represent a conservative estimate of average exposure conditions over an exposure area.

Risk Calculation

Potential risks associated with exposure estimates presented in the BERA are expressed as HQs, and are calculated as the ratio of the EPC to ESV for the direct contact pathway and the summed EDD for ingestion pathways to the TRV for ingestion pathways, as follows:

$$HQ = \frac{EPC}{ESV} \, or \, \frac{EDD}{TRV}$$

Potential ecological risk may be characterized based on HQs for direct and ingestion pathways, as follows:

- $HQs_{NOEC/NOAEL}$ less than or equal to 1.0 indicates limited potential for adverse effects because constituent concentrations result in an exposure that has not been demonstrated to cause adverse ecological effects.
- $HQs_{NOEC/NOAEL}$ greater than 1.0 indicates that an EPC or EDD for the constituent exceeds an ecological benchmark representing a NOEC or NOAEL. The exposure may or may not constitute an actual risk; however, the potential for adverse effects cannot be dismissed and further evaluation is warranted.

HQs calculated based on LOEC ESVs or TRV_{LOAEL} endpoints were used to assess the likelihood of adverse effects based on exposure to concentrations or doses known to be associated with an adverse effect on survival, growth, or reproduction. The relative frequency and magnitude of LOEC ESVs or TRV_{LOAEL} exceedances were used to identify potential risk drivers within receptor groups and exposure areas.

7.2.4 Risk Characterization and Conclusions

Risk characterization in the BERA focused on establishing causal relationships, if present, between ecological effects and Site-specific exposure to COCs. A description of ecological risks is documented in the BERA for each assessment endpoint based on the findings and interpretations of risk estimates from corresponding measurement endpoints. The risk description provides a weight-of-evidence evaluation of the likelihood and ecological significance of the estimated risks and may be used to support risk management decision-making (USEPA, 1997a). Key elements included in the BERA risk description include:

- Identifying thresholds for ecological effects for observed exposure-response relationships;
- Estimating the likelihood of adverse ecological effects;
- Evaluating the spatial extent of risk within exposure areas; and
- Assessing the potential for identified risks to persist in the future, considering the potential for natural recovery once the sources of COCs or migration pathways to the exposure area are mitigated.

The risk characterization presented risk estimates for direct contact and ingestion pathways and characterized risk for individual exposure areas within the terrestrial, transitional, and aquatic habitat categories. Along with wildlife ingestion summaries and small range receptor exceedance maps, direct contact risk estimates are presented in Table 6-1 through Table 6-56 and Figure 6-1 through Figure 6-41 of the BERA.

The findings of the BERA are summarized below to clearly identify the assessment procedures used, the potential risks identified, and the uncertainties associated with the conclusions. The BERA findings are evaluated for each ecological exposure area to support area-specific recommendations to guide risk management decision-making for the Site.

Terrestrial Exposure Areas

The overall results of the BERA for the terrestrial exposure areas are presented in Table 28 of this RIR (Table 8-1 of the BERA) and are summarized below.

<u>Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination</u>

Current conditions in the following terrestrial exposure areas at the Site are not likely to result in adverse ecological effects resulting from exposure to Site-related COCs:

- the Eastern Undeveloped Area;
- the North-Central Undeveloped Area;
- the Western Undeveloped Area; and
- the Flathead River Riparian Area.

For the Eastern Undeveloped Area, North-Central Undeveloped Area, and Western Undeveloped Area, some sampling locations were identified with concentrations of barium or manganese that exceeded LOECs for terrestrial plants. However, these metals were present at concentrations consistent with background concentrations, and their presence was not attributed to Site-related pathways. Bis(2-ethylhexyl) phthalate in the Eastern Undeveloped Area exceeded a HQ_{NOAEL} of 1 for the yellow-billed cuckoo, a special status species that is evaluated based only NOAEL endpoints. However, as discussed in Section 7.1.7 of the BERA, bis(2-ethylhexyl) phthalate is not related to historical Site operations and is a common laboratory contaminant. Furthermore, it is not likely that yellow-billed cuckoo would be present at the Site due to its rarity in Montana and the absence of basic habitat requirements at the Site.

<u>Exposure Areas That Pose Risks Due to Site-Related Contamination</u>

Current conditions in the following terrestrial exposure areas at the Site have the potential to result in adverse effects to terrestrial receptors:

- Main Plant Area;
- Central Landfills Area;
- Incremental Sampling Methodology; and
- Industrial Landfill Area.

The key conclusions with respect to each of the above areas are presented below.

Main Plant Area

Risk estimates for the Main Plant Area, particularly in the north-central portion of this exposure area, indicate the potential for adverse effects associated with exposure to PAHs in soil within localized areas proximal to former operations. Direct contact exposure to PAHs in the Main Plant Area may result in adverse direct contact effects to terrestrial invertebrates in these localized areas. Exposure estimates for PAHs in soil resulted in wildlife ingestion HQ_{LOAEL} values that exceeded 1 for two avian receptors (the American woodcock and yellow-billed cuckoo), primarily due to the modeled ingestion of terrestrial invertebrates. In the northern portion of the Main Plant Area within the Operational Area footprint, there is potential for adverse effects for small mammals including the short-tailed shrew (exposure > HQ_{LOAEL} at 5 of 90 stations) and meadow vole (exposure > HQ_{LOAEL} at 9 of 90 stations).

Central Landfills Area

Risk estimates for the Central Landfills Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals, including copper, in soil within localized areas near the former Wet Scrubber Sludge Pond. The direct contact evaluation indicates that potential risk to soil invertebrates and terrestrial plants is low, although localized areas of PAHs and one elevated copper result at CFSB-002 (7,260 mg/kg) resulted in some NOEC and LOEC exceedances. Wildlife ingestion models indicate the potential for adverse effects to two avian receptors (the American woodcock and yellow-billed cuckoo) and short-tailed shrew associated with exposure to copper, PAHs, and aroclor 1254 assuming conservative exposure assumptions. However, wildlife exposure to copper was largely attributable to the anomalously high concentration at CFSB-002; EPCs for PAHs were also influenced by localized stations with elevated concentrations. Similar to the Main Plant Area, it is not likely that yellow-billed cuckoo would be exposed at estimated doses due to its rarity in Montana and the absence of basic habitat requirements in the Central Landfills Area. The modeled ingestion of terrestrial invertebrate prey items was the critical exposure pathway for wildlife receptors.

Incremental Sampling Methodology (ISM) Grid

Ecological risk estimates for the ISM Grid (i.e., Operational Area) were similar to risk estimates for overlapping areas within the Main Plant Area and Central Landfills Area. Direct contact exposure estimates indicate moderate risk to soil invertebrates and terrestrial plants based on soil exposure to PAHs and select metals, including copper, selenium (plants only), and zinc. Several of the DUs, particularly in the central third of the ISM Grid within the Central Landfills Area, contained concentrations of constituents that exceeded LOAEL-based benchmarks protective of small range receptors. Exceedances of LOAEL-based benchmarks in these DUs were primarily associated with LMW and HMW PAH exposure to the short-tailed shrew.

Industrial Landfill Area

Risk estimates for the Industrial Landfill Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals in soil. Risk estimates for the Industrial Landfill Area indicate limited potential for adverse effects associated with direct contact exposure to soil invertebrates and terrestrial plants. Wildlife ingestion models indicate estimated doses of nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) resulting in HQ_{LOAEL} values from 1 to 5 in the Industrial Landfill Area, primarily due to the modeled ingestion of terrestrial invertebrate prey items. As a result, nickel and PAHs in soil at the Industrial Landfills Area represent a moderate risk to ecological receptors due to direct contact and indirect ingestion exposure pathways.

Based on these findings, the potential for adverse effects to ecological receptors exposed to soil in localized areas of the Main Plant Area, Central Landfills Area, ISM Grid, and Industrial Landfill Area cannot be entirely dismissed under current conditions. Concern regarding ecological exposure is limited to small bird and mammal populations that may use modified and disturbed habitats in developed areas of the Site. However, concerns regarding exposure to receptors representing other trophic groups is reduced due to the low-quality habitat available in these areas under current, developed conditions relative to the undeveloped portions of the Site.

Transitional Exposure Areas

Transitional exposure areas were evaluated assuming both dry (terrestrial) and inundated (semi-aquatic/aquatic) conditions. The overall results of the BERA for the transitional exposure areas are presented in Table 29 of this RIR (Table 8-2 of the BERA; terrestrial scenario) and Table 30 of this RIR (Table 8-3 of the BERA; aquatic scenario) and are summarized below.

<u>Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination</u>

Current conditions in the following transitional exposure areas at the Site are not likely to result in adverse ecological effects resulting from the exposure to Site-related COCs:

- Cedar Creek Reservoir Overflow Ditch; and
- Northern Surface Water Feature.

Risk estimates for the Cedar Creek Reservoir Overflow Ditch indicate minimal risks to ecological receptors under dry and inundated scenarios. During periods of inundation, direct contact risk associated with surface water and sediment in the Cedar Creek Reservoir Overflow Ditch is expected to be minimal. Some exceedances of NOECs and LOECs in sediment and surface water were noted; however, consideration of BTVs, concentration gradients, the low magnitude and frequency of exceedances, and other factors indicate that Site-related toxicity related to these constituents is unlikely. For times of the year when inundation does not occur, direct contact risk to terrestrial organisms is expected to be negligible relative to background risk. Wildlife risks associated with direct and indirect ingestion pathways to exposure media within the Cedar Creek Reservoir Overflow Ditch were negligible. The small-range receptor evaluation indicated that a single sample in this exposure area had concentrations that exceeded only the NOAEL benchmark; however, no LOAEL-based benchmarks were exceeded. Therefore, no constituents in media associated with the Cedar Creek Reservoir Overflow Ditch are considered to be of concern for direct or indirect ingestion by wildlife receptors.

The potential for adverse effects associated with constituents in media at the Northern Surface Water Feature Area is considered minimal under both dry and inundated scenarios. During periods of inundation, direct contact exposure to COCs in surface water and sediment is expected to be limited to background exposure. During dry periods, risks to soil invertebrates and terrestrial plants are negligible. Wildlife ingestion modeling results indicated HQ_{LOAEL} values slightly exceeding 1 for barium and selenium exposure to American dipper. However, this risk estimate is likely overestimated because inundation is seasonal and varies interannually and likely does not support a permanent benthic invertebrate community to provide a forage base for American dipper.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Current conditions in the following transitional exposure areas at the Site have the potential to result in adverse effects to ecological receptors:

- North Percolation Pond Area; and
- South Percolation Ponds.

The key conclusions with respect to each of the above areas are presented below.

North Percolation Pond Area

Risk estimates for the North Percolation Pond Area indicate the potential for adverse effects based on exposure through direct contact and wildlife ingestion pathways. The greatest potential for adverse direct contact effects is associated with exposure to cyanide, fluoride, metals, and PAHs during inundated conditions in the North-East Pond. Under dry scenarios, exposure to PAHs in soil exceeded NOEC values protective of soil invertebrates. Elevated risks associated with direct and indirect ingestion by wildlife receptors were also observed in the North Percolation Pond based on the results of the food chain modeling.

The North Percolation Ponds represent low quality habitat for terrestrial or aquatic receptors, based on their use as a former wastewater management structure. Based on the degraded habitat function and value of the North Percolation Ponds, exposure pathways may be more limited than the exposure assumptions used in direct contact and ingestion pathway evaluations. However, based on the risk estimates presented in the BERA, exposure to waste related COCs in multiple media in the North Percolation Ponds has the potential to adversely affect ecological receptors. Further actions should be considered to reduce or further study the elevated ecological risk at this exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond until the future uses of the North Percolation Pond are determined.

South Percolation Ponds

The potential for adverse effects associated with constituents in media at the South Percolation Ponds is considered minimal under dry scenarios, but moderate under inundated scenarios due to potential adverse effects associated with direct contact with cyanide, metals, and PAHs in surface water. During periods of inundation, exposure to cyanide and select metals in surface water has the greatest potential for adverse effects to temporary aquatic communities via direct contact exposure pathways. Risk associated with direct and indirect ingestion by wildlife receptors in South Percolation Pond media is minimal based on the results of the food chain modeling.

Aquatic Exposure Areas

The overall results of the BERA for the aquatic exposure areas are presented in Table 31 of this RIR (Table 8-4 of the BERA) and are summarized in this section.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

The conditions in one aquatic exposure area and a portion of another do not pose significant potential for adverse ecological effects resulting from the presence of Site-related COCs. These exposure areas include:

- Flathead River (excluding the Backwater Seep Sampling Area); and
- Cedar Creek.

For the portion of the Flathead River outside of the Backwater Seep Sampling Area, risk to ecological receptors is expected to be minimal. Outside of stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations were below NOEC benchmarks based on National Recommended Water Quality Criteria (NRWQC) criterion continuous concentration (CCC) and MDEQ chronic criteria, respectively. Filtered aluminum concentrations were below MDEQ chronic criteria. Barium concentrations in surface water outside of the Backwater Seep Sampling Area are consistent with regional conditions. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Flathead River main channel.

Potential risks associated with direct contact with surface water and sediment and wildlife ingestion pathways in Cedar Creek are considered to be negligible. Direct contact EPCs are generally below NOECs, with the exception of barium. However, barium concentrations in surface water and sediment porewater are consistent upgradient to downgradient, indicating that concentrations are representative of upgradient/background conditions. Potential exposure to wildlife foraging in Cedar Creek is not considered to exceed background exposure.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Exposure conditions in two aquatic exposure areas indicate the potential for adverse ecological effects due to direct contact pathways:

- Flathead River – Backwater Seep Sampling Area; and
- Flathead River Riparian Area Channel.

The key conclusions with respect to these areas are presented below.

Flathead River – Backwater Seep Sampling Area

The evaluation of Flathead River sediment, sediment porewater, and surface water data indicate that the greatest potential for ecological exposure to Site-related constituents is associated with direct contact exposure within the Backwater Seep Sampling Area, and areas where groundwater containing cyanide and fluoride discharges to surface water. Surface water exposure was greatest to cyanide (total and free), barium, and aluminum, with greater concentrations observed in the Backwater Seep Sampling Area and adjacent stations immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028). Attenuation of surface water concentrations occurs rapidly with increasing distance from the Backwater Seep Sampling Area, particularly during periods of elevated discharge within the Flathead River. Outside of the stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations did not exceed chronic NRWQC- and DEQ-7-based benchmarks, respectively, in multiple rounds of surface water sampling events. This finding indicates that the potential area of exposure to aquatic receptors at concentrations exceeding NOECs and LOECs based on NRWQC (free cyanide) and MDEQ (total cyanide) benchmarks is spatially-limited to a groundwater-surface water mixing zone along the shoreline within and immediately adjacent to the Backwater Seep Sampling Area. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Backwater Seep Sampling Area. Further evaluation of chronic, direct contact exposure to cyanide in surface water and sediment porewater in the Backwater Seep Sampling Area/Flathead River Riparian Area Channel may be warranted.

Flathead River Riparian Area Channel

The evaluation of sediment and surface water data in the Flathead River Riparian Area Channel indicate the potential for adverse effects associated with direct contact exposure of aquatic receptors to cyanide (total and free), fluoride, and metals in surface water. Surface water data indicate potential exposure to COCs may be influenced by groundwater discharge associated with the Backwater Seep Sampling Area and surface discharge from the South Percolation Ponds. A temporal analysis of COC concentrations in surface water indicate that the greatest chronic exposure to cyanide in the Flathead River Riparian Area Channel likely occurs during periods of elevated discharge within the Flathead River.

7.2.5 Uncertainty Analysis

A critical component of the BERA is the analysis of uncertainty that is inherent in the ERA process. A thorough uncertainty analysis is necessary to understand how potential uncertainty may affect the risk estimates and associated risk characterization that may be used to support risk management decision-making. Section 7 of the BERA provides an evaluation of the uncertainty associated with each of the following factors, including an assessment of whether the uncertainty would contribute to potential over- or under-estimation of risk.

- Adequacy, Representativeness, and Quality of Sampling Data
- Temporal (Seasonal) Variability in Exposure
- Exposure to Pathways Not Included in the BERA
- Potential Exposure to Constituents Not Detected in the Datasets
- Potential Exposure to Constituents Lacking Ecotoxicity Data
- Selection of Substitution Value for Non-Detected Results
- Background Evaluation Methods
- Appropriateness of Variables Used in the Dose Rate Models
- Uncertainty Associated with the HQ Method of Estimating Risk
- Uncertainty Associated with Acid Volatile Sulfide-Simultaneously Extracted Metals (AVS-SEM) Results
- Calculation of HQs for Large Home Range Receptors
- Incremental and Discrete Soil Sample Results in the Operational Area

As with the BHHRA, the BERA presented the potential ecological risks using a RME approach that used conservative estimates and assumptions coupled with more realistic scenarios to ensure that actual Site risks are not underestimated. Conservative assumptions regarding exposure concentrations, bioavailability of constituents, receptor selection/presence at a given exposure area, uptake of constituents into food and prey items, and the selection of benchmarks used to assess potential toxicity result in an estimate of ecological risk that is more likely to be overestimated than underestimated.

8. Summary and Conclusions

This RI is a comprehensive study that sets a foundation to inform risk management decisions and evaluate remedial alternatives for the CFAC Site. The dataset collected within the Study Area and from reference areas during RI supports the development of a CSM that describes the following:

- The nature and extent of contamination in various environmental media in the Study Area;
- The degree to which these media are affected by ongoing sources and by contaminant fate and transport processes that affect the spatial and temporal distribution of contamination; and
- The resultant risks to human health and ecological receptors from exposure to COCs.

Sections 8.1 through 8.4 summarize the findings of the RI.

8.1 Nature and Extent of COCs Contributing to Risk

Multiple phases of investigation were completed as part of the RI in order to generate a comprehensive dataset for the Study Area. A summary of the scope of work for each investigation phase of the RI, including the Phase I SC, Supplemental South Pond Assessment, Phase II SC, and the Background Investigation, is provided in Section 2.

Approximately 39 chemicals were retained as COPCS for evaluation in the BHHRA and approximately 40 chemicals were retained as COPCs for evaluation in the BERA. However, the results of the risk assessments indicated that only a subset of COPCs contribute to risk estimates that exceed *de minimis* levels for potential human health risk (i.e., excess lifetime cancer risk of 1E-6 for carcinogens; or hazard quotient of 1 for non-carcinogens) or pose moderate risk from the ecological perspective[28]. Thus, these COCs contributing to risk exceeding *de minimis* levels were the focus for in-depth evaluation within the nature and extent of contamination sections of this RIR. In addition, although cyanide and fluoride are not risk drivers with respect to soil, both of these primary COCs were retained for in-depth evaluation of their nature and extent in soil due to their prevalence in groundwater and surface water.

The COCs identified to drive risk at the Site for each media type and exposure area based on the results of the BHHRA and BERA are summarized in the table below. Tables 9 and 10 detail the exposure areas in which each of these COCs were identified and the selection criteria for the BHHRA and BERA COCs contributing to risk, respectively.

[28] BERA Soil COC selection criteria:
Med-Large Home Range Wildlife: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Small Home Range Wildlife: Sample points exceeding LOAEL-based back calculated value;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance);
ISM samples: localized exceedance was not justification for removal based on averaged EPC across DU;
PAH direct contact exposure selected based on exposure areas with points exceeding MATC.
BERA Sediment/Porewater selection criteria:
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COCs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance).

COCs Contributing to Risk	Soil	Groundwater (UU)	Groundwater (BUU)	Sediment	Surface Water	Porewater
BHHRA COCs	arsenic manganese benzo(a)anthracene benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene dibenz(a,h)anthracene indeno(1,2,3-c,d)pyrene* PCB-1254 (Aroclor 1254)	total cyanide free cyanide arsenic bis(2-ehtylhexyl)phthalate fluoride	arsenic antimony	arsenic benzo(a)pyrene benzo(b)fluoranthene* dibenz(a,h)anthracene* indeno(1,2,3-c,d)pyrene*	NA	NA
BERA COCs	barium copper nickel selenium thallium* vanadium zinc HMW PAHs LMW PAHs PCB-1254 (Aroclor 1254)	NA	NA	barium cadmium* copper total cyanide free cyanide lead* nickel* selenium* vanadium* zinc* HMW PAHs* LMW PAHs*	aluminum barium cadmium* copper total cyanide free cyanide iron zinc* fluoride* Multiple PAH compounds*	barium copper total cyanide free cyanide

A summary of the nature and extent of these COCs is provided below.

Nature and Extent of Cyanide and Fluoride

Based on review of the box and whisker plots and statistical summary tables (Appendices Q1 and Q2 and Tables 11 and 12), cyanide concentrations in soil across the Site ranged from <0.02 to 137 mg/kg. The highest concentrations of cyanide in soil were generally found in the former industrial and operational areas of the Site including the Central Landfills Area, Main Plant Area, and North Percolation Ponds; as well as the South Percolation Ponds and Backwater Seep Sampling Area. Concentrations of cyanide in the South Percolation Ponds are higher than those in the Main Plant Area and Central Landfills Area but are generally within the same order of magnitude. Outside of the Former Drum Storage Area, concentrations of cyanide in soil in the Central Landfills Area were generally similar to or less than those observed in the other industrial areas of the Site. Concentrations of cyanide observed in the undeveloped areas of the Site, the Industrial Landfill Area, and the Flathead River Area are similar to the range of background concentrations.

As described in the Phase II SC Data Summary Report, BHHRA, and BERA, concentrations of COCs generally decrease with increasing depth. The surface soil interval (0 to 0.5 ft-bls) generally has the greatest COC concentrations. The average concentration of total cyanide generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals (17-22 and >22 ft-bls) were generally collected to delineate hot spots identified in the Phase I SC, and, therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average cyanide concentration of 1.31 mg/kg
- 0.5-2 ft-bls – average cyanide concentration of 1.30 mg/kg
- 2-10 ft-bls – average cyanide concentration of 0.77 mg/kg
- 10-17 ft-bls – average cyanide concentration of 0.08 mg/kg
- 17-22 ft-bls – average cyanide concentration of 0.08 mg/kg

* Only present within the North Percolation Ponds; co-located with COCs contributing to risk.

- >22 ft-bls – average cyanide concentration of 0.09 mg/kg

Based on review of the box and whisker plots and statistical summary tables (Appendix Q3 and Tables 11 and 12), fluoride concentrations in soil across the Site ranged from <0.014 to 810 mg/kg, with the highest concentrations in the Main Plant, North Percolation Ponds, and Central Landfill Area; and a single high detection in the Industrial Landfill Area. Outside these areas, fluoride concentrations within the Site were less than those observed in the industrial areas, and typically ranged between 1 to 20 mg/kg. Concentrations of fluoride in background areas were generally less than concentrations on-Site, with the exception of Background Reference Area #4 which is within the same order of magnitude (i.e., 1 to 10 mg/kg) as the undeveloped areas, Flathead River Area, South Percolation Ponds, and the majority of the Industrial Landfill Area.

The average concentration of fluoride generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals (17-22 and >22 ft-bls) were generally collected to delineate hot spots identified in the Phase I SC, and therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average fluoride concentration of 43.45 mg/kg
- 0.5-2 ft-bls – average fluoride concentration of 35.53 mg/kg
- 2-10 ft-bls – average fluoride concentration of 27.57 mg/kg
- 10-17 ft-bls – average fluoride concentration of 16.80 mg/kg
- 17-22 ft-bls – average fluoride concentration of 20.07 mg/kg
- >22 ft-bls – average fluoride concentration of 8.19 mg/kg

Cyanide and fluoride are identified as the primary COCs in groundwater based upon the frequency of detection and exceedance of water quality standards, as well as based upon contribution to estimated risks at the Site. Concentrations are highest adjacent to the primary source areas within the Plume Core Area, (footprint of elevated concentrations of cyanide and fluoride in upper hydrogeologic unit groundwater), including the West Landfill and Wet Scrubber Sludge Pond. Groundwater statistical summary tables are included in Table 4. Cyanide and fluoride emanate from this source area (as described further in Section 8.2) and migrate in south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the Plume Core Area were less than one-half of the MCL in all six rounds of sampling and are typically non-detect or at background concentrations[29] adjacent to Aluminum City.

Based on review of the box and whisker plots and statistical summary tables (Appendices R1, R2, R3, and R4 and Table 15), cyanide concentrations in surface water ranged from <2 to 630 µg/L, with the majority of the highest concentrations in the Backwater Seep Sampling Area and Riparian Sampling Area, followed by the South Percolation Ponds and North Percolation Ponds. The distribution of free cyanide was similar to total cyanide, but at lower concentrations. The hydrogeologic studies (i.e., groundwater and surface water elevation data) indicate that groundwater discharges to the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; and ultimately to the Flathead River. Thus, the source of elevated cyanide concentrations in these Site features is groundwater. Concentrations of cyanide in the

[29] Within the western and northern portions of the Site, the detections of fluoride in groundwater are similar to the average 160 µg/l concentration measured in public and community water supply wells.

remaining surface water features (Flathead River, Cedar Creek, Cedar Creek Reservoir Overflow Ditch, and Northern Surface Water Feature) were mostly non-detect (i.e., <2 µg/L).

Based on review of the box and whisker plots and statistical summary tables (Appendices S1 and S2 and Table 16), cyanide concentrations in sediment ranged from <0.067 to 8.5 mg/kg, with the highest concentrations occurring in the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds). Concentrations in the Flathead River, Cedar Creek, and the Northern Surface Water Feature were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as cyanide concentrations in background sediment.

Based on review of the box and whisker plots and statistical summary tables (Appendix R5 and Table 15), fluoride concentrations in surface water ranged from <12 to 22,400 µg/L, with the highest concentrations in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area and the South Percolation Ponds. Concentrations in the Flathead River, Cedar Creek, the Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature were markedly lower and generally within the same order of magnitude as fluoride concentrations in background surface water.

Based on review of the box and whisker plots and statistical summary tables (Appendix S3 and Table 16), fluoride concentrations in sediment ranged from <0.17 to 219 mg/kg, with the maximum concentration in the North Percolation Ponds, followed by the Backwater Seep Sampling Area/Riparian Sampling Area. Concentrations of fluoride in the Northern Surface Water Feature were less than those in the North Percolation Ponds and the Backwater Seep Sampling Area/Riparian Sampling Area, but at concentrations higher than background sediment. Concentrations in the Flathead River and Cedar Creek were markedly lower and mostly non-detect. Concentrations in these features were generally within the same order of magnitude as concentrations in background sediment.

Nature and Extent of PAHs

For presentation purposes, benzo(a)pyrene was selected as an indicator analyte for PAHs because it was the most frequently detected at elevated concentrations, and it is the PAH that contributes most to estimated risk in each exposure area.

Based on review of the box and whisker plots and statistical summary tables (Appendix Q4 and Tables 11 and 12), benzo(a)pyrene concentrations in soil range from <0.001 to 2,000 mg/kg, with the highest concentrations in the North-Percolation Ponds and Main Plant Area. Concentrations of benzo(a)pyrene were generally similar throughout the Central Landfills Area, Industrial Landfill Area, South Percolation Ponds, and Eastern Undeveloped Area, with the exception of a few high concentrations in the Central Landfills Area and Industrial Landfill Area. Benzo(a)pyrene concentrations were lowest within the North-Central and Western Undeveloped Areas, the Flathead River Area, and the Backwater Seep Sampling Area. Within these areas, concentrations were similar to, or within the same order of magnitude, as background reference areas.

The average concentration of benzo(a)pyrene generally decreased with increasing depth, as summarized below (Tables 9a through 9g of the Phase II SC Data Summary Report). It should be noted that some deeper depth intervals were generally collected to delineate hot spots identified in the Phase I SC, and therefore, don't necessarily exhibit a continual decrease in increasing depth.

- 0-0.5 ft-bls – average benzo(a)pyrene concentration of 15.59 mg/kg
- 0.5-2 ft-bls – average benzo(a)pyrene concentration of 6.91 mg/kg

- 2-10 ft-bls – average benzo(a)pyrene concentration of 18.41 mg/kg
- 10-17 ft-bls – average benzo(a)pyrene concentration of 0.46 mg/kg
- 17-22 ft-bls – average benzo(a)pyrene concentration of 0.91 mg/kg
- >22 ft-bls – benzo(a)pyrene was non-detect

SVOCs were detected in less than 6% of groundwater samples collected from monitoring wells screened in the upper hydrogeologic unit throughout the RI (Table 14a of the Phase II SC Data Summary Report). Groundwater statistical summary tables are included in Tables 13 and 14. In general, SVOCs are not impacting groundwater quality across the Site, with the exception of isolated detections in a few monitoring wells.

The results of the RI indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of PAHs in sediment, followed by the effluent ditch, and the North-West Percolation Pond. The soils/sediments within the North Percolation Pond appear to be the source of the PAHs in the pond surface water (as described further in Section 8.2). As presented in the box and whisker plots and statistical summary tables (Appendices R7 and S4 and Tables 15 and 16), concentrations of benzo(a)pyrene in sediment and surface water are highest in the North Percolation Ponds, followed by the Backwater Seep Sampling Area.

Nature and Extent of Metals

The areal distribution of the detected metals is widespread across the Site. Sixteen different metals were detected at frequencies between 90% and 100% of the samples collected. It should be noted that all of the metals detected can be found as naturally occurring substances in the environment. Based on their frequency of detection and magnitude of concentrations, select metals are indicative of naturally occurring substances in the environment, as documented via the Background Investigation included as Section 4.4.2.3 within the Phase II SC Data Summary Report. However, the areal distribution of metal detections and the magnitude of metal concentrations around certain Site features indicate that concentrations of some metals are in part a result of the former operations. This is most evident for the North Percolation Pond Area, and to a lesser extent for soil samples from within the Main Plant, Central Landfill, and Industrial Landfill Areas. Concentrations of metals driving risk are presented in a soil statistical summary, included in Tables 11 and 12, and soil box plots, included in Appendices Q6 through Q14.

The results of the RI confirmed that many metals, which can naturally occur in the environment, were detected frequently in groundwater samples. The most commonly detected metals in groundwater in all six sampling rounds were barium, calcium, potassium, and sodium, which were detected in 100% of groundwater samples. The highest concentrations of these metals were limited to monitoring wells located downgradient of the West Landfill and Wet Scrubber Sludge Pond.

Total concentrations of antimony, arsenic, barium, lead, mercury, and thallium were detected at elevated concentrations in surface water samples. As presented in Table 15, elevated concentrations of metals in surface water were most commonly observed in the North and South Percolation Ponds and Riparian Sampling Area.

Thirteen different metals were detected in 100% of sediment samples collected during the RI. Aluminum and arsenic were detected at the highest concentrations in sediment. A single elevated concentration of aluminum occurred in the sediment sample collected from CFSDP-024 within the North-East Percolation

Pond; while elevated arsenic was wide-spread throughout the sediment samples, but were highest in the North Percolation Ponds, Backwater Seep Sampling Area, and Riparian Sampling Area.

Nature and Extent of PCBs

PCBs were detected in 2% of all soil samples. The most commonly detected type of PCB was Aroclor 1254. Aroclor 1254 was observed in one surficial soil sample (CFSB-227 in the Central Landfill Area with a concentration of 1.2 mg/kg) and in four samples (shallow sample collected from CFSB-224, surface and shallow sample collected from CFSB-227, and shallow sample collected from CFSB-229), all in the Central Landfill Area within the footprint of the Operational Area, south of the West Scrubber Sludge Pond. Aroclor 1254 was also detected in three surface samples and one shallow sample collected west of the West Rectifier Yard within the Main Plant Area. As presented in the box and whisker plots and statistical summary tables (Appendix Q5 and Tables 11 and 12), aroclor 1254 was not detected in any other exposure areas. PCBs were not detected in any sediment samples.

Detailed Discussion of Individual COCs

A discussion of individual COCs contributing to risk at the Site is provided below. The discussion addresses ranges of concentration, vertical and horizontal extent of contamination, and spatial patterns of contamination within the Site, and (where applicable) comparison to BTVs to assess if hot spots or areas of elevated concentrations relative to background concentrations are present. Comparisons to human health and ecological screening criteria are not included in the discussion below; all comparisons to screening levels are discussed in Section 7 and provided in the Phase II SC Data Summary Report.

8.2 Sources of COCs in Site Media

The RIR identified the following Site features as potential source areas:

- Main Plant Area;
- Landfills;
- Percolation Ponds; and
- Former Drum Storage Area.

A summary of each potential source area is provided below.

Main Plant Area

The findings from the RI indicate that concentrations of PAHs, cyanide, and fluoride are the primary COCs present in soil throughout the Main Plant Area based upon the frequency and magnitude of exceedances of screening levels. However, these concentrations in soil do not appear to be a significant source of cyanide and fluoride in groundwater. Despite the widespread occurrence of PAHs in soil across the area and the exceedances of various screening criteria, PAHs are generally non-detect in groundwater in all sampling rounds. The concentrations of cyanide and fluoride in groundwater within and downgradient (south) of the Main Plant Area are less than those measured in wells upgradient (north) of the Main Plant Area near the landfills, suggesting that the Main Plant soils are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the soils were a significant source, an increase in cyanide and fluoride concentrations would be expected).

Landfills

The West Landfill and Wet Scrubber Sludge Pond are the primary sources of cyanide and fluoride in groundwater at the Site. The iso-concentration maps indicate that the highest cyanide and fluoride concentrations in groundwater appear to originate at the Wet Scrubber Sludge Pond and the West Landfill consistently during all six rounds of sampling. Adjacent to the West Landfill and Wet Scrubber Sludge Pond, groundwater elevations in the upper hydrogeologic unit can fluctuate more than 70 feet seasonally. Cyanide and fluoride emanate from this source area and migrate in south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the Plume Core Area were less than one-half of the USEPA MCL in all six rounds of sampling and are typically non-detect or at background concentrations adjacent to Aluminum City.

The Center Landfill is likely a secondary source area for the observed elevated cyanide and fluoride concentrations in groundwater, based on the elevated concentrations in groundwater adjacent to the landfill.

The results of the RI indicated that the Industrial Landfill, East Landfill, and Sanitary Landfill are not significant contributing sources to the cyanide and fluoride in groundwater.

Percolation Ponds

The results of the RI indicated that the North-East Percolation Pond and its influent ditch typically contained among the highest concentrations of cyanide and PAHs in soil and sediment, followed by the effluent ditch, and the North-West Percolation Pond. However, concentrations of cyanide and fluoride in groundwater downgradient (south) of the North Percolation Ponds are less than those measured in wells upgradient of the ponds. This continued decrease in concentrations as groundwater flows beneath the ponds suggests that the ponds are not a significant source of the cyanide and fluoride concentrations observed in groundwater (i.e., if the ponds were a significant source, an increase in cyanide and fluoride concentrations would be expected). Additionally, although SVOCs were detected frequently in North Percolation Pond soil, they were not detected in any groundwater monitoring wells immediately downgradient from the North Percolation Ponds, indicating that the SVOCs in soil are not a source to groundwater. However, it’s likely that the soils/sediments within the North Percolation Pond are the source of the COCs in the surface water from the pond.

The results of the RI indicate that the South Percolation Ponds are not a source of contamination at the Site, but as discussed below in Section 8.3, groundwater seepage and the migration of water from South Percolation Ponds could potentially impact surface water, sediment, sediment porewater within the Flathead River.

Former Drum Storage Area

In the Former Drum Storage Area, cyanide and fluoride were detected at elevated concentrations in surface and shallow samples but decreased by an order of magnitude with increasing depth. Based on this finding, this feature may be a contributing source to the elevated cyanide and fluoride concentrations in groundwater that appear to originate beneath this area and the West Landfill and Wet Scrubber Sludge Pond. However, the decrease in concentrations with depth and the absence of any observed waste materials suggest that any contribution from this area to groundwater contamination is much less than the contribution from the adjacent landfills.

8.3 Contaminant Fate and Transport

An evaluation of the fate and transport of COCs at the Site was conducted based upon knowledge of the Site physical characteristics, the concentrations and extent of COCs in various media, and source area characteristics. The evaluation considered the physicochemical characteristics of the COCs and various physical, chemical, and biological processes that influence contaminant fate and transport. The fate and transport analysis focused on contaminants that were identified as primary COCs through the risk assessment process, as described in Section 7. A summary of the fate and transport evaluation is provided below.

Migration of COCs from Source Areas

The results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective. All other primary COCs identified in soil, sediment, or surface water samples within the source areas appear to be stable and not migrating at levels of concern based upon risk assessment results.

The six rounds of groundwater sampling conducted during the RI indicate that the West Landfill and Wet Scrubber Sludge Pond appear to be the primary sources of the cyanide and fluoride in groundwater. The Center Landfill and Former Drum Storage Area appear to be potentially contributing sources, but to a lesser degree than the West Landfill and Wet Scrubber Sludge Pond.

A consistent pattern was observed during all six rounds of groundwater sampling; cyanide and fluoride migrates in a south/south-westerly direction from the aforementioned landfills toward the Flathead River. Total cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit decrease with increasing distance away from the landfills. Cyanide and fluoride concentrations measured in monitoring wells outside of the contours shown on Plate 18 and Plate 19 are less than one-half of the USEPA MCL in all six rounds of sampling. Cyanide concentrations are typically non-detect in the north, west, and south-west portions of the Site (e.g., near Aluminum City) during all rounds of sampling. These data, as well as the six rounds of groundwater flow data, indicate that migration of the cyanide and fluoride is not in the direction towards Aluminum City, but rather follows the southerly groundwater flow patterns towards the Flathead River. The findings also indicate that there is limited vertical migration and cyanide and fluoride are primarily migrating horizontally within the upper hydrogeologic unit.

The hydrogeologic studies (i.e., groundwater elevation data and surface water elevation data) indicate that groundwater discharges to the Flathead River. The Backwater Seep Sampling Area, the Riparian Sampling Area, and the South Percolation Pond Area are all located within the extent of the "Seep Area" where groundwater is expressed from the upper hydrogeologic unit to the Flathead River. Elevated concentrations of cyanide in sediment and sediment porewater are present in the Backwater Seep Sampling Area and Riparian Sampling Area. Elevated concentrations of fluoride in sediment porewater are present in the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds; though fluoride was not detected at elevated concentrations in sediment in these features. These concentrations, along with the groundwater flow, indicate the groundwater is the primary source of the cyanide and fluoride concentrations in surface water, sediment, and sediment porewater measured in these areas. Concentrations of cyanide in surface water, sediment, and sediment porewater up-river in the Flathead River were typically non-detect, further supporting that groundwater discharge is the primary source of the cyanide in the sediment and surface water of the Backwater Seep Sampling Area and Riparian Sampling Area. In addition, direct discharges into the South Percolation Ponds could have contributed to surface water and sediment impacts in this area.

All surface water, sediment, and sediment porewater samples collected within the main stem of the Flathead River downgradient of the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds during all six rounds of sampling were generally non-detect for total cyanide. Fluoride was generally detected in surface water and sediment samples collected within the main stem of the Flathead River downgradient of these areas, but at concentrations below screening levels; fluoride was typically not detected in sediment porewater samples. These findings confirmed that the elevated levels of cyanide and fluoride found in groundwater and in the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Pond, are not measurably impacting surface water, sediment, or sediment porewater quality within the main channel of the Flathead River.

Cyanide and Fluoride Flux

The results of the RI indicate that groundwater is the primary migration pathway for the potential transport of COCs from the various source areas. In addition, results indicate that cyanide and fluoride are the primary COCs from a contaminant migration/fate and transport perspective. Results of subsurface characterization and analytical laboratory testing were utilized to estimate the mass flux of cyanide and fluoride in the affected media (i.e., upper hydrogeologic unit groundwater). The purpose of the assessment was to evaluate the general areas of the Site where most of the groundwater COCs are located as a basis for evaluating potential future Site impacts and to focus on areas for evaluating potential remediation alternatives in the FS. Contaminant characteristics and physicochemical properties including leaching, advection and dispersion, diffusion, precipitation/dissolution, partitioning and adsorption, biological degradation and transformation, dilution, photolysis, and volatilization were considered as part of the fate and transport analysis.

The evaluations were conducted for areas directly downgradient of the primary source areas (i.e., landfills) and in areas south of the landfills along the groundwater flow path toward the Flathead River. Plate 20 and Plate 21 present the locations of groundwater flow transects and sub-transects that were evaluated for cyanide and fluoride in groundwater, respectively. In general, the transects cover the extent of the Plume Core Area and in some cases, extend outside the Plume Core Area. Groundwater velocity, contaminant velocity, and mass flux estimates were developed based on a number of interpretations and assumptions; therefore, the quantities presented should be considered approximate, order of magnitude estimates.

The results of the cyanide and fluoride mass flux is provided below. Data inputs and assumptions for calculations to generate these estimates, including Darcy velocity/specific discharge, groundwater effective velocity, and contaminant velocity are provided in Section 6.4.

Contaminant flux for cyanide and fluoride was calculated for each sub-transect. Contaminant flux calculations for each sub-transect are presented in Tables 24 and 25. A summary of the mass flux for each flow transect (sum of mass flux for all respective sub-transects) is provided below. Two estimates of contaminant flux dependent on the saturated thickness are presented to provide a range of flux.

Flow Transect	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
A	5,449,998	2,724,999	25,051,208	12,525,604

Flow Transect	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
B	2,112,737	1,056,369	6,825,376	3,412,688
C	1,669,841	834,920	1,948,292	974,146
D	1,092,460	546,230	1,939,107	969,554

The above evaluation indicates that mass flux of cyanide and fluoride are highest immediately downgradient of the landfills, which is consistent with the understanding that the landfills are the primary source of cyanide and fluoride in groundwater. Contaminant flux decreases with increasing distance from the landfills. With respect to cyanide, the decrease in flux with increasing distance from the landfills is likely due to various attenuation process such as biodegradation and sorption.

Fluoride flux decreases by an order of magnitude in Flow Transects B and C, downgradient of the landfills and north of the Main Plant Area. A potential explanation for this decrease in concentration is the precipitation of fluoride out of groundwater immediately outside and downgradient of the primary source area as described in Section 6.3.4.

Cyanide and fluoride flux continue to decrease with increasing distance from the source area toward Flathead River. As stated in Section 3.2.4, groundwater from the upper hydrogeologic unit is expressed with the extent of the “Seep Area” and then to Flathead River. Based on the data collected during the RI, cyanide was non-detect in all surface water, sediment, and sediment porewater samples collected within the main stem of the Flathead River downgradient of the Backwater Seep Sampling Area, Riparian Sampling Area, and South Percolation Ponds during all six rounds of sampling, with the exception of one surface water sample collected in Phase I Round 1. Fluoride was generally detected in surface water and sediment samples collected within the main stem of the Flathead River, but at concentrations below screening levels. These findings indicate that the cyanide and fluoride groundwater flux estimated in Flow Transect D just north of Flathead River is not measurably impacting the surface water quality of the main channel of the Flathead River.

The observations noted above (i.e., cyanide and fluoride not measurably impacting Flathead River) were further evaluated by calculating the maximum concentration that could be expected in the river based upon the groundwater flux estimates previously described, assuming all the groundwater discharged to the river. The data inputs and assumptions for this estimate is provided in Section 6.4.3.

Based upon the results of the calculations, it is estimated that the maximum hypothetical concentration in the Flathead River for cyanide and fluoride utilizing the minimum Flathead River discharge for the three-year period is 0.135 µg/L and 0.240 µg/L, respectively. Utilizing the mean Flathead River discharge for June 2018, the hypothetical concentration in the Flathead River for cyanide and fluoride is 0.021 µg/L and 0.037 µg/L, respectively.

These hypothetical concentrations are below the limits of detection for cyanide and fluoride (detection limit of 2 µg/L and 12 µg/L respectively), which is consistent with the fact that both constituents are typically non-detect within the main stem of the Flathead River. In addition, the hypothetical cyanide and fluoride concentrations are below the most conservative human health and ecological screening criteria (i.e., USEPA Tapwater RSL of 0.15 µg/L and 80 µg/L, respectively).

8.4 Baseline Risk Assessment

The objective of the BHHRA and BERA was to conservatively characterize the potential risks to human and ecological receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action. The BHHRA and BERA met this objective and provides the risk managers with the necessary information to support the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human or ecological receptors from exposure to COCs.

A summary table of the COCs in exposure areas which contribute to risk estimates that exceed *de minimis* levels for potential human health risk (i.e., excess lifetime cancer risk of 1E-6 for carcinogens; or hazard quotient of 1 for non-carcinogens) or pose moderate risk from the ecological perspective was provided in summary Section 8.1.

8.4.1 BHHRA Risk Characterization and Conclusions

The BHHRA evaluated potential human health risks to receptors at the Site. Data collected during the RI investigation activities within each exposure area were used to characterize potential risks. The receptors evaluated in the current and future scenarios, as appropriate, included industrial workers (industrial worker, landfill management worker, stormwater management worker), construction workers, recreational trespassers (ATV rider and hunter), adolescent trespassers, adolescent and adult recreationist (boaters, floaters, and fisher), and residents (adult and child). The BHHRA included the evaluation of potential exposures to COPCs in soil, surface water, sediment, and groundwater, as well as the potential exposure to COPCs in fish (i.e., uptake of COPCs in surface water) by the recreationist (fisher) and exposure to COPCs in venison (i.e., uptake of COPCs in soil) by recreational trespassers (hunter). Default and Site-specific exposure assumptions were developed for these receptors.

Table 9-1 through Table 9-35 and Appendix I and Appendix J of the BHHRA presented the calculated cumulative risks for each receptor by COPC in each potentially complete exposure scenario identified in the CEM. Table 27 of this RIR (Table 9-36 of the BHHRA) presents a summary of the ELCR and HI for each receptor.

Based on the evaluation of the BHHRA results, the following general conclusions can be drawn regarding human health risks at the Site.

<u>Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination</u>

The conditions in the following exposure areas at the Site do not pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs. These exposure areas include:

- North-Central Undeveloped Area;
- Eastern Undeveloped Area;
- Western Undeveloped Area;
- South Percolation Pond Area;
- Flathead River Area; and
- Backwater Seep Sampling Area.

As shown in Table 27, it is noted that risk characterization results for the three undeveloped areas (i.e., Eastern, Western, and North-Central Undeveloped Areas) indicate a ELCR above 1E-06 or a non-cancer risk (HI >1) for exposure to surface soil. However in each case, the risk was due to the presence of arsenic or manganese in soil, both of which were found in background soil samples at comparable concentrations. Therefore, these are not attributable to Site-related contamination, but rather to naturally occurring background conditions.

In addition, it is noted in the Western Undeveloped Area that one isolated detection of bis(2-ethylhexyl) phthalate in groundwater, at a concentration of 73 µg/L at monitoring well CFMW-069 during the October 2018 sampling event resulted in a calculated risk of 1E-05 for drinking water exposure under the hypothetical future residential scenario evaluated for this area. The prior sample collected at this location in June 2018 was non-detect, with an MDL of 4.4 µg/L. Bis(2-ethylhexyl) phthalate is not a contaminant associated with historical operations at the Site, and it has not been identified at levels of concern anywhere on the Site. Given these factors and that bis(2-ethylhexyl) phthalate is recognized as common field and lab contaminant (associated with plasticware), the calculated risk appears overestimated and unrelated to Site-related contamination.

<u>Exposure Areas That Pose Risks Due to Site-Related Contamination</u>

The conditions in the following exposure areas at the Site pose ELCR above *de minimis* levels or potential for non-cancer effects due to the presence of Site-related COCs:

- North Percolation Pond Area;
- Main Plant Area;
- Central Landfills Area: and
- Industrial Landfill Area.

In addition, groundwater within the Plume Core Area poses risk based upon a hypothetical future residential drinking water scenario.

The key conclusions with respect to each of the above areas are presented below.

<u>North Percolation Pond Area</u>: This area presents high potential risk within the Site, with a calculated cumulative ELCR of 1E-04 for a stormwater management work scenario and 5E-05 for a trespasser scenario. In each case, the risk driver is exposure to PAHs within the pond. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the North Percolation Pond Area.

<u>Main Plant Area</u>: Risk in the Main Plant Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 8E-06 for the industrial worker scenario. Discrete samples were collected across the entirety of the Main Plant Area (i.e., 290 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the construction worker and trespasser scenario to 2E-05 for the industrial worker scenario. The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the ELCR within the Main Plant Area. This area also exhibits some potential non-cancer effects with the HI of 4 (developmental, nervous, and thyroid target organ systems) for both the industrial and construction worker.

<u>Central Landfills Area</u>: Risk in the Central Landfills Area was calculated using both discrete and ISM soil sampling data. Using the discrete data, the calculated cumulative ELCRs range from 6E-07 for the trespasser scenario to 1E-05 for the landfill management worker scenario. Discrete samples were collected

across the entirety of the Central Landfills Area (i.e., 128 acres). Using the ISM data, the calculated cumulative ECLRs range from 2E-06 for the trespasser scenario to 3E-05 for the landfill management worker. The ISM data was collected from a limited portion of the Site (i.e., a combined 43 acres between the Central Landfills Area and Main Plant Area). PAHs in soil are the primary risk driver for the Central Landfills Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Central Landfill Area.

Industrial Landfill Area: The calculated cumulative ELCRs range from 2E-06 for the trespasser scenario to 1E-05 for the landfill management worker scenario. PAHs in soil are the primary risk driver for the Industrial Landfill Area. The BHHRA results indicate no potential for non-cancer risk effects due to COCs in the Industrial Landfill Area.

Groundwater Plume Core Area: As noted within the BHHRA, CFAC intends to prohibit the use of groundwater beneath the Site for potable use. However, as required by USEPA, the BHHRA evaluated risk associated with exposure to groundwater within the Plume Core Area under a residential exposure scenario[30] to provide a conservative evaluation of potential health risk in the absence of any controls.

The Plume Core Area was defined based upon evaluation of the cyanide and fluoride extents in groundwater within the upper hydrogeologic unit as described in Section 3.1. Within this area, the calculated HIs for future adult exposure to cyanide, free cyanide, and fluoride are 7E+01, 2E+00, and 5E+00, respectively; and cumulative HI is 8E+01. The calculated HIs for future child exposure to cyanide, free cyanide, and fluoride are 1E+02, 4E+00, and 9E+00, respectively, and cumulative HI is 1E+02. The results indicate potential for non-cancer effects if groundwater within the Plume Core Area is to be used as a source of drinking water.

In addition to the non-cancer effects, the results of the BHHRA indicate a calculated cumulative ELCR of 2E-04 for lifetime exposure (i.e. including exposure as a child, adolescent, and adult) to arsenic in groundwater under a future residential exposure scenario. Review of the data indicates that the EPC of 9.8 µg/L is primarily driven by elevated concentrations measured in two wells (CFMW-012 and CFMW-015), where maximum concentrations were approximately 92 µg/L. The vast majority of wells within the Plume Core Area are non-detect for arsenic, with the typical MDL less than 1 µg/L.

The objective of the BHHRA was to conservatively characterize the potential risks to human receptors posed by exposure to affected environmental media at the Site in the absence of any remedial action. The BHHRA met this objective and provides the risk managers with the necessary information to support the FS in the evaluation of remedial alternatives to address any unacceptable current or future risk to human receptors from exposure to COCs.

8.4.2 BERA Risk Characterization and Conclusions

The findings of the BERA are summarized below to clearly identify the assessment procedures used, the potential risks identified, and the uncertainties associated with the conclusions. The BERA findings are evaluated for each ecological exposure area to support area-specific recommendations to guide risk management decision-making for the Site.

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[30] The BHHRA evaluated residential exposure in the Western Undeveloped Area including an assessment of the cumulative potential residential risks from exposure to soils and upper hydrogeologic groundwater (see BHHRA: Section 6.1.7 Western Undeveloped Area). In addition, the BHHRA assessed the cumulative potential residential risks from exposure to the plume core area groundwater as well as site-wide groundwater in the below upper hydrogeologic unit (see BHHRA: Section 6.1.13 Additional Groundwater Evaluation).

Terrestrial Exposure Areas

The overall results of the BERA for the terrestrial exposure areas are presented in Table 28 of this RIR (Table 8-1 of the BERA) and are summarized below.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

Current conditions in the following terrestrial exposure areas at the Site are not likely to result in adverse ecological effects resulting from exposure to Site-related COCs:

- the Eastern Undeveloped Area;
- the North-Central Undeveloped Area;
- the Western Undeveloped Area; and
- the Flathead River Riparian Area.

For the Eastern Undeveloped Area, North-Central Undeveloped Area, and Western Undeveloped Area, some sampling locations were identified with concentrations of barium or manganese that exceeded LOECs for terrestrial plants. However, these metals were present at concentrations consistent with background concentrations, and their presence was not attributed to Site-related pathways. Bis(2-ethylhexyl) phthalate in the Eastern Undeveloped Area exceeded a HQ_{NOAEL} of 1 for the yellow-billed cuckoo, a special status species that is evaluated based only NOAEL endpoints. However, as discussed in Section 7.1.7 of the BERA, bis(2-ethylhexyl) phthalate is not related to historical Site operations and is a common laboratory contaminant. Furthermore, it is not likely that yellow-billed cuckoo would be present at the Site due to its rarity in Montana and the absence of basic habitat requirements at the Site.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Current conditions in the following terrestrial exposure areas at the Site have the potential to result in adverse effects to terrestrial receptors:

- Main Plant Area;
- Central Landfills Area;
- Incremental Sampling Methodology Grid; and
- Industrial Landfill Area.

The key conclusions with respect to each of the above areas are presented below.

Main Plant Area

Risk estimates for the Main Plant Area, particularly in the north-central portion of this exposure area, indicate the potential for adverse effects associated with exposure to PAHs in soil within localized areas proximal to former operations. Direct contact exposure to PAHs in the Main Plant Area may result in adverse direct contact effects to terrestrial invertebrates in these localized areas. Exposure estimates for PAHs in soil resulted in wildlife ingestion HQ_{LOAEL} values that exceeded 1 for two avian receptors (the American woodcock and yellow-billed cuckoo), primarily due to the modeled ingestion of terrestrial invertebrates. In the northern portion of the Main Plant Area within the Operational Area footprint, there is potential for adverse effects for small mammals including the short-tailed shrew (exposure > HQ_{LOAEL} at 5 of 90 stations) and meadow vole (exposure > HQ_{LOAEL} at 9 of 90 stations).

Central Landfills Area

Risk estimates for the Central Landfills Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals, including copper, in soil within localized areas near the former Wet Scrubber Sludge Pond. The direct contact evaluation indicates that potential risk to soil invertebrates and terrestrial plants is low, although localized areas of PAHs and one elevated copper result at CFSB-002 (7,260 mg/kg) resulted in some NOEC and LOEC exceedances. Wildlife ingestion models indicate the potential for adverse effects to two avian receptors (the American woodcock and yellow-billed cuckoo) and short-tailed shrew associated with exposure to copper, PAHs, and aroclor 1254 assuming conservative exposure assumptions. However, wildlife exposure to copper was largely attributable to the anomalously high concentration at CFSB-002; EPCs for PAHs were also influenced by localized stations with elevated concentrations. Similar to the Main Plant Area, it is not likely that yellow-billed cuckoo would be exposed at estimated doses due to its rarity in Montana and the absence of basic habitat requirements in the Central Landfills Area. The modeled ingestion of terrestrial invertebrate prey items was the critical exposure pathway for wildlife receptors.

ISM Grid

Ecological risk estimates for the ISM Grid (i.e., Operational Area) were similar to risk estimates for overlapping areas within the Main Plant Area and Central Landfills Area. Direct contact exposure estimates indicate moderate risk to soil invertebrates and terrestrial plants based on soil exposure to PAHs and select metals, including copper, selenium (plants only), and zinc. Several of the DUs, particularly in the central third of the ISM Grid within the Central Landfills Area, contained concentrations of constituents that exceeded LOAEL-based benchmarks protective of small range receptors. Exceedances of LOAEL-based benchmarks in these DUs were primarily associated with LMW and HMW PAH exposure to the short-tailed shrew.

Industrial Landfill Area

Risk estimates for the Industrial Landfill Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals in soil. Risk estimates for the Industrial Landfill Area indicate limited potential for adverse effects associated with direct contact exposure to soil invertebrates and terrestrial plants. Wildlife ingestion models indicate estimated doses of nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) resulting in HQ_{LOAEL} values from 1 to 5 in the Industrial Landfill Area, primarily due to the modeled ingestion of terrestrial invertebrate prey items. As a result, nickel and PAHs in soil at the Industrial Landfills Area represent a moderate risk to ecological receptors due to direct contact and indirect ingestion exposure pathways.

Based on these findings, the potential for adverse effects to ecological receptors exposed to soil in localized areas of the Main Plant Area, Central Landfills Area, ISM Grid, and Industrial Landfill Area cannot be entirely dismissed under current conditions. Concern regarding ecological exposure is limited to small bird and mammal populations that may use modified and disturbed habitats in developed areas of the Site. However, concerns regarding exposure to receptors representing other trophic groups is reduced due to the low-quality habitat available in these areas under current, developed conditions relative to the undeveloped portions of the Site.

Transitional Exposure Areas

Transitional exposure areas were evaluated assuming both dry (terrestrial) and inundated (semi-aquatic/aquatic) conditions. The overall results of the BERA for the transitional exposure areas are presented in Table 29 of this RIR (Table 8-2 of the BERA; terrestrial scenario) and Table 30 of this RIR (Table 8-3 of the BERA; aquatic scenario) and are summarized below.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

Current conditions in the following transitional exposure areas at the Site are not likely to result in adverse ecological effects resulting from the exposure to Site-related COCs:

- Cedar Creek Reservoir Overflow Ditch; and
- Northern Surface Water Feature.

Risk estimates for the Cedar Creek Reservoir Overflow Ditch indicate minimal risks to ecological receptors under dry and inundated scenarios. During periods of inundation, direct contact risk associated with surface water and sediment in the Cedar Creek Reservoir Overflow Ditch is expected to be minimal. Some exceedances of NOECs and LOECs in sediment and surface water were noted; however, consideration of BTVs, concentration gradients, the low magnitude and frequency of exceedances, and other factors indicate that Site-related toxicity related to these constituents is unlikely. For times of the year when inundation does not occur, direct contact risk to terrestrial organisms is expected to be negligible relative to background risk. Wildlife risks associated with direct and indirect ingestion pathways to exposure media within the Cedar Creek Reservoir Overflow Ditch were negligible. The small-range receptor evaluation indicated that a single sample in this exposure area had concentrations that exceeded only the NOAEL benchmark; however, no LOAEL-based benchmarks were exceeded. Therefore, no constituents in media associated with the Cedar Creek Reservoir Overflow Ditch are considered to be of concern for direct or indirect ingestion by wildlife receptors.

The potential for adverse effects associated with constituents in media at the Northern Surface Water Feature Area is considered minimal under both dry and inundated scenarios. During periods of inundation, direct contact exposure to COCs in surface water and sediment is expected to be limited to background exposure. During dry periods, risks to soil invertebrates and terrestrial plants are negligible. Wildlife ingestion modeling results indicated HQ_{LOAEL} values slightly exceeding 1 for barium and selenium exposure to American dipper. However, this risk estimate is likely overestimated because inundation is seasonal and varies interannually and likely does not support a permanent benthic invertebrate community to provide a forage base for American dipper.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Current conditions in the following transitional exposure areas at the Site have the potential to result in adverse effects to ecological receptors:

- North Percolation Pond Area; and
- South Percolation Ponds

The key conclusions with respect to each of the above areas are presented below.

North Percolation Pond Area

Risk estimates for the North Percolation Pond Area indicate the potential for adverse effects based on exposure through direct contact and wildlife ingestion pathways. The greatest potential for adverse direct contact effects is associated with exposure to cyanide, fluoride, metals, and PAHs during inundated conditions in the North-East Pond. Under dry scenarios, exposure to PAHs in soil exceeded NOEC values protective of soil invertebrates. Elevated risks associated with direct and indirect ingestion by wildlife receptors were also observed in the North Percolation Pond based on the results of the food chain modeling.

The North Percolation Ponds represent low quality habitat for terrestrial or aquatic receptors, based on their use as a former wastewater management structure. Based on the degraded habitat function and value of the North Percolation Ponds, exposure pathways may be more limited than the exposure assumptions used in direct contact and ingestion pathway evaluations. However, based on the risk estimates presented in the BERA, exposure to waste related COCs in multiple media in the North Percolation Ponds has the potential to adversely affect ecological receptors. Further actions should be considered to reduce or further study the elevated ecological risk at this exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond until the future uses of the North Percolation Pond are determined.

South Percolation Ponds

The potential for adverse effects associated with constituents in media at the South Percolation Ponds is considered minimal under dry scenarios, but moderate under inundated scenarios due to potential adverse effects associated with direct contact with cyanide, metals, and PAHs in surface water. During periods of inundation, exposure to cyanide and select metals in surface water has the greatest potential for adverse effects to temporary aquatic communities via direct contact exposure pathways. Risk associated with direct and indirect ingestion by wildlife receptors in South Percolation Pond media is minimal based on the results of the food chain modeling.

Aquatic Exposure Areas

The overall results of the BERA for the aquatic exposure areas are presented in Table 31 of this RIR (Table 8-4 of the BERA) and are summarized in this section.

Exposure Areas That Do Not Pose Risks Due to Site-Related Contamination

The conditions in one aquatic exposure area and a portion of another do not pose significant potential for adverse ecological effects resulting from the presence of Site-related COCs. These exposure areas include:

- Flathead River (excluding the Backwater Seep Sampling Area); and
- Cedar Creek.

For the portion of the Flathead River outside of the Backwater Seep Sampling Area, risk to ecological receptors is expected to be minimal. Outside of stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations were below NOEC benchmarks based on NRWQC CCC and MDEQ chronic criteria, respectively. Filtered aluminum concentrations were below MDEQ chronic criteria. Barium concentrations in surface water outside of the Backwater Seep Sampling Area are consistent with regional conditions. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Flathead River main channel.

Potential risks associated with direct contact with surface water and sediment and wildlife ingestion pathways in Cedar Creek are considered to be negligible. Direct contact EPCs are generally below NOECs, with the exception of barium. However, barium concentrations in surface water and sediment porewater are consistent upgradient to downgradient, indicating that concentrations are representative of upgradient/background conditions. Potential exposure to wildlife foraging in Cedar Creek is not considered to exceed background exposure.

Exposure Areas That Pose Risks Due to Site-Related Contamination

Exposure conditions in two aquatic exposure areas indicate the potential for adverse ecological effects due to direct contact pathways:

- Flathead River – Backwater Seep Sampling Area; and
- Flathead River Riparian Area Channel.

The key conclusions with respect to these areas are presented below.

Flathead River – Backwater Seep Sampling Area

The evaluation of Flathead River sediment, sediment porewater, and surface water data indicate that the greatest potential for ecological exposure to Site-related constituents is associated with direct contact exposure within the Backwater Seep Sampling Area, and areas where groundwater containing cyanide and fluoride discharges to surface water. Surface water exposure was greatest to cyanide (total and free), barium, and aluminum, with greater concentrations observed in the Backwater Seep Sampling Area and adjacent stations immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028). Attenuation of surface water concentrations occurs rapidly with increasing distance from the Backwater Seep Sampling Area, particularly during periods of elevated discharge within the Flathead River. Outside of the stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-026 through CFSWP-028), free and total cyanide concentrations did not exceed chronic NRWQC- and DEQ-7-based benchmarks, respectively, in multiple rounds of surface water sampling events. This finding indicates that the potential area of exposure to aquatic receptors at concentrations exceeding NOECs and LOECs based on NRWQC (free cyanide) and MDEQ (total cyanide) benchmarks is spatially-limited to a groundwater-surface water mixing zone along the shoreline within and immediately adjacent to the Backwater Seep Sampling Area. Potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal in the Backwater Seep Sampling Area. Further evaluation of chronic, direct contact exposure to cyanide in surface water and sediment porewater in the Backwater Seep Sampling Area/Flathead River Riparian Area may be warranted.

Flathead River Riparian Area Channel

The evaluation of sediment and surface water data in the Flathead River Riparian Area Channel indicate the potential for adverse effects associated with direct contact exposure of aquatic receptors to cyanide (total and free), fluoride, and metals in surface water. Surface water data indicate potential exposure to COCs may be influenced by groundwater discharge associated with the Backwater Seep Sampling Area and surface discharge from the South Percolation Ponds. A temporal analysis of COC concentrations in surface water indicate that the greatest chronic exposure to cyanide in the Flathead River Riparian Area Channel likely occurs during periods of elevated discharge within the Flathead River.

8.5 Recommended Preliminary Remedial Action Objectives (PRAOs)

RAOs are qualitative statements that describe what a remedial action is intended to accomplish at a Site. RAOs can be specific to certain COCs, environmental media, and the exposure pathways and receptors to be protected. RAOs can take into consideration both current and future land use, as well as groundwater and surface water beneficial use designations. For the RIR, RAOs are considered preliminary (PRAOs) and are subject to change as a result of stakeholder discussion and development of the FS.

Based on the findings of the BHHRA and BERA, it is recommended that the following exposure areas be carried forward for evaluation of remedial alternatives in the FS:

- Main Plant Area;
- Central Landfills Area;
- Industrial Landfill Area;
- North Percolation Pond Area;
- South Percolation Ponds;
- Backwater Seep Sampling Area and Flathead River Riparian Area Channel; and
- Groundwater (Plume Core Area).

The following exposure areas generally exhibit *de minimis* risk to human health and ecological receptors and, as such, are not proposed for further evaluation in the FS:

- Western Undeveloped Area;
- North-Central Undeveloped Area (including the Northern Surface Water Feature);
- Eastern Undeveloped Area;
- Cedar Creek;
- Cedar Creek Reservoir Overflow Ditch; and
- Flathead River (outside of the Backwater Seep Sampling Area).

The FSWP will specify the RAOs for each of the aforementioned areas and also develop preliminary remediation goals (PRGs) for various media in each area, as appropriate. PRGs specify concentrations of COCs in various media that are protective of human health and ecological receptors. Therefore, PRGs can be used to help define the area and volume of environmental media that need to be addressed by a remedial action. PRGs also are used to assist in the screening of technologies and development of remedial action alternatives that precede the detailed analysis of alternatives in the FS.

Based upon the results of the BHHRA and BERA, the following are recommended PRAOs to be considered, and potentially further refined or expanded upon, during preparation of the FSWP. These PRAOs are based upon reasonable anticipated future use of each exposure area as outlined in the BHHRA and BERA. It is also noted that the approach for developing and applying the PRGs referenced below will be presented in the FSWP.

- PRAO #1: Protect future Site workers and trespassers by reducing potential for direct contact exposure to the COCs exceeding PRGs. Based upon BHHRA results, PRAO #1 is applicable to the Main Plant Area, Central Landfills Area, Industrial Landfill Area, and the North Percolation Pond Area. PAHs are the primary risk driver in these areas.
- PRAO #2: Protect terrestrial ecological receptor communities by reducing potential for direct contact exposure to the COCs exceeding PRGs in the Main Plant Area, Central Landfills Area, and Industrial Landfill Area. Based upon the BERA results, PAHs are a primary risk driver in each area, as well as select metals in Central Landfills Area and Industrial Landfill Area.
- PRAO #3: Protect transitional ecological receptor communities by reducing potential for direct contact and wildlife ingestion exposures to COCs exceeding PRGs in the North Percolation Pond Area and South Percolation Ponds. PAHs, cyanide, and metals are risk drivers in these areas.

- PRAO #4: Protect aquatic ecological receptor communities by reducing potential for direct contact exposure to COCs exceeding PRGs in the Backwater Seep Sampling Area and the Riparian Sampling Area.
- PRAO #5: Improve and protect groundwater quality by reducing the migration of COCs from identified source areas.
- PRAO #6: Improve groundwater and surface water quality towards promulgated water quality standards to the extent practicable.

Respectfully submitted,

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TABLES

Notes Utilized Throughout Tables and Appendices	
# > LOD	Number Of Samples Greater Than The Limit Of Detection
% > LOD	Percent Of Samples Greater Than The Limit Of Detection
AVS	Acid Volatile Sulfide
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BTV	Background Threshold Value
BUU	Below Upper Hydrogeologic Unit
CFMW	Columbia Falls Monitoring Well
CFPWP	Columbia Falls Porewater Point
CFSB	Columbia Falls Soil Boring
CFSDP	Columbia Falls Sediment Point
CFSWP	Columbia Falls Surface Water Point
COPC	Contaminant of Potential Concern
COPEC	Constituent of Potential Ecological Concern
DEQ-7	Department Of Environmental Quality
DEQ-7 Human Health Standards	Montana Department Of Environmental Quality - DEQ Circular 7 Human Health Standards
DEQ-7 Chronic	Montana Department Of Environmental Quality - DEQ Chronic Water Quality Standards
DEQ-7 Acute	Montana Department Of Environmental Quality - DEQ Acute Water Quality Standards
DI	Dissolved
DOC	Dissolved Organic Compound
DQO	Data Quality Objectives
DRY	Well or Water Feature Is Dry
DTB	Depth To Bottom
DTP	Depth To Product
DTW	Depth To Water
DUP	Duplicate Sample
EA	Exposure Area
EDD	Estimated Daily Dose
ELCR	Excess Lifetime Cancer Risk
EPA	United States Environmental Protection Agency
EPA Drinking MCL	United States Environmental Protection Agency Risk Based Screening Level Drinking Water MCL
EPA Tapwater RSL	United States Environmental Protection Agency Risk Based Screening Level Tapwater RSL
EPC	Exposure Point Concentration
ESV	Ecological Screening Value
FD	Field Duplicate
F_{OC}	Fraction of Soil Organic Carbon (g/g)
ft	Feet
ft-btoc	Feet Below Top Of Casing
ft/day	Feet Per Day
ft^2	Cubic Feet
ft-als	Feet Above Land Surface
ft-amsl	Feet Above Mean Sea Level
ft-bls	Feet Below Land Surface
gal/year	Gallons Per Year
GW	Groundwater
GWE	Groundwater Elevation
HI	Hazard Index
HMW	High Molecular Weight
HQ	Hazard Quotient
Industrial RSL	United States Environmental Protection Agency Industrial Soil Regional Screening Level
ISM	Incremental Sampling Methodology
ISS	Incremental Soil Sampling
J	Estimated Value
J-	Estimated Low Bias
J+	Estimated High Bias
K	Hydraulic Conductivity
K_d	Distributed Coefficient
K_{OC}	Soil Adsorption Coefficient (L/Kg)
LL	Low Level
LMW	Low Molecular Weight
LOAEL	Lowest Observed Adverse Effect Level Dose
LOD	Limit Of Detection
LOEC	Lowest Observed Effect Concentration
Max	Maximum
MATC	Maximum Acceptable Toxicant Concentration
MDEQ	Montana Department Of Environmental Quality
MDL	Method Detection Limit
mg/day	Milligrams Per Day
mg/ft^2	Milligrams Per Cubic Feet
mg/kg	Milligrams Per Kilogram
mg/l	Milligrams Per Liter
Min	Minimum
MSW	Municipal Solid Waste
N	Normal
NA	No Information Available

Notes Utilized Throughout Tables and Appendices	
ND	Non Detect
NM	Not Measured
No.	Number
NOAEL	No Observed Adverse Effect Level Dose
NOEC	No Observed Effect Concentration
ORP	Oxidation Reduction Potential
P2	Phase II Site Characterization
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PW	Sediment Porewater
R1	Round 1
R2	Round 2
Residential RSL	United States Environmental Protection Agency Residential Soil Regional Screening Level
Risk SSL	United States Environmental Protection Agency Human Health Protection Of Ground Water - Risk-Based Soil Screening Level
R_f	Retardation Factor
RF	Groundwater Velocity/Solute Velocity
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SE or SD	Sediment
SEM	Simultaneously Extracted Metals
SO	Soil
SO #1	Soil Background Reference Area #1: Glacial Till And Alluvium
SO #2	Soil Background Reference Area #2: Fluvial Deposits And Riverwash
SO #3	Soil Background Reference Area #3: Fluvial Deposits And Riverwash
SO #4	Soil Background Reference Area #4: Mountainous Land With Glacial Deposits
SPL	Spent Potliner
SSPA	Supplemental South Pond Assessment
SVOC	Semivolatile Organic Compound
SW	Surface Water
SW #1/SD #1	Surface Water/Sediment Background Reference Area #1: Upgradient Flathead River
SW #2/SD #2	Surface Water/Sediment Background Reference Area #2: Upgradient Cedar Creek
T	Total
T	LCS Or LCSD Is Outside Acceptance Limits
TAL	Target Analyte List
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
U	Indicates That Analyte Was Not Detected At The Limit Reported
UCL	Upper Confidence Limit
µg/L (ug/l)	Micrograms Per Liter
UNK	Unknown
USEPA	United States Environmental Protection Agency
UU	Upper Hydrogeologic Unit
VOC	Volatile Organic Compound
WG	Groundwater
Median Statistics Only Calculated if 50% of Results are Above LOD / Mean Statistics Only Calculated if 15% of Results are Above LOD	
All Statistics And Counts Of Exceedances In The Statistical Summaries Include Non-Detects With ½ MDL Value.	

Table 1. Landfill Construction Detail Summary
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Landfill	Years of Operation	Construction	Type of Waste	Area (acres)	Estimated Geotech Tests	Depth of Landfill (ft-bls)	Maximum Height of Landfill (ft-als)	Estimated Bottom of Landfill to GW (ft)	Associated Upper Unit Monitoring Wells	Minimum DTW (ft-bls)	Maximum DTW (ft-bls)	Minimum GWE (NAVD88)	Maximum GWE (NAVD88)
West	1955 – 1981	Unlined Earth Cap 1981 Clay Cap 1992 Synthetic Cap 1994	SPL (1955 – 1970 only), sanitary, MSW, scrap (steel, wood, strapping, scrap from shops)	7.8	8	35	30	71	CFMW-002 CFMW-007 CFMW-010 CFMW-012	35.52	86.65	3058.28	3113.68
Center ("Carbon")	1970 – 1980	Unlined Clay Cap 18-inches of Till	SPL, solvents, sanitary, scrap	1.8	2	0	15	91	CFMW-016 CFMW-016a CFMW-017 CFMW-020	57.20	139.11	3061.84	3109.74
East	1980 – 1990	Clay Liner 6-inch Clay Cover and Synthetic Cap 18-inch Vegetated Till Cover	SPL (1980-1990)	2.4	3	0	30	124	CFMW-018 CFMW-023	108.70	130.31	3079.67	3103.60
Sanitary	1981 – 1982	Clay Liner Cap-type Unknown	MSW, sanitary	3.8	4	Unknown	Unknown	60 (from grade)	CFMW-008 CFMW-008a	22.58	93.60	3099.37	3170.39
Industrial	1970s – Operations ceased in 2009	Unknown	Scrap metal, wood, MSW	12.4	13	Unknown	Unknown	UNK	CFMW-003 CFMW-066 CFMW-067	18.85	30.60	3121.48	3140.08
Wet Scrubber Sludge Pond	1955 – 1980	Unlined Earth Cap 1981	Sludge from wet scrubber (until 1976)	10.8	11	Unknown	Unknown	UNK	CFMW-012 CFMW-015 CFMW-016 CFMW-016a CFMW-019 CFMW-021	57.20	105.24	3058.31	3109.39
Asbestos (Northern)	1980s – 2009	Unknown	Asbestos	Unknown	-	Unknown	Unknown	UNK	NA	NA	NA	NA	NA
Asbestos (Southern)	1980s	Unknown	Asbestos	Unknown	-	Unknown	Unknown	UNK	NA	NA	NA	NA	NA
North Leachate Pond	Unknown – 1994	Hypalon Liner	NA	0.6	1	Unknown	Unknown	UNK	Associated with the East Landfill	NA	NA	NA	NA
South Leachate Pond	Unknown – 1990	Hypalon Liner	NA	0.9	1	Unknown	Unknown	UNK	Associated with the East Landfill	NA	NA	NA	NA
North-East Percolation Pond	1955 – 2009 2009 – present	NA	Various operations from Main Plant Stormwater	2	NA	Unknown	Unknown	UNK	CFMW-028 CFMW-028a CFMW-029 CFMA-031	29.67	73.07	3058.21	3079.82
North-West Percolation Pond	1972 – 2009 2009 – present	NA	Water from NE Percolation Pond, connected by unlined ditch	8	NA	Unknown	Unknown	UNK	CFMW-025 CFMW-025b CFMW-026	24.44	44.27	3059.99	3083.19
West Percolation Pond	1980s – 2009 2009 – present	NA	Boiler blowdown/stormwater	0.05	NA	Unknown	Unknown	UNK	CFMW-043	41.55	55.70	3054.21	3068.36
South Percolation Ponds	1960s	Unlined ditch	Main Plant wastewater and stormwater; various operations	2.4 (West) 1.2 (Middle) 6.6 (East)	NA	Unknown	Unknown	UNK	CFMW-061 CFMW-064	8.29	14.40	3013.44	3020.58

Table 2. Summary of RI Field Activities
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Field Program	Dates Completed	Associated Reports	Description
Phase I Site Characterization	April 2016 through July 2017	Remedial Investigation/Feasibility Study Work Plan Phase I Sampling and Analysis Plan Sampling and Analysis Plan Addendum Phase I Site Characterization Data Summary Report Groundwater/Surface Water Data Summary Report	Geophysical surveys - Electrical Resistivity/Induced Polarization Survey (April 2016) of the landfills and Ground Penetrating Radar (May 2016)
			Site Reconnaissance conducted in April 2016
			Installation of 44 new monitoring wells from May to August 2016 - 28 water table monitoring wells within the upper hydrogeologic unit and 16 deeper wells within the below upper hydrogeologic unit
			Development of newly installed monitoring wells to establish hydraulic connection with the hydrogeologic units
			Completion of 124 soil borings and collection of over 419 soil samples across the Site
			Collection of 110 incremental soil samples within the Operational Area
			Asbestos landfill exploratory test pitting was conducted in August 2016 at 15 locations within the Asbestos Landfills
			Landfill soil gas survey was completed in April 2016 at 14 locations in the West Scrubber Sludge Pond, West Landfill, Sanitary Landfill, Center Landfill, and Industrial Landfill and ten existing landfill vents in the West Landfill
			Passive soil gas investigation was conducted in June 2016 at eight locations within the Former Hazardous Waste Drum Storage Area and at two locations within the Operational Area
			Asbestos surface sampling for asbestos-containing material was conducted in July and August 2017 within the Asbestos Landfills at 56 sample locations
			Collection of four rounds of groundwater samples during quarterly sampling and completion of four comprehensive gauging rounds
			Round 1 (September 2016) - 60 groundwater samples were collected
			Round 2 (December 2016) - 58 groundwater samples were collected
			Round 3 (March 2017) - 61 groundwater samples were collected
			Round 4 (June 2017) - 63 groundwater samples were collected
			Completion of slug testing at all newly installed monitoring wells
			Collection of four rounds of surface water samples during quarterly sampling
			Round 1 (June through September 2016) - 22 surface water samples were collected
			Round 2 (December 2016) - 19 surface water samples were collected
			Round 3 (March 2017) - 24 surface water samples were collected
			Round 4 (June 2017) - 23 surface water samples were collected
			Collection of sediment samples took place during Round 1 surface water sampling (September 2016) - 12 sediment samples were collected
Supplemental South Pond Assessment	October and November 2017	Remedial Investigation/Feasibility Study Work Plan Expedited Risk Assessment Sampling and Analysis Plan for South Percolation Ponds Phase II Site Characterization Data Summary Report	Collection of 43 soil samples from 18 boring locations within the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Ponds
			Collection of 13 surface water samples from the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Ponds
			Collection of 16 sediment samples from the Backwater Seep Sampling Area, Riparian Sampling Area, and the South Percolation Ponds
Phase II Site Characterization	June 2018 through October 2018	Remedial Investigation/Feasibility Study Work Plan Phase II Sampling and Analysis Plan Phase II Site Characterization Data Summary Report	Geophysical surveys - Ground Penetrating Radar for the Rectifier Yards (April 2018)
			Site Reconnaissance conducted in April 2018
			Installation of eight new water table monitoring wells conducted during April and May 2018
			Completion of 142 soil borings and collection of 449 soil samples conducted from April 2018 through June 2018
			Collection of 51 samples within the Main Plant building in May 2018
			Collection of 36 soil samples for the landfill cover investigation conducted in May and June 2018
			Collection of 24 samples for Operational Area ISM sampling conducted in May 2018
			Collection of two rounds of groundwater samples during the high and low-water seasons and completion of two comprehensive gauging rounds
			Round 1 (June 2018) - 76 groundwater samples were collected
			Round 2 (October 2018) - 72 groundwater samples were collected
			Completion of slug testing at all newly installed monitoring wells
			Collection of two rounds of surface water samples during the high and low-water seasons
			Round 1 (June 2018) - 54 surface water samples were collected
			Round 2 (October 2018) - 35 surface water samples were collected
			Collection of 44 sediment samples throughout the high and low-water seasons
			Collection of 44 sediment porewater samples throughout the high and low-water seasons
Background Investigation	June 2018 through October 2018	Remedial Investigation/Feasibility Study Work Plan Background Investigation Sampling and Analysis Plan Phase II Site Characterization Data Summary Report	Completion of 40 soil borings and collection of 40 background soil samples within the four background soil reference areas conducted in September 2018
			Collection of two rounds of background surface water samples during high and low-water seasons within the two background surface water reference areas
			Round 1 (June 2018) - 20 background surface water samples were collected
			Round 2 (October 2018) - 20 background surface water samples were collected
			Collection of 20 background sediment samples within the two background surface water reference areas in October 2018

Table 3. Summary of Soil Samples Collected During the Remedial Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Stations	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Phase I	Soil	Operational Area	Operational Area Soil Investigation	4/18/16 through 7/26/16	51	110	Assess whether any potential source areas are present in this former Operational Area	TCL SVOCs 8270, TAL Metals 6010, TCL PCBs 8082, TCL Pesticides 8081 (surface samples only), Total Cyanide 9012, Fluoride 300, Lead in sieved form (from select surface samples)	Phase I SAP
Phase I	Soil	Asbestos Landfills	Asbestos Landfill Test Pitting	8/15/16 through 8/18/16	15	0	Further define the extent and contents of the landfills	No samples collected - only visual inspections were made at the test pit locations	Phase I SAP
Phase I	Soil	Site-Wide	Site-Wide Soil Borings and Soil Sampling	5/18/16 through 8/31/16	124	419	Confirm potential source areas identified in the preliminary CSM presented in the RI/FS Work Plan and to identify any potential additional source areas	TCL VOCs 8260, TCL SVOCs 8270, TAL Metals 6010, TCL PCBs 8082, TCL Pesticides 8081 (select surface samples only), Total Cyanide 9012, Fluoride 300, Lead in sieved form (from select surface samples), PCDD/PCDFs (samples within the Rectifier Area only), TOC via Lloyd Kahn (only samples from deep monitoring well locations), and Grain Size Analysis D422, Bulk Density D-2937-04, and Moisture Content D2216-90 (from select samples)	Phase I SAP
SSPA	Soil	Backwater Seep Area, Riparian Sampling Area, South Percolation Ponds	SSPA Sampling	10/31/17 through 11/8/17	18	43	Characterize the area and vertical extent of COPCs in the South Percolation Pond Area and surrounding areas	TCL VOCs 8260, TCL SVOCs 8270, TAL Metals 6010, Total Cyanide 9012, Fluoride 300, TOC via Lloyd Kahn, and Grain Size Analysis D422 (from select samples)	Expedited Risk Assessment SAP
Phase II	Soil	Site-Wide	Site-Wide Soil Borings and Soil Sampling	4/28/18 through 6/28/18	134	405	Delineate the horizontal and vertical nature and extent of COPCs	TCL SVOCs LL 8270, TAL Metals 6010, Total Cyanide 9012, Fluoride 300, TOC via Lloyd Kahn (0-2 ft-bls samples only); and PCDD/PCDF 8290A and TCL PCBs (for Dioxin and Furan compounds delineation); TCL PCBs (for PCB delineation in the Operational Area); TAL Total Chromium 6020A and Cr(VI) 7196A (for chromium characterization); and VOCs (for opportunistic samples)	Phase II SAP
Phase II	Soil	Site-Wide	Monitoring Well Soil Borings and Soil Sampling	4/30/18 through 5/16/18	8	44	Delineate the horizontal and vertical nature and extent of COPCs at the locations of the monitoring wells	TCL SVOCs LL 8270, TAL Metals 6010, Total Cyanide 9012, Fluoride 300, and TOC via Lloyd Kahn (0-2 ft-bls samples only); and TOC via Lloyd Kahn, Grain Size Analysis D422, Moisture Content D2216-90, and Bulk Density D-2937-04 for samples collected above and within the water table	Phase II SAP
Phase II	Soil	Operational Area	Operational Area Soil Investigation	5/14/18 through 5/23/18	12	24	Retest the areas of the Operational Area that were incorrectly sampled during the Phase I SC	TCL SVOCs LL 8270, TAL Metals 6010, TCL PCBs 8082, TCL Pesticides 8081 (surface samples only), Total Cyanide 9012, Fluoride 300, and TOC via Lloyd Kahn	Phase II SAP
Phase II	Soil	Main Plant Area	Main Plant Building Footprint and Utility Tunnel Soil Borings	5/11/18 through 5/17/18	16	51	Characterize the soil beneath the former potroom basements and to investigate soil quality surrounding the Main Plant utility tunnel	TCL VOCs 8260, TCL SVOCs LL 8270, TAL Metals 6010, Total Cyanide 9012, and Fluoride 300	Phase II SAP
Phase II	Soil	Sanitary Landfill, Center Landfill, Wet Scrubber Sludge Pond Landfill, and Industrial Landfill	Landfill Cover Soil Borings	5/5/18 through 6/16/18	18	36	Characterize the nature of the landfill covers, and to evaluate the geotechnical parameters of the landfill covers for use in the FS	TCL VOCs 8260, TCL SVOCs LL 8270, TAL Metals 6010, Total Cyanide 9012, and Fluoride 300, Grain Size Analysis D422, Moisture Content D2216-90, Bulk Density D-2937-04, specific gravity D854, Atterberg limits D4318, Porosity, Standard Proctor D698, and Flexible or Fixed Wall Permeability D2434	Phase II SAP

Table 4. Summary of Groundwater Samples Collected During the Remedial Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Phase I	Groundwater	On-Site Monitoring Wells	Phase I Round 1 GW/SW Sampling	9/12/16 through 9/21/16	60	Quarterly groundwater sampling event to characterize groundwater quality	Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, and Free Cyanide at certain locations	Phase I SAP
Phase I	Groundwater	On-Site Monitoring Wells	Phase I Round 2 GW/SW Sampling	12/5/16 through 12/19/16	58	Quarterly groundwater sampling event to characterize groundwater quality	Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, and Free Cyanide at certain locations	Phase I SAP
Phase I	Groundwater	On-Site Monitoring Wells	Phase I Round 3 GW/SW Sampling	3/20/17 through 3/30/17	61	Quarterly groundwater sampling event to characterize groundwater quality	Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, and Free Cyanide at certain locations	Phase I SAP
Phase I	Groundwater	On-Site Monitoring Wells	Phase I Round 4 GW/SW Sampling	6/19/17 through 6/29/17	63	Quarterly groundwater sampling event to characterize groundwater quality	Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, and Free Cyanide at certain locations	Phase I SAP
Phase II	Groundwater	On-Site Monitoring Wells	Phase II Round 1 GW/SW Sampling	6/6/18 through 6/26/18	76	High-water groundwater sampling event to evaluate temporal variability and seasonal concentrations	Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total and Dissolved Cyanide 335.4, Total and Dissolved Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, PCBs, and Dioxin and Furan compounds at certain locations	Phase II SAP
Phase II	Groundwater	On-Site Monitoring Wells	Phase II Round 2 GW/SW Sampling	10/3/18 through 10/23/18	72	Low-water groundwater sampling event to evaluate temporal variability and seasonal concentrations	Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total and Dissolved Cyanide 335.4, Total and Dissolved Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B, SVOC 8270D, PCBs, and Dioxin and Furan compounds at certain locations	Phase II SAP

Table 5. Summary of Surface Water Samples Collected During the Remedial Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Phase I	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, South Percolation Ponds	Phase I Round 1 GW/SW Sampling	6/6/16 through 9/16/16	22	Quarterly surface water sampling event to characterize surface water quality	Total TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B and SVOC 8270D at certain locations	Phase I SAP
Phase I	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, South Percolation Ponds	Phase I Round 2 GW/SW Sampling	11/30/16 through 12/20/16	19	Quarterly surface water sampling event to characterize surface water quality	Total TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B and SVOC 8270D at certain locations	Phase I SAP
Phase I	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, North-West Percolation Pond, South Percolation Ponds	Phase I Round 3 GW/SW Sampling	3/13/17 through 4/4/17	24	Quarterly surface water sampling event to characterize surface water quality	Total TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B and SVOC 8270D at certain locations	Phase I SAP
Phase I	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, North-East Percolation Pond, South Percolation Ponds	Phase I Round 4 GW/SW Sampling	6/12/17 through 6/15/17	23	Quarterly surface water sampling event to characterize surface water quality	Total TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations, and VOC 8260B and SVOC 8270D at certain locations	Phase I SAP
SSPA	Surface Water	Backwater Seep Area, Riparian Sampling Area, South Percolation Ponds	SSPA Sampling	10/31/17 through 11/7/17	13	Supplemental South Pond Sampling to address the surface water quality in the South Percolation Ponds and adjacent areas	VOC 8260B, SVOC 8270D, Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Dissolved and Total Cyanide 335.4, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, and TDS at all locations	Expedited Risk Assessment SAP
Phase II	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, Riparian Sampling Area, South Percolation Ponds	Phase II Round 1 GW/SW Sampling	6/6/18 through 6/27/18	54	High-water surface water sampling to evaluate temporal variability and seasonal concentrations	Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Total Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, TDS, TOC via Lloyd Kahn, and DOC at all locations, and SVOC 8270D LL and alkylated PAHs at certain locations	Phase II SAP
Phase II	Surface Water	Backwater Seep Area, Cedar Creek, Cedar Creek Reservoir Overflow, Flathead River, Northern Surface Water Feature, Riparian Sampling Area, South Percolation Ponds	Phase II Round 2 GW/SW Sampling	10/3/18 through 10/18/18	35	Low-water surface water sampling to evaluate temporal variability and seasonal concentrations	Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Total Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, TDS, TOC via Lloyd Kahn, and DOC at all locations, and SVOC 8270D LL and alkylated PAHs at certain locations	Phase II SAP

Table 6. Summary of Sediment Samples Collected During the Remedial Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Phase I	Sediment	Backwater Seep Area, Cedar Creek, Flathead River, Northwest and Northeast Percolation Ponds, South Percolation Ponds	Phase I Sediment Sampling	8/29/16 through 9/9/16	12	Sampling event to determine sediment quality	SVOC 8270D LL, TAL Metals, Total Cyanide, PCBs, Pesticides, Fluoride, TOC via Lloyd Kahn, and Grain Size Analysis at all locations	Phase I SAP
SSPA	Sediment	Backwater Seep Area, Riparian Sampling Area, South Percolation Ponds	SSPA Sampling	10/31/17 through 11/7/17	16	Sampling event to determine sediment quality in the South Percolation Ponds and adjacent areas	VOC 8260B, SVOC 8270D LL, TAL Metals, Total Cyanide, Fluoride, TOC via Lloyd Kahn, Grain Size Analysis, Moisture Content D2216-90, and Bulk Density D-2937-04 at all locations and Free Cyanide in select locations	Expedited Risk Assessment SAP
Phase II	Sediment	Backwater Seep Area, Cedar Creek, Flathead River, Northern Surface Water Feature, Riparian Sampling Area, South Percolation Ponds	Phase II Sediment Sampling	10/3/18 through 10/18/18	44	Sampling event to determine sediment quality	SVOC 8270D LL, TAL Metals, Total Cyanide, Fluoride, TOC via Lloyd Kahn, and Grain Size Analysis at all locations and Moisture Content D2216-90 and Bulk Density D-2937-04, AVS-SEM, and alkylated PAHs in select locations	Phase II SAP

Table 7. Summary of Sediment Porewater Samples Collected During the Remedial Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Phase II	Porewater	Northern Surface Water Feature	Phase II Round 1 GW/SW Sampling	6/18/18 through 6/21/18	10	Porewater sampling to evaluate the total recoverable concentrations of inorganic and non-volatile organic COPCs	SVOC 8270D LL, Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Dissolved Cyanide 335.4, Dissolved Free Cyanide 9016, Dissolved Fluoride 300, Dissolved Chloride 300.0, Dissolved Sulfate 300.0, Dissolved Orthophosphate 9056A, Dissolved Nitrate, Nitrite as N 353.2, Dissolved Ammonia 350.1, Dissolved Sulfide, Dissolved Alkalinity, TDS, and DOC at all locations, and dissolved alkylated PAHs at certain locations	Phase II SAP
Phase II	Porewater	Backwater Seep Area, Cedar Creek, Flathead River, Riparian Sampling Area, South Percolation Ponds	Phase II Round 2 GW/SW Sampling	10/3/18 through 10/18/18	34	Porewater sampling to evaluate the total recoverable concentrations of inorganic and non-volatile organic COPCs	SVOC 8270D LL, Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Dissolved Cyanide 335.4, Dissolved Free Cyanide 9016, Dissolved Fluoride 300, Dissolved Chloride 300.0, Dissolved Sulfate 300.0, Dissolved Orthophosphate 9056A, Dissolved Nitrate, Nitrite as N 353.2, Dissolved Ammonia 350.1, Dissolved Sulfide, Dissolved Alkalinity, TDS, and DOC at all locations, and dissolved alkylated PAHs at certain locations	Phase II SAP

Table 8. Summary of Soil, Surface Water, and Sediment Samples Collected During the Background Investigation
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Program	Media	Location	Field Program	Collection Date	Number of Samples	Description and Rationale/DQO	Analyses	Reference
Background	Background Soil	Background Soil Reference Areas #1, #2, #3, and #4	Phase II	6/7/18 through 6/13/18	40	Background soil sampling to evaluate the soil quality outside of the Site	TCL VOCs 8260, TCL SVOCs LL 8270, TAL Metals 6010, Total Cyanide 9012, Fluoride 300, TOC via Lloyd Kahn, Grain Size Analysis, and Moisture Content and Bulk Density (in half number of samples)	Background SAP
Background	Background Surface Water	Background Surface Water Reference Areas - Background Cedar Creek and Background Flathead River	Phase II Round 1 GW/SW Sampling	6/7/18 through 6/13/18	20	Background surface water sampling to evaluate the surface water quality outside of the Site; coincides with the high-water sampling event	SVOC 8270D LL, Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Total Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, TDS, TOC via Lloyd Kahn, and DOC at all locations	Background SAP
Background	Background Surface Water	Background Surface Water Reference Areas - Background Cedar Creek and Background Flathead River	Phase II Round 2 GW/SW Sampling	10/2/18 through 10/15/18	20	Background surface water sampling to evaluate the surface water quality outside of the Site; coincides with the low-water sampling event	SVOC 8270D LL, Total and Dissolved TAL Metals 6020A/7470A, Hardness 2340C, Total Cyanide 335.4, Total Free Cyanide 9016, Fluoride 300, Chloride 300.0, Sulfate 300.0, Orthophosphate 9056A, Nitrate, Nitrite as N 353.2, Ammonia 350.1, Sulfide, Alkalinity, TSS, TDS, TOC via Lloyd Kahn, and DOC at all locations	Background SAP
Background	Background Sediment	Background Surface Water Reference Areas - Background Cedar Creek and Background Flathead River	Phase II Round 2 GW/SW Sampling	10/2/18 through 10/15/18	20	Background sediment sampling to evaluate the surface water quality outside of the Site; coincides with the low-water sampling event	SVOC 8270D LL, TAL Metals, Total Cyanide, Fluoride, TOC via Lloyd Kahn, GSA at all locations and Moisture Content D2216-90 and Bulk Density D-2937-04 in select locations	Background SAP

Table 9a. Soil BHHRA COCs

Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Terrestrial Exposure Areas								Transitional Exposure Areas			
	Main Plant Area	Central Landfills Area	Industrial Landfills Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Operational Area/ISS Grid	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir	Northern Surface Water Feature
Metals												
Arsenic	X	X	X	X	X	X		X	X			
Manganese	X											
PAHs												
Benzo(a)anthracene	X	X						X	X			
Benzo(a)pyrene	X	X	X					X	X			
Benzo(b)fluoranthene	X	X						X	X			
Benzo(k)fluoranthene									X			
Dibenz(a,h)anthracene	X	X	X					X	X			
Ideno(1,2,3-c,d)pyrene	X	X						X	X			
PCBs												
Aroclor 1254		X										

Note:

Blue color indicates additional COPC; COPC risk did not exceed 10-6, but it is a risk contributor

Table 9b. Groundwater BHHRA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit
Metals		
Antimony		X
Arsenic	X	X
PAHs		
Bis(2-ethylhexyl) phthalate	X	
Other Inorganics		
Cyanide, total	X	
Cyanide, free	X	
Fluoride	X	

Table 9c. Sediment BHHRA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Transitional Exposure Areas					Aquatic Exposure Areas		
	North Percolation Pond	Central Landfill Area	South Percolation Pond	Cedar Creek Reservoir Overflow Ditch	Northern Surface Water Feature	Flathead River (including Backwater Seep Sampling Area)	Flathead River-Riparian Channel	Cedar Creek
Metals								
Arsenic	X							
PAHs								
Benzo(a)pyrene	X							
Benzo(b)fluoranthene	X							
Dibenz(a,h)anthracene	X	X						
Indeno(1,2,3-c,d)pyrene	X							

Table 10a. Soil BERA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Terrestrial Exposure Areas								Transitional Exposure Areas			
	Main Plant Area	Central Landfills Area	Industrial Landfills Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Operational Area/ISS Grid	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir	Northern Surface Water Feature
Metals												
Barium									1	1		
Copper		2,3						1				
Nickel		3	2,3						1,2,3			
Selenium								1	1			
Thallium									1			
Vanadium			2						1			
Zinc								1				
PAHs												
LMW PAHs	1	1,3						1	1,2,3			
HMW PAHs	1, 3	1, 2,3	2,3					1, 3	1,2,3			
PCBs												
Aroclor 1254		2,3						3				

Notes:
1 = Direct Contact risk
2 = Wildlife Ingestion risk
3 = Small-range receptor risk

Selection criteria:
Med-Large Home Range Wildlife: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Small Home Range Wildlife: Sample points exceeding LOAEL-based back calculated value
Direct contact: LOEC exceedances based on based on point comparisons, except for COPECs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance)
For ISS samples, localized exceedance was not justification for removal based on averaged EPC across DU
PAH direct contact exposure selected based on exposure areas with points exceeding maximum acceptable toxicant concentration (MATC)

Table 10b. Surface Water BERA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Transitional Exposure Areas				Aquatic Exposure Areas		
	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir	Northern Surface Water Feature	Flathead River (including Backwater Seep Sampling Area)	Flathead River-Riparian Channel	Cedar Creek
Metals							
Aluminum	1	1			1	1	
Barium	1	1				1	
Cadmium	1						
Copper	1	1					
Iron		1					
Zinc	1						
Other Inorganics							
Cyanide, total		1			1*	1	
Cyanide, free		1			1*	1	
Fluoride	1						
PAHs							
Multiple PAH Compounds	1						

Notes:

1 = Direct Contact risk

2 = Wildlife Ingestion risk

3 = Small-range receptor risk

NA = Medium not applicable for this exposure area.

*= Focused COPEC for the Backwater Seep Sampling Area

Table 10c. Sediment BERA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Transitional Exposure Areas				Aquatic Exposure Areas		
	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir Overflow Ditch	Northern Surface Water Feature	Flathead River (including Backwater Seep Sampling Area)	Flathead River-Riparian Channel	Cedar Creek
Metals							
Barium	1	1,2				1	
Cadmium	1						
Copper		1*					
Lead	1						
Nickel	1						
Selenium	1,2						
Vanadium	2						
Zinc	1						
Other Inorganics							
Cyanide, total	1	1				1	
Cyanide, free					1**	1	
PAHs							
LMW PAHs	1,2						
HMW PAHs	1,2						

Notes:
1 = Direct Contact risk
2 = Wildlife Ingestion risk
* = Divalent metal that is likely not bioavailable, according to the results of the acid volatile sulfide-simultaneously extractable metals and porewater evaluation.
**= Focused COPEC for the Backwater Seep Sampling Area

Selection criteria:
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COPECs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance)

Table 10d. Sediment Porewater BERA COCs
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

COPC	Transitional Exposure Areas				Aquatic Exposure Areas		
	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir Overflow Ditch	Northern Surface Water Feature	Flathead River (including Backwater Seep Sampling Area)	Flathead River-Riparian Channel	Cedar Creek
Metals							
Barium		1,2				1	
Copper		1*					
Other Inorganics							
Cyanide, total		1				1	
Cyanide, free					1**	1	

Notes:
1 = Direct Contact risk
2 = Wildlife Ingestion risk
* = Divalent metal that is likely not bioavailable, according to the results of the acid volatile sulfide-simultaneously extractable metals and porewater evaluation.
**= Focused COPEC for the Backwater Seep Sampling Area

Selection criteria:
Wildlife Ingestion: HQ_{LOAEL} > 1 based on refined exposure evaluation;
Direct contact: LOEC exceedances based on based on point comparisons, except for COPECs that were addressed as part of the BERA risk characterization (e.g., background evaluation, localized exceedance)

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	<0.015	0.99	0.14	0.076	0.191	70	89.7	0	0	2.3	0	0	15	78	100	0.002	30	38	0.1
		0.5-2	SO	T	86	mg/kg	<0.016	2.4	0.121	0.0495	0.289	66	76.7	1	1	2.3	0	0	15	86	100	0.002	20	23	0.1
		2-10	SO	T	14	mg/kg	<0.054	15.3	1.143	-	4.075	4	28.6	1	7	2.3	1	7	15	14	100	0.002	2	14	0.1
		10-17	SO	T	98	mg/kg	<0.014	8.4	0.171	-	0.934	40	40.8	2	2	2.3	0	0	15	98	100	0.002	9	9	0.1
		17-22	SO	T	21	mg/kg	<0.054	0.14	0.045	-	0.03	5	23.8	0	0	2.3	0	0	15	21	100	0.002	1	5	0.1
		>22	SO	T	19	mg/kg	<0.03	2.6	0.236	0.061	0.596	11	57.9	1	5	2.3	0	0	15	19	100	0.002	4	21	0.1
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	0.19	137	13.383	3.15	32.23	20	100	11	55	2.3	2	10	15	20	100	0.002	20	100	0.1
		0.5-2	SO	T	20	mg/kg	<0.064	125	14.1	1.25	31.442	19	95	7	35	2.3	4	20	15	20	100	0.002	17	85	0.1
		2-10	SO	T	5	mg/kg	<0.061	0.39	0.124	-	0.155	2	40	0	0	2.3	0	0	15	5	100	0.002	2	40	0.1
		10-17	SO	T	19	mg/kg	<0.02	0.46	0.139	0.072	0.135	14	73.7	0	0	2.3	0	0	15	19	100	0.002	8	42	0.1
		17-22	SO	T	5	mg/kg	<0.062	0.26	0.105	-	0.105	2	40	0	0	2.3	0	0	15	5	100	0.002	2	40	0.1
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	<0.016	9.9	0.385	0.096	1.297	46	76.7	1	2	2.3	0	0	15	60	100	0.002	28	47	0.1
		0.5-2	SO	T	55	mg/kg	<0.015	13	0.423	0.036	1.825	34	61.8	2	4	2.3	0	0	15	55	100	0.002	14	25	0.1
		2-10	SO	T	6	mg/kg	<0.064	0.58	0.226	0.105	0.247	4	66.7	0	0	2.3	0	0	15	6	100	0.002	3	50	0.1
		10-17	SO	T	36	mg/kg	<0.015	1.1	0.093	-	0.21	17	47.2	0	0	2.3	0	0	15	36	100	0.002	6	17	0.1
		17-22	SO	T	1	mg/kg	<0.068	<0.068	-	-	-	0	0	0	0	2.3	0	0	15	1	100	0.002	0	0	0.1
		>22	SO	T	4	mg/kg	<0.016	0.16	0.046	-	0.076	1	25	0	0	2.3	0	0	15	4	100	0.002	1	25	0.1
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	<0.061	0.42	0.095	-	0.104	7	41.2	0	0	2.3	0	0	15	17	100	0.002	4	24	0.1
		0.5-2	SO	T	17	mg/kg	<0.059	0.22	0.062	-	0.052	6	35.3	0	0	2.3	0	0	15	17	100	0.002	3	18	0.1
		10-17	SO	T	6	mg/kg	<0.017	<0.067	-	-	-	0	0	0	0	2.3	0	0	15	6	100	0.002	0	0	0.1
		>22	SO	T	1	mg/kg	0.022	0.022	0.022	0.022	-	1	100	0	0	2.3	0	0	15	1	100	0.002	0	0	0.1
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	<0.062	0.64	0.218	0.17	0.197	12	70.6	0	0	2.3	0	0	15	17	100	0.002	11	65	0.1
		0.5-2	SO	T	15	mg/kg	<0.056	0.22	0.07	-	0.058	5	33.3	0	0	2.3	0	0	15	15	100	0.002	4	27	0.1
		10-17	SO	T	3	mg/kg	0.079	0.13	0.1	0.09	0.027	3	100	0	0	2.3	0	0	15	3	100	0.002	1	33	0.1
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	<0.026	1.5	0.201	0.12	0.333	13	56.5	0	0	2.3	0	0	15	23	100	0.002	12	52	0.1
		0.5-2	SO	T	20	mg/kg	<0.024	0.28	0.062	-	0.064	6	30	0	0	2.3	0	0	15	20	100	0.002	3	15	0.1
		10-17	SO	T	13	mg/kg	<0.017	0.027	0.031	-	0.008	2	15.4	0	0	2.3	0	0	15	13	100	0.002	0	0	0.1
		>22	SO	T	1	mg/kg	0.023	0.023	0.023	0.023	-	1	100	0	0	2.3	0	0	15	1	100	0.002	0	0	0.1
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	<0.056	2.2	0.225	0.12	0.391	26	83.9	0	0	2.3	0	0	15	31	100	0.002	19	61	0.1
		0.5-2	SO	T	31	mg/kg	<0.059	0.21	0.073	0.042	0.053	19	61.3	0	0	2.3	0	0	15	31	100	0.002	7	23	0.1
		10-17	SO	T	18	mg/kg	<0.017	0.078	0.027	-	0.016	8	44.4	0	0	2.3	0	0	15	18	100	0.002	0	0	0.1
		>22	SO	T	3	mg/kg	<0.019	0.032	0.017	-	0.013	1	33.3	0	0	2.3	0	0	15	3	100	0.002	0	0	0.1
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	<0.02	16.4	1.029	0.24	3.369	17	73.9	1	4	2.3	1	4	15	23	100	0.002	15	65	0.1
		0.5-2	SO	T	23	mg/kg	<0.017	0.71	0.2	0.07	0.205	17	73.9	0	0	2.3	0	0	15	23	100	0.002	10	43	0.1
		2-10	SO	T	9	mg/kg	<0.064	1.1	0.189	0.035	0.352	5	55.6	0	0	2.3	0	0	15	9	100	0.002	2	22	0.1
		10-17	SO	T	11	mg/kg	<0.018	0.27	0.071	0.044	0.079	8	72.7	0	0	2.3	0	0	15	11	100	0.002	3	27	0.1
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	<0.033	0.067	0.029	-	0.02	1	16.7	0	0	2.3	0	0	15	6	100	0.002	0	0	0.1
		0.5-2	SO	T	1	mg/kg	<0.069	<0.069	-	-	-	0	0	0	0	2.3	0	0	15	1	100	0.002	0	0	0.1
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	<0.077	1.9	0.886	0.96	0.776	6	85.7	0	0	2.3	0	0	15	7	100	0.002	6	86	0.1
		0.5-2	SO	T	7	mg/kg	<0.071	3.7	1.405	1.4	1.324	6	85.7	1	14	2.3	0	0	15	7	100	0.002	5	71	0.1
Cyanide, Free	8. South Percolation Pond Area	0-0.5	SO	T	1	mg/kg	<0.56	<0.56	-	-	-	0	0	0	0	2.3	0	0	15	1	100	0.002	1	100	0.1
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	5	mg/kg	<0.4	<0.43	-	-	-	0	0	0	0	2.3	0	0	15	5	100	0.002	5	100	0.1

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	**Exposure Area**	**Depth Interval**	**Matrix**	**Fraction**	**No. of Results**	**Unit**	**Min**	**Max**	**Mean**	**Median**	**Standard Deviation**	**# > LOD**	**% > LOD**	**No. Exceeding**	**% Exceeding**	**Screening Level**	**No. Exceeding**	**% Exceeding**	**Screening Level**	**No. Exceeding**	**% Exceeding**	**Screening Level**	**No. Exceeding**	**% Exceeding**	**Screening Level**
Fluoride	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	1.97	571	67.347	36	89.195	78	100	2	3	310	0	0	4700	65	83	12	73	94	6.5
		0.5-2	SO	T	86	mg/kg	1.55	367	47.601	25.8	67.333	86	100	2	2	310	0	0	4700	64	74	12	77	90	6.5
		2-10	SO	T	14	mg/kg	0.63	293	31.859	6.485	76.762	14	100	0	0	310	0	0	4700	5	36	12	7	50	6.5
		10-17	SO	T	98	mg/kg	<0.16	232	18.831	7.925	36.011	95	96.9	0	0	310	0	0	4700	34	35	12	54	55	6.5
		17-22	SO	T	21	mg/kg	<0.16	76.6	6.428	2.04	16.366	19	90.5	0	0	310	0	0	4700	2	10	12	4	19	6.5
		>22	SO	T	19	mg/kg	<0.16	46.1	8.166	3.83	13.486	18	94.7	0	0	310	0	0	4700	3	16	12	4	21	6.5
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	2.42	241	91.911	52.05	79.443	20	100	0	0	310	0	0	4700	18	90	12	19	95	6.5
		0.5-2	SO	T	20	mg/kg	4.06	306	75.843	51.25	84.945	20	100	0	0	310	0	0	4700	14	70	12	18	90	6.5
		2-10	SO	T	5	mg/kg	2.93	32.7	19.796	25.9	14.517	5	100	0	0	310	0	0	4700	3	60	12	3	60	6.5
		10-17	SO	T	19	mg/kg	0.87	102	23.828	20.9	24.125	19	100	0	0	310	0	0	4700	12	63	12	13	68	6.5
		17-22	SO	T	5	mg/kg	1.92	36	19.326	25	13.857	5	100	0	0	310	0	0	4700	3	60	12	4	80	6.5
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	1.3	796	58.196	21.25	126.085	60	100	2	3	310	0	0	4700	39	65	12	49	82	6.5
		0.5-2	SO	T	55	mg/kg	3.66	538	58.502	21.7	94.931	55	100	2	4	310	0	0	4700	39	71	12	47	85	6.5
		2-10	SO	T	6	mg/kg	2.85	32.5	16.058	14.15	9.755	6	100	0	0	310	0	0	4700	5	83	12	5	83	6.5
		10-17	SO	T	36	mg/kg	0.35	263	21.646	10.55	44.002	36	100	0	0	310	0	0	4700	15	42	12	22	61	6.5
		17-22	SO	T	1	mg/kg	18.3	18.3	18.3	18.3	-	1	100	0	0	310	0	0	4700	1	100	12	1	100	6.5
		>22	SO	T	4	mg/kg	0.28	8.6	2.493	0.545	4.074	4	100	0	0	310	0	0	4700	0	0	12	1	25	6.5
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	2.24	398	31.211	5.17	94.796	17	100	1	6	310	0	0	4700	4	24	12	7	41	6.5
		0.5-2	SO	T	17	mg/kg	<0.17	810	83.971	8.01	214.452	16	94.1	2	12	310	0	0	4700	6	35	12	11	65	6.5
		10-17	SO	T	6	mg/kg	0.99	2.76	2.125	2.54	0.774	6	100	0	0	310	0	0	4700	0	0	12	0	0	6.5
		>22	SO	T	1	mg/kg	0.34	0.34	0.34	0.34	-	1	100	0	0	310	0	0	4700	0	0	12	0	0	6.5
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	0.75	32.9	10.55	5.16	10.812	17	100	0	0	310	0	0	4700	8	47	12	8	47	6.5
		0.5-2	SO	T	15	mg/kg	0.69	41.3	14.642	18.4	12.299	15	100	0	0	310	0	0	4700	9	60	12	9	60	6.5
		10-17	SO	T	3	mg/kg	0.75	1.93	1.277	1.15	0.6	3	100	0	0	310	0	0	4700	0	0	12	0	0	6.5
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	1.81	27.6	8.423	7.17	5.992	23	100	0	0	310	0	0	4700	6	26	12	13	57	6.5
		0.5-2	SO	T	20	mg/kg	0.79	12	6.295	6.145	3.585	20	100	0	0	310	0	0	4700	0	0	12	10	50	6.5
		10-17	SO	T	13	mg/kg	0.54	7.87	1.879	0.9	2.181	13	100	0	0	310	0	0	4700	0	0	12	1	8	6.5
		>22	SO	T	1	mg/kg	2.08	2.08	2.08	2.08	-	1	100	0	0	310	0	0	4700	0	0	12	0	0	6.5
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	1.15	15.4	5.215	3.47	3.725	31	100	0	0	310	0	0	4700	2	6	12	9	29	6.5
		0.5-2	SO	T	31	mg/kg	0.31	12.5	4.047	2.87	3.089	31	100	0	0	310	0	0	4700	1	3	12	6	19	6.5
		10-17	SO	T	18	mg/kg	<0.21	4.55	1.571	0.945	1.357	16	88.9	0	0	310	0	0	4700	0	0	12	0	0	6.5
		>22	SO	T	3	mg/kg	0.92	1.98	1.453	1.46	0.53	3	100	0	0	310	0	0	4700	0	0	12	0	0	6.5
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	1.8	44.1	14.193	14.4	10.494	23	100	0	0	310	0	0	4700	15	65	12	16	70	6.5
		0.5-2	SO	T	23	mg/kg	1.26	31.4	12.951	12.4	7.593	23	100	0	0	310	0	0	4700	13	57	12	18	78	6.5
		2-10	SO	T	9	mg/kg	0.8	27.5	12.668	13.3	9.304	9	100	0	0	310	0	0	4700	6	67	12	6	67	6.5
		10-17	SO	T	11	mg/kg	1.61	9.41	5.183	5.33	2.749	11	100	0	0	310	0	0	4700	0	0	12	4	36	6.5
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	0.36	15.3	3.268	0.805	5.911	6	100	0	0	310	0	0	4700	1	17	12	1	17	6.5
		0.5-2	SO	T	1	mg/kg	12	12	12	12	-	1	100	0	0	310	0	0	4700	0	0	12	1	100	6.5
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	12.8	32.7	20.186	17	7.1	7	100	0	0	310	0	0	4700	7	100	12	7	100	6.5
		0.5-2	SO	T	7	mg/kg	1.58	22.9	16.069	16.7	7.082	7	100	0	0	310	0	0	4700	6	86	12	6	86	6.5

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Benzo[a]pyrene	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	<0.012	130	5.665	0.55	16.5	76	97.4	66	85	0.11	22	28	2.1	75	96	0.029	26	33	1.52
		0.5-2	SO	T	86	mg/kg	<0.002	34	1.445	0.135	4.722	76	88.4	44	51	0.11	12	14	2.1	60	70	0.029	15	17	1.52
		2-10	SO	T	14	mg/kg	<0.002	450	32.73	0.012	120.103	9	64.3	5	36	0.11	3	21	2.1	6	43	0.029	3	21	1.52
		10-17	SO	T	98	mg/kg	<0.001	23	0.536	0.021	2.563	56	57.1	27	28	0.11	4	4	2.1	43	44	0.029	5	5	1.52
		17-22	SO	T	21	mg/kg	<0.002	6.7	0.912	-	1.84	8	38.1	6	29	0.11	4	19	2.1	7	33	0.029	5	24	1.52
		>22	SO	T	12	mg/kg	<0.002	2.9	0.254	-	0.834	5	41.7	2	17	0.11	1	8	2.1	2	17	0.029	1	8	1.52
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	<0.012	2000	175.025	25.5	452.262	19	95	19	95	0.11	17	85	2.1	19	95	0.029	18	90	1.52
		0.5-2	SO	T	18	mg/kg	<0.011	490	86.042	16.5	152.438	17	94.4	16	89	0.11	13	72	2.1	17	94	0.029	13	72	1.52
		2-10	SO	T	5	mg/kg	0.003	1.5	0.771	0.77	0.683	5	100	4	80	0.11	0	0	2.1	4	80	0.029	0	0	1.52
		10-17	SO	T	19	mg/kg	<0.002	14	1.395	0.0078	3.442	12	63.2	6	32	0.11	3	16	2.1	7	37	0.029	4	21	1.52
		17-22	SO	T	5	mg/kg	<0.002	1.6	0.322	0.0021	0.715	3	60	1	20	0.11	0	0	2.1	1	20	0.029	1	20	1.52
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	<0.011	100	2.66	0.265	13.204	58	96.7	45	75	0.11	6	10	2.1	57	95	0.029	6	10	1.52
		0.5-2	SO	T	55	mg/kg	<0.011	75	1.797	0.069	10.231	52	94.5	21	38	0.11	3	5	2.1	38	69	0.029	3	5	1.52
		2-10	SO	T	6	mg/kg	0.003	0.71	0.156	0.054	0.274	6	100	1	17	0.11	0	0	2.1	3	50	0.029	0	0	1.52
		10-17	SO	T	36	mg/kg	<0.01	5.6	0.194	0.007	0.93	19	52.8	6	17	0.11	1	3	2.1	10	28	0.029	1	3	1.52
		17-22	SO	T	1	mg/kg	0.039	0.039	0.039	0.039	-	1	100	0	0	0.11	0	0	2.1	1	100	0.029	0	0	1.52
		>22	SO	T	1	mg/kg	<0.011	<0.011	-	-	-	0	0	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	0.007	53	4.76	0.15	13.596	17	100	9	53	0.11	2	12	2.1	16	94	0.029	3	18	1.52
		0.5-2	SO	T	17	mg/kg	<0.002	13	1.997	0.028	4.25	12	70.6	5	29	0.11	4	24	2.1	8	47	0.029	4	24	1.52
		10-17	SO	T	6	mg/kg	<0.002	0.003	0.002	0.002	0.002	3	50	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
		>22	SO	T	1	mg/kg	<0.012	<0.012	-	-	-	0	0	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	0.0097	1.9	0.45	0.29	0.514	17	100	13	76	0.11	0	0	2.1	15	88	0.029	1	6	1.52
		0.5-2	SO	T	15	mg/kg	0.0026	0.18	0.049	0.042	0.047	15	100	2	13	0.11	0	0	2.1	8	53	0.029	0	0	1.52
		10-17	SO	T	3	mg/kg	<0.002	0.004	0.002	-	0.002	1	33.3	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	<0.016	0.22	0.056	0.047	0.053	22	95.7	2	9	0.11	0	0	2.1	15	65	0.029	0	0	1.52
		0.5-2	SO	T	20	mg/kg	<0.002	0.066	0.013	0.005	0.018	13	65	0	0	0.11	0	0	2.1	3	15	0.029	0	0	1.52
		10-17	SO	T	13	mg/kg	<0.002	0.076	0.008	-	0.02	3	23.1	0	0	0.11	0	0	2.1	1	8	0.029	0	0	1.52
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	<0.011	0.27	0.042	0.023	0.055	26	83.9	3	10	0.11	0	0	2.1	11	35	0.029	0	0	1.52
		0.5-2	SO	T	31	mg/kg	<0.002	0.14	0.009	-	0.025	12	38.7	1	3	0.11	0	0	2.1	1	3	0.029	0	0	1.52
		10-17	SO	T	18	mg/kg	<0.002	0.02	0.005	-	0.004	3	16.7	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	<0.013	2.8	0.246	0.084	0.569	19	82.6	11	48	0.11	1	4	2.1	19	83	0.029	1	4	1.52
		0.5-2	SO	T	23	mg/kg	<0.01	4	0.219	0.034	0.826	14	60.9	3	13	0.11	1	4	2.1	12	52	0.029	1	4	1.52
		2-10	SO	T	9	mg/kg	<0.011	0.11	0.044	0.032	0.037	7	77.8	0	0	0.11	0	0	2.1	5	56	0.029	0	0	1.52
		10-17	SO	T	11	mg/kg	<0.011	0.019	0.009	-	0.005	3	27.3	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	<0.012	<0.014	-	-	-	0	0	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
		0.5-2	SO	T	1	mg/kg	<0.011	<0.011	-	-	-	0	0	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	<0.013	0.036	0.015	-	0.013	2	28.6	0	0	0.11	0	0	2.1	2	29	0.029	0	0	1.52
		0.5-2	SO	T	7	mg/kg	<0.011	0.027	-	-	-	1	14.3	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	EPA Residential Soil RSL: No. Exceeding	EPA Residential Soil RSL: % Exceeding	EPA Residential Soil RSL: Screening Level	EPA Industrial Soil RSL: No. Exceeding	EPA Industrial Soil RSL: % Exceeding	EPA Industrial Soil RSL: Screening Level	EPA Protection Of Groundwater Risk-Based Soil RSL: No. Exceeding	EPA Protection Of Groundwater Risk-Based Soil RSL: % Exceeding	EPA Protection Of Groundwater Risk-Based Soil RSL: Screening Level	Minimum Ecological Screening Level: No. Exceeding	Minimum Ecological Screening Level: % Exceeding	Minimum Ecological Screening Level: Screening Level
Aroclor 1254	1. Main Plant Area	0-0.5	SO	T	68	mg/kg	<0.001	0.11	-	-	-	3	4.4	0	0	0.12	0	0	0.97	68	100	0.002	3	4	0.041
		0.5-2	SO	T	76	mg/kg	<0.001	0.064	-	-	-	1	1.3	0	0	0.12	0	0	0.97	76	100	0.002	1	1	0.041
		2-10	SO	T	1	mg/kg	<0.017	<0.017	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
		10-17	SO	T	68	mg/kg	<0.009	<0.01	-	-	-	0	0	0	0	0.12	0	0	0.97	68	100	0.002	0	0	0.041
		17-22	SO	T	1	mg/kg	<0.009	<0.009	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
		>22	SO	T	1	mg/kg	<0.001	<0.001	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
	2. North Percolation Pond Area	0-0.5	SO	T	9	mg/kg	<0.001	<0.024	-	-	-	0	0	0	0	0.12	0	0	0.97	9	100	0.002	0	0	0.041
		0.5-2	SO	T	9	mg/kg	<0.01	<0.022	-	-	-	0	0	0	0	0.12	0	0	0.97	9	100	0.002	0	0	0.041
		10-17	SO	T	9	mg/kg	<0.001	<0.01	-	-	-	0	0	0	0	0.12	0	0	0.97	9	100	0.002	0	0	0.041
	3. Central Landfills Area	0-0.5	SO	T	38	mg/kg	<0.009	1.2	-	-	-	2	5.3	1	3	0.12	1	3	0.97	38	100	0.002	2	5	0.041
		0.5-2	SO	T	35	mg/kg	<0.001	0.91	-	-	-	4	11.4	3	9	0.12	0	0	0.97	35	100	0.002	4	11	0.041
		10-17	SO	T	27	mg/kg	<0.001	<0.013	-	-	-	0	0	0	0	0.12	0	0	0.97	27	100	0.002	0	0	0.041
		>22	SO	T	1	mg/kg	<0.001	<0.001	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
	4. Industrial Landfill Area	0-0.5	SO	T	1	mg/kg	<0.011	<0.011	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
		0.5-2	SO	T	1	mg/kg	<0.01	<0.01	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
		10-17	SO	T	1	mg/kg	<0.01	<0.01	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
		>22	SO	T	1	mg/kg	<0.011	<0.011	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
	5. Eastern Undeveloped Area	0-0.5	SO	T	1	mg/kg	<0.011	<0.011	-	-	-	0	0	0	0	0.12	0	0	0.97	1	100	0.002	0	0	0.041
	6. North-Central Undeveloped Area	0-0.5	SO	T	6	mg/kg	<0.011	<0.017	-	-	-	0	0	0	0	0.12	0	0	0.97	6	100	0.002	0	0	0.041
		0.5-2	SO	T	3	mg/kg	<0.01	<0.014	-	-	-	0	0	0	0	0.12	0	0	0.97	3	100	0.002	0	0	0.041
		10-17	SO	T	3	mg/kg	<0.0094	<0.01	-	-	-	0	0	0	0	0.12	0	0	0.97	3	100	0.002	0	0	0.041
	7. Western Undeveloped Area	0-0.5	SO	T	11	mg/kg	<0.001	<0.012	-	-	-	0	0	0	0	0.12	0	0	0.97	11	100	0.002	0	0	0.041
		0.5-2	SO	T	11	mg/kg	<0.001	<0.013	-	-	-	0	0	0	0	0.12	0	0	0.97	11	100	0.002	0	0	0.041
		10-17	SO	T	11	mg/kg	<0.001	<0.012	-	-	-	0	0	0	0	0.12	0	0	0.97	11	100	0.002	0	0	0.041
	8. South Percolation Pond Area	0-0.5	SO	T	13	mg/kg	<0.001	<0.021	-	-	-	0	0	0	0	0.12	0	0	0.97	13	100	0.002	0	0	0.041
		0.5-2	SO	T	13	mg/kg	<0.001	<0.015	-	-	-	0	0	0	0	0.12	0	0	0.97	13	100	0.002	0	0	0.041
		2-10	SO	T	2	mg/kg	<0.001	<0.001	-	-	-	0	0	0	0	0.12	0	0	0.97	2	100	0.002	0	0	0.041
		10-17	SO	T	11	mg/kg	<0.001	<0.012	-	-	-	0	0	0	0	0.12	0	0	0.97	11	100	0.002	0	0	0.041
	9. Flathead River Area	0-0.5	SO	T	5	mg/kg	<0.011	<0.013	-	-	-	0	0	0	0	0.12	0	0	0.97	5	100	0.002	0	0	0.041

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Arsenic	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	2.3	7.6	4.613	4.55	1.237	78	100	78	100	0.68	69	88	3	78	100	0.002	78	100	0.25
		0.5-2	SO	T	86	mg/kg	1.6	8.8	4.338	4.2	1.221	86	100	86	100	0.68	76	88	3	86	100	0.002	86	100	0.25
		2-10	SO	T	14	mg/kg	2.9	34.2	6.207	4.15	8.092	14	100	14	100	0.68	12	86	3	14	100	0.002	14	100	0.25
		10-17	SO	T	98	mg/kg	1.6	13.1	3.739	3.6	1.307	98	100	98	100	0.68	77	79	3	98	100	0.002	98	100	0.25
		17-22	SO	T	21	mg/kg	1.6	6.3	3.543	3.4	1.024	21	100	21	100	0.68	14	67	3	21	100	0.002	21	100	0.25
		>22	SO	T	12	mg/kg	2.3	6.3	3.75	3.7	1.036	12	100	12	100	0.68	9	75	3	12	100	0.002	12	100	0.25
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	2.5	22.7	9.94	8.6	5.471	20	100	20	100	0.68	18	90	3	20	100	0.002	20	100	0.25
		0.5-2	SO	T	20	mg/kg	2.4	34.1	11.495	8.35	8.706	20	100	20	100	0.68	19	95	3	20	100	0.002	20	100	0.25
		2-10	SO	T	5	mg/kg	2.9	4.8	3.78	3.4	0.789	5	100	5	100	0.68	4	80	3	5	100	0.002	5	100	0.25
		10-17	SO	T	19	mg/kg	1.3	8.8	4.158	4	1.648	19	100	19	100	0.68	17	89	3	19	100	0.002	19	100	0.25
		17-22	SO	T	5	mg/kg	4.4	7.1	5.1	4.7	1.138	5	100	5	100	0.68	5	100	3	5	100	0.002	5	100	0.25
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	3.6	11.8	6.107	5.6	1.876	60	100	60	100	0.68	60	100	3	60	100	0.002	60	100	0.25
		0.5-2	SO	T	55	mg/kg	2.8	17.9	6.304	5.7	3.037	55	100	55	100	0.68	54	98	3	55	100	0.002	55	100	0.25
		2-10	SO	T	6	mg/kg	3.5	7.5	4.667	4.4	1.45	6	100	6	100	0.68	6	100	3	6	100	0.002	6	100	0.25
		10-17	SO	T	36	mg/kg	3.1	8.4	4.719	4.45	1.352	36	100	36	100	0.68	36	100	3	36	100	0.002	36	100	0.25
		17-22	SO	T	1	mg/kg	7.2	7.2	7.2	7.2	-	1	100	1	100	0.68	1	100	3	1	100	0.002	1	100	0.25
		>22	SO	T	1	mg/kg	4.6	4.6	4.6	4.6	-	1	100	1	100	0.68	1	100	3	1	100	0.002	1	100	0.25
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	4.1	23.5	6.788	5.6	4.43	17	100	17	100	0.68	17	100	3	17	100	0.002	17	100	0.25
		0.5-2	SO	T	17	mg/kg	4	23.2	6.676	6.1	4.491	17	100	17	100	0.68	17	100	3	17	100	0.002	17	100	0.25
		10-17	SO	T	6	mg/kg	3.5	5.4	4.383	4.4	0.757	6	100	6	100	0.68	6	100	3	6	100	0.002	6	100	0.25
		>22	SO	T	1	mg/kg	5.5	5.5	5.5	5.5	-	1	100	1	100	0.68	1	100	3	1	100	0.002	1	100	0.25
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	2.8	12.4	6.118	5.5	2.447	17	100	17	100	0.68	16	94	3	17	100	0.002	17	100	0.25
		0.5-2	SO	T	15	mg/kg	2	7.5	5.133	5.1	1.772	15	100	15	100	0.68	12	80	3	15	100	0.002	15	100	0.25
		10-17	SO	T	3	mg/kg	3.5	7.1	5.167	4.9	1.815	3	100	3	100	0.68	3	100	3	3	100	0.002	3	100	0.25
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	2.8	15.8	6.252	5.2	2.955	23	100	23	100	0.68	22	96	3	23	100	0.002	23	100	0.25
		0.5-2	SO	T	20	mg/kg	2	15.3	6.72	5.9	4.045	20	100	20	100	0.68	16	80	3	20	100	0.002	20	100	0.25
		10-17	SO	T	13	mg/kg	3.3	15.6	6.869	4.9	3.665	13	100	13	100	0.68	13	100	3	13	100	0.002	13	100	0.25
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	2.1	9	5.013	4.6	1.684	31	100	31	100	0.68	28	90	3	31	100	0.002	31	100	0.25
		0.5-2	SO	T	31	mg/kg	2	10.8	5.039	4.7	2.012	31	100	31	100	0.68	28	90	3	31	100	0.002	31	100	0.25
		10-17	SO	T	18	mg/kg	2.1	9.2	4.267	4.15	1.682	18	100	18	100	0.68	13	72	3	18	100	0.002	18	100	0.25
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	<0.84	5.7	2.964	3.2	1.577	22	95.7	21	91	0.68	12	52	3	23	100	0.002	23	100	0.25
		0.5-2	SO	T	23	mg/kg	<0.7	8.2	3.061	3.1	1.843	22	95.7	21	91	0.68	12	52	3	23	100	0.002	23	100	0.25
		2-10	SO	T	9	mg/kg	0.53	5	3.181	3.7	1.419	9	100	8	89	0.68	6	67	3	9	100	0.002	9	100	0.25
		10-17	SO	T	11	mg/kg	1.7	8.4	3.773	3.3	1.955	11	100	11	100	0.68	6	55	3	11	100	0.002	11	100	0.25
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	3.5	5.3	4.167	4.1	0.662	6	100	6	100	0.68	6	100	3	6	100	0.002	6	100	0.25
		0.5-2	SO	T	1	mg/kg	5.6	5.6	5.6	5.6	-	1	100	1	100	0.68	1	100	3	1	100	0.002	1	100	0.25
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	4.4	5.4	4.971	5	0.377	7	100	7	100	0.68	7	100	3	7	100	0.002	7	100	0.25
		0.5-2	SO	T	7	mg/kg	1.9	4.9	4.029	4.3	1.014	7	100	7	100	0.68	6	86	3	7	100	0.002	7	100	0.25

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Barium	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	40.3	376	120.781	99.6	68.903	78	100	0	0	1500	0	0	22000	78	100	16	78	100	1.04
		0.5-2	SO	T	86	mg/kg	32.6	392	106.265	88.65	58.548	86	100	0	0	1500	0	0	22000	86	100	16	86	100	1.04
		2-10	SO	T	14	mg/kg	55.5	510	108.721	68.25	118.833	14	100	0	0	1500	0	0	22000	14	100	16	14	100	1.04
		10-17	SO	T	98	mg/kg	24.8	261	76.294	66	35.941	98	100	0	0	1500	0	0	22000	98	100	16	98	100	1.04
		17-22	SO	T	21	mg/kg	33.8	316	81.176	71.5	55.725	21	100	0	0	1500	0	0	22000	21	100	16	21	100	1.04
		>22	SO	T	12	mg/kg	39.1	114	66.833	58.7	23.012	12	100	0	0	1500	0	0	22000	12	100	16	12	100	1.04
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	19.6	461	174.345	168.5	104.009	20	100	0	0	1500	0	0	22000	20	100	16	20	100	1.04
		0.5-2	SO	T	20	mg/kg	43.5	1560	227.255	112	339.216	20	100	1	5	1500	0	0	22000	20	100	16	20	100	1.04
		2-10	SO	T	5	mg/kg	56	148	80.08	63.8	38.415	5	100	0	0	1500	0	0	22000	5	100	16	5	100	1.04
		10-17	SO	T	19	mg/kg	22.7	160	70.989	66.6	35.814	19	100	0	0	1500	0	0	22000	19	100	16	19	100	1.04
		17-22	SO	T	5	mg/kg	47.7	120	79.9	69	28.553	5	100	0	0	1500	0	0	22000	5	100	16	5	100	1.04
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	55.3	420	149.97	119	89.653	60	100	0	0	1500	0	0	22000	60	100	16	60	100	1.04
		0.5-2	SO	T	55	mg/kg	40.7	436	123.335	102	79.472	55	100	0	0	1500	0	0	22000	55	100	16	55	100	1.04
		2-10	SO	T	6	mg/kg	56.1	113	78.65	71.5	20.019	6	100	0	0	1500	0	0	22000	6	100	16	6	100	1.04
		10-17	SO	T	36	mg/kg	29.5	133	67.986	62.35	29.313	36	100	0	0	1500	0	0	22000	36	100	16	36	100	1.04
		17-22	SO	T	1	mg/kg	44	44	44	44	-	1	100	0	0	1500	0	0	22000	1	100	16	1	100	1.04
		>22	SO	T	1	mg/kg	55.5	55.5	55.5	55.5	-	1	100	0	0	1500	0	0	22000	1	100	16	1	100	1.04
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	64.2	436	180.724	194	108.785	17	100	0	0	1500	0	0	22000	17	100	16	17	100	1.04
		0.5-2	SO	T	17	mg/kg	49.7	234	117.241	92.5	56.04	17	100	0	0	1500	0	0	22000	17	100	16	17	100	1.04
		10-17	SO	T	6	mg/kg	33.6	80.6	51.933	49.3	19.441	6	100	0	0	1500	0	0	22000	6	100	16	6	100	1.04
		>22	SO	T	1	mg/kg	92.4	92.4	92.4	92.4	-	1	100	0	0	1500	0	0	22000	1	100	16	1	100	1.04
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	45.3	1060	473.535	295	344.033	17	100	0	0	1500	0	0	22000	17	100	16	17	100	1.04
		0.5-2	SO	T	15	mg/kg	62.6	712	315.507	324	187.084	15	100	0	0	1500	0	0	22000	15	100	16	15	100	1.04
		10-17	SO	T	3	mg/kg	98.2	229	183.067	222	73.58	3	100	0	0	1500	0	0	22000	3	100	16	3	100	1.04
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	103	905	324.522	293	165.379	23	100	0	0	1500	0	0	22000	23	100	16	23	100	1.04
		0.5-2	SO	T	20	mg/kg	57.9	477	192.535	170	120.28	20	100	0	0	1500	0	0	22000	20	100	16	20	100	1.04
		10-17	SO	T	13	mg/kg	43	139	82.185	75.6	28.891	13	100	0	0	1500	0	0	22000	13	100	16	13	100	1.04
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	83.8	499	271.623	278	114.172	31	100	0	0	1500	0	0	22000	31	100	16	31	100	1.04
		0.5-2	SO	T	31	mg/kg	74.5	533	234.81	218	118.21	31	100	0	0	1500	0	0	22000	31	100	16	31	100	1.04
		10-17	SO	T	18	mg/kg	30.3	172	75.117	75.95	32.653	18	100	0	0	1500	0	0	22000	18	100	16	18	100	1.04
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	52.3	972	285.517	174	275.158	23	100	0	0	1500	0	0	22000	23	100	16	23	100	1.04
		0.5-2	SO	T	23	mg/kg	43.1	555	140.439	98.6	106.107	23	100	0	0	1500	0	0	22000	23	100	16	23	100	1.04
		2-10	SO	T	9	mg/kg	53.3	165	100.533	93.5	31.602	9	100	0	0	1500	0	0	22000	9	100	16	9	100	1.04
		10-17	SO	T	11	mg/kg	34.1	87.9	57.645	54.1	20.893	11	100	0	0	1500	0	0	22000	11	100	16	11	100	1.04
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	38	162	107.767	109	44.625	6	100	0	0	1500	0	0	22000	6	100	16	6	100	1.04
		0.5-2	SO	T	1	mg/kg	130	130	130	130	-	1	100	0	0	1500	0	0	22000	1	100	16	1	100	1.04
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	153	236	185.286	190	32.04	7	100	0	0	1500	0	0	22000	7	100	16	7	100	1.04
		0.5-2	SO	T	7	mg/kg	125	168	144.571	144	16.682	7	100	0	0	1500	0	0	22000	7	100	16	7	100	1.04

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Copper	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	7.4	34.5	15.347	14.6	5.071	78	100	0	0	310	0	0	4700	78	100	2.8	78	100	5.4
		0.5-2	SO	T	86	mg/kg	5.6	52.6	14.455	13.6	6.12	86	100	0	0	310	0	0	4700	86	100	2.8	86	100	5.4
		2-10	SO	T	14	mg/kg	9.6	22.4	14.443	13.3	3.323	14	100	0	0	310	0	0	4700	14	100	2.8	14	100	5.4
		10-17	SO	T	98	mg/kg	4.1	36.7	12.664	11.85	4.795	98	100	0	0	310	0	0	4700	98	100	2.8	96	98	5.4
		17-22	SO	T	21	mg/kg	6.7	66	13.481	10.9	12.26	21	100	0	0	310	0	0	4700	21	100	2.8	21	100	5.4
		>22	SO	T	12	mg/kg	8.3	23.3	11.883	10.6	4.064	12	100	0	0	310	0	0	4700	12	100	2.8	12	100	5.4
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	6.4	71.6	32.885	28.45	19.574	20	100	0	0	310	0	0	4700	20	100	2.8	20	100	5.4
		0.5-2	SO	T	20	mg/kg	7	40.7	19.445	17.5	9.258	20	100	0	0	310	0	0	4700	20	100	2.8	20	100	5.4
		2-10	SO	T	5	mg/kg	9	16.6	12.54	11.3	3.148	5	100	0	0	310	0	0	4700	5	100	2.8	5	100	5.4
		10-17	SO	T	19	mg/kg	4.3	17.5	9.632	9.6	2.786	19	100	0	0	310	0	0	4700	19	100	2.8	17	89	5.4
		17-22	SO	T	5	mg/kg	9.3	18.7	12.56	11.2	3.627	5	100	0	0	310	0	0	4700	5	100	2.8	5	100	5.4
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	6.7	7260	136.253	13.95	935.289	60	100	1	2	310	1	2	4700	60	100	2.8	60	100	5.4
		0.5-2	SO	T	55	mg/kg	5.9	45.7	15.411	13.9	7.052	55	100	0	0	310	0	0	4700	55	100	2.8	55	100	5.4
		2-10	SO	T	6	mg/kg	8.1	19.3	13.55	13	3.851	6	100	0	0	310	0	0	4700	6	100	2.8	6	100	5.4
		10-17	SO	T	36	mg/kg	6.3	240	18.194	11.25	38.193	36	100	0	0	310	0	0	4700	36	100	2.8	36	100	5.4
		17-22	SO	T	1	mg/kg	13.1	13.1	13.1	13.1	-	1	100	0	0	310	0	0	4700	1	100	2.8	1	100	5.4
		>22	SO	T	1	mg/kg	10.4	10.4	10.4	10.4	-	1	100	0	0	310	0	0	4700	1	100	2.8	1	100	5.4
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	7.5	54.6	15.118	12.2	10.98	17	100	0	0	310	0	0	4700	17	100	2.8	17	100	5.4
		0.5-2	SO	T	17	mg/kg	6.5	776	59.353	15.1	184.741	17	100	1	6	310	0	0	4700	17	100	2.8	17	100	5.4
		10-17	SO	T	6	mg/kg	5.1	16	10.95	10.85	4.485	6	100	0	0	310	0	0	4700	6	100	2.8	5	83	5.4
		>22	SO	T	1	mg/kg	9.4	9.4	9.4	9.4	-	1	100	0	0	310	0	0	4700	1	100	2.8	1	100	5.4
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	5.9	19.8	13.259	13.2	3.621	17	100	0	0	310	0	0	4700	17	100	2.8	17	100	5.4
		0.5-2	SO	T	15	mg/kg	4.7	17.1	10.367	10.3	3.376	15	100	0	0	310	0	0	4700	15	100	2.8	14	93	5.4
		10-17	SO	T	3	mg/kg	8.9	15	11.067	9.3	3.412	3	100	0	0	310	0	0	4700	3	100	2.8	3	100	5.4
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	4	32.1	15.687	14.3	6.818	23	100	0	0	310	0	0	4700	23	100	2.8	22	96	5.4
		0.5-2	SO	T	20	mg/kg	3.5	21.8	12.63	12.7	4.954	20	100	0	0	310	0	0	4700	20	100	2.8	19	95	5.4
		10-17	SO	T	13	mg/kg	10	17.5	12.592	12.2	2.246	13	100	0	0	310	0	0	4700	13	100	2.8	13	100	5.4
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	7	27	16.252	16.1	5.414	31	100	0	0	310	0	0	4700	31	100	2.8	31	100	5.4
		0.5-2	SO	T	31	mg/kg	8.1	25.9	15.455	13.3	4.78	31	100	0	0	310	0	0	4700	31	100	2.8	31	100	5.4
		10-17	SO	T	18	mg/kg	3.7	20.2	11.883	12.2	3.797	18	100	0	0	310	0	0	4700	18	100	2.8	17	94	5.4
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	8.9	694	70.67	18.3	147.181	23	100	1	4	310	0	0	4700	23	100	2.8	23	100	5.4
		0.5-2	SO	T	23	mg/kg	3.3	374	41.126	13.3	79.138	23	100	1	4	310	0	0	4700	23	100	2.8	22	96	5.4
		2-10	SO	T	9	mg/kg	3.8	22.1	12.667	12.2	4.789	9	100	0	0	310	0	0	4700	9	100	2.8	8	89	5.4
		10-17	SO	T	11	mg/kg	5.7	19.5	11.7	12	4.417	11	100	0	0	310	0	0	4700	11	100	2.8	11	100	5.4
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	9.5	19	12.283	11.1	3.472	6	100	0	0	310	0	0	4700	6	100	2.8	6	100	5.4
		0.5-2	SO	T	1	mg/kg	18.1	18.1	18.1	18.1	-	1	100	0	0	310	0	0	4700	1	100	2.8	1	100	5.4
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	15.2	22.7	17.786	18.1	2.659	7	100	0	0	310	0	0	4700	7	100	2.8	7	100	5.4
		0.5-2	SO	T	7	mg/kg	14.3	17.5	15.371	15.1	1.144	7	100	0	0	310	0	0	4700	7	100	2.8	7	100	5.4

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Manganese	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	178	1270	426.667	379	158.102	78	100	77	99	180	0	0	2600	78	100	2.8	76	97	220
		0.5-2	SO	1	86	mg/kg	161	920	415.267	394	117.535	86	100	85	99	180	0	0	2600	86	100	2.8	83	97	220
		2-10	SO	T	14	mg/kg	73.4	491	318.029	330.5	94.168	14	100	13	93	180	0	0	2600	14	100	2.8	13	93	220
		10-17	SO	T	98	mg/kg	169	855	346.041	338.5	103.47	98	100	96	98	180	0	0	2600	98	100	2.8	90	92	220
		17-22	SO	T	21	mg/kg	240	719	363.905	334	118.116	21	100	21	100	180	0	0	2600	21	100	2.8	21	100	220
		>22	SO	T	12	mg/kg	220	371	306.417	311.5	49.972	12	100	12	100	180	0	0	2600	12	100	2.8	11	92	220
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	12.8	479	148.365	89.5	143.749	20	100	6	30	180	0	0	2600	20	100	2.8	6	30	220
		0.5-2	SO	T	20	mg/kg	36.5	762	208.32	159.5	179.614	20	100	10	50	180	0	0	2600	20	100	2.8	6	30	220
		2-10	SO	T	5	mg/kg	285	393	328.8	323	39.322	5	100	5	100	180	0	0	2600	5	100	2.8	5	100	220
		10-17	SO	T	19	mg/kg	177	821	334.842	315	135.549	19	100	18	95	180	0	0	2600	19	100	2.8	17	89	220
		17-22	SO	T	5	mg/kg	268	579	345.2	286	132.264	5	100	5	100	180	0	0	2600	5	100	2.8	5	100	220
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	156	1570	518.833	445.5	256.758	60	100	59	98	180	0	0	2600	60	100	2.8	59	98	220
		0.5-2	SO	T	55	mg/kg	129	1050	438.982	397	180.374	55	100	53	96	180	0	0	2600	55	100	2.8	52	95	220
		2-10	SO	T	6	mg/kg	280	497	395.167	394	86.719	6	100	6	100	180	0	0	2600	6	100	2.8	6	100	220
		10-17	SO	T	36	mg/kg	227	675	359.639	344	87.686	36	100	36	100	180	0	0	2600	36	100	2.8	36	100	220
		17-22	SO	T	1	mg/kg	395	395	395	395	-	1	100	1	100	180	0	0	2600	1	100	2.8	1	100	220
		>22	SO	T	1	mg/kg	399	399	399	399	-	1	100	1	100	180	0	0	2600	1	100	2.8	1	100	220
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	284	2620	704.471	400	642.115	17	100	17	100	180	1	6	2600	17	100	2.8	17	100	220
		0.5-2	SO	T	17	mg/kg	137	606	367.941	387	130.928	17	100	15	88	180	0	0	2600	17	100	2.8	14	82	220
		10-17	SO	T	6	mg/kg	227	510	343.167	335.5	94.808	6	100	6	100	180	0	0	2600	6	100	2.8	6	100	220
		>22	SO	T	1	mg/kg	325	325	325	325	-	1	100	1	100	180	0	0	2600	1	100	2.8	1	100	220
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	210	3950	1199.235	924	1030.537	17	100	17	100	180	2	12	2600	17	100	2.8	16	94	220
		0.5-2	SO	T	15	mg/kg	169	1290	509.2	522	289.066	15	100	14	93	180	0	0	2600	15	100	2.8	14	93	220
		10-17	SO	T	3	mg/kg	254	323	300	323	39.837	3	100	3	100	180	0	0	2600	3	100	2.8	3	100	220
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	49.4	1140	538.943	550	282.875	23	100	20	87	180	0	0	2600	23	100	2.8	20	87	220
		0.5-2	SO	T	20	mg/kg	36.1	886	446.575	442	237.307	20	100	18	90	180	0	0	2600	20	100	2.8	17	85	220
		10-17	SO	T	13	mg/kg	224	688	388.923	379	115.563	13	100	13	100	180	0	0	2600	13	100	2.8	13	100	220
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	62.7	2210	513.313	446	393.874	31	100	27	87	180	0	0	2600	31	100	2.8	27	87	220
		0.5-2	SO	T	31	mg/kg	53.7	662	343.8	394	175.325	31	100	23	74	180	0	0	2600	31	100	2.8	23	74	220
		10-17	SO	T	18	mg/kg	115	642	336.611	314	136.569	18	100	15	83	180	0	0	2600	18	100	2.8	14	78	220
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	14.8	415	204.791	215	139.591	23	100	12	52	180	0	0	2600	23	100	2.8	11	48	220
		0.5-2	SO	T	23	mg/kg	10.7	365	181.422	121	117.772	23	100	10	43	180	0	0	2600	23	100	2.8	10	43	220
		2-10	SO	T	9	mg/kg	76.6	394	240.389	282	112.952	9	100	6	67	180	0	0	2600	9	100	2.8	6	67	220
		10-17	SO	T	11	mg/kg	78.2	293	199.382	216	83.514	11	100	7	64	180	0	0	2600	11	100	2.8	5	45	220
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	219	366	276.167	275	54.101	6	100	6	100	180	0	0	2600	6	100	2.8	5	83	220
		0.5-2	SO	T	1	mg/kg	352	352	352	352	-	1	100	1	100	180	0	0	2600	1	100	2.8	1	100	220
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	249	467	338.714	304	75.659	7	100	7	100	180	0	0	2600	7	100	2.8	7	100	220
		0.5-2	SO	T	7	mg/kg	76.4	330	213.343	191	93.293	7	100	4	57	180	0	0	2600	7	100	2.8	3	43	220

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	EPA Residential Soil RSL No. Exceeding	EPA Residential Soil RSL % Exceeding	EPA Residential Soil RSL Screening Level	EPA Industrial Soil RSL No. Exceeding	EPA Industrial Soil RSL % Exceeding	EPA Industrial Soil RSL Screening Level	EPA Protection Of Groundwater Risk-Based Soil RSL No. Exceeding	EPA Protection Of Groundwater Risk-Based Soil RSL % Exceeding	EPA Protection Of Groundwater Risk-Based Soil RSL Screening Level	Minimum Ecological Screening Level No. Exceeding	Minimum Ecological Screening Level % Exceeding	Minimum Ecological Screening Level Screening Level
Nickel	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	6.3	140	20.705	14.1	19.461	78	100	0	0	150	0	0	2200	78	100	2.6	73	94	9.7
		0.5-2	SO	T	86	mg/kg	6.5	98.1	14.412	11.35	12.897	86	100	0	0	150	0	0	2200	86	100	2.6	67	78	9.7
		2-10	SO	T	14	mg/kg	7.8	252	27.5	10.15	64.641	14	100	1	7	150	0	0	2200	14	100	2.6	8	57	9.7
		10-17	SO	T	98	mg/kg	4.5	16.6	9.67	9.4	2.203	98	100	0	0	150	0	0	2200	98	100	2.6	45	46	9.7
		17-22	SO	T	21	mg/kg	6.6	64.6	12.148	9.6	12.182	21	100	0	0	150	0	0	2200	21	100	2.6	10	48	9.7
		>22	SO	T	12	mg/kg	8.1	10.6	9.125	9.35	0.781	12	100	0	0	150	0	0	2200	12	100	2.6	1	8	9.7
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	17.9	1250	215	144.5	274.962	20	100	10	50	150	0	0	2200	20	100	2.6	20	100	9.7
		0.5-2	SO	T	20	mg/kg	10.3	719	131.245	73.65	166.953	20	100	5	25	150	0	0	2200	20	100	2.6	20	100	9.7
		2-10	SO	T	5	mg/kg	7.8	20.6	12.8	12.6	4.812	5	100	0	0	150	0	0	2200	5	100	2.6	4	80	9.7
		10-17	SO	T	19	mg/kg	6.1	18.1	10.784	10	3.515	19	100	0	0	150	0	0	2200	19	100	2.6	11	58	9.7
		17-22	SO	T	5	mg/kg	8	13.5	10.96	10.5	2.4	5	100	0	0	150	0	0	2200	5	100	2.6	3	60	9.7
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	8.6	89	21.075	16.45	14.769	60	100	0	0	150	0	0	2200	60	100	2.6	56	93	9.7
		0.5-2	SO	T	55	mg/kg	4.9	534	27.402	12.7	78.202	55	100	2	4	150	0	0	2200	55	100	2.6	47	85	9.7
		2-10	SO	T	6	mg/kg	9.7	39.8	16.367	11.85	11.56	6	100	0	0	150	0	0	2200	6	100	2.6	5	83	9.7
		10-17	SO	T	36	mg/kg	7.2	17.7	10.122	9.4	2.512	36	100	0	0	150	0	0	2200	36	100	2.6	17	47	9.7
		17-22	SO	T	1	mg/kg	10.6	10.6	10.6	10.6	-	1	100	0	0	150	0	0	2200	1	100	2.6	1	100	9.7
		>22	SO	T	1	mg/kg	8.8	8.8	8.8	8.8	-	1	100	0	0	150	0	0	2200	1	100	2.6	0	0	9.7
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	7.8	463	43.594	14.2	108.704	17	100	1	6	150	0	0	2200	17	100	2.6	16	94	9.7
		0.5-2	SO	T	17	mg/kg	9.8	513	47.065	12.1	121.368	17	100	1	6	150	0	0	2200	17	100	2.6	17	100	9.7
		10-17	SO	T	6	mg/kg	5.6	15.3	8.917	8.4	3.645	6	100	0	0	150	0	0	2200	6	100	2.6	2	33	9.7
		>22	SO	T	1	mg/kg	7.5	7.5	7.5	7.5	-	1	100	0	0	150	0	0	2200	1	100	2.6	0	0	9.7
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	7.9	68.9	27.129	19	19.607	17	100	0	0	150	0	0	2200	17	100	2.6	15	88	9.7
		0.5-2	SO	T	15	mg/kg	7.4	13.8	10.4	10.6	1.88	15	100	0	0	150	0	0	2200	15	100	2.6	9	60	9.7
		10-17	SO	T	3	mg/kg	7.9	8.9	8.3	8.1	0.529	3	100	0	0	150	0	0	2200	3	100	2.6	0	0	9.7
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	4.2	35.7	12.448	12.2	5.967	23	100	0	0	150	0	0	2200	23	100	2.6	18	78	9.7
		0.5-2	SO	T	20	mg/kg	5	15.4	10.01	10.55	2.786	20	100	0	0	150	0	0	2200	20	100	2.6	11	55	9.7
		10-17	SO	T	13	mg/kg	6.9	13.7	10.062	9.8	1.938	13	100	0	0	150	0	0	2200	13	100	2.6	8	62	9.7
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	8.9	14.3	11.6	11.3	1.562	31	100	0	0	150	0	0	2200	31	100	2.6	28	90	9.7
		0.5-2	SO	T	31	mg/kg	8.9	14.2	11.139	11.2	1.302	31	100	0	0	150	0	0	2200	31	100	2.6	27	87	9.7
		10-17	SO	T	18	mg/kg	5.2	13.4	9.6	9.8	1.852	18	100	0	0	150	0	0	2200	18	100	2.6	9	50	9.7
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	4.4	53.9	15.174	12.7	9.331	23	100	0	0	150	0	0	2200	23	100	2.6	21	91	9.7
		0.5-2	SO	T	23	mg/kg	4.3	26.6	11.261	10.8	3.847	23	100	0	0	150	0	0	2200	23	100	2.6	16	70	9.7
		2-10	SO	T	9	mg/kg	3.5	13.2	9.622	10	2.757	9	100	0	0	150	0	0	2200	9	100	2.6	5	56	9.7
		10-17	SO	T	11	mg/kg	6.5	11.5	9.209	8.4	1.812	11	100	0	0	150	0	0	2200	11	100	2.6	5	45	9.7
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	9.8	14.2	12.133	12.1	1.467	6	100	0	0	150	0	0	2200	6	100	2.6	6	100	9.7
		0.5-2	SO	T	1	mg/kg	14.3	14.3	14.3	14.3	-	1	100	0	0	150	0	0	2200	1	100	2.6	1	100	9.7
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	11.5	16.4	13.857	13.9	1.633	7	100	0	0	150	0	0	2200	7	100	2.6	7	100	9.7
		0.5-2	SO	T	7	mg/kg	9.2	14.2	12.486	12.8	1.569	7	100	0	0	150	0	0	2200	7	100	2.6	6	86	9.7

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Selenium	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	<0.23	0.66	-	-	-	5	6.4	0	0	39	0	0	580	78	100	0.052	78	100	0.028
		0.5-2	SO	T	86	mg/kg	<0.24	0.55	-	-	-	6	7.0	0	0	39	0	0	580	86	100	0.052	86	100	0.028
		2-10	SO	T	14	mg/kg	<0.29	1.4	-	-	-	1	7.1	0	0	39	0	0	580	14	100	0.052	14	100	0.028
		10-17	SO	T	98	mg/kg	<0.23	<0.42	-	-	-	0	0	0	0	39	0	0	580	98	100	0.052	98	100	0.028
		17-22	SO	T	21	mg/kg	<0.27	<0.35	-	-	-	0	0	0	0	39	0	0	580	21	100	0.052	21	100	0.028
		>22	SO	T	12	mg/kg	<0.28	<0.35	-	-	-	0	0	0	0	39	0	0	580	12	100	0.052	12	100	0.028
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	<0.25	3.3	0.823	0.68	0.796	14	70	0	0	39	0	0	580	20	100	0.052	20	100	0.028
		0.5-2	SO	T	20	mg/kg	<0.23	2.8	0.655	0.3	0.729	10	50	0	0	39	0	0	580	20	100	0.052	20	100	0.028
		2-10	SO	T	5	mg/kg	<0.23	<0.3	-	-	-	0	0	0	0	39	0	0	580	5	100	0.052	5	100	0.028
		10-17	SO	T	19	mg/kg	<0.25	0.38	-	-	-	1	5.3	0	0	39	0	0	580	19	100	0.052	19	100	0.028
		17-22	SO	T	5	mg/kg	<0.29	<0.36	-	-	-	0	0	0	0	39	0	0	580	5	100	0.052	5	100	0.028
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	<0.24	1.2	0.257	-	0.228	13	21.7	0	0	39	0	0	580	60	100	0.052	60	100	0.028
		0.5-2	SO	T	55	mg/kg	<0.23	3	-	-	-	6	10.9	0	0	39	0	0	580	55	100	0.052	55	100	0.028
		2-10	SO	T	6	mg/kg	<0.23	<0.32	-	-	-	0	0	0	0	39	0	0	580	6	100	0.052	6	100	0.028
		10-17	SO	T	36	mg/kg	<0.23	<0.46	-	-	-	0	0	0	0	39	0	0	580	36	100	0.052	36	100	0.028
		17-22	SO	T	1	mg/kg	<0.32	<0.32	-	-	-	0	0	0	0	39	0	0	580	1	100	0.052	1	100	0.028
		>22	SO	T	1	mg/kg	<0.36	<0.36	-	-	-	0	0	0	0	39	0	0	580	1	100	0.052	1	100	0.028
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	<0.25	0.75	0.221	-	0.156	3	17.6	0	0	39	0	0	580	17	100	0.052	17	100	0.028
		0.5-2	SO	T	17	mg/kg	<0.24	0.39	-	-	-	1	5.9	0	0	39	0	0	580	17	100	0.052	17	100	0.028
		10-17	SO	T	6	mg/kg	<0.24	<0.4	-	-	-	0	0	0	0	39	0	0	580	6	100	0.052	6	100	0.028
		>22	SO	T	1	mg/kg	<0.46	<0.46	-	-	-	0	0	0	0	39	0	0	580	1	100	0.052	1	100	0.028
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	<0.23	0.64	0.228	-	0.173	3	17.6	0	0	39	0	0	580	17	100	0.052	17	100	0.028
		0.5-2	SO	T	15	mg/kg	<0.23	0.52	-	-	-	1	6.7	0	0	39	0	0	580	15	100	0.052	15	100	0.028
		10-17	SO	T	3	mg/kg	<0.24	<0.25	-	-	-	0	0	0	0	39	0	0	580	3	100	0.052	3	100	0.028
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	<0.25	1.4	0.3	-	0.287	6	26.1	0	0	39	0	0	580	23	100	0.052	23	100	0.028
		0.5-2	SO	T	20	mg/kg	<0.24	0.42	0.203	-	0.08	4	20	0	0	39	0	0	580	20	100	0.052	20	100	0.028
		10-17	SO	T	13	mg/kg	<0.26	<0.38	-	-	-	0	0	0	0	39	0	0	580	13	100	0.052	13	100	0.028
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	<0.25	0.93	0.367	-	0.283	13	41.9	0	0	39	0	0	580	31	100	0.052	31	100	0.028
		0.5-2	SO	T	31	mg/kg	<0.23	1.1	0.273	-	0.238	8	25.8	0	0	39	0	0	580	31	100	0.052	31	100	0.028
		10-17	SO	T	18	mg/kg	<0.24	0.7	-	-	-	1	5.6	0	0	39	0	0	580	18	100	0.052	18	100	0.028
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	<0.27	1.3	-	-	-	3	13.0	0	0	39	0	0	580	23	100	0.052	23	100	0.028
		0.5-2	SO	T	23	mg/kg	<0.25	0.61	-	-	-	1	4.3	0	0	39	0	0	580	23	100	0.052	23	100	0.028
		2-10	SO	T	9	mg/kg	<0.25	<0.34	-	-	-	0	0	0	0	39	0	0	580	9	100	0.052	9	100	0.028
		10-17	SO	T	11	mg/kg	<0.36	<0.48	-	-	-	0	0	0	0	39	0	0	580	11	100	0.052	11	100	0.028
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	<0.29	<0.37	-	-	-	0	0	0	0	39	0	0	580	6	100	0.052	6	100	0.028
		0.5-2	SO	T	1	mg/kg	<0.32	<0.32	-	-	-	0	0	0	0	39	0	0	580	1	100	0.052	1	100	0.028
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	<0.32	<0.44	-	-	-	0	0	0	0	39	0	0	580	7	100	0.052	7	100	0.028
		0.5-2	SO	T	7	mg/kg	<0.29	0.65	-	-	-	1	14.3	0	0	39	0	0	580	7	100	0.052	7	100	0.028

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Thallium	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	<0.098	<0.2	-	-	-	0	0	27	35	0.078	0	0	1.2	78	100	0.001	78	100	0.027
		0.5-2	SO	1	86	mg/kg	<0.1	0.13	-	-	-	1	1.2	29	34	0.078	0	0	1.2	86	100	0.001	86	100	0.027
		2-10	SO	T	14	mg/kg	<0.12	2.2	-	-	-	1	7.1	1	7	0.078	1	7	1.2	14	100	0.001	14	100	0.027
		10-17	SO	T	98	mg/kg	<0.098	0.13	-	-	-	1	1.0	18	18	0.078	0	0	1.2	98	100	0.001	98	100	0.027
		17-22	SO	T	21	mg/kg	<0.12	0.15	-	-	-	1	4.8	1	5	0.078	0	0	1.2	21	100	0.001	21	100	0.027
		>22	SO	T	12	mg/kg	<0.12	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	12	100	0.001	12	100	0.027
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	<0.11	4.6	0.75	0.28	1.275	17	85	19	95	0.078	2	10	1.2	20	100	0.001	20	100	0.027
		0.5-2	SO	T	20	mg/kg	<0.099	4.5	0.856	0.255	1.262	16	80	16	80	0.078	4	20	1.2	20	100	0.001	20	100	0.027
		2-10	SO	T	5	mg/kg	<0.1	0.18	0.082	-	0.055	1	20	1	20	0.078	0	0	1.2	5	100	0.001	5	100	0.027
		10-17	SO	T	19	mg/kg	<0.11	0.21	0.107	-	0.056	7	36.8	9	47	0.078	0	0	1.2	19	100	0.001	19	100	0.027
		17-22	SO	T	5	mg/kg	<0.14	0.16	0.103	-	0.044	2	40	2	40	0.078	0	0	1.2	5	100	0.001	5	100	0.027
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	<0.1	0.14	-	-	-	7	11.7	17	28	0.078	0	0	1.2	60	100	0.001	60	100	0.027
		0.5-2	SO	T	55	mg/kg	<0.099	1.1	0.11	-	0.181	9	16.4	13	24	0.078	0	0	1.2	55	100	0.001	55	100	0.027
		2-10	SO	T	6	mg/kg	<0.098	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	6	100	0.001	6	100	0.027
		10-17	SO	T	36	mg/kg	<0.1	<0.18	-	-	-	0	0	7	19	0.078	0	0	1.2	36	100	0.001	36	100	0.027
		17-22	SO	T	1	mg/kg	<0.14	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	1	100	0.001	1	100	0.027
		>22	SO	T	1	mg/kg	<0.14	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	1	100	0.001	1	100	0.027
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	<0.11	0.17	-	-	-	2	11.8	3	18	0.078	0	0	1.2	17	100	0.001	17	100	0.027
		0.5-2	SO	T	17	mg/kg	<0.1	0.19	0.079	-	0.035	3	17.6	3	18	0.078	0	0	1.2	17	100	0.001	17	100	0.027
		10-17	SO	T	6	mg/kg	<0.11	<0.16	-	-	-	0	0	1	17	0.078	0	0	1.2	6	100	0.001	6	100	0.027
		>22	SO	T	1	mg/kg	<0.19	<0.19	-	-	-	0	0	1	100	0.078	0	0	1.2	1	100	0.001	1	100	0.027
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	<0.1	0.15	0.087	-	0.034	4	23.5	8	47	0.078	0	0	1.2	17	100	0.001	17	100	0.027
		0.5-2	SO	T	15	mg/kg	<0.098	0.13	0.07	-	0.027	3	20	4	27	0.078	0	0	1.2	15	100	0.001	15	100	0.027
		10-17	SO	T	3	mg/kg	<0.1	<0.11	-	-	-	0	0	0	0	0.078	0	0	1.2	3	100	0.001	3	100	0.027
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	<0.11	0.19	-	-	-	1	4.3	12	52	0.078	0	0	1.2	23	100	0.001	23	100	0.027
		0.5-2	SO	T	20	mg/kg	<0.11	0.41	-	-	-	2	10	6	30	0.078	0	0	1.2	20	100	0.001	20	100	0.027
		10-17	SO	T	13	mg/kg	<0.11	<0.15	-	-	-	0	0	0	0	0.078	0	0	1.2	13	100	0.001	13	100	0.027
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	<0.11	<0.18	-	-	-	0	0	7	23	0.078	0	0	1.2	31	100	0.001	31	100	0.027
		0.5-2	SO	T	31	mg/kg	<0.099	0.14	-	-	-	2	6.5	7	23	0.078	0	0	1.2	31	100	0.001	31	100	0.027
		10-17	SO	T	18	mg/kg	<0.1	<0.2	-	-	-	0	0	2	11	0.078	0	0	1.2	18	100	0.001	18	100	0.027
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	<0.12	0.2	-	-	-	1	4.3	14	61	0.078	0	0	1.2	23	100	0.001	23	100	0.027
		0.5-2	SO	T	23	mg/kg	<0.11	<0.24	-	-	-	0	0	12	52	0.078	0	0	1.2	23	100	0.001	23	100	0.027
		2-10	SO	T	9	mg/kg	<0.11	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	9	100	0.001	9	100	0.027
		10-17	SO	T	11	mg/kg	<0.15	<0.2	-	-	-	0	0	9	82	0.078	0	0	1.2	11	100	0.001	11	100	0.027
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	<0.12	<0.16	-	-	-	0	0	1	17	0.078	0	0	1.2	6	100	0.001	6	100	0.027
		0.5-2	SO	T	1	mg/kg	<0.14	<0.14	-	-	-	0	0	0	0	0.078	0	0	1.2	1	100	0.001	1	100	0.027
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	<0.13	<0.19	-	-	-	0	0	4	57	0.078	0	0	1.2	7	100	0.001	7	100	0.027
		0.5-2	SO	T	7	mg/kg	<0.12	<0.19	-	-	-	0	0	3	43	0.078	0	0	1.2	7	100	0.001	7	100	0.027

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Vanadium	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	4.1	31.6	12.665	11.75	4.978	78	100	0	0	39	0	0	580	63	81	8.6	78	100	0.714
		0.5-2	SO	T	86	mg/kg	4.3	31.8	10.592	9.65	4.179	86	100	0	0	39	0	0	580	57	66	8.6	86	100	0.714
		2-10	SO	T	14	mg/kg	6.4	166	20.35	7.55	42.08	14	100	1	7	39	0	0	580	6	43	8.6	14	100	0.714
		10-17	SO	T	98	mg/kg	3.2	15.2	8.067	7.8	2.384	98	100	0	0	39	0	0	580	34	35	8.6	98	100	0.714
		17-22	SO	T	21	mg/kg	5.4	14	7.99	7.3	2.103	21	100	0	0	39	0	0	580	8	38	8.6	21	100	0.714
		>22	SO	T	12	mg/kg	4.9	12	7.658	7.6	1.975	12	100	0	0	39	0	0	580	2	17	8.6	12	100	0.714
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	13.3	348	69.28	46.25	77.09	20	100	12	60	39	0	0	580	20	100	8.6	20	100	0.714
		0.5-2	SO	T	20	mg/kg	6.1	186	47.29	28.7	46.545	20	100	7	35	39	0	0	580	19	95	8.6	20	100	0.714
		2-10	SO	T	5	mg/kg	6.1	20.9	11.52	10.7	5.585	5	100	0	0	39	0	0	580	4	80	8.6	5	100	0.714
		10-17	SO	T	19	mg/kg	4.1	18.2	9.632	8.1	4.218	19	100	0	0	39	0	0	580	8	42	8.6	19	100	0.714
		17-22	SO	T	5	mg/kg	5.1	14.1	8.94	6.5	4.175	5	100	0	0	39	0	0	580	2	40	8.6	5	100	0.714
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	4	27.7	13.503	12.2	4.965	60	100	0	0	39	0	0	580	50	83	8.6	60	100	0.714
		0.5-2	SO	T	55	mg/kg	3	151	15.422	10	23.533	55	100	2	4	39	0	0	580	39	71	8.6	55	100	0.714
		2-10	SO	T	6	mg/kg	5.6	17	9.4	8.4	4.077	6	100	0	0	39	0	0	580	2	33	8.6	6	100	0.714
		10-17	SO	T	36	mg/kg	3.5	14.7	7.108	6.6	2.316	36	100	0	0	39	0	0	580	7	19	8.6	36	100	0.714
		17-22	SO	T	1	mg/kg	7.1	7.1	7.1	7.1	-	1	100	0	0	39	0	0	580	0	0	8.6	1	100	0.714
		>22	SO	T	1	mg/kg	7	7	7	7	-	1	100	0	0	39	0	0	580	0	0	8.6	1	100	0.714
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	4.6	169	21.888	12.9	38.221	17	100	1	6	39	0	0	580	14	82	8.6	17	100	0.714
		0.5-2	SO	T	17	mg/kg	7	163	22.5	10.7	37.462	17	100	2	12	39	0	0	580	13	76	8.6	17	100	0.714
		10-17	SO	T	6	mg/kg	3.5	10.6	5.667	5.05	2.617	6	100	0	0	39	0	0	580	1	17	8.6	6	100	0.714
		>22	SO	T	1	mg/kg	5.6	5.6	5.6	5.6	-	1	100	0	0	39	0	0	580	0	0	8.6	1	100	0.714
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	4.9	25.7	14.241	12.6	6.893	17	100	0	0	39	0	0	580	13	76	8.6	17	100	0.714
		0.5-2	SO	T	15	mg/kg	5.4	15.6	9.573	9.5	3.161	15	100	0	0	39	0	0	580	8	53	8.6	15	100	0.714
		10-17	SO	T	3	mg/kg	5.4	6	5.733	5.8	0.306	3	100	0	0	39	0	0	580	0	0	8.6	3	100	0.714
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	4.3	20.4	11.961	11.8	3.691	23	100	0	0	39	0	0	580	20	87	8.6	23	100	0.714
		0.5-2	SO	T	20	mg/kg	4	18.3	10.17	10.1	3.758	20	100	0	0	39	0	0	580	12	60	8.6	20	100	0.714
		10-17	SO	T	13	mg/kg	5.8	9.8	7.115	7	1.281	13	100	0	0	39	0	0	580	2	15	8.6	13	100	0.714
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	6.3	17.3	12.265	12.5	2.711	31	100	0	0	39	0	0	580	29	94	8.6	31	100	0.714
		0.5-2	SO	T	31	mg/kg	6.8	21.4	12.468	12.4	3.284	31	100	0	0	39	0	0	580	28	90	8.6	31	100	0.714
		10-17	SO	T	18	mg/kg	4.9	11.4	8.033	8.1	1.724	18	100	0	0	39	0	0	580	6	33	8.6	18	100	0.714
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	3.2	26.2	11.309	11.1	5.294	23	100	0	0	39	0	0	580	14	61	8.6	23	100	0.714
		0.5-2	SO	T	23	mg/kg	2.6	55.7	12.961	11.1	10.178	23	100	1	4	39	0	0	580	17	74	8.6	23	100	0.714
		2-10	SO	T	9	mg/kg	4	15.2	10.2	11	3.432	9	100	0	0	39	0	0	580	5	56	8.6	9	100	0.714
		10-17	SO	T	11	mg/kg	5.2	14.4	9.455	9.1	3.318	11	100	0	0	39	0	0	580	6	55	8.6	11	100	0.714
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	7.5	22.3	16.317	17.6	5.868	6	100	0	0	39	0	0	580	5	83	8.6	6	100	0.714
		0.5-2	SO	T	1	mg/kg	14.3	14.3	14.3	14.3	-	1	100	0	0	39	0	0	580	1	100	8.6	1	100	0.714
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	11.2	16.6	14.429	14.3	1.953	7	100	0	0	39	0	0	580	7	100	8.6	7	100	0.714
		0.5-2	SO	T	7	mg/kg	11	17	14.886	15.6	2.062	7	100	0	0	39	0	0	580	7	100	8.6	7	100	0.714

Table 11. Statistical Summary by Exposure Area – Site-Wide Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Zinc	1. Main Plant Area	0-0.5	SO	T	78	mg/kg	22.2	238	56.8	48.25	31.606	78	100	0	0	2300	0	0	35000	62	79	37	78	100	6.62
		0.5-2	SO	T	86	mg/kg	22.8	244	47.88	40.35	29.836	86	100	0	0	2300	0	0	35000	56	65	37	86	100	6.62
		2-10	SO	T	14	mg/kg	24.8	403	61.036	34.65	98.806	14	100	0	0	2300	0	0	35000	4	29	37	14	100	6.62
		10-17	SO	T	98	mg/kg	11.3	61.5	31.569	30.95	7.494	98	100	0	0	2300	0	0	35000	21	21	37	98	100	6.62
		17-22	SO	T	21	mg/kg	20.4	39.2	30.052	30.4	4.795	21	100	0	0	2300	0	0	35000	2	10	37	21	100	6.62
		>22	SO	T	12	mg/kg	24.1	35.3	29.742	29.5	3.581	12	100	0	0	2300	0	0	35000	0	0	37	12	100	6.62
	2. North Percolation Pond Area	0-0.5	SO	T	20	mg/kg	42.2	694	225.4	205	139.861	20	100	0	0	2300	0	0	35000	20	100	37	20	100	6.62
		0.5-2	SO	T	20	mg/kg	29.2	675	167.45	107	165.807	20	100	0	0	2300	0	0	35000	19	95	37	20	100	6.62
		2-10	SO	T	5	mg/kg	26.7	51.4	38.58	36	10.506	5	100	0	0	2300	0	0	35000	2	40	37	5	100	6.62
		10-17	SO	T	19	mg/kg	19.8	73.4	36.253	32.4	13.954	19	100	0	0	2300	0	0	35000	7	37	37	19	100	6.62
		17-22	SO	T	5	mg/kg	29.9	47.9	37.58	36.1	7.713	5	100	0	0	2300	0	0	35000	2	40	37	5	100	6.62
	3. Central Landfills Area	0-0.5	SO	T	60	mg/kg	28.9	129	56.265	49.95	23.164	60	100	0	0	2300	0	0	35000	52	87	37	60	100	6.62
		0.5-2	SO	T	55	mg/kg	28.7	113	46.884	42.4	17.121	55	100	0	0	2300	0	0	35000	39	71	37	55	100	6.62
		2-10	SO	T	6	mg/kg	29	51.9	39.117	39.75	7.655	6	100	0	0	2300	0	0	35000	4	67	37	6	100	6.62
		10-17	SO	T	36	mg/kg	25.2	50.1	35.767	35.9	6.146	36	100	0	0	2300	0	0	35000	16	44	37	36	100	6.62
		17-22	SO	T	1	mg/kg	35.5	35.5	35.5	35.5	-	1	100	0	0	2300	0	0	35000	0	0	37	1	100	6.62
		>22	SO	T	1	mg/kg	36.2	36.2	36.2	36.2	-	1	100	0	0	2300	0	0	35000	0	0	37	1	100	6.62
	4. Industrial Landfill Area	0-0.5	SO	T	17	mg/kg	36.9	89.1	58.512	60.9	14.541	17	100	0	0	2300	0	0	35000	16	94	37	17	100	6.62
		0.5-2	SO	T	17	mg/kg	37.5	56.9	46.206	44.4	6.432	17	100	0	0	2300	0	0	35000	17	100	37	17	100	6.62
		10-17	SO	T	6	mg/kg	21.5	41	30.9	30.45	9.008	6	100	0	0	2300	0	0	35000	3	50	37	6	100	6.62
		>22	SO	T	1	mg/kg	28.2	28.2	28.2	28.2	-	1	100	0	0	2300	0	0	35000	0	0	37	1	100	6.62
	5. Eastern Undeveloped Area	0-0.5	SO	T	17	mg/kg	25.3	150	71.412	64.3	35.984	17	100	0	0	2300	0	0	35000	13	76	37	17	100	6.62
		0.5-2	SO	T	15	mg/kg	28.8	93.3	47.573	46	18.098	15	100	0	0	2300	0	0	35000	10	67	37	15	100	6.62
		10-17	SO	T	3	mg/kg	26.7	30.1	27.9	26.9	1.908	3	100	0	0	2300	0	0	35000	0	0	37	3	100	6.62
	6. North-Central Undeveloped Area	0-0.5	SO	T	23	mg/kg	13.6	112	57.387	53.1	21.379	23	100	0	0	2300	0	0	35000	22	96	37	23	100	6.62
		0.5-2	SO	T	20	mg/kg	10.1	116	43.63	38.65	22.893	20	100	0	0	2300	0	0	35000	10	50	37	20	100	6.62
		10-17	SO	T	13	mg/kg	23.1	54	36.115	37.9	7.901	13	100	0	0	2300	0	0	35000	7	54	37	13	100	6.62
	7. Western Undeveloped Area	0-0.5	SO	T	31	mg/kg	34.1	89	55.355	55.7	14.817	31	100	0	0	2300	0	0	35000	29	94	37	31	100	6.62
		0.5-2	SO	T	31	mg/kg	30.1	64.8	44.232	43.7	9.506	31	100	0	0	2300	0	0	35000	21	68	37	31	100	6.62
		10-17	SO	T	18	mg/kg	16.9	41.3	30.267	29.75	6.662	18	100	0	0	2300	0	0	35000	3	17	37	18	100	6.62
	8. South Percolation Pond Area	0-0.5	SO	T	23	mg/kg	16.3	351	72.904	46.4	74.809	23	100	0	0	2300	0	0	35000	17	74	37	23	100	6.62
		0.5-2	SO	T	23	mg/kg	13.1	266	51.452	41.1	48.721	23	100	0	0	2300	0	0	35000	15	65	37	23	100	6.62
		2-10	SO	T	9	mg/kg	17.6	46.7	32.767	33.3	8.82	9	100	0	0	2300	0	0	35000	2	22	37	9	100	6.62
		10-17	SO	T	11	mg/kg	24.9	37.9	32.136	33.6	4.335	11	100	0	0	2300	0	0	35000	1	9	37	11	100	6.62
	9. Flathead River Area	0-0.5	SO	T	6	mg/kg	35	50	39.233	37.6	5.399	6	100	0	0	2300	0	0	35000	4	67	37	6	100	6.62
		0.5-2	SO	T	1	mg/kg	46.8	46.8	46.8	46.8	-	1	100	0	0	2300	0	0	35000	1	100	37	1	100	6.62
	9A. Backwater Seep Sampling Area	0-0.5	SO	T	7	mg/kg	42.2	56.3	48.314	48.1	4.502	7	100	0	0	2300	0	0	35000	7	100	37	7	100	6.62
		0.5-2	SO	T	7	mg/kg	28.8	47.8	41.586	43.4	6.238	7	100	0	0	2300	0	0	35000	6	86	37	7	100	6.62

Table 12. Statistical Summary by Exposure Area – Operational Area Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	0.021	0.81	0.334	0.29	0.258	14	100	0	0	2.3	0	0	15	14	100	0.002	11	79	0.1
		0.5-2	SO	T	14	mg/kg	0.082	1.2	0.361	0.25	0.318	14	100	0	0	2.3	0	0	15	14	100	0.002	13	93	0.1
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	0.11	18.2	1.244	0.31	3.377	29	100	2	7	2.3	1	3	15	29	100	0.002	29	100	0.1
		0.5-2	SO	T	29	mg/kg	<0.064	4.1	0.661	0.16	1.057	27	93.1	2	7	2.3	0	0	15	29	100	0.002	22	76	0.1
Fluoride	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	56.3	632	283.214	285.5	212.29	14	100	6	43	310	0	0	4700	14	100	12	14	100	6.5
		0.5-2	SO	T	14	mg/kg	79.1	709	244.921	179.5	196.685	14	100	3	21	310	0	0	4700	14	100	12	14	100	6.5
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	27.6	976	271.328	117	285.537	29	100	8	28	310	0	0	4700	29	100	12	29	100	6.5
		0.5-2	SO	T	29	mg/kg	16.6	946	264.876	136	287.944	29	100	8	28	310	0	0	4700	29	100	12	29	100	6.5
Benzo[a]pyrene	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	0.34	110	16.588	4.35	29.52	14	100	14	100	0.11	10	71	2.1	14	100	0.029	11	79	1.52
		0.5-2	SO	T	14	mg/kg	0.12	8.2	1.816	1.045	2.207	14	100	14	100	0.11	3	21	2.1	14	100	0.029	4	29	1.52
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	0.36	130	8.246	2.1	23.937	29	100	29	100	0.11	14	48	2.1	29	100	0.029	19	66	1.52
		0.5-2	SO	T	29	mg/kg	<0.01	240	14.972	0.53	46.898	28	96.6	22	76	0.11	11	38	2.1	27	93	0.029	12	41	1.52
Aroclor 1254	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	<0.009	<0.009	-	-	-	0	0	0	0	0.12	0	0	0.97	14	100	0.002	0	0	0.041
		0.5-2	SO	T	14	mg/kg	<0.009	<0.009	-	-	-	0	0	0	0	0.12	0	0	0.97	14	100	0.002	0	0	0.041
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	<0.009	0.27	0.034	-	0.066	8	27.6	2	7	0.12	0	0	0.97	29	100	0.002	8	28	0.041
		0.5-2	SO	T	29	mg/kg	<9.2E-05	1.3	0.106	-	0.279	6	20.7	5	17	0.12	1	3	0.97	28	97	0.002	6	21	0.041
Arsenic	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	4.5	31.3	9.429	6.2	7.609	14	100	14	100	0.68	14	100	3	14	100	0.002	14	100	0.25
		0.5-2	SO	T	14	mg/kg	4.1	8.2	5.293	5.15	1.045	14	100	14	100	0.68	14	100	3	14	100	0.002	14	100	0.25
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	4.2	12.3	5.872	5.3	1.661	29	100	29	100	0.68	29	100	3	29	100	0.002	29	100	0.25
		0.5-2	SO	T	29	mg/kg	4.4	9.3	5.572	5.5	1	29	100	29	100	0.68	29	100	3	29	100	0.002	29	100	0.25
Barium	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	116	286	177.214	157	57.01	14	100	0	0	1500	0	0	22000	14	100	16	14	100	1.04
		0.5-2	SO	T	14	mg/kg	116	302	183	159.5	61.156	14	100	0	0	1500	0	0	22000	14	100	16	14	100	1.04
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	59.4	293	137.555	120	59.211	29	100	0	0	1500	0	0	22000	29	100	16	29	100	1.04
		0.5-2	SO	T	29	mg/kg	74.8	184	129.272	121	27.799	29	100	0	0	1500	0	0	22000	29	100	16	29	100	1.04
Copper	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	15.8	887	153.907	32.8	252.478	14	100	3	21	310	0	0	4700	14	100	2.8	14	100	5.4
		0.5-2	SO	T	14	mg/kg	15.4	73.1	28.321	20.75	16.464	14	100	0	0	310	0	0	4700	14	100	2.8	14	100	5.4
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	14.6	381	42.076	21.9	67.193	29	100	1	3	310	0	0	4700	29	100	2.8	29	100	5.4
		0.5-2	SO	T	29	mg/kg	14.1	721	57.81	17.1	146.433	29	100	2	7	310	0	0	4700	29	100	2.8	29	100	5.4
Manganese	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	387	731	492.143	465.5	97.304	14	100	14	100	180	0	0	2600	14	100	2.8	14	100	220
		0.5-2	SO	T	14	mg/kg	363	686	508.5	484	110.369	14	100	14	100	180	0	0	2600	14	100	2.8	14	100	220
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	341	657	474.897	465	85.085	29	100	29	100	180	0	0	2600	29	100	2.8	29	100	220
		0.5-2	SO	T	29	mg/kg	386	629	487.207	477	55.592	29	100	29	100	180	0	0	2600	29	100	2.8	29	100	220
Nickel	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	13.4	62.8	37.35	41.9	15.521	14	100	0	0	150	0	0	2200	14	100	2.6	14	100	9.7
		0.5-2	SO	T	14	mg/kg	14.2	35.3	18.907	17.5	5.234	14	100	0	0	150	0	0	2200	14	100	2.6	14	100	9.7
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	17.5	142	40.962	33.2	25.625	29	100	0	0	150	0	0	2200	29	100	2.6	29	100	9.7
		0.5-2	SO	T	29	mg/kg	12.3	62.3	18.803	15.4	9.848	29	100	0	0	150	0	0	2200	29	100	2.6	29	100	9.7
Selenium	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	0.73	2.6	1.406	1.1	0.601	14	100	0	0	39	0	0	580	14	100	0.052	14	100	0.028
		0.5-2	SO	T	14	mg/kg	0.8	1.9	1.253	1.1	0.364	14	100	0	0	39	0	0	580	14	100	0.052	14	100	0.028
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	0.22	13.3	1.826	1.5	2.508	29	100	0	0	39	0	0	580	29	100	0.052	29	100	0.028
		0.5-2	SO	T	29	mg/kg	0.18	2	1.103	1.5	0.671	29	100	0	0	39	0	0	580	29	100	0.052	29	100	0.028
Thallium	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	0.087	0.22	0.137	0.125	0.044	14	100	14	100	0.078	0	0	1.2	14	100	0.001	14	100	0.027
		0.5-2	SO	T	14	mg/kg	0.079	0.14	0.103	0.098	0.016	14	100	14	100	0.078	0	0	1.2	14	100	0.001	14	100	0.027
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	0.067	0.4	0.129	0.11	0.063	29	100	27	93	0.078	0	0	1.2	29	100	0.001	29	100	0.027
		0.5-2	SO	T	29	mg/kg	0.06	0.16	0.104	0.098	0.028	29	100	24	83	0.078	0	0	1.2	29	100	0.001	29	100	0.027

Table 12. Statistical Summary by Exposure Area – Operational Area Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Vanadium	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	12.3	44.5	22.036	20.35	9.345	14	100	1	7	39	0	0	580	14	100	8.6	14	100	0.714
		0.5-2	SO	T	14	mg/kg	12.6	18.8	15.114	15.05	1.879	14	100	0	0	39	0	0	580	14	100	8.6	14	100	0.714
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	12.9	54.5	21.683	19.5	8.906	29	100	1	3	39	0	0	580	29	100	8.6	29	100	0.714
		0.5-2	SO	T	29	mg/kg	8.6	54.1	15.903	13.4	8.541	29	100	1	3	39	0	0	580	28	97	8.6	29	100	0.714
Zinc	1. Main Plant Area	0-0.5	SO	T	14	mg/kg	48.2	1720	326.036	100.1	480.265	14	100	0	0	2300	0	0	35000	14	100	37	14	100	6.62
		0.5-2	SO	T	14	mg/kg	44.8	204	83.414	67.35	45.289	14	100	0	0	2300	0	0	35000	14	100	37	14	100	6.62
	3. Central Landfills Area	0-0.5	SO	T	29	mg/kg	48.3	117	72.738	69.6	15.723	29	100	0	0	2300	0	0	35000	29	100	37	29	100	6.62
		0.5-2	SO	T	29	mg/kg	44.4	214	63.517	53.4	31.656	29	100	0	0	2300	0	0	35000	29	100	37	29	100	6.62

Table 13. Statistical Summary by Hydrogeologic Unit – Groundwater in the Upper Unit
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													DEQ-7 Human Health Standards			EPA Risk Based Screening Level Drinking Water MCL			EPA Risk Based Screening Level Tapwater RSL		
Analyte	Exposure Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	1. Main Plant Area	WG	T	143	ug/l	<2	1010	244.4	201	211.6	131	91.6	72	50	200	72	50	200	143	100	0.15
		WG	DI	74	ug/l	<2	1070	280.5	241.5	236.5	66	89.2	39	53	200	39	53	200	74	100	0.15
	2. North Percolation Pond Area	WG	T	6	ug/l	560	895	696.8	679	137.3	6	100	6	100	200	6	100	200	6	100	0.15
		WG	DI	3	ug/l	520	918	672.7	580	214.6	3	100	3	100	200	3	100	200	3	100	0.15
	3. Central Landfills Area	WG	T	97	ug/l	<2	10800	1149.6	169	2079.4	76	78.4	47	48	200	47	48	200	97	100	0.15
		WG	DI	50	ug/l	<2	11500	1048.4	108	2298.5	32	64	22	44	200	22	44	200	50	100	0.15
	4. Industrial Landfill Area	WG	T	10	ug/l	<2	29.9	12	13.6	9.2	7	70	0	0	200	0	0	200	10	100	0.15
		WG	DI	7	ug/l	<2	18.8	8.9	11.3	7.8	4	57.1	0	0	200	0	0	200	7	100	0.15
	6. North-Central Undeveloped Area	WG	T	12	ug/l	<2	235	70	36.6	83.2	8	66.7	1	8	200	1	8	200	12	100	0.15
		WG	DI	6	ug/l	<2	186	64.1	35.8	78.2	3	50	0	0	200	0	0	200	6	100	0.15
	7. Western Undeveloped Area	WG	T	22	ug/l	<2	22.1	-	-	-	3	13.6	0	0	200	0	0	200	22	100	0.15
		WG	DI	16	ug/l	<2	18.9	3.3	-	6	3	18.8	0	0	200	0	0	200	16	100	0.15
	8. South Percolation Pond Area	WG	T	12	ug/l	<2	81.6	32.2	23.9	30.3	10	83.3	0	0	200	0	0	200	12	100	0.15
		WG	DI	6	ug/l	<2	84.3	42.8	47	34.6	5	83.3	0	0	200	0	0	200	6	100	0.15
Cyanide, Free	1. Main Plant Area	WG	T	94	ug/l	<1.5	305	17.4	8.8	35.4	78	82.98	1	1	200	1	1	200	94	100	0.15
		WG	DI	73	ug/l	<1.5	66.2	11.1	7.2	12.3	64	87.7	0	0	200	0	0	200	73	100	0.15
	2. North Percolation Pond Area	WG	T	4	ug/l	9.2	62	31.4	27.3	22.7	4	100	0	0	200	0	0	200	4	100	0.15
		WG	DI	3	ug/l	11.1	46.3	24	14.5	19.4	3	100	0	0	200	0	0	200	3	100	0.15
	3. Central Landfills Area	WG	T	64	ug/l	<1.5	306	29.7	4.7	52.5	39	60.9	1	2	200	1	2	200	64	100	0.15
		WG	DI	50	ug/l	<1.5	150	18.5	3.3	32.1	31	62	0	0	200	0	0	200	50	100	0.15
	4. Industrial Landfill Area	WG	T	8	ug/l	<1.5	1.9	1	-	0.5	2	25	0	0	200	0	0	200	8	100	0.15
		WG	DI	7	ug/l	<1.5	1.6	-	-	-	1	14.3	0	0	200	0	0	200	7	100	0.15
	6. North-Central Undeveloped Area	WG	T	8	ug/l	<1.5	7.4	2.8	-	2.9	3	37.5	0	0	200	0	0	200	8	100	0.15
		WG	DI	6	ug/l	<1.5	3.3	1.4	-	1.1	2	33.3	0	0	200	0	0	200	6	100	0.15
	7. Western Undeveloped Area	WG	T	14	ug/l	<1.5	1.7	-	-	-	1	7.1	0	0	200	0	0	200	14	100	0.15
		WG	DI	14	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	200	0	0	200	14	100	0.15
	8. South Percolation Pond Area	WG	T	8	ug/l	<1.5	1.8	-	-	-	1	12.5	0	0	200	0	0	200	8	100	0.15
		WG	DI	6	ug/l	<1.5	1.8	0.9	-	0.4	1	16.7	0	0	200	0	0	200	6	100	0.15
Fluoride	1. Main Plant Area	WG	T	143	ug/l	<12	8570	2091.6	2100	1348.7	141	98.6	8	6	4000	8	6	4000	141	99	80
		WG	DI	24	ug/l	190	8400	2320.6	2155	1894.8	24	100	2	8	4000	2	8	4000	24	100	80
	2. North Percolation Pond Area	WG	T	6	ug/l	1970	5160	3410	3205	1292.1	6	100	2	33	4000	2	33	4000	6	100	80
		WG	DI	1	ug/l	5190	5190	5190	5190	-	1	100	1	100	4000	1	100	4000	1	100	80
	3. Central Landfills Area	WG	T	97	ug/l	<12	52900	5813.9	971	10403.2	96	99	28	29	4000	28	29	4000	94	97	80
		WG	DI	18	ug/l	126	55300	6455.4	964	14230.1	18	100	5	28	4000	5	28	4000	18	100	80
	4. Industrial Landfill Area	WG	T	10	ug/l	<12	1420	427.2	313.5	477.4	6	60	0	0	4000	0	0	4000	6	60	80
		WG	DI	1	ug/l	<60	<60	-	-	-	0	0	0	0	4000	0	0	4000	0	0	80
	6. North-Central Undeveloped Area	WG	T	12	ug/l	<12	336	197.5	195.5	100.3	11	91.7	0	0	4000	0	0	4000	11	92	80
		WG	DI	2	ug/l	120	298	209	209	125.9	2	100	0	0	4000	0	0	4000	2	100	80
	7. Western Undeveloped Area	WG	T	22	ug/l	<12	1050	188.1	108	281.5	17	77.3	0	0	4000	0	0	4000	16	73	80
		WG	DI	2	ug/l	96	188	142	142	65.1	2	100	0	0	4000	0	0	4000	2	100	80
	8. South Percolation Pond Area	WG	T	12	ug/l	269	786	499.8	471	213.9	12	100	0	0	4000	0	0	4000	12	100	80
		WG	DI	2	ug/l	312	638	475	475	230.5	2	100	0	0	4000	0	0	4000	2	100	80

Table 13. Statistical Summary by Hydrogeologic Unit – Groundwater in the Upper Unit
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													DEQ-7 Human Health Standards			EPA Risk Based Screening Level Drinking Water MCL			EPA Risk Based Screening Level Tapwater RSL		
Analyte	Exposure Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Benzo[a]pyrene	1. Main Plant Area	WG	T	79	ug/l	<0.049	<0.16	-	-	-	0	0.	77	97	0.05	0	0	0.2	78	99	0.025
	2. North Percolation Pond Area	WG	T	4	ug/l	<0.16	<0.16	-	-	-	0	0.	4	100	0.05	0	0	0.2	4	100	0.025
	3. Central Landfills Area	WG	T	57	ug/l	<0.16	<0.17	-	-	-	0	0	57	100	0.05	0	0	0.2	57	100	0.025
	4. Industrial Landfill Area	WG	T	8	ug/l	<0.051	0	-	-	-	1	12.5	5	63	0.05	0	0	0.2	7	88	0.025
	6. North-Central Undeveloped Area	WG	T	10	ug/l	<0.049	<0.053	-	-	-	0	0.	0	0	0.05	0	0	0.2	7	70	0.025
	7. Western Undeveloped Area	WG	T	8	ug/l	<0.16	<0.16	-	-	-	0	0.	8	100	0.05	0	0	0.2	8	100	0.025
	8. South Percolation Pond Area	WG	T	4	ug/l	<0.16	<0.16	-	-	-	0	0.	4	100	0.05	0	0	0.2	4	100	0.025
Arsenic	1. Main Plant Area	WG	T	74	ug/l	<0.8	13.7	-	-	-	9	12.2	4	5	10	4	5	10	74	100	0.052
		WG	DI	143	ug/l	<0.8	12.6	-	-	-	16	11.2	4	3	10	4	3	10	143	100	0.052
	2. North Percolation Pond Area	WG	T	3	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	10	0	0	10	3	100	0.052
		WG	DI	6	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	10	0	0	10	6	100	0.052
	3. Central Landfills Area	WG	T	50	ug/l	<0.8	82.1	8.4	-	22.1	22	44	5	10	10	5	10	10	50	100	0.052
		WG	DI	97	ug/l	<0.6	92.6	6.8	-	19.5	36	37.1	10	10	10	10	10	10	97	100	0.052
	4. Industrial Landfill Area	WG	T	7	ug/l	<0.8	3.3	1.3	1.1	1	5	71.4	0	0	10	0	0	10	7	100	0.052
		WG	DI	10	ug/l	<0.8	1	0.5	-	0.2	3	30	0	0	10	0	0	10	10	100	0.052
	6. North-Central Undeveloped Area	WG	T	6	ug/l	<0.8	1.9	0.7	-	0.6	2	33.3	0	0	10	0	0	10	6	100	0.052
		WG	DI	12	ug/l	<0.6	1.2	0.6	-	0.3	5	41.7	0	0	10	0	0	10	12	100	0.052
	7. Western Undeveloped Area	WG	T	16	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	10	0	0	10	16	100	0.052
		WG	DI	22	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	10	0	0	10	22	100	0.052
	8. South Percolation Pond Area	WG	T	6	ug/l	<0.8	1	0.5	-	0.2	1	16.7	0	0	10	0	0	10	6	100	0.052
		WG	DI	12	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	10	0	0	10	12	100	0.052

Table 14. Statistical Summary by Hydrogeologic Unit – Groundwater Below the Upper Unit
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													DEQ-7 Human Health Standards			EPA Risk Based Screening Level Drinking Water MCL			EPA Risk Based Screening Level Tapwater RSL		
Analyte	Exposure Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	1. Main Plant Area	WG	T	24	ug/l	<2	13.9	3.6	-	3.8	10	41.7	0	0	200	0	0	200	24	100	0.15
		WG	DI	12	ug/l	<2	13.3	4.1	2.1	4.1	7	58.3	0	0	200	0	0	200	12	100	0.15
	3. Central Landfills Area	WG	T	12	ug/l	<2	2.4	1.2	-	0.5	2	16.7	0	0	200	0	0	200	12	100	0.15
		WG	DI	6	ug/l	<2	2.8	2.1	2.4	0.9	4	66.7	0	0	200	0	0	200	6	100	0.15
	4. Industrial Landfill Area	WG	T	6	ug/l	<2	2.1	1.2	-	0.4	1	16.7	0	0	200	0	0	200	6	100	0.15
		WG	DI	3	ug/l	<2	<2	-	-	-	0	0	0	0	200	0	0	200	3	100	0.15
	6. North-Central Undeveloped Area	WG	T	6	ug/l	<2	<2	-	-	-	0	0	0	0	200	0	0	200	6	100	0.15
		WG	DI	3	ug/l	<2	<2	-	-	-	0	0	0	0	200	0	0	200	3	100	0.15
	7. Western Undeveloped Area	WG	T	30	ug/l	<2	3.3	-	-	-	1	3.3	0	0	200	0	0	200	30	100	0.15
		WG	DI	15	ug/l	<2	<2	-	-	-	0	0	0	0	200	0	0	200	15	100	0.15
Cyanide, Free	1. Main Plant Area	WG	T	11	ug/l	<1.5	3.9	-	-	-	1	9.1	0	0	200	0	0	200	11	100	0.15
		WG	DI	10	ug/l	<1.5	2.9	1.1	-	0.8	2	20	0	0	200	0	0	200	10	100	0.15
	3. Central Landfills Area	WG	T	4	ug/l	<1.5	2	1.1	-	0.6	1	25	0	0	200	0	0	200	4	100	0.15
		WG	DI	4	ug/l	<1.5	3.8	1.8	1.2	1.4	2	50	0	0	200	0	0	200	4	100	0.15
	4. Industrial Landfill Area	WG	T	4	ug/l	<1.5	2.7	1.2	-	1	1	25	0	0	200	0	0	200	4	100	0.15
		WG	DI	3	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	200	0	0	200	3	100	0.15
	6. North-Central Undeveloped Area	WG	T	2	ug/l	<1.5	2	1.4	1.4	0.9	1	50	0	0	200	0	0	200	2	100	0.15
		WG	DI	2	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	200	0	0	200	2	100	0.15
	7. Western Undeveloped Area	WG	T	12	ug/l	<1.5	3.1	1.1	-	0.9	2	16.7	0	0	200	0	0	200	12	100	0.15
		WG	DI	11	ug/l	<1.5	4.8	1.2	-	1.2	2	18.2	0	0	200	0	0	200	11	100	0.15
Fluoride	1. Main Plant Area	WG	T	24	ug/l	<15	762	273.5	201.5	195.2	23	95.8	0	0	4000	0	0	4000	21	88	80
		WG	DI	4	ug/l	116	595	331.5	307.5	218.5	4	100	0	0	4000	0	0	4000	4	100	80
	3. Central Landfills Area	WG	T	12	ug/l	<12	361	136.4	136.5	96.5	10	83.3	0	0	4000	0	0	4000	9	75	80
		WG	DI	2	ug/l	90.2	145	117.6	117.6	38.7	2	100	0	0	4000	0	0	4000	2	100	80
	4. Industrial Landfill Area	WG	T	6	ug/l	114	373	278.7	294	90.4	6	100	0	0	4000	0	0	4000	6	100	80
		WG	DI	1	ug/l	274	274	274	274	-	1	100	0	0	4000	0	0	4000	1	100	80
	6. North-Central Undeveloped Area	WG	T	6	ug/l	96.9	246	180.8	195.5	51	6	100	0	0	4000	0	0	4000	6	100	80
		WG	DI	1	ug/l	170	170	170	170	-	1	100	0	0	4000	0	0	4000	1	100	80
	7. Western Undeveloped Area	WG	T	30	ug/l	<12	569	194.2	182.5	134.8	26	86.7	0	0	4000	0	0	4000	25	83	80
		WG	DI	5	ug/l	157	649	306.4	209	203.8	5	100	0	0	4000	0	0	4000	5	100	80
Benzo[a]pyrene	1. Main Plant Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4. Industrial Landfill Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7. Western Undeveloped Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		WG	T	4	ug/l	<0.2	<0.2	-	-	-	0	0	4	100	0.05	0	0	0.2	4	100	0.025
	3. Central Landfills Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6. North-Central Undeveloped Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 14. Statistical Summary by Hydrogeologic Unit – Groundwater Below the Upper Unit
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													DEQ-7 Human Health Standards			EPA Risk Based Screening Level Drinking Water MCL			EPA Risk Based Screening Level Tapwater RSL		
Analyte	Exposure Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Antimony	1. Main Plant Area	WG	T	12	ug/l	<0.6	70.7	12.3	0.5	25.3	6	50	3	25	6	3	25	6	5	42	0.78
		WG	DI	24	ug/l	<0.6	84.5	6.8	-	20.6	7	29.2	3	13	6	3	13	6	7	29	0.78
	3. Central Landfills Area	WG	T	6	ug/l	<0.6	1	0.4	-	0.3	1	16.7	0	0	6	0	0	6	1	17	0.78
		WG	DI	12	ug/l	<0.6	<0.6	-	-	-	0	0	0	0	6	0	0	6	0	0	0.78
	4. Industrial Landfill Area	WG	T	3	ug/l	<0.6	1.5	0.7	-	0.7	1	33.3	0	0	6	0	0	6	1	33	0.78
		WG	DI	6	ug/l	<0.6	0.6	0.4	-	0.2	2	33.3	0	0	6	0	0	6	0	0	0.78
	6. North-Central Undeveloped Area	WG	T	3	ug/l	<0.6	0.8	0.5	-	0.3	1	33.3	0	0	6	0	0	6	1	33	0.78
		WG	DI	6	ug/l	<0.6	<0.6	-	-	-	0	0	0	0	6	0	0	6	0	0	0.78
	7. Western Undeveloped Area	WG	T	15	ug/l	<0.6	3.1	0.8	-	0.9	4	26.7	0	0	6	0	0	6	4	27	0.78
		WG	DI	30	ug/l	<0.6	2.8	-	-	-	3	10	0	0	6	0	0	6	3	10	0.78
Arsenic	1. Main Plant Area	WG	T	12	ug/l	<0.8	5.3	0.9	-	1.4	3	25	0	0	10	0	0	10	12	100	0.052
		WG	DI	24	ug/l	<0.8	2.7	0.6	-	0.6	5	20.8	0	0	10	0	0	10	24	100	0.052
	3. Central Landfills Area	WG	T	6	ug/l	<0.8	1.8	0.9	0.7	0.6	3	50	0	0	10	0	0	10	6	100	0.052
		WG	DI	12	ug/l	<0.8	8.3	1.5	0.8	2.2	6	50	0	0	10	0	0	10	12	100	0.052
	4. Industrial Landfill Area	WG	T	3	ug/l	3.6	6.2	4.5	3.8	1.4	3	100	0	0	10	0	0	10	3	100	0.052
		WG	DI	6	ug/l	2.8	6.5	4	3.3	1.5	6	100	0	0	10	0	0	10	6	100	0.052
	6. North-Central Undeveloped Area	WG	T	3	ug/l	<0.8	2.1	1.1	0.8	0.9	2	66.7	0	0	10	0	0	10	3	100	0.052
		WG	DI	6	ug/l	<0.8	3.3	1.5	1.4	1	5	83.3	0	0	10	0	0	10	6	100	0.052
	7. Western Undeveloped Area	WG	T	15	ug/l	<0.8	4.6	1.6	0.9	1.3	11	73.3	0	0	10	0	0	10	15	100	0.052
		WG	DI	30	ug/l	<0.6	4.3	1.2	-	1.3	13	43.3	0	0	10	0	0	10	30	100	0.052

Table 15. Statistical Summary by Surface Water Feature – Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													Minimum ESV			DEQ 7 Acute			DEQ 7 Chronic		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	Backwater Seep Sampling Area	WS	T	30	ug/l	<2	378	100.7	35.1	116.3	27	90	27	90	5	20	67	22	27	90	5.2
		WS	DI	9	ug/l	11.7	328	108.7	27.3	127	9	100	9	100	5	7	78	22	9	100	5.2
	Cedar Creek	WS	T	32	ug/l	<2	15.3	2	-	3	7	21.9	2	6	5	0	0	22	2	6	5.2
		WS	DI	8	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
		WS	DI	5	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Flathead River	WS	T	46	ug/l	<2	3.2	-	-	-	1	2.2	0	0	5	0	0	22	0	0	5.2
		WS	DI	6	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	North Percolation Pond	WS	T	2	ug/l	<2	7.6	4.3	4.3	4.7	1	50	1	50	5	0	0	22	1	50	5.2
		WS	DI	1	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Northern Surface Water Feature	WS	T	16	ug/l	<2	4.4	-	-	-	1	6.3	0	0	5	0	0	22	0	0	5.2
		WS	DI	1	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Riparian Sampling Area	WS	T	15	ug/l	5.1	630	169	98.6	176.7	15	100	15	100	5	11	73	22	14	93	5.2
		WS	DI	5	ug/l	9.9	245	95.4	91.4	92.9	5	100	5	100	5	4	80	22	5	100	5.2
	South Percolation Pond	WS	T	26	ug/l	<2	139	15.7	3.4	31	15	57.7	11	42	5	4	15	22	11	42	5.2
		WS	DI	5	ug/l	<2	68.2	26.9	5.3	33.7	3	60	3	60	5	2	40	22	3	60	5.2
Cyanide, Free	Backwater Seep Sampling Area	WS	T	24	ug/l	<1.5	139	20.7	6.3	32.4	22	91.7	14	58	5	7	29	22	14	58	5.2
		WS	DI	9	ug/l	1.6	42.2	11.2	5.6	13.	9	100	7	78	5	1	11	22	7	78	5.2
	Cedar Creek	WS	T	20	ug/l	<1.5	7.7	-	-	-	2	10	1	5	5	0	0	22	1	5	5.2
		WS	DI	2	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Cedar Creek Reservoir Overflow Ditch	WS	T	11	ug/l	<1.5	5.8	1.4	-	1.5	3	27.3	1	9	5	0	0	22	1	9	5.2
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WS	T	24	ug/l	<1.5	1.8	0.9	-	0.3	4	16.7	0	0	5	0	0	22	0	0	5.2
		WS	DI	1	ug/l	1.6	1.6	1.6	1.6	-	1	100	0	0	5	0	0	22	0	0	5.2
	North Percolation Pond	WS	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Northern Surface Water Feature	WS	T	10	ug/l	<1.5	4.1	2	2.1	1.2	6	60	0	0	5	0	0	22	0	0	5.2
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Riparian Sampling Area	WS	T	15	ug/l	<1.5	140	27.1	14.3	37.2	14	93.3	9	60	5	5	33	22	9	60	5.2
		WS	DI	5	ug/l	1.8	63.5	19.4	3.4	26.7	5	100	2	40	5	2	40	22	2	40	5.2
	South Percolation Pond	WS	T	16	ug/l	<1.5	10	3.7	2.7	2.8	13	81.3	5	31	5	0	0	22	4	25	5.2
		WS	DI	3	ug/l	1.7	4.9	3	2.5	1.7	3	100	0	0	5	0	0	22	0	0	5.2

Table 15. Statistical Summary by Surface Water Feature – Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													Minimum ESV			DEQ 7 Acute			DEQ 7 Chronic		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Fluoride	Backwater Seep Sampling Area	WS	T	30	ug/l	40.2	2570	868.7	399.5	944.2	30	100	28	93	120	-	-	-	-	-	-
		WS	DI	3	ug/l	167	558	303.3	185	220.7	3	100	3	100	120	-	-	-	-	-	-
	Cedar Creek	WS	T	28	ug/l	<12	137	90.8	117.5	50.	22	78.6	11	39	120	-	-	-	-	-	-
		WS	DI	4	ug/l	121	131	128.	130	4.7	4	100	4	100	120	-	-	-	-	-	-
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	38.7	2600	220.2	99.6	485.4	27	100	9	33	120	-	-	-	-	-	-
		WS	DI	5	ug/l	126	185	149	129	29.4	5	100	5	100	120	-	-	-	-	-	-
	Flathead River	WS	T	46	ug/l	<12	547	71.9	35.9	87.4	35	76.1	7	15	120	-	-	-	-	-	-
		WS	DI	6	ug/l	109	119	116.7	118	3.8	6	100	0	0	120	-	-	-	-	-	-
	North Percolation Pond	WS	T	2	ug/l	2150	22400	12275	12275	14318.9	2	100	2	100	120	-	-	-	-	-	-
		WS	DI	1	ug/l	21500	21500	21500	21500	-	1	100	1	100	120	-	-	-	-	-	-
	Northern Surface Water Feature	WS	T	16	ug/l	166	301	214.7	214	29.9	16	100	16	100	120	-	-	-	-	-	-
		WS	DI	1	ug/l	188	188	188	188	-	1	100	1	100	120	-	-	-	-	-	-
	Riparian Sampling Area	WS	T	15	ug/l	1920	3640	2394	2200	516.6	15	100	15	100	120	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	South Percolation Pond	WS	T	26	ug/l	250	9240	1037	351.5	1852	26	100	26	100	120	-	-	-	-	-	-
		WS	DI	3	ug/l	289	1860	817.7	304	902.7	3	100	3	100	120	-	-	-	-	-	-
Benzo[a]pyrene	Backwater Seep Sampling Area	WS	T	10	ug/l	<0.05	0.3	-	-	-	1	10	10	100	0.014	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cedar Creek	WS	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	edar Creek Reservoir Overflow Dit	WS	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WS	T	1	ug/l	<0.05	<0.049	-	-	-	0	0	1	100	0.014	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	North Percolation Pond	WS	T	1	ug/l	3.9	3.9	3.9	3.9	-	1	100	1	100	0.014	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Northern Surface Water Feature	WS	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Riparian Sampling Area	WS	T	6	ug/l	<0.05	<0.16	-	-	-	0	0	6	100	0.014	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	South Percolation Pond	WS	T	5	ug/l	<0.2	0.4	0.1	-	0.1	1	20	5	100	0.014	-	-	-	-	-	-
		WS	DI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 15. Statistical Summary by Surface Water Feature – Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													Minimum ESV			DEQ 7 Acute			DEQ 7 Chronic		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Aluminum	Backwater Seep Sampling Area	WS	T	30	ug/l	<15	1180	366.2	256	309.8	28	93.3	23	77	87	4	13	750	23	77	87
		WS	DI	21	ug/l	<15	75.3	16.7	-	17.1	6	28.6	0	0	87	0	0	750	0	0	87
	Cedar Creek	WS	T	28	ug/l	<15	85.5	25.1	20	19.2	18	64.3	0	0	87	0	0	750	0	0	87
		WS	DI	16	ug/l	<15	<15	-	-	-	0	0	0	0	87	0	0	750	0	0	87
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<15	1610	101.1	23.1	315.8	20	74.1	2	7	87	1	4	750	2	7	87
		WS	DI	16	ug/l	<15	36.1	-	-	-	1	6.3	0	0	87	0	0	750	0	0	87
	Flathead River	WS	T	46	ug/l	<15	1540	269.5	46.9	382	42	91.3	21	46	87	6	13	750	21	46	87
		WS	DI	28	ug/l	<15	44.8	12.5	-	9.8	6	21.4	0	0	87	0	0	750	0	0	87
	North Percolation Pond	WS	T	2	ug/l	109	8630	4369.5	4369.5	6025.3	2	100	2	100	87	1	50	750	2	100	87
		WS	DI	1	ug/l	4780	4780	4780	4780	-	1	100	1	100	87	1	100	750	1	100	87
	Northern Surface Water Feature	WS	T	16	ug/l	<15	5750	485.9	53.5	1423	15	93.8	6	38	87	2	13	750	6	38	87
		WS	DI	11	ug/l	<15	<15	-	-	-	0	0	0	0	87	0	0	750	0	0	87
	Riparian Sampling Area	WS	T	15	ug/l	53.1	32000	3591.6	444	8448.9	15	100	12	80	87	5	33	750	12	80	87
		WS	DI	15	ug/l	<15	614	183.9	50.4	231.5	11	73.3	6	40	87	0	0	750	6	40	87
	South Percolation Pond	WS	T	26	ug/l	<13.5	24500	1491	135.5	4793.1	22	84.6	13	50	87	6	23	750	13	50	87
		WS	DI	17	ug/l	<15	2360	259.3	42.6	575.5	9	52.9	6	35	87	2	12	750	6	35	87
Arsenic	Backwater Seep Sampling Area	WS	DI	21	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	3.1	0	0	340	0	0	150
		WS	T	30	ug/l	<0.8	1	-	-	-	3	10	0	0	3.1	0	0	340	0	0	150
	Cedar Creek	WS	DI	16	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	3.1	0	0	340	0	0	150
		WS	T	28	ug/l	<0.8	<0.8	-	-	-	0	0	0	0	3.1	0	0	340	0	0	150
	Cedar Creek Reservoir Overflow Ditch	WS	DI	16	ug/l	<0.8	0.7	-	-	-	1	6.3	0	0	3.1	0	0	340	0	0	150
		WS	T	27	ug/l	<0.8	2.2	0.5	-	0.5	5	18.5	0	0	3.1	0	0	340	0	0	150
	Flathead River	WS	DI	28	ug/l	<0.8	<0.8	-	-	-	0	0.	0	0	3.1	0	0	340	0	0	150
		WS	T	46	ug/l	<0.8	0.9	-	-	-	2	4.3	0	0	3.1	0	0	340	0	0	150
	North Percolation Pond	WS	DI	1	ug/l	1	1	1	1	-	1	100	0	0	3.1	0	0	340	0	0	150
		WS	T	2	ug/l	<0.6	2.4	1.4	1.4	1.5	1	50	0	0	3.1	0	0	340	0	0	150
	Northern Surface Water Feature	WS	DI	11	ug/l	<0.8	1.5	0.6	-	0.4	4	36.4	0	0	3.1	0	0	340	0	0	150
		WS	T	16	ug/l	<0.6	3.7	0.9	0.8	0.8	10	62.5	1	6	3.1	0	0	340	0	0	150
	Riparian Sampling Area	WS	DI	15	ug/l	<0.8	5.5	1.7	0.8	1.9	9	60	4	27	3.1	0	0	340	0	0	150
		WS	T	15	ug/l	<0.8	18.5	3.6	1.4	4.7	10	66.7	7	47	3.1	0	0	340	0	0	150
	South Percolation Pond	WS	DI	17	ug/l	<0.8	2.9	0.8	-	0.7	5	29.4	0	0	3.1	0	0	340	0	0	150
		WS	T	26	ug/l	<0.8	4.4	0.8	-	1.1	7	26.9	2	8	3.1	0	0	340	0	0	150
Barium	Backwater Seep Sampling Area	WS	T	30	ug/l	79.	216	129.3	116.5	40.8	30	100	30	100	4	-	-	-	-	-	-
		WS	DI	21	ug/l	62.5	191	113.3	110	40.6	21	100	21	100	4	-	-	-	-	-	-
	Cedar Creek	WS	T	28	ug/l	85.9	130	104.7	104	10.9	28	100	28	100	4	-	-	-	-	-	-
		WS	DI	16	ug/l	85.9	117	99.7	93.4	11.3	16	100	16	100	4	-	-	-	-	-	-
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	63.4	209	90.8	79.7	32.3	27	100	27	100	4	-	-	-	-	-	-
		WS	DI	16	ug/l	69.9	218	91	80.9	35.4	16	100	16	100	4	-	-	-	-	-	-
	Flathead River	WS	T	46	ug/l	62.8	190	97.5	101.5	24.5	46	100	46	100	4	-	-	-	-	-	-
		WS	DI	28	ug/l	63.6	140	81.9	70.6	21.6	28	100	28	100	4	-	-	-	-	-	-
	North Percolation Pond	WS	T	2	ug/l	43.4	234	138.7	138.7	134.8	2	100	2	100	4	-	-	-	-	-	-
		WS	DI	1	ug/l	26.4	26.4	26.4	26.4	-	1	100	1	100	4	-	-	-	-	-	-
	Northern Surface Water Feature	WS	T	16	ug/l	77.9	245	124.9	104	49.3	16	100	16	100	4	-	-	-	-	-	-
		WS	DI	11	ug/l	83.5	229	121.3	96.5	47.4	11	100	11	100	4	-	-	-	-	-	-
	Riparian Sampling Area	WS	T	15	ug/l	122	1230	327.8	254	266	15	100	15	100	4	-	-	-	-	-	-
		WS	DI	15	ug/l	117	401	230.5	218	81	15	100	15	100	4	-	-	-	-	-	-
	South Percolation Pond	WS	T	26	ug/l	156	2710	370.6	263.5	488.2	26	100	26	100	4	-	-	-	-	-	-
		WS	DI	17	ug/l	119	527	259.2	257	104.6	17	100	17	100	4	-	-	-	-	-	-

Table 15. Statistical Summary by Surface Water Feature – Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	Minimum ESV No. Exceeding	Minimum ESV % Exceeding	Minimum ESV Screening Level	DEQ 7 Acute No. Exceeding	DEQ 7 Acute % Exceeding	DEQ 7 Acute Screening Level	DEQ 7 Chronic No. Exceeding	DEQ 7 Chronic % Exceeding	DEQ 7 Chronic Screening Level
Cadmium	Backwater Seep Sampling Area	WS	T	30	ug/l	<0.6	<0.6	-	-	-	0	0	30	100	0.09	0	0	0.049	30	100	0.25
		WS	DI	21	ug/l	<0.6	<0.6	-	-	-	0	0	21	100	0.09	0	0	0.049	21	100	0.25
	Cedar Creek	WS	T	28	ug/l	<0.6	<0.6	-	-	-	0	0	28	100	0.09	0	0	0.049	28	100	0.25
		WS	DI	16	ug/l	<0.6	<0.6	-	-	-	0	0	16	100	0.09	0	0	0.049	16	100	0.25
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<0.6	<0.6	-	-	-	0	0	27	100	0.09	0	0	0.049	27	100	0.25
		WS	DI	16	ug/l	<0.6	<0.6	-	-	-	0	0	16	100	0.09	0	0	0.049	16	100	0.25
	Flathead River	WS	T	46	ug/l	<0.6	<0.6	-	-	-	0	0	46	100	0.09	0	0	0.049	46	100	0.25
		WS	DI	28	ug/l	<0.6	<0.6	-	-	-	0	0	28	100	0.09	0	0	0.049	28	100	0.25
	North Percolation Pond	WS	T	2	ug/l	<0.7	3	1.7	1.7	1.9	1	50	2	100	0.09	1	50	0.049	2	100	0.25
		WS	DI	1	ug/l	2.5	2.5	2.5	2.5	-	1	100	1	100	0.09	1	100	0.049	1	100	0.25
	Northern Surface Water Feature	WS	T	16	ug/l	<0.6	<0.61	-	-	-	0	0	16	100	0.09	0	0	0.049	16	100	0.25
		WS	DI	11	ug/l	<0.6	<0.61	-	-	-	0	0	11	100	0.09	0	0	0.049	11	100	0.25
	Riparian Sampling Area	WS	T	15	ug/l	<0.6	0.9	-	-	-	1	6.7	15	100	0.09	1	7	0.049	15	n	0.25
		WS	DI	15	ug/l	<0.6	<0.6	-	-	-	0	0	15	100	0.09	0	0	0.049	15	100	0.25
	South Percolation Pond	WS	T	26	ug/l	<0.6	1	-	-	-	2	7.7	26	100	0.09	2	8	0.049	26	100	0.25
		WS	DI	17	ug/l	<0.6	<0.6	-	-	-	0	0	17	100	0.09	0	0	0.049	17	100	0.25
Copper	Backwater Seep Sampling Area	WS	T	30	ug/l	<1.9	12.3	2.2	-	2.9	11	36.7	30	100	0.23	5	17	3.79	2	7	8.038
		WS	DI	21	ug/l	<1.9	26.4	-	-	-	1	4.8	21	100	0.23	1	5	3.79	1	5	8.038
	Cedar Creek	WS	T	28	ug/l	<1.9	8.5	1.9	-	2.1	9	32.1	28	100	0.23	5	18	3.79	1	4	8.038
		WS	DI	16	ug/l	<1.9	<1.9	-	-	-	0	0	16	100	0.23	0	0	3.79	0	0	8.038
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<1.9	7.2	1.8	-	1.8	9	33.3	27	100	0.23	4	15	3.79	0	0	8.038
		WS	DI	16	ug/l	<1.9	<1.9	-	-	-	0	0	16	100	0.23	0	0	3.79	0	0	8.038
	Flathead River	WS	T	46	ug/l	<1.9	7.5	1.5	-	1.7	10	21.7	46	100	0.23	4	9	3.79	0	0	8.038
		WS	DI	28	ug/l	<1.9	3	-	-	-	1	3.6	28	100	0.23	0	0	3.79	0	0	8.038
	North Percolation Pond	WS	T	2	ug/l	3.8	16.5	10.2	10.2	9	2	100	2	100	0.23	2	100	3.79	1	50	8.038
		WS	DI	1	ug/l	2	2	2	2	-	1	100	1	100	0.23	0	0	3.79	0	0	8.038
	Northern Surface Water Feature	WS	T	16	ug/l	<1.9	5.7	-	-	-	2	12.5	16	100	0.23	1	6	3.79	0	0	8.038
		WS	DI	11	ug/l	<1.9	<1.9	-	-	-	0	0	11	100	0.23	0	0	3.79	0	0	8.038
	Riparian Sampling Area	WS	T	15	ug/l	<1.9	67.7	10	3.1	17.4	12	80	15	100	0.23	6	40	3.79	4	27	8.038
		WS	DI	15	ug/l	<1.9	1.8	1	-	0.3	3	20	15	100	0.23	0	0	3.79	0	0	8.038
	South Percolation Pond	WS	T	26	ug/l	<1.9	183	14.5	2.7	37.5	19	73.1	26	100	0.23	11	42	3.79	7	27	8.038
		WS	DI	17	ug/l	<1.4	33.4	3.9	-	7.8	7	41.2	17	100	0.23	4	24	3.79	1	6	8.038

Table 15. Statistical Summary by Surface Water Feature – Surface Water
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													Minimum ESV			DEQ 7 Acute			DEQ 7 Chronic		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Iron	Backwater Seep Sampling Area	WS	T	30	ug/l	<45.7	1620	480.4	350	370.4	29	96.7	25	83	158	-	-	-	3	10	1000
		WS	DI	21	ug/l	<42.4	164	62.2	45.8	49.3	11	52.4	1	5	158	-	-	-	0	0	1000
	Cedar Creek	WS	T	28	ug/l	<45.7	304	-	-	-	3	10.7	1	4	158	-	-	-	0	0	1000
		WS	DI	16	ug/l	<45.7	<45.7	-	-	-	0	0	0	0	158	-	-	-	0	0	1000
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<42.4	2910	147.2	-	556.7	5	18.5	2	7	158	-	-	-	1	4	1000
		WS	DI	16	ug/l	<45.7	<45.7	-	-	-	0	0	0	0	158	-	-	-	0	0	1000
	Flathead River	WS	T	46	ug/l	<42.4	1640	310.3	-	438.5	22	47.8	18	39	158	-	-	-	5	11	1000
		WS	DI	28	ug/l	<45.7	<45.7	-	-	-	0	0	0	0	158	-	-	-	0	0	1000
	North Percolation Pond	WS	T	2	ug/l	<42.4	817	419.1	419.1	562.7	1	50	1	50	158	-	-	-	0	0	1000
		WS	DI	1	ug/l	<42.4	<42.4	-	-	-	0	0	0	0	158	-	-	-	0	0	1000
	Northern Surface Water Feature	WS	T	16	ug/l	<45.7	4760	363.4	36.6	1175	8	50	3	19	158	-	-	-	1	6	1000
		WS	DI	11	ug/l	<45.7	-	-	-	-	0	0	0	0	158	-	-	-	0	0	1000
	Riparian Sampling Area	WS	T	15	ug/l	196	52100	7172.4	1440	13440.8	15	100	15	100	158	-	-	-	9	60	1000
		WS	DI	15	ug/l	48.7	10200	1372.4	222	2621.8	15	100	9	60	158	-	-	-	5	33	1000
	South Percolation Pond	WS	T	26	ug/l	<42.4	22500	1423.3	172.5	4394.7	23	88.5	13	50	158	-	-	-	4	15	1000
		WS	DI	17	ug/l	<45.7	1430	217.5	59.4	387.6	10	58.8	3	18	158	-	-	-	1	6	1000
Zinc	Backwater Seep Sampling Area	WS	T	30	ug/l	<5.4	19.9	5.1	-	4.6	6	20	0	0	30	0	0	37	0	0	103.4
		WS	DI	21	ug/l	<5.4	5.8	-	-	-	1	4.8	0	0	30	0	0	37	0	0	103.4
	Cedar Creek	WS	T	28	ug/l	<5.4	16.4	-	-	-	2	7.1	0	0	30	0	0	37	0	0	103.4
		WS	DI	16	ug/l	<5.4	25.4	-	-	-	1	6.3	0	0	30	0	0	37	0	0	103.4
	Cedar Creek Reservoir Overflow Ditch	WS	T	27	ug/l	<5.4	18.9	-	-	-	3	11.1	0	0	30	0	0	37	0	0	103.4
		WS	DI	16	ug/l	<5.4	<5.4	-	-	-	0	0	0	0	30	0	0	37	0	0	103.4
	Flathead River	WS	T	46	ug/l	<5.4	8.8	-	-	-	2	4.3	0	0	30	0	0	37	0	0	103.4
		WS	DI	28	ug/l	<5.4	6.8	-	-	-	2	7.1	0	0	30	0	0	37	0	0	103.4
	North Percolation Pond	WS	T	2	ug/l	<7	537	270.3	270.3	377.2	1	50	1	50	30	1	50	37	1	50	103.4
		WS	DI	1	ug/l	512	512	512	512	-	1	100	1	100	30	1	100	37	1	100	103.4
	Northern Surface Water Feature	WS	T	16	ug/l	<5.4	19.2	-	-	-	2	12.5	0	0	30	0	0	37	0	0	103.4
		WS	DI	11	ug/l	<5.4	<5.4	-	-	-	0	0	0	0	30	0	0	37	0	0	103.4
	Riparian Sampling Area	WS	T	15	ug/l	<5.4	192	24.1	-	50.5	6	40	3	20	30	2	13	37	1	7	103.4
		WS	DI	15	ug/l	<5.4	13.5	-	-	-	2	13.3	0	0	30	0	0	37	0	0	103.4
	South Percolation Pond	WS	T	26	ug/l	<5.4	179	17.6	-	37.2	11	42.3	3	12	30	3	12	37	1	4	103.4
		WS	DI	17	ug/l	<5.4	58.8	6.7	-	13.5	3	17.6	1	6	30	1	6	37	0	0	103.4

Table 16. Statistical Summary by Surface Water Feature – Sediment
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	Backwater Seep Sampling Area	SE	T	15	mg/kg	0.35	8.3	1.805	1.1	1.967	15	100	3	20	2.3	0	0	15	15	100	0.0015	15	100	0.0001
	North Percolation Pond	SE	T	2	mg/kg	0.096	7.8	3.948	3.948	5.448	2	100	1	50	2.3	0	0	15	2	100	0.0015	2	100	0.0001
	Flathead River	SE	T	12	mg/kg	<0.067	0.087	-	-	-	1	8.3	0	0	2.3	0	0	15	12	100	0.0015	12	100	0.0001
	Cedar Creek	SE	T	9	mg/kg	<0.075	0.24	0.104	-	0.071	4	44.4	0	0	2.3	0	0	15	9	100	0.0015	9	100	0.0001
	Northern Surface Water Feature	SE	T	10	mg/kg	<0.07	0.6	0.202	0.083	0.227	5	50	0	0	2.3	0	0	15	10	100	0.0015	10	100	0.0001
	Riparian Sampling Area	SE	T	10	mg/kg	0.27	1.7	0.815	0.735	0.412	10	100	0	0	2.3	0	0	15	10	100	0.0015	10	100	0.0001
	South Percolation Pond	SE	T	14	mg/kg	<0.1	8.5	1.186	0.535	2.184	12	85.7	1	7	2.3	0	0	15	14	100	0.0015	14	100	0.0001
Cyanide, Free	Backwater Seep Sampling Area	SE	T	4	mg/kg	<0.42	<0.5	-	-	-	0	0	0	0	2.3	0	0	15	4	100	0.0015	4	100	0.0001
	North Percolation Pond	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cedar Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Northern Surface Water Feature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Riparian Sampling Area	SE	T	1	mg/kg	<0.45	<0.45	-	-	-	0	0	0	0	2.3	0	0	15	1	100	0.0015	1	100	0.0001
	South Percolation Pond	SE	T	1	mg/kg	0.89	0.89	0.89	0.89	-	1	100	0	0	2.3	0	0	15	1	100	0.0015	1	100	0.0001
Fluoride	Backwater Seep Sampling Area	SE	T	15	mg/kg	2.23	69.2	16.432	10.4	16.602	15	100	0	0	310	0	0	4700	7	47	12	-	-	-
	North Percolation Pond	SE	T	2	mg/kg	56.6	219	137.8	137.8	114.834	2	100	0	0	310	0	0	4700	2	100	12	-	-	-
	Flathead River	SE	T	12	mg/kg	<0.17	2.93	0.432	-	0.851	2	16.7	0	0	310	0	0	4700	0	0	12	-	-	-
	Cedar Creek	SE	T	9	mg/kg	<0.2	1.71	0.631	-	0.724	3	33.3	0	0	310	0	0	4700	0	0	12	-	-	-
	Northern Surface Water Feature	SE	T	10	mg/kg	1.14	9.59	3.782	2.93	2.979	10	100	0	0	310	0	0	4700	0	0	12	-	-	-
	Riparian Sampling Area	SE	T	10	mg/kg	1.91	22.2	12.537	13.545	8.604	10	100	0	0	310	0	0	4700	5	50	12	-	-	-
	South Percolation Pond	SE	T	14	mg/kg	<0.31	93.7	23.835	18.9	28.104	10	71.4	0	0	310	0	0	4700	9	64	12	-	-	-
Benzo[a]pyrene	Backwater Seep Sampling Area	SE	T	15	mg/kg	<0.002	1.2	0.224	0.038	0.362	9	60	5	33	0.11	0	0	2.1	9	60	0.029	8	53	0.032
	North Percolation Pond	SE	T	2	mg/kg	19	100	59.5	59.5	57.276	2	100	2	100	0.11	2	100	2.1	2	100	0.029	2	100	0.032
	Flathead River	SE	T	12	mg/kg	<0.0009	0.99	0.088	-	0.284	5	41.7	1	8	0.11	0	0	2.1	2	17	0.029	2	17	0.032
	Cedar Creek	SE	T	9	mg/kg	<0.002	0.094	0.039	0.043	0.037	6	66.7	0	0	0.11	0	0	2.1	5	56	0.029	5	56	0.032
	Northern Surface Water Feature	SE	T	10	mg/kg	<0.002	0.086	0.044	0.035	0.032	9	90	0	0	0.11	0	0	2.1	6	60	0.029	6	60	0.032
	Riparian Sampling Area	SE	T	10	mg/kg	<0.014	0.091	0.036	0.019	0.033	8	80	0	0	0.11	0	0	2.1	4	40	0.029	4	40	0.032
	South Percolation Pond	SE	T	14	mg/kg	0.11	0.86	0.349	0.25	0.228	14	100	13	93	0.11	0	0	2.1	14	100	0.029	14	100	0.032
Arsenic	Backwater Seep Sampling Area	SE	T	15	mg/kg	2.8	6.2	4.107	4.1	1.019	15	100	15	100	0.68	13	87	3	15	100	0.0015	0	0	9.79
	North Percolation Pond	SE	T	2	mg/kg	7.6	26.4	17	17	13.294	2	100	2	100	0.68	2	100	3	2	100	0.0015	1	50	9.79
	Flathead River	SE	T	12	mg/kg	2.7	4.2	3.342	3.35	0.434	12	100	12	100	0.68	9	75	3	12	100	0.0015	0	0	9.79
	Cedar Creek	SE	T	9	mg/kg	1.8	4.2	2.589	2.3	0.791	9	100	9	100	0.68	2	22	3	9	100	0.0015	0	0	9.79
	Northern Surface Water Feature	SE	T	10	mg/kg	3.2	14.5	7.48	6	4.139	10	100	10	100	0.68	10	100	3	10	100	0.0015	3	30	9.79
	Riparian Sampling Area	SE	T	10	mg/kg	2.5	6.1	4.04	3.8	1.224	10	100	10	100	0.68	8	80	3	10	100	0.0015	0	0	9.79
	South Percolation Pond	SE	T	14	mg/kg	<0.65	2.6	1.496	1.3	0.69	13	92.9	13	93	0.68	0	0	3	14	100	0.0015	0	0	9.79
Barium	Backwater Seep Sampling Area	SE	T	15	mg/kg	44.6	151	109.553	121	35.483	15	100	0	0	1500	0	0	22000	15	100	16	-	-	-
	North Percolation Pond	SE	T	2	mg/kg	317	539	428	428	156.978	2	100	0	0	1500	0	0	22000	2	100	16	-	-	-
	Flathead River	SE	T	12	mg/kg	45.4	87.2	60.133	53.4	14.544	12	100	0	0	1500	0	0	22000	12	100	16	-	-	-
	Cedar Creek	SE	T	9	mg/kg	20.2	249	122.833	97.1	68.094	9	100	0	0	1500	0	0	22000	9	100	16	-	-	-
	Northern Surface Water Feature	SE	T	10	mg/kg	136	884	427.6	378	237.851	10	100	0	0	1500	0	0	22000	10	100	16	-	-	-
	Riparian Sampling Area	SE	T	10	mg/kg	83.9	208	135.67	130	43.609	10	100	0	0	1500	0	0	22000	10	100	16	-	-	-
	South Percolation Pond	SE	T	14	mg/kg	234	969	639	696.5	201.289	14	100	0	0	1500	0	0	22000	14	100	16	-	-	-

Table 16. Statistical Summary by Surface Water Feature – Sediment
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cadmium	South Percolation Pond	SE	T	14	mg/kg	<0.51	0.95	-	-	-	1	7.1	0	0	7.1	0	0	98	14	100	0.069	1	7	0.583
	Riparian Sampling Area	SE	T	10	mg/kg	<0.36	<0.49	-	-	-	0	0	0	0	7.1	0	0	98	10	100	0.069	0	0	0.583
	Northern Surface Water Feature	SE	T	10	mg/kg	<0.37	<1.4	-	-	-	0	0	0	0	7.1	0	0	98	10	100	0.069	2	20	0.583
	North Percolation Pond	SE	T	2	mg/kg	2.7	8	5.35	5.35	3.748	2	100	1	50	7.1	0	0	98	2	100	0.069	2	100	0.583
	Flathead River	SE	T	12	mg/kg	<0.32	<0.51	-	-	-	0	0	0	0	7.1	0	0	98	12	100	0.069	0	0	0.583
	Cedar Creek	SE	T	9	mg/kg	<0.34	<1.3	-	-	-	0	0	0	0	7.1	0	0	98	9	100	0.069	1	11	0.583
	Backwater Seep Sampling Area	SE	T	15	mg/kg	<0.39	<0.64	-	-	-	0	0	0	0	7.1	0	0	98	15	100	0.069	0	0	0.583
Copper	Backwater Seep Sampling Area	SE	T	15	mg/kg	6.9	17.1	12.66	13.6	2.96	15	100	0	0	310	0	0	4700	15	100	2.8	0	0	28
	North Percolation Pond	SE	T	2	mg/kg	56.4	83.6	70	70	19.233	2	100	0	0	310	0	0	4700	2	100	2.8	2	100	28
	Flathead River	SE	T	12	mg/kg	7.2	11.8	9.217	9.3	1.324	12	100	0	0	310	0	0	4700	12	100	2.8	0	0	28
	Cedar Creek	SE	T	9	mg/kg	3.3	20.8	9.244	5.4	6.027	9	100	0	0	310	0	0	4700	9	100	2.8	0	0	28
	Northern Surface Water Feature	SE	T	10	mg/kg	10.1	42.5	20.03	16.8	11.147	10	100	0	0	310	0	0	4700	10	100	2.8	2	20	28
	Riparian Sampling Area	SE	T	10	mg/kg	10	20.7	15.17	15.1	3.304	10	100	0	0	310	0	0	4700	10	100	2.8	0	0	28
	South Percolation Pond	SE	T	14	mg/kg	20.9	143	57.514	39.7	39.008	14	100	0	0	310	0	0	4700	14	100	2.8	11	79	28
Lead	South Percolation Pond	SE	T	14	mg/kg	5.8	22.3	11.25	9.3	4.687	14	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	Riparian Sampling Area	SE	T	10	mg/kg	6.8	11.6	8.43	8.25	1.548	10	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	Northern Surface Water Feature	SE	T	10	mg/kg	6.1	17.6	11.45	11.4	3.789	10	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	North Percolation Pond	SE	T	2	mg/kg	24.8	109	66.9	66.9	59.538	2	100	0	0	400	0	0	800	-	-	-	1	50	35.8
	Flathead River	SE	T	12	mg/kg	4.3	6.9	5.333	5.4	0.718	12	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	Cedar Creek	SE	T	9	mg/kg	4.9	10.3	6.444	6	1.679	9	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	Backwater Seep Sampling Area	SE	T	15	mg/kg	4.7	11.7	8.053	8.3	1.672	15	100	0	0	400	0	0	800	-	-	-	0	0	35.8
Nickel	South Percolation Pond	SE	T	14	mg/kg	5.4	25	14.557	14.15	4.83	14	100	0	0	150	0	0	2200	14	100	2.6	2	14	19.5
	Riparian Sampling Area	SE	T	10	mg/kg	11.4	16.1	13.02	12.55	1.72	10	100	0	0	150	0	0	2200	10	100	2.6	0	0	19.5
	Northern Surface Water Feature	SE	T	10	mg/kg	6	15.2	10.63	11	3.239	10	100	0	0	150	0	0	2200	10	100	2.6	0	0	19.5
	North Percolation Pond	SE	T	2	mg/kg	208	771	489.5	489.5	398.101	2	100	2	100	150	0	0	2200	2	100	2.6	2	100	19.5
	Flathead River	SE	T	12	mg/kg	8.4	11.3	9.733	9.6	1.051	12	100	0	0	150	0	0	2200	12	100	2.6	0	0	19.5
	Cedar Creek	SE	T	9	mg/kg	6.9	13.8	9.967	10.1	2.272	9	100	0	0	150	0	0	2200	9	100	2.6	0	0	19.5
	Backwater Seep Sampling Area	SE	T	15	mg/kg	9.4	18.5	11.78	11.6	2.164	15	100	0	0	150	0	0	2200	15	100	2.6	0	0	19.5
Selenium	South Percolation Pond	SE	T	14	mg/kg	<0.45	0.97	0.4	-	0.226	3	21.4	0	0	39	0	0	580	14	100	0.052	0	0	2
	Riparian Sampling Area	SE	T	10	mg/kg	<0.31	<0.42	-	-	-	0	0	0	0	39	0	0	580	10	100	0.052	0	0	2
	Northern Surface Water Feature	SE	T	10	mg/kg	<0.32	4.4	0.907	-	1.418	3	30	0	0	39	0	0	580	10	100	0.052	2	20	2
	North Percolation Pond	SE	T	2	mg/kg	0.89	3.4	2.145	2.145	1.775	2	100	0	0	39	0	0	580	2	100	0.052	1	50	2
	Flathead River	SE	T	12	mg/kg	<0.28	<0.44	-	-	-	0	0	0	0	39	0	0	580	12	100	0.052	0	0	2
	Cedar Creek	SE	T	9	mg/kg	<0.3	1.8	-	-	-	1	11.1	0	0	39	0	0	580	9	100	0.052	0	0	2
	Backwater Seep Sampling Area	SE	T	15	mg/kg	<0.34	<0.55	-	-	-	0	0	0	0	39	0	0	580	15	100	0.052	0	0	2
Vanadium	South Percolation Pond	SE	T	14	mg/kg	2.3	19.4	9.364	9.15	5.211	14	100	0	0	39	0	0	580	8	57	8.6	-	-	-
	Riparian Sampling Area	SE	T	10	mg/kg	11.8	24.2	16.28	15.2	4.035	10	100	0	0	39	0	0	580	10	100	8.6	-	-	-
	Northern Surface Water Feature	SE	T	10	mg/kg	7.9	17.2	11.52	11.1	2.757	10	100	0	0	39	0	0	580	8	80	8.6	-	-	-
	North Percolation Pond	SE	T	2	mg/kg	66.1	233	149.55	149.55	118.016	2	100	2	100	39	0	0	580	2	100	8.6	-	-	-
	Flathead River	SE	T	12	mg/kg	8.4	25.5	15.075	14.45	4.993	12	100	0	0	39	0	0	580	11	92	8.6	-	-	-
	Cedar Creek	SE	T	9	mg/kg	4.6	8.8	7.089	7.4	1.458	9	100	0	0	39	0	0	580	1	11	8.6	-	-	-
	Backwater Seep Sampling Area	SE	T	15	mg/kg	8.1	17.5	12.86	12.6	2.445	15	100	0	0	39	0	0	580	14	93	8.6	-	-	-
Zinc	Backwater Seep Sampling Area	SE	T	15	mg/kg	33	58.4	42.16	41.4	6.822	15	100	0	0	2300	0	0	35000	12	80	37	0	0	98
	Cedar Creek	SE	T	9	mg/kg	37.3	58.5	47.6	48.8	6.844	9	100	0	0	2300	0	0	35000	9	100	37	0	0	98
	Flathead River	SE	T	12	mg/kg	28.7	39.5	33.983	34.2	3.819	12	100	0	0	2300	0	0	35000	3	25	37	0	0	98
	North Percolation Pond	SE	T	2	mg/kg	349	871	610	610	369.11	2	100	0	0	2300	0	0	35000	2	100	37	2	100	98
	Northern Surface Water Feature	SE	T	2	mg/kg	349	871	610	610	369.11	2	100	0	0	2300	0	0	35000	2	100	37	2	100	98
	Riparian Sampling Area	SE	T	10	mg/kg	37.2	55	45.66	43.65	6.3	10	100	0	0	2300	0	0	35000	10	100	37	0	0	98
	South Percolation Pond	SE	T	14	mg/kg	38.1	174	78.2	53.5	48.183	14	100	0	0	2300	0	0	35000	14	100	37	3	21	98

Table 17. Statistical Summary by Surface Water Feature – Sediment Porewater
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													Minimum ESV			DEQ 7 Acute			DEQ 7 Chronic		
Analyte	Surface Water Feature	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Leve	No. Exceeding	% Exceeding	Screening Leve	No. Exceeding	% Exceeding	Screening Leve
Cyanide. Total	Backwater Seep Sampling Area	WP	DI	6	ug/l	38.8	491	262.1	264	199.6	6	100	6	100	5	6	100	22	6	100	5.2
	Cedar Creek	WP	DI	6	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	<2	<2	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Northern Surface Water Feature	WP	DI	10	ug/l	<2	4.1	1.7	-	1.2	3	30	0	0	5	0	0	22	0	0	5.2
	Riparian Sampling Area	WP	DI	5	ug/l	52.7	429	238.3	283	153.2	5	100	5	100	5	5	100	22	5	100	5.2
	South Percolation Pond	WP	DI	6	ug/l	<2	129	38.7	19.5	49.9	4	66.7	4	67	5	3	50	22	4	67	5.2
Cyanide, Free	Backwater Seep Sampling Area	WP	DI	6	ug/l	3.6	62.4	23.6	12.6	25.4	6	100	3	50	5	2	33	22	3	50	5.2
	Cedar Creek	WP	DI	6	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	<1.5	3.6	1.2	-	1.	2	18.2	0	0	5	0	0	22	0	0	5.2
	Northern Surface Water Feature	WP	DI	10	ug/l	<1.5	8.3	1.9	-	2.4	3	30	1	10	5	0	0	22	1	10	5.2
	Riparian Sampling Area	WP	DI	5	ug/l	2.4	38.7	19.9	19.6	17.6	5	100	3	60	5	2	40	22	3	60	5.2
	South Percolation Pond	WP	DI	6	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	5	0	0	22	0	0	5.2
Fluoride	Backwater Seep Sampling Area	WP	DI	6	ug/l	782	3140	1852	1865	769.3	6	100	6	100	120	-	-	-	-	-	-
	Cedar Creek	WP	DI	6	ug/l	<12	<12	-	-	-	0	0	0	0	120	-	-	-	-	-	-
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	<12	113	-	-	-	1	9.1	0	0	120	-	-	-	-	-	-
	Northern Surface Water Feature	WP	DI	10	ug/l	172	256	208.7	206.5	25.2	10	100	10	100	120	-	-	-	-	-	-
	Riparian Sampling Area	WP	DI	5	ug/l	1650	2410	2002	1940	333.7	5	100	5	100	120	-	-	-	-	-	-
	South Percolation Pond	WP	DI	6	ug/l	275	2210	869.5	322	889.3	6	100	6	100	120	-	-	-	-	-	-
Benzo[a]pyrene	Backwater Seep Sampling Area	WP	T	6	ug/l	<0.05	0.1	0.04	-	0.03	1	16.7	6	100	0.014	-	-	-	-	-	-
	Cedar Creek	WP	T	6	ug/l	<0.05	<0.05	-	-	-	0	0	6	100	0.014	-	-	-	-	-	-
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	T	11	ug/l	<0.05	<0.05	-	-	-	0	0	11	100	0.014	-	-	-	-	-	-
	Northern Surface Water Feature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Riparian Sampling Area	WP	T	5	ug/l	<0.05	0.1	0.03	-	0.01	1	20	5	100	0.014	-	-	-	-	-	-
	South Percolation Pond	WP	T	6	ug/l	<0.05	<0.06	-	-	-	0	0	6	100	0.014	-	-	-	-	-	-
Arsenic	Backwater Seep Sampling Area	WP	DI	6	ug/l	<0.77	<0.77	-	-	-	0	0	0	0	3.1	0	0	340	0	0	150
	Cedar Creek	WP	DI	6	ug/l	<0.77	1	0.7	-	0.4	2	33.3	0	0	3.1	0	0	340	0	0	150
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	<0.77	<0.77	-	-	-	0	0	0	0	3.1	0	0	340	0	0	150
	Northern Surface Water Feature	WP	DI	10	ug/l	<0.77	2	0.7	-	0.5	3	30	0	0	3.1	0	0	340	0	0	150
	Riparian Sampling Area	WP	DI	5	ug/l	<0.77	3.9	1.3	0.82	1.5	3	60	1	20	3.1	0	0	340	0	0	150
	South Percolation Pond	WP	DI	6	ug/l	<0.77	1.4	0.6	-	0.4	1	16.7	0	0	3.1	0	0	340	0	0	150
Barium	Backwater Seep Sampling Area	WP	DI	6	ug/l	103	182	152.8	156.5	26.5	6	100	6	100	4	-	-	-	-	-	-
	Cedar Creek	WP	DI	6	ug/l	101	269	145.5	122	63.3	6	100	6	100	4	-	-	-	-	-	-
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	95.4	261	136.7	110	52.2	11	100	11	100	4	-	-	-	-	-	-
	Northern Surface Water Feature	WP	DI	10	ug/l	87.4	313	145.7	123.5	66.9	10	100	10	100	4	-	-	-	-	-	-
	Riparian Sampling Area	WP	DI	5	ug/l	154	394	287.8	285	105.4	5	100	5	100	4	-	-	-	-	-	-
	South Percolation Pond	WP	DI	6	ug/l	173	421	286.7	285.5	86.7	6	100	6	100	4	-	-	-	-	-	-
Copper	Backwater Seep Sampling Area	WP	DI	6	ug/l	<1.9	<1.9	-	-	-	0	0	6	100	0.23	0	0	3.79	0	0	2.85
	Cedar Creek	WP	DI	6	ug/l	<1.9	<1.9	-	-	-	0	0	6	100	0.23	0	0	3.79	0	0	2.85
	Cedar Creek Reservoir Overflow Ditch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Flathead River	WP	DI	11	ug/l	<1.9	<1.9	-	-	-	0	0	11	100	0.23	0	0	3.79	0	0	2.85
	Northern Surface Water Feature	WP	DI	10	ug/l	<1.9	<1.9	-	-	-	0	0	10	100	0.23	0	0	3.79	0	0	2.85
	Riparian Sampling Area	WP	DI	5	ug/l	<1.9	<1.9	-	-	-	0	0	5	100	0.23	0	0	3.79	0	0	2.85
	South Percolation Pond	WP	DI	6	ug/l	<1.9	2.9	1.3	-	0.8	1	16.7	6	100	0.23	0	0	3.79	1	17	2.85

Table 18. Statistical Summary by Background Soil Reference Areas – Background Soil
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

														EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Exposure Area	Depth Interval	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Lev	No. Exceeding	% Exceeding	Screening Lev	No. Exceeding	% Exceeding	Screening Lev	No. Exceeding	% Exceeding	Screening Lev
Cyanide, Total	SO#1	0-0.5	SO	T	10	mg/kg	<0.059	0.5	0.177	0.13	0.134	9	90	0	0	2.3	0	0	15	10	100	0.0015	7	70	0.1
	SO#2	0-0.5	SO	T	10	mg/kg	<0.055	0.16	0.064	-	0.046	4	40	0	0	2.3	0	0	15	10	100	0.0015	2	20	0.1
	SO#3	0-0.5	SO	T	10	mg/kg	0.06	2.4	0.36	0.145	0.718	10	100	1	10	2.3	0	0	15	10	100	0.0015	7	70	0.1
	SO#4	0-0.5	SO	T	10	mg/kg	0.13	0.62	0.323	0.28	0.162	10	100	0	0	2.3	0	0	15	10	100	0.0015	10	100	0.1
Fluoride	SO#1	0-0.5	SO	T	10	mg/kg	<0.16	2.92	1.173	1.21	1.108	6	60	0	0	310	0	0	4700	0	0	12	0	0	6.5
	SO#2	0-0.5	SO	T	10	mg/kg	<0.15	2.68	-	-	-	1	10	0	0	310	0	0	4700	0	0	12	0	0	6.5
	SO#3	0-0.5	SO	T	10	mg/kg	<0.16	<0.24	-	-	-	0	0	0	0	310	0	0	4700	0	0	12	0	0	6.5
	SO#4	0-0.5	SO	T	10	mg/kg	<0.16	9.41	3.589	3.23	2.797	9	90	0	0	310	0	0	4700	0	0	12	1	10	6.5
Benzo[a]pyrene	SO#1	0-0.5	SO	T	10	mg/kg	0.003	0.029	0.018	0.019	0.007	10	100	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	SO#2	0-0.5	SO	T	10	mg/kg	0.003	0.02	0.014	0.015	0.006	10	100	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	SO#3	0-0.5	SO	T	10	mg/kg	<0.004	0.017	0.008	0.007	0.005	9	90	0	0	0.11	0	0	2.1	0	0	0.029	0	0	1.52
	SO#4	0-0.5	SO	T	10	mg/kg	0.021	0.21	0.065	0.041	0.061	10	100	2	20	0.11	0	0	2.1	7	70	0.029	0	0	1.52
Arsenic	SO#1	0-0.5	SO	T	10	mg/kg	2.4	4.7	3.9	3.95	0.631	10	100	10	100	0.68	9	90	3	10	100	0.0015	10	100	0.25
	SO#2	0-0.5	SO	T	10	mg/kg	3.6	6.6	4.52	4.15	0.991	10	100	10	100	0.68	10	100	3	10	100	0.0015	10	100	0.25
	SO#3	0-0.5	SO	T	10	mg/kg	2.7	12.1	6.97	6.9	2.411	10	100	10	100	0.68	9	90	3	10	100	0.0015	10	100	0.25
	SO#4	0-0.5	SO	T	10	mg/kg	2.7	53.7	18.35	10.55	19.188	10	100	10	100	0.68	9	90	3	10	100	0.0015	10	100	0.25
Barium	SO#1	0-0.5	SO	T	10	mg/kg	99.5	205	154.95	170	42.86	10	100	0	0	1500	0	0	22000	10	100	16	10	100	1.04
	SO#2	0-0.5	SO	T	10	mg/kg	58	243	141.72	147	59.86	10	100	0	0	1500	0	0	22000	10	100	16	10	100	1.04
	SO#3	0-0.5	SO	T	10	mg/kg	126	324	198.7	204	66.40	10	100	0	0	1500	0	0	22000	10	100	16	10	100	1.04
	SO#4	0-0.5	SO	T	10	mg/kg	291	641	395.6	343.5	116.16	10	100	0	0	1500	0	0	22000	10	100	16	10	100	1.04
Copper	SO#1	0-0.5	SO	T	10	mg/kg	9	16.3	11.63	11.6	2.16	10	100	0	0	310	0	0	4700	10	100	2.8	10	100	5.4
	SO#2	0-0.5	SO	T	10	mg/kg	10.9	20	14.85	14.75	3.32	10	100	0	0	310	0	0	4700	10	100	2.8	10	100	5.4
	SO#3	0-0.5	SO	T	10	mg/kg	15.7	25.3	18.39	17.55	2.69	10	100	0	0	310	0	0	4700	10	100	2.8	10	100	5.4
	SO#4	0-0.5	SO	T	10	mg/kg	4.9	52.4	15.01	7.45	15.21	10	100	0	0	310	0	0	4700	10	100	2.8	9	90	5.4
Manganese	SO#1	0-0.5	SO	T	10	mg/kg	396	621	480.5	466	64.05	10	100	10	100	180	0	0	2600	10	100	2.8	10	100	220
	SO#2	0-0.5	SO	T	10	mg/kg	243	577	341.5	312.5	113.58	10	100	10	100	180	0	0	2600	10	100	2.8	10	100	220
	SO#3	0-0.5	SO	T	10	mg/kg	151	892	530	482	204.18	10	100	9	90	180	0	0	2600	10	100	2.8	9	90	220
	SO#4	0-0.5	SO	T	10	mg/kg	151	1970	837.5	757	572.84	10	100	9	90	180	0	0	2600	10	100	2.8	9	90	220
Nickel	SO#1	0-0.5	SO	T	10	mg/kg	8.6	13.9	11.07	10.9	1.56	10	100	0	0	150	0	0	2200	10	100	2.6	8	80	9.7
	SO#2	0-0.5	SO	T	10	mg/kg	9.7	14.3	12.22	11.95	1.49	10	100	0	0	150	0	0	2200	10	100	2.6	9	90	9.7
	SO#3	0-0.5	SO	T	10	mg/kg	11.3	20.7	14.8	14.15	2.57	10	100	0	0	150	0	0	2200	10	100	2.6	10	100	9.7
	SO#4	0-0.5	SO	T	10	mg/kg	8.2	20.5	12.18	11.35	3.76	10	100	0	0	150	0	0	2200	10	100	2.6	7	70	9.7
Selenium	SO#1	0-0.5	SO	T	10	mg/kg	<0.24	<0.3	-	-	-	0	0	0	0	39	0	0	580	10	100	0.052	10	100	0.0276
	SO#2	0-0.5	SO	T	10	mg/kg	<0.25	<0.35	-	-	-	0	0	0	0	39	0	0	580	10	100	0.052	10	100	0.0276
	SO#3	0-0.5	SO	T	10	mg/kg	<0.28	1.1	0.411	0.34	0.279	7	70	0	0	39	0	0	580	10	100	0.052	10	100	0.0276
	SO#4	0-0.5	SO	T	10	mg/kg	<0.25	2.2	0.58	-	0.785	3	30	0	0	39	0	0	580	10	100	0.052	10	100	0.0276
Thallium	SO#1	0-0.5	SO	T	10	mg/kg	<0.1	<0.13	-	-	-	0	0	0	0	0.078	0	0	1.2	10	100	0.0014	10	100	0.027
	SO#2	0-0.5	SO	T	10	mg/kg	<0.11	0.12	-	-	-	1	10	1	10	0.078	0	0	1.2	10	100	0.0014	10	100	0.027
	SO#3	0-0.5	SO	T	10	mg/kg	<0.13	0.22	0.135	0.145	0.049	7	70	8	80	0.078	0	0	1.2	10	100	0.0014	10	100	0.027
	SO#4	0-0.5	SO	T	10	mg/kg	<0.11	0.45	0.152	-	0.138	4	40	5	50	0.078	0	0	1.2	10	100	0.0014	10	100	0.027
Vanadium	SO#1	0-0.5	SO	T	10	mg/kg	9	14.1	11.19	10.9	1.722	10	100	0	0	39	0	0	580	10	100	8.6	10	100	0.714
	SO#2	0-0.5	SO	T	10	mg/kg	12.3	17.5	14.95	15.1	1.477	10	100	0	0	39	0	0	580	10	100	8.6	10	100	0.714
	SO#3	0-0.5	SO	T	10	mg/kg	9.6	21.9	15.13	15.6	3.305	10	100	0	0	39	0	0	580	10	100	8.6	10	100	0.714
	SO#4	0-0.5	SO	T	10	mg/kg	8.5	27.6	12.8	11.1	5.577	10	100	0	0	39	0	0	580	9	90	8.6	10	100	0.714
Zinc	SO#1	0-0.5	SO	T	10	mg/kg	35	59.8	47.69	48.1	6.724	10	100	0	0	2300	0	0	35000	9	90	37	10	100	6.62
	SO#2	0-0.5	SO	T	10	mg/kg	32.5	52.6	41.9	40.55	6.214	10	100	0	0	2300	0	0	35000	8	80	37	10	100	6.62
	SO#3	0-0.5	SO	T	10	mg/kg	50.8	88.3	70.25	72.2	13.277	10	100	0	0	2300	0	0	35000	10	100	37	10	100	6.62
	SO#4	0-0.5	SO	T	10	mg/kg	34.6	83	56.77	55.1	15.943	10	100	0	0	2300	0	0	35000	9	90	37	10	100	6.62

Table 19. Statistical Summary by Background Surface Water Reference Areas – Background Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													DEQ-7 Human Health Standards			EPA Risk Based Screening Level Drinking			EPA Risk Based Screening Level Tapwater		
Analyte	Background Reference Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	#1: Upgradient Flathead River	WS	T	20	ug/l	<2	<2	-	-	-	0	0	0	0	4	0	0	200	20	100	0.15
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<2	<2	-	-	-	0	0	0	0	4	0	0	200	20	100	0.15
Cyanide, Free	#1: Upgradient Flathead River	WS	T	20	ug/l	<1.5	2.4	0.9	-	0.4	3	15	0	0	4	0	0	200	20	100	0.15
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<1.5	<1.5	-	-	-	0	0	0	0	4	0	0	200	20	100	0.15
Fluoride	#1: Upgradient Flathead River	WS	T	20	ug/l	<12	3500	218.1	13.8	783.2	10	50	0	0	4000	0	0	4000	2	10	80
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<12	86	43.8	42.7	38.8	10	50	0	0	4000	0	0	4000	7	35	80
Benzo[a]pyrene	#1: Upgradient Flathead River	WS	T	20	ug/l	<0.049	<0.05	-	-	-	0	0	20	100	0.0012	0	0	0.2	13	65	0.025
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<0.05	<0.05	-	-	-	0	0	20	100	0.0012	0	0	0.2	9	45	0.025
Arsenic	#1: Upgradient Flathead River	WS	T	20	ug/l	<0.77	<0.77	-	-	-	0	0	0	0	10	0	0	10	20	100	0.052
		WS	DI	20	ug/l	<0.77	<0.77	-	-	-	0	0	0	0	10	0	0	10	20	100	0.052
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<0.77	1.5	-	-	-	1	5	0	0	10	0	0	10	20	100	0.052
		WS	DI	20	ug/l	<0.77	1.6	-	-	-	1	5	0	0	10	0	0	10	20	100	0.052
Aluminum	#1: Upgradient Flathead River	WS	T	20	ug/l	<15	435	108.8	56.9	132.1	18	90	-	-	-	-	-	-	0	0	2000
		WS	DI	20	ug/l	<15	15.8	-	-	-	1	5	-	-	-	-	-	-	0	0	2000
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<15	50.2	19.4	17.3	11	14	70	-	-	-	-	-	-	0	0	2000
		WS	DI	20	ug/l	<15	<15	-	-	-	0	0	-	-	-	-	-	-	0	0	2000
Barium	#1: Upgradient Flathead River	WS	T	20	ug/l	71.6	129	92.6	91.3	15.8	20	100	0	0	1000	0	0	2000	0	0	380
		WS	DI	20	ug/l	66.7	121	86.4	85.1	14.8	20	100	0	0	1000	0	0	2000	0	0	380
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	30.3	264	76.8	53.9	64.1	20	100	0	0	1000	0	0	2000	0	0	380
		WS	DI	20	ug/l	32.5	248	67	53.8	49.2	20	100	0	0	1000	0	0	2000	0	0	380
Copper	#1: Upgradient Flathead River	WS	T	20	ug/l	<1.9	3.8	-	-	-	1	5	0	0	1300	0	0	1300	0	0	80
		WS	DI	20	ug/l	<1.9	<1.9	-	-	-	0	0	0	0	1300	0	0	1300	0	0	80
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<1.9	8.8	2.1	-	2.3	5	25	0	0	1300	0	0	1300	0	0	80
		WS	DI	20	ug/l	<1.9	<1.9	-	-	-	0	0	0	0	1300	0	0	1300	0	0	80
Iron	#1: Upgradient Flathead River	WS	T	20	ug/l	<45.7	527	126.5	61.7	155.8	12	60	-	-	-	-	-	-	0	0	1400
		WS	DI	20	ug/l	<45.7	<45.7	-	-	-	0	0	-	-	-	-	-	-	0	0	1400
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<45.7	178	34.3	-	35.7	3	15	-	-	-	-	-	-	0	0	1400
		WS	DI	20	ug/l	<45.7	<45.7	-	-	-	0	0	-	-	-	-	-	-	0	0	1400
Zinc	#1: Upgradient Flathead River	WS	T	20	ug/l	<5.4	7.2	-	-	-	1	5	0	0	7400	-	-	-	0	0	600
		WS	DI	20	ug/l	<5.4	<5.4	-	-	-	0	0	0	0	7400	-	-	-	0	0	600
	#2: Upgradient Cedar Creek	WS	T	20	ug/l	<5.4	<5.4	-	-	-	0	0	0	0	7400	-	-	-	0	0	600
		WS	DI	20	ug/l	<5.4	14.7	-	-	-	2	10	0	0	7400	-	-	-	0	0	600

Table 20. Statistical Summary by Background Surface Water Reference Areas – Background Sediment
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

													EPA Residential Soil RSL			EPA Industrial Soil RSL			EPA Protection Of Groundwater Risk-Based Soil RSL			Minimum Ecological Screening Level		
Analyte	Background Reference Area	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	# > LOD	% > LOD	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level	No. Exceeding	% Exceeding	Screening Level
Cyanide, Total	#1: Upgradient Flathead River	SE	T	10	mg/kg	<0.067	<0.086	-	-	-	0	0	0	0	2.3	0	0	15	10	100	0.0015	10	100	0.0001
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	<0.072	0.13	0.069	-	0.033	3	30	0	0	2.3	0	0	15	10	100	0.0015	10	100	0.0001
Fluoride	#1: Upgradient Flathead River	SE	T	10	mg/kg	<0.17	<0.21	-	-	-	0	0	0	0	310	0	0	4700	0	0	12	-	-	-
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	<0.17	<0.44	-	-	-	0	0	0	0	310	0	0	4700	0	0	12	-	-	-
Benzo[a]pyrene	#1: Upgradient Flathead River	SE	T	10	mg/kg	<0.0007	0.004	-	-	-	1	10	0	0	0.11	0	0	2.1	0	0	0.029	0	0	0.032
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	<0.0008	<0.025	-	-	-	0	0	0	0	0.11	0	0	2.1	0	0	0.029	0	0	0.032
Arsenic	#1: Upgradient Flathead River	SE	T	10	mg/kg	1.7	5.8	3.34	3.5	1.353	10	100	10	100	0.68	5	50	3	10	100	0.0015	0	0	9.79
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	2	7	5.02	5.4	1.669	10	100	10	100	0.68	8	80	3	10	100	0.0015	0	0	9.79
Barium	#1: Upgradient Flathead River	SE	T	10	mg/kg	29	105	55.08	56.3	24.601	10	100	0	0	1500	0	0	22000	10	100	16	-	-	-
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	22.4	215	99.31	68.45	66.645	10	100	0	0	1500	0	0	22000	10	100	16	-	-	-
Cadmium	#1: Upgradient Flathead River	SE	T	10	mg/kg	<0.35	<0.45	-	-	-	0	0	0	0	7.1	0	0	98	10	100	0.069	0	0	0.583
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	<0.26	<0.73	-	-	-	0	0	0	0	7.1	0	0	98	10	100	0.069	0	0	0.583
Copper	#1: Upgradient Flathead River	SE	T	10	mg/kg	4.7	15	9.08	8.55	3.699	10	100	0	0	310	0	0	4700	10	100	2.8	0	0	28
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	4.8	26.1	11.77	8.8	6.584	10	100	0	0	310	0	0	4700	10	100	2.8	0	0	28
Lead	#1: Upgradient Flathead River	SE	T	10	mg/kg	2.8	11.4	5.51	4.1	2.799	10	100	0	0	400	0	0	800	-	-	-	0	0	35.8
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	5.6	24.7	12.69	12.15	6.046	10	100	0	0	400	0	0	800	-	-	-	0	0	35.8
Nickel	#1: Upgradient Flathead River	SE	T	10	mg/kg	6.1	12.9	9.3	9.15	2.412	10	100	0	0	150	0	0	2200	10	100	2.6	0	0	19.5
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	9.5	14.5	12.21	12.55	1.969	10	100	0	0	150	0	0	2200	10	100	2.6	0	0	19.5
Selenium	#1: Upgradient Flathead River	SE	T	10	mg/kg	<0.3	<0.39	-	-	-	0	0	0	0	39	0	0	580	10	100	0.052	0	0	2
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	<0.23	0.79	0.246	-	0.207	2	20	0	0	39	0	0	580	10	100	0.052	0	0	2
Vanadium	#1: Upgradient Flathead River	SE	T	10	mg/kg	5.2	18.7	10.8	9.75	4.982	10	100	0	0	39	0	0	580	6	60	8.6	-	-	-
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	5.3	11.8	9.58	10.25	2.162	10	100	0	0	39	0	0	580	8	80	8.6	-	-	-
Zinc	#1: Upgradient Flathead River	SE	T	10	mg/kg	21.6	42	30.73	27.75	8.253	10	100	0	0	2300	0	0	35000	3	30	37	0	0	98
	#2: Upgradient Cedar Creek	SE	T	10	mg/kg	28.9	63.5	48.77	49.95	11.393	10	100	0	0	2300	0	0	35000	8	80	37	0	0	98

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-001	CFSWP-001-SW	09/16/2016	N	T	P1 R1	88000	0.71	8.36	77.6	2.704	46.8	107.5
CFSWP-001	CFSWP-001-SW	12/02/2016	N	T	P1 R2	90000	0.73	8.53	79.1	2.782	47.7	109.6
CFSWP-001	CFSWP-001-SW	04/04/2017	N	T	P1 R3	86000	0.70	8.20	76.2	2.626	45.9	105.4
CFSWP-001	CFSWP-001-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	06/14/2017	N	T	P1 R4	72000	0.61	7.05	65.9	2.094	39.5	90.7
CFSWP-001	CFSWP-001-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	06/07/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-001	CFSWP-001-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	10/05/2018	N	T	P2 R2	160000	1.15	13.94	126.6	5.787	77.6	178.4
CFSWP-002	CFSWP-002-SW	09/16/2016	N	T	P1 R1	86000	0.70	8.20	76.2	2.626	45.9	105.4
CFSWP-002	CFSWP-002-SW	12/02/2016	N	T	P1 R2	92000	0.74	8.69	80.5	2.861	48.6	111.6
CFSWP-002	CFSWP-002-SW	04/04/2017	N	T	P1 R3	84000	0.69	8.04	74.7	2.548	45.0	103.4
CFSWP-002	CFSWP-002-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	06/14/2017	N	T	P1 R4	72000	0.61	7.05	65.9	2.094	39.5	90.7
CFSWP-002	CFSWP-002-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	06/07/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-002	CFSWP-002-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	10/05/2018	N	T	P2 R2	82000	0.67	7.87	73.3	2.471	44.1	101.3
CFSWP-003	CFSWP-003-SW	09/09/2016	N	T	P1 R1	90000	0.73	8.53	79.1	2.782	47.7	109.6
CFSWP-003	CFSWP-003-SW	12/01/2016	N	T	P1 R2	108000	0.84	9.96	91.8	3.509	55.7	127.9
CFSWP-003	CFSWP-003-SW	03/16/2017	N	T	P1 R3	88000	0.71	8.36	77.6	2.704	46.8	107.5
CFSWP-003	CFSWP-003-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	06/14/2017	N	T	P1 R4	74000	0.62	7.21	67.3	2.169	40.4	92.8
CFSWP-003	CFSWP-003-SW	10/31/2017	N	T	SSPA	125000	0.94	11.29	103.5	4.227	63.0	144.8
CFSWP-003	CFSWP-003-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	06/06/2018	N	T	P2 R1	79400	0.66	7.66	71.3	2.372	42.9	98.5
CFSWP-003	CFSWP-003-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	10/04/2018	N	T	P2 R2	132000	0.99	11.83	108.2	4.530	66.0	151.6
CFSWP-004	CFSWP-004-SW	09/09/2016	N	T	P1 R1	222000	1.49	18.44	165.6	8.781	102.4	235.5
CFSWP-004	CFSWP-004-SW	12/01/2016	N	T	P1 R2	216000	1.46	18.01	161.9	8.480	100.1	230.1
CFSWP-004	CFSWP-004-SW	03/16/2017	N	T	P1 R3	104000	0.82	9.65	89.0	3.344	53.9	123.9
CFSWP-004	CFSWP-004-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	06/14/2017	N	T	P1 R4	70000	0.59	6.88	64.3	2.020	38.6	88.6
CFSWP-004	CFSWP-004-SW	10/31/2017	N	T	SSPA	222000	1.49	18.44	165.6	8.781	102.4	235.5
CFSWP-004	CFSWP-004-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	06/06/2018	N	T	P2 R1	111000	0.86	10.20	93.9	3.634	57.0	130.9
CFSWP-004	CFSWP-004-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	10/04/2018	N	T	P2 R2	250000	1.64	20.41	182.5	10.215	113.2	260.4
CFSWP-005	CFSWP-005-SW	09/09/2016	N	T	P1 R1	218000	1.47	18.16	163.2	8.580	100.9	231.9
CFSWP-005	CFSWP-005-SW	12/01/2016	N	T	P1 R2	252000	1.65	20.55	183.7	10.319	114.0	262.2
CFSWP-005	CFSWP-005-SW	03/16/2017	N	T	P1 R3	106000	0.83	9.81	90.4	3.427	54.8	125.9
CFSWP-005	CFSWP-005-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	06/14/2017	N	T	P1 R4	130000	0.97	11.67	106.8	4.443	65.1	149.6
CFSWP-005	CFSWP-005-SW	11/01/2017	N	T	SSPA	222000	1.49	18.44	165.6	8.781	102.4	235.5
CFSWP-005	CFSWP-005-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	06/06/2018	N	T	P2 R1	107000	0.83	9.88	91.1	3.468	55.2	126.9
CFSWP-005	CFSWP-005-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	10/18/2018	N	T	P2 R2	228000	1.52	18.87	169.3	9.084	104.8	240.9
CFSWP-006	CFSWP-006-SW	09/09/2016	N	T	P1 R1	90000	0.73	8.53	79.1	2.782	47.7	109.6
CFSWP-006	CFSWP-006-SW	12/01/2016	N	T	P1 R2	150000	1.09	13.19	120.1	5.331	73.5	168.9
CFSWP-006	CFSWP-006-SW	03/16/2017	N	T	P1 R3	88000	0.71	8.36	77.6	2.704	46.8	107.5

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Aquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-006	CFSWP-006-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-006	CFSWP-006-SW	06/14/2017	N	T	P1 R4	70000	0.59	6.88	64.3	2.020	38.6	88.6
CFSWP-006	CFSWP-006-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-006	CFSWP-006-SW	06/06/2018	N	T	P2 R1	73400	0.62	7.16	66.9	2.146	40.2	92.2
CFSWP-006	CFSWP-006-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-006	CFSWP-006-SW	10/04/2018	N	T	P2 R2	80000	0.66	7.71	71.8	2.395	43.2	99.2
CFSWP-007	CFSWP-007-SW	09/16/2016	N	T	P1 R1	86000	0.70	8.20	76.2	2.626	45.9	105.4
CFSWP-007	CFSWP-007-SW	12/02/2016	N	T	P1 R2	90000	0.73	8.53	79.1	2.782	47.7	109.6
CFSWP-007	CFSWP-007-SW	03/16/2017	N	T	P1 R3	82000	0.67	7.87	73.3	2.471	44.1	101.3
CFSWP-007	CFSWP-007-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	06/14/2017	N	T	P1 R4	72000	0.61	7.05	65.9	2.094	39.5	90.7
CFSWP-007	CFSWP-007-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	06/07/2018	N	T	P2 R1	75400	0.63	7.33	68.4	2.221	41.1	94.3
CFSWP-007	CFSWP-007-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	10/03/2018	N	T	P2 R2	89600	0.72	8.49	78.8	2.767	47.5	109.2
CFSWP-008	CFSWP-008-SW	09/16/2016	N	T	P1 R1	84000	0.69	8.04	74.7	2.548	45.0	103.4
CFSWP-008	CFSWP-008-SW	12/02/2016	N	T	P1 R2	92000	0.74	8.69	80.5	2.861	48.6	111.6
CFSWP-008	CFSWP-008-SW	04/04/2017	N	T	P1 R3	84000	0.69	8.04	74.7	2.548	45.0	103.4
CFSWP-008	CFSWP-008-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	06/14/2017	N	T	P1 R4	70000	0.59	6.88	64.3	2.020	38.6	88.6
CFSWP-008	CFSWP-008-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	06/07/2018	N	T	P2 R1	75400	0.63	7.33	68.4	2.221	41.1	94.3
CFSWP-008	CFSWP-008-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	10/03/2018	N	T	P2 R2	91500	0.74	8.65	80.1	2.841	48.4	111.1
CFSWP-009	CFSWP-009-SW	06/07/2016	N	T	P1 R1	170000	1.21	14.68	133.1	6.252	81.7	187.8
CFSWP-009	CFSWP-009-SW	04/03/2017	N	T	P1 R3	170000	1.21	14.68	133.1	6.252	81.7	187.8
CFSWP-009	CFSWP-009-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-009	CFSWP-009-SW	06/12/2017	N	T	P1 R4	188000	1.31	16.00	144.5	7.106	89.0	204.6
CFSWP-009	CFSWP-009-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-009	CFSWP-009-SW	06/14/2018	N	T	P2 R1	163000	1.17	14.16	128.6	5.926	78.9	181.3
CFSWP-010	CFSWP-010-SW	06/07/2016	N	T	P1 R1	164000	1.17	14.24	129.2	5.972	79.3	182.2
CFSWP-010	CFSWP-010-SW	03/15/2017	N	T	P1 R3	138000	1.02	12.28	112.2	4.794	68.5	157.4
CFSWP-010	CFSWP-010-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-010	CFSWP-010-SW	06/12/2017	N	T	P1 R4	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-010	CFSWP-010-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-010	CFSWP-010-SW	06/14/2018	N	T	P2 R1	167000	1.19	14.46	131.2	6.112	80.5	185.0
CFSWP-011	CFSWP-011-SW	06/07/2016	N	T	P1 R1	156000	1.13	13.64	124.0	5.604	76.0	174.6
CFSWP-011	CFSWP-011-SW	04/03/2017	N	T	P1 R3	170000	1.21	14.68	133.1	6.252	81.7	187.8
CFSWP-011	CFSWP-011-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-011	CFSWP-011-SW	06/12/2017	N	T	P1 R4	168000	1.20	14.53	131.8	6.158	80.9	186.0
CFSWP-011	CFSWP-011-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-011	CFSWP-011-SW	06/14/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-012	CFSWP-012-SW	06/07/2016	N	T	P1 R1	152000	1.10	13.34	121.4	5.422	74.3	170.8
CFSWP-012	CFSWP-012-SW	04/03/2017	N	T	P1 R3	168000	1.20	14.53	131.8	6.158	80.9	186.0
CFSWP-012	CFSWP-012-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-012	CFSWP-012-SW	06/12/2017	N	T	P1 R4	164000	1.17	14.24	129.2	5.972	79.3	182.2
CFSWP-012	CFSWP-012-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-012	CFSWP-012-SW	06/14/2018	N	T	P2 R1	155000	1.12	13.57	123.4	5.558	75.6	173.7
CFSWP-013	CFSWP-013-SW	06/07/2016	N	T	P1 R1	156000	1.13	13.64	124.0	5.604	76.0	174.6
CFSWP-013	CFSWP-013-SW	11/30/2016	N	T	P1 R2	170000	1.21	14.68	133.1	6.252	81.7	187.8
CFSWP-013	CFSWP-013-SW	03/15/2017	N	T	P1 R3	158000	1.14	13.79	125.3	5.696	76.8	176.5

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-013	CFSWP-013-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-013	CFSWP-013-SW	06/12/2017	N	T	P1 R4	172000	1.22	14.83	134.4	6.346	82.5	189.7
CFSWP-013	CFSWP-013-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-013	CFSWP-013-SW	06/14/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-014	CFSWP-014-SW	08/29/2016	N	T	P1 R1	164000	1.17	14.24	129.2	5.972	79.3	182.2
CFSWP-014	CFSWP-014-SW	11/30/2016	N	T	P1 R2	196000	1.35	16.58	149.5	7.494	92.2	211.9
CFSWP-014	CFSWP-014-SW	03/13/2017	N	T	P1 R3	200000	1.37	16.87	152.0	7.689	93.8	215.6
CFSWP-014	CFSWP-014-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	06/13/2017	N	T	P1 R4	176000	1.24	15.12	136.9	6.534	84.2	193.4
CFSWP-014	CFSWP-014-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	06/11/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-014	CFSWP-014-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	10/10/2018	N	T	P2 R2	172000	1.22	14.83	134.4	6.346	82.5	189.7
CFSWP-015	CFSWP-015-SW	08/29/2016	N	T	P1 R1	178000	1.25	15.27	138.2	6.629	85.0	195.3
CFSWP-015	CFSWP-015-SW	11/30/2016	N	T	P1 R2	196000	1.35	16.58	149.5	7.494	92.2	211.9
CFSWP-015	CFSWP-015-SW	12/20/2016	N	T	P1 R2	208000	1.42	17.44	157.0	8.082	96.9	222.8
CFSWP-015	CFSWP-015-SW	03/13/2017	N	T	P1 R3	202000	1.38	17.01	153.3	7.787	94.6	217.4
CFSWP-015	CFSWP-015-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	06/13/2017	N	T	P1 R4	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-015	CFSWP-015-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	06/11/2018	N	T	P2 R1	163000	1.17	14.16	128.6	5.926	78.9	181.3
CFSWP-015	CFSWP-015-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	10/09/2018	N	T	P2 R2	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-016	CFSWP-016-SW	08/29/2016	N	T	P1 R1	172000	1.22	14.83	134.4	6.346	82.5	189.7
CFSWP-016	CFSWP-016-SW	11/30/2016	N	T	P1 R2	200000	1.37	16.87	152.0	7.689	93.8	215.6
CFSWP-016	CFSWP-016-SW	03/13/2017	N	T	P1 R3	202000	1.38	17.01	153.3	7.787	94.6	217.4
CFSWP-016	CFSWP-016-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	06/12/2017	N	T	P1 R4	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-016	CFSWP-016-SW	06/12/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	06/12/2018	N	T	P2 R1	167000	1.19	14.46	131.2	6.112	80.5	185.0
CFSWP-016	CFSWP-016-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	10/09/2018	N	T	P2 R2	188000	1.31	16.00	144.5	7.106	89.0	204.6
CFSWP-017	CFSWP-017-SW	09/16/2016	N	T	P1 R1	124000	0.94	11.21	102.8	4.184	62.6	143.8
CFSWP-017	CFSWP-017-SW	12/02/2016	N	T	P1 R2	92000	0.74	8.69	80.5	2.861	48.6	111.6
CFSWP-017	CFSWP-017-SW	04/04/2017	N	T	P1 R3	88000	0.71	8.36	77.6	2.704	46.8	107.5
CFSWP-017	CFSWP-017-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	06/14/2017	N	T	P1 R4	66000	0.57	6.54	61.3	1.875	36.7	84.3
CFSWP-017	CFSWP-017-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	06/07/2018	N	T	P2 R1	73400	0.62	7.16	66.9	2.146	40.2	92.2
CFSWP-017	CFSWP-017-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	10/03/2018	N	T	P2 R2	127000	0.96	11.44	104.8	4.313	63.9	146.7
CFSWP-018	CFSWP-018-SW	06/06/2016	N	T	P1 R1	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-018	CFSWP-018-SW	12/01/2016	N	T	P1 R2	260000	1.69	21.11	188.5	10.738	117.1	269.2
CFSWP-018	CFSWP-018-SW	04/03/2017	N	T	P1 R3	184000	1.29	15.71	142.0	6.914	87.4	200.9
CFSWP-018	CFSWP-018-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	06/15/2017	N	T	P1 R4	216000	1.46	18.01	161.9	8.480	100.1	230.1
CFSWP-018	CFSWP-018-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	06/21/2018	N	T	P2 R1	218000	1.47	18.16	163.2	8.580	100.9	231.9
CFSWP-018	CFSWP-018-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	10/17/2018	N	T	P2 R2	176000	1.24	15.12	136.9	6.534	84.2	193.4
CFSWP-019	CFSWP-019-SW	06/06/2016	N	T	P1 R1	180000	1.26	15.42	139.5	6.724	85.8	197.2

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-019	CFSWP-019-SW	12/01/2016	N	T	P1 R2	208000	1.42	17.44	157.0	8.082	96.9	222.8
CFSWP-019	CFSWP-019-SW	04/03/2017	N	T	P1 R3	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-019	CFSWP-019-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	06/15/2017	N	T	P1 R4	168000	1.20	14.53	131.8	6.158	80.9	186.0
CFSWP-019	CFSWP-019-SW	11/07/2017	N	T	SSPA	535000	2.39	30.50	268.2	18.581	168.5	387.8
CFSWP-019	CFSWP-019-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	06/21/2018	N	T	P2 R1	171000	1.21	14.75	133.7	6.299	82.1	188.8
CFSWP-019	CFSWP-019-SW	10/16/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	10/16/2018	N	T	P2 R2	168000	1.20	14.53	131.8	6.158	80.9	186.0
CFSWP-020	CFSWP-020-SW	06/06/2016	N	T	P1 R1	176000	1.24	15.12	136.9	6.534	84.2	193.4
CFSWP-020	CFSWP-020-SW	12/01/2016	N	T	P1 R2	256000	1.67	20.83	186.1	10.528	115.5	265.7
CFSWP-020	CFSWP-020-SW	03/16/2017	N	T	P1 R3	160000	1.15	13.94	126.6	5.787	77.6	178.4
CFSWP-020	CFSWP-020-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	06/15/2017	N	T	P1 R4	160000	1.15	13.94	126.6	5.787	77.6	178.4
CFSWP-020	CFSWP-020-SW	11/07/2017	N	T	SSPA	1740000	2.39	30.50	268.2	18.581	168.5	387.8
CFSWP-020	CFSWP-020-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	06/21/2018	N	T	P2 R1	155000	1.12	13.57	123.4	5.558	75.6	173.7
CFSWP-020	CFSWP-020-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	10/11/2018	N	T	P2 R2	144000	1.06	12.74	116.2	5.061	71.0	163.2
CFSWP-021	CFSWP-021-SW	06/06/2016	N	T	P1 R1	168000	1.20	14.53	131.8	6.158	80.9	186.0
CFSWP-021	CFSWP-021-SW	11/30/2016	N	T	P1 R2	304000	1.92	24.12	214.2	13.102	133.6	307.4
CFSWP-021	CFSWP-021-SW	03/15/2017	N	T	P1 R3	204000	1.40	17.16	154.5	7.885	95.3	219.2
CFSWP-021	CFSWP-021-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-021	CFSWP-021-SW	06/15/2017	N	T	P1 R4	184000	1.29	15.71	142.0	6.914	87.4	200.9
CFSWP-021	CFSWP-021-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-021	CFSWP-021-SW	06/19/2018	N	T	P2 R1	187000	1.30	15.93	143.9	7.058	88.6	203.6
CFSWP-022	CFSWP-022-SW	06/06/2016	N	T	P1 R1	172000	1.22	14.83	134.4	6.346	82.5	189.7
CFSWP-022	CFSWP-022-SW	04/03/2017	N	T	P1 R3	166000	1.18	14.39	130.5	6.065	80.1	184.1
CFSWP-022	CFSWP-022-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-022	CFSWP-022-SW	06/20/2018	N	T	P2 R1	167000	1.19	14.46	131.2	6.112	80.5	185.0
CFSWP-023	CFSWP-023-SW	04/03/2017	N	T	P1 R3	224000	1.50	18.58	166.8	8.882	103.2	237.3
CFSWP-024	CFSWP-024-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-024	CFSWP-024-SW	06/15/2017	N	T	P1 R4	50000	0.45	5.16	48.8	1.317	29.0	66.6
CFSWP-025	CFSWP-025-SW	12/20/2016	N	T	P1 R2	206000	1.41	17.30	155.8	7.984	96.1	221.0
CFSWP-025	CFSWP-025-SW	03/13/2017	N	T	P1 R3	204000	1.40	17.16	154.5	7.885	95.3	219.2
CFSWP-025	CFSWP-025-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	06/13/2017	N	T	P1 R4	176000	1.24	15.12	136.9	6.534	84.2	193.4
CFSWP-025	CFSWP-025-SW	06/12/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	06/12/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-025	CFSWP-025-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	10/10/2018	N	T	P2 R2	180000	1.26	15.42	139.5	6.724	85.8	197.2
CFSWP-026	CFSWP-026-SW	10/31/2017	N	T	SSPA	107000	0.83	9.88	91.1	3.468	55.2	126.9
CFSWP-026	CFSWP-026-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-026	CFSWP-026-SW	06/07/2018	N	T	P2 R1	75400	0.63	7.33	68.4	2.221	41.1	94.3
CFSWP-026	CFSWP-026-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-026	CFSWP-026-SW	10/05/2018	N	T	P2 R2	92000	0.74	8.69	80.5	2.861	48.6	111.6
CFSWP-027	CFSWP-027-SW	10/31/2017	N	T	SSPA	101000	0.80	9.41	86.9	3.222	52.6	120.8
CFSWP-027	CFSWP-027-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-027	CFSWP-027-SW	06/06/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-027	CFSWP-027-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-027	CFSWP-027-SW	10/05/2018	N	T	P2 R2	98000	0.78	9.17	84.8	3.101	51.3	117.8

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Aquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-028	CFSWP-028-SW	10/31/2017	N	T	SSPA	103000	0.81	9.57	88.3	3.304	53.5	122.9
CFSWP-028	CFSWP-028-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-028	CFSWP-028-SW	06/06/2018	N	T	P2 R1	69500	0.59	6.84	64.0	2.002	38.3	88.0
CFSWP-028	CFSWP-028-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-028	CFSWP-028-SW	10/04/2018	N	T	P2 R2	100000	0.79	9.33	86.2	3.182	52.2	119.8
CFSWP-029	CFSWP-029-SW	11/01/2017	N	T	SSPA	230000	1.54	19.01	170.5	9.186	105.5	242.7
CFSWP-029	CFSWP-029-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-029	CFSWP-029-SW	06/22/2018	N	T	P2 R1	214000	1.45	17.87	160.7	8.380	99.3	228.3
CFSWP-029	CFSWP-029-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-029	CFSWP-029-SW	10/18/2018	N	T	P2 R2	224000	1.50	18.58	166.8	8.882	103.2	237.3
CFSWP-030	CFSWP-030-SW	11/03/2017	N	T	SSPA	176000	1.24	15.12	136.9	6.534	84.2	193.4
CFSWP-030	CFSWP-030-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-030	CFSWP-030-SW	06/22/2018	N	T	P2 R1	202000	1.38	17.01	153.3	7.787	94.6	217.4
CFSWP-030	CFSWP-030-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-030	CFSWP-030-SW	10/18/2018	N	T	P2 R2	156000	1.13	13.64	124.0	5.604	76.0	174.6
CFSWP-031	CFSWP-031-SW	11/03/2017	N	T	SSPA	329000	2.04	25.81	228.6	14.489	142.9	328.7
CFSWP-031	CFSWP-031-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-031	CFSWP-031-SW	06/22/2018	N	T	P2 R1	218000	1.47	18.16	163.2	8.580	100.9	231.9
CFSWP-031	CFSWP-031-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-031	CFSWP-031-SW	10/18/2018	N	T	P2 R2	200000	1.37	16.87	152.0	7.689	93.8	215.6
CFSWP-032	CFSWP-032-SW	11/03/2017	N	T	SSPA	257000	1.68	20.90	186.7	10.580	115.9	266.6
CFSWP-032	CFSWP-032-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-032	CFSWP-032-SW	06/22/2018	N	T	P2 R1	226000	1.51	18.72	168.0	8.983	104.0	239.1
CFSWP-032	CFSWP-032-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-032	CFSWP-032-SW	10/17/2018	N	T	P2 R2	208000	1.42	17.44	157.0	8.082	96.9	222.8
CFSWP-033	CFSWP-033-SW	11/03/2017	N	T	SSPA	238000	1.58	19.57	175.3	9.595	108.6	249.8
CFSWP-033	CFSWP-033-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-033	CFSWP-033-SW	06/22/2018	N	T	P2 R1	218000	1.47	18.16	163.2	8.580	100.9	231.9
CFSWP-033	CFSWP-033-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-033	CFSWP-033-SW	10/17/2018	N	T	P2 R2	256000	1.67	20.83	186.1	10.528	115.5	265.7
CFSWP-034	CFSWP-034-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-034	CFSWP-034-SW	06/07/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-034	CFSWP-034-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-034	CFSWP-034-SW	10/05/2018	N	T	P2 R2	80000	0.66	7.71	71.8	2.395	43.2	99.2
CFSWP-035	CFSWP-035-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-035	CFSWP-035-SW	06/07/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-035	CFSWP-035-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-035	CFSWP-035-SW	10/05/2018	N	T	P2 R2	80000	0.66	7.71	71.8	2.395	43.2	99.2
CFSWP-036	CFSWP-036-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-036	CFSWP-036-SW	06/06/2018	N	T	P2 R1	67500	0.58	6.67	62.5	1.929	37.4	85.9
CFSWP-036	CFSWP-036-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-036	CFSWP-036-SW	10/04/2018	N	T	P2 R2	88000	0.71	8.36	77.6	2.704	46.8	107.5
CFSWP-037	CFSWP-037-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-037	CFSWP-037-SW	06/06/2018	N	T	P2 R1	57600	0.51	5.82	54.9	1.576	32.7	75.1
CFSWP-037	CFSWP-037-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-037	CFSWP-037-SW	10/03/2018	N	T	P2 R2	89600	0.72	8.49	78.8	2.767	47.5	109.2
CFSWP-038	CFSWP-038-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-038	CFSWP-038-SW	06/07/2018	N	T	P2 R1	71500	0.60	7.00	65.5	2.076	39.3	90.2
CFSWP-038	CFSWP-038-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-038	CFSWP-038-SW	10/03/2018	N	T	P2 R2	91500	0.74	8.65	80.1	2.841	48.4	111.1
CFSWP-039	CFSWP-039-SW	06/15/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA

Table 21. Calculation of Hardness-Specific DEQ-7 Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Chronic Aquatic Life Standards					
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Zinc
CFSWP-039	CFSWP-039-SW	06/15/2018	N	T	P2 R1	163000	1.17	14.16	128.6	5.926	78.9	181.3
CFSWP-039	CFSWP-039-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-039	CFSWP-039-SW	10/11/2018	N	T	P2 R2	204000	1.40	17.16	154.5	7.885	95.3	219.2
CFSWP-040	CFSWP-040-SW	06/15/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-040	CFSWP-040-SW	06/15/2018	N	T	P2 R1	155000	1.12	13.57	123.4	5.558	75.6	173.7
CFSWP-041	CFSWP-041-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-041	CFSWP-041-SW	06/14/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-042	CFSWP-042-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-042	CFSWP-042-SW	06/14/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-043	CFSWP-043-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-043	CFSWP-043-SW	06/14/2018	N	T	P2 R1	163000	1.17	14.16	128.6	5.926	78.9	181.3
CFSWP-043	CFSWP-043-SW	06/18/2018	N	T	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-044	CFSWP-044-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-044	CFSWP-044-SW	06/11/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-044	CFSWP-044-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-044	CFSWP-044-SW	10/10/2018	N	T	P2 R2	184000	1.29	15.71	142.0	6.914	87.4	200.9
CFSWP-045	CFSWP-045-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-045	CFSWP-045-SW	06/11/2018	N	T	P2 R1	163000	1.17	14.16	128.6	5.926	78.9	181.3
CFSWP-045	CFSWP-045-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-045	CFSWP-045-SW	10/09/2018	N	T	P2 R2	184000	1.29	15.71	142.0	6.914	87.4	200.9
CFSWP-046	CFSWP-046-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-046	CFSWP-046-SW	06/19/2018	N	T	P2 R1	270000	1.75	21.80	194.4	11.266	120.9	278.0
CFSWP-047	CFSWP-047-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-047	CFSWP-047-SW	06/19/2018	N	T	P2 R1	179000	1.26	15.34	138.8	6.676	85.4	196.2
CFSWP-048	CFSWP-048-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-048	CFSWP-048-SW	06/20/2018	N	T	P2 R1	175000	1.23	15.05	136.3	6.487	83.7	192.5
CFSWP-049	CFSWP-049-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-049	CFSWP-049-SW	06/20/2018	N	T	P2 R1	226000	1.51	18.72	168.0	8.983	104.0	239.1
CFSWP-050	CFSWP-050-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-050	CFSWP-050-SW	06/21/2018	N	T	P2 R1	183000	1.28	15.63	141.4	6.867	87.0	199.9
CFSWP-051	CFSWP-051-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-051	CFSWP-051-SW	06/21/2018	N	T	P2 R1	187000	1.30	15.93	143.9	7.058	88.6	203.6
CFSWP-052	CFSWP-052-SW	06/18/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-052	CFSWP-052-SW	06/18/2018	N	T	P2 R1	246000	1.62	20.13	180.1	10.007	111.7	256.9
CFSWP-053	CFSWP-053-SW	06/18/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-053	CFSWP-053-SW	06/18/2018	N	T	P2 R1	171000	1.21	14.75	133.7	6.299	82.1	188.8
CFSWP-058	CFSWP-058-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-058	CFSWP-058-SW	06/21/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-058	CFSWP-058-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-058	CFSWP-058-SW	10/11/2018	N	T	P2 R2	224000	1.50	18.58	166.8	8.882	103.2	237.3
CFSWP-059	CFSWP-059-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-059	CFSWP-059-SW	06/22/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-059	CFSWP-059-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-059	CFSWP-059-SW	10/11/2018	N	T	P2 R2	188000	1.31	16.00	144.5	7.106	89.0	204.6
CFSWP-060	CFSWP-060-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA
CFSWP-060	CFSWP-060-SW	06/22/2018	N	T	P2 R1	159000	1.14	13.87	126.0	5.741	77.2	177.5
CFSWP-060	CFSWP-060-SW	10/16/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA
CFSWP-060	CFSWP-060-SW	10/16/2018	N	T	P2 R2	152000	1.10	13.34	121.4	5.422	74.3	170.8

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-001	CFSWP-001-SW	09/16/2016	N	T	P1 R1	88000	1.68	12.41	1624	69.38	421	3.258	107.5
CFSWP-001	CFSWP-001-SW	12/02/2016	N	T	P1 R2	90000	1.71	12.68	1654	71.40	429	3.386	109.6
CFSWP-001	CFSWP-001-SW	04/04/2017	N	T	P1 R3	86000	1.64	12.14	1594	67.38	413	3.131	105.4
CFSWP-001	CFSWP-001-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	06/14/2017	N	T	P1 R4	72000	1.38	10.27	1378	53.74	355	2.307	90.7
CFSWP-001	CFSWP-001-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	06/07/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-001	CFSWP-001-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-001	CFSWP-001-SW	10/05/2018	N	T	P2 R2	160000	3.01	21.80	2650	148.52	698	9.109	178.4
CFSWP-002	CFSWP-002-SW	09/16/2016	N	T	P1 R1	86000	1.64	12.14	1594	67.38	413	3.131	105.4
CFSWP-002	CFSWP-002-SW	12/02/2016	N	T	P1 R2	92000	1.75	12.94	1684	73.42	437	3.517	111.6
CFSWP-002	CFSWP-002-SW	04/04/2017	N	T	P1 R3	84000	1.60	11.88	1563	65.39	405	3.007	103.4
CFSWP-002	CFSWP-002-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	06/14/2017	N	T	P1 R4	72000	1.38	10.27	1378	53.74	355	2.307	90.7
CFSWP-002	CFSWP-002-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	06/07/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-002	CFSWP-002-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-002	CFSWP-002-SW	10/05/2018	N	T	P2 R2	82000	1.56	11.61	1533	63.42	397	2.885	101.3
CFSWP-003	CFSWP-003-SW	09/09/2016	N	T	P1 R1	90000	1.71	12.68	1654	71.40	429	3.386	109.6
CFSWP-003	CFSWP-003-SW	12/01/2016	N	T	P1 R2	108000	2.05	15.05	1920	90.05	501	4.633	127.9
CFSWP-003	CFSWP-003-SW	03/16/2017	N	T	P1 R3	88000	1.68	12.41	1624	69.38	421	3.258	107.5
CFSWP-003	CFSWP-003-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	06/14/2017	N	T	P1 R4	74000	1.42	10.54	1409	55.65	364	2.418	92.8
CFSWP-003	CFSWP-003-SW	10/31/2017	N	T	SSPA	125000	2.36	17.27	2165	108.47	567	5.958	144.8
CFSWP-003	CFSWP-003-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	06/06/2018	N	T	P2 R1	79400	1.52	11.26	1493	60.87	386	2.730	98.5
CFSWP-003	CFSWP-003-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-003	CFSWP-003-SW	10/04/2018	N	T	P2 R2	132000	2.49	18.18	2263	116.26	593	6.543	151.6
CFSWP-004	CFSWP-004-SW	09/09/2016	N	T	P1 R1	222000	4.15	29.68	3465	225.34	921	16.000	235.5
CFSWP-004	CFSWP-004-SW	12/01/2016	N	T	P1 R2	216000	4.04	28.92	3388	217.62	900	15.264	230.1
CFSWP-004	CFSWP-004-SW	03/16/2017	N	T	P1 R3	104000	1.97	14.53	1862	85.82	485	4.342	123.9
CFSWP-004	CFSWP-004-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	06/14/2017	N	T	P1 R4	70000	1.34	10.00	1346	51.85	347	2.198	88.6
CFSWP-004	CFSWP-004-SW	10/31/2017	N	T	SSPA	222000	4.15	29.68	3465	225.34	921	16.000	235.5
CFSWP-004	CFSWP-004-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	06/06/2018	N	T	P2 R1	111000	2.10	15.45	1964	93.25	512	4.857	130.9
CFSWP-004	CFSWP-004-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-004	CFSWP-004-SW	10/04/2018	N	T	P2 R2	250000	4.66	33.19	3819	262.12	1019	19.627	260.4
CFSWP-005	CFSWP-005-SW	09/09/2016	N	T	P1 R1	218000	4.08	29.17	3414	220.18	907	15.508	231.9
CFSWP-005	CFSWP-005-SW	12/01/2016	N	T	P1 R2	252000	4.70	33.44	3844	264.80	1025	19.898	262.2
CFSWP-005	CFSWP-005-SW	03/16/2017	N	T	P1 R3	106000	2.01	14.79	1891	87.93	493	4.487	125.9
CFSWP-005	CFSWP-005-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	06/14/2017	N	T	P1 R4	130000	2.46	17.92	2235	114.02	586	6.374	149.6
CFSWP-005	CFSWP-005-SW	11/01/2017	N	T	SSPA	222000	4.15	29.68	3465	225.34	921	16.000	235.5
CFSWP-005	CFSWP-005-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	06/06/2018	N	T	P2 R1	107000	2.03	14.92	1906	88.99	497	4.560	126.9
CFSWP-005	CFSWP-005-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-005	CFSWP-005-SW	10/18/2018	N	T	P2 R2	228000	4.26	30.43	3541	233.12	942	16.751	240.9
CFSWP-006	CFSWP-006-SW	09/09/2016	N	T	P1 R1	90000	1.71	12.68	1654	71.40	429	3.386	109.6
CFSWP-006	CFSWP-006-SW	12/01/2016	N	T	P1 R2	150000	2.83	20.51	2513	136.80	661	8.152	168.9
CFSWP-006	CFSWP-006-SW	03/16/2017	N	T	P1 R3	88000	1.68	12.41	1624	69.38	421	3.258	107.5
CFSWP-006	CFSWP-006-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-006	CFSWP-006-SW	06/14/2017	N	T	P1 R4	70000	1.34	10.00	1346	51.85	347	2.198	88.6
CFSWP-006	CFSWP-006-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-006	CFSWP-006-SW	06/06/2018	N	T	P2 R1	73400	1.40	10.46	1400	55.08	361	2.384	92.2
CFSWP-006	CFSWP-006-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-006	CFSWP-006-SW	10/04/2018	N	T	P2 R2	80000	1.53	11.34	1502	61.46	388	2.765	99.2
CFSWP-007	CFSWP-007-SW	09/16/2016	N	T	P1 R1	86000	1.64	12.14	1594	67.38	413	3.131	105.4
CFSWP-007	CFSWP-007-SW	12/02/2016	N	T	P1 R2	90000	1.71	12.68	1654	71.40	429	3.386	109.6
CFSWP-007	CFSWP-007-SW	03/16/2017	N	T	P1 R3	82000	1.56	11.61	1533	63.42	397	2.885	101.3
CFSWP-007	CFSWP-007-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	06/14/2017	N	T	P1 R4	72000	1.38	10.27	1378	53.74	355	2.307	90.7
CFSWP-007	CFSWP-007-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	06/07/2018	N	T	P2 R1	75400	1.44	10.73	1431	56.99	369	2.497	94.3
CFSWP-007	CFSWP-007-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-007	CFSWP-007-SW	10/03/2018	N	T	P2 R2	89600	1.71	12.62	1648	70.99	428	3.360	109.2
CFSWP-008	CFSWP-008-SW	09/16/2016	N	T	P1 R1	84000	1.60	11.88	1563	65.39	405	3.007	103.4
CFSWP-008	CFSWP-008-SW	12/02/2016	N	T	P1 R2	92000	1.75	12.94	1684	73.42	437	3.517	111.6
CFSWP-008	CFSWP-008-SW	04/04/2017	N	T	P1 R3	84000	1.60	11.88	1563	65.39	405	3.007	103.4
CFSWP-008	CFSWP-008-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	06/14/2017	N	T	P1 R4	70000	1.34	10.00	1346	51.85	347	2.198	88.6
CFSWP-008	CFSWP-008-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	06/07/2018	N	T	P2 R1	75400	1.44	10.73	1431	56.99	369	2.497	94.3
CFSWP-008	CFSWP-008-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-008	CFSWP-008-SW	10/03/2018	N	T	P2 R2	91500	1.74	12.88	1677	72.92	435	3.484	111.1
CFSWP-009	CFSWP-009-SW	06/07/2016	N	T	P1 R1	170000	3.19	23.08	2784	160.43	735	10.110	187.8
CFSWP-009	CFSWP-009-SW	04/03/2017	N	T	P1 R3	170000	3.19	23.08	2784	160.43	735	10.110	187.8
CFSWP-009	CFSWP-009-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-009	CFSWP-009-SW	06/12/2017	N	T	P1 R4	188000	3.53	25.38	3024	182.36	800	12.021	204.6
CFSWP-009	CFSWP-009-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-009	CFSWP-009-SW	06/14/2018	N	T	P2 R1	163000	3.07	22.18	2690	152.07	709	9.405	181.3
CFSWP-010	CFSWP-010-SW	06/07/2016	N	T	P1 R1	164000	3.08	22.31	2704	153.26	713	9.505	182.2
CFSWP-010	CFSWP-010-SW	03/15/2017	N	T	P1 R3	138000	2.60	18.96	2347	123.03	616	7.063	157.4
CFSWP-010	CFSWP-010-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-010	CFSWP-010-SW	06/12/2017	N	T	P1 R4	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-010	CFSWP-010-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-010	CFSWP-010-SW	06/14/2018	N	T	P2 R1	167000	3.14	22.70	2744	156.84	724	9.806	185.0
CFSWP-011	CFSWP-011-SW	06/07/2016	N	T	P1 R1	156000	2.94	21.28	2595	143.81	683	8.721	174.6
CFSWP-011	CFSWP-011-SW	04/03/2017	N	T	P1 R3	170000	3.19	23.08	2784	160.43	735	10.110	187.8
CFSWP-011	CFSWP-011-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-011	CFSWP-011-SW	06/12/2017	N	T	P1 R4	168000	3.16	22.82	2758	158.03	728	9.907	186.0
CFSWP-011	CFSWP-011-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-011	CFSWP-011-SW	06/14/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-012	CFSWP-012-SW	06/07/2016	N	T	P1 R1	152000	2.86	20.77	2541	139.13	669	8.340	170.8
CFSWP-012	CFSWP-012-SW	04/03/2017	N	T	P1 R3	168000	3.16	22.82	2758	158.03	728	9.907	186.0
CFSWP-012	CFSWP-012-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-012	CFSWP-012-SW	06/12/2017	N	T	P1 R4	164000	3.08	22.31	2704	153.26	713	9.505	182.2
CFSWP-012	CFSWP-012-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-012	CFSWP-012-SW	06/14/2018	N	T	P2 R1	155000	2.92	21.16	2582	142.63	680	8.625	173.7
CFSWP-013	CFSWP-013-SW	06/07/2016	N	T	P1 R1	156000	2.94	21.28	2595	143.81	683	8.721	174.6
CFSWP-013	CFSWP-013-SW	11/30/2016	N	T	P1 R2	170000	3.19	23.08	2784	160.43	735	10.110	187.8
CFSWP-013	CFSWP-013-SW	03/15/2017	N	T	P1 R3	158000	2.97	21.54	2622	146.16	691	8.914	176.5
CFSWP-013	CFSWP-013-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-013	CFSWP-013-SW	06/12/2017	N	T	P1 R4	172000	3.23	23.34	2811	162.84	742	10.316	189.7
CFSWP-013	CFSWP-013-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-013	CFSWP-013-SW	06/14/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-014	CFSWP-014-SW	08/29/2016	N	T	P1 R1	164000	3.08	22.31	2704	153.26	713	9.505	182.2
CFSWP-014	CFSWP-014-SW	11/30/2016	N	T	P1 R2	196000	3.67	26.39	3129	192.30	829	12.915	211.9

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-014	CFSWP-014-SW	03/13/2017	N	T	P1 R3	200000	3.75	26.90	3181	197.31	843	13.371	215.6
CFSWP-014	CFSWP-014-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	06/13/2017	N	T	P1 R4	176000	3.30	23.85	2865	167.67	757	10.732	193.4
CFSWP-014	CFSWP-014-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	06/11/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-014	CFSWP-014-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-014	CFSWP-014-SW	10/10/2018	N	T	P2 R2	172000	3.23	23.34	2811	162.84	742	10.316	189.7
CFSWP-015	CFSWP-015-SW	08/29/2016	N	T	P1 R1	178000	3.34	24.10	2891	170.10	764	10.943	195.3
CFSWP-015	CFSWP-015-SW	11/30/2016	N	T	P1 R2	196000	3.67	26.39	3129	192.30	829	12.915	211.9
CFSWP-015	CFSWP-015-SW	12/20/2016	N	T	P1 R2	208000	3.89	27.91	3285	207.41	872	14.304	222.8
CFSWP-015	CFSWP-015-SW	03/13/2017	N	T	P1 R3	202000	3.78	27.15	3207	199.82	850	13.602	217.4
CFSWP-015	CFSWP-015-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	06/13/2017	N	T	P1 R4	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-015	CFSWP-015-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	06/11/2018	N	T	P2 R1	163000	3.07	22.18	2690	152.07	709	9.405	181.3
CFSWP-015	CFSWP-015-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-015	CFSWP-015-SW	10/09/2018	N	T	P2 R2	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-016	CFSWP-016-SW	08/29/2016	N	T	P1 R1	172000	3.23	23.34	2811	162.84	742	10.316	189.7
CFSWP-016	CFSWP-016-SW	11/30/2016	N	T	P1 R2	200000	3.75	26.90	3181	197.31	843	13.371	215.6
CFSWP-016	CFSWP-016-SW	03/13/2017	N	T	P1 R3	202000	3.78	27.15	3207	199.82	850	13.602	217.4
CFSWP-016	CFSWP-016-SW	06/12/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	06/12/2017	N	T	P1 R4	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-016	CFSWP-016-SW	06/12/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	06/12/2018	N	T	P2 R1	167000	3.14	22.70	2744	156.84	724	9.806	185.0
CFSWP-016	CFSWP-016-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-016	CFSWP-016-SW	10/09/2018	N	T	P2 R2	188000	3.53	25.38	3024	182.36	800	12.021	204.6
CFSWP-017	CFSWP-017-SW	09/16/2016	N	T	P1 R1	124000	2.35	17.14	2150	107.36	563	5.876	143.8
CFSWP-017	CFSWP-017-SW	12/02/2016	N	T	P1 R2	92000	1.75	12.94	1684	73.42	437	3.517	111.6
CFSWP-017	CFSWP-017-SW	04/04/2017	N	T	P1 R3	88000	1.68	12.41	1624	69.38	421	3.258	107.5
CFSWP-017	CFSWP-017-SW	06/14/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	06/14/2017	N	T	P1 R4	66000	1.27	9.46	1283	48.11	330	1.986	84.3
CFSWP-017	CFSWP-017-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	06/07/2018	N	T	P2 R1	73400	1.40	10.46	1400	55.08	361	2.384	92.2
CFSWP-017	CFSWP-017-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-017	CFSWP-017-SW	10/03/2018	N	T	P2 R2	127000	2.40	17.53	2193	110.68	574	6.123	146.7
CFSWP-018	CFSWP-018-SW	06/06/2016	N	T	P1 R1	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-018	CFSWP-018-SW	12/01/2016	N	T	P1 R2	260000	4.84	34.44	3943	275.54	1053	20.997	269.2
CFSWP-018	CFSWP-018-SW	04/03/2017	N	T	P1 R3	184000	3.45	24.87	2971	177.44	786	11.585	200.9
CFSWP-018	CFSWP-018-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	06/15/2017	N	T	P1 R4	216000	4.04	28.92	3388	217.62	900	15.264	230.1
CFSWP-018	CFSWP-018-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	06/21/2018	N	T	P2 R1	218000	4.08	29.17	3414	220.18	907	15.508	231.9
CFSWP-018	CFSWP-018-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-018	CFSWP-018-SW	10/17/2018	N	T	P2 R2	176000	3.30	23.85	2865	167.67	757	10.732	193.4
CFSWP-019	CFSWP-019-SW	06/06/2016	N	T	P1 R1	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-019	CFSWP-019-SW	12/01/2016	N	T	P1 R2	208000	3.89	27.91	3285	207.41	872	14.304	222.8
CFSWP-019	CFSWP-019-SW	04/03/2017	N	T	P1 R3	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-019	CFSWP-019-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	06/15/2017	N	T	P1 R4	168000	3.16	22.82	2758	158.03	728	9.907	186.0
CFSWP-019	CFSWP-019-SW	11/07/2017	N	T	SSPA	535000	7.38	51.68	5612	476.82	1516	44.050	387.8
CFSWP-019	CFSWP-019-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	06/21/2018	N	T	P2 R1	171000	3.21	23.21	2798	161.63	739	10.213	188.8
CFSWP-019	CFSWP-019-SW	10/16/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-019	CFSWP-019-SW	10/16/2018	N	T	P2 R2	168000	3.16	22.82	2758	158.03	728	9.907	186.0

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Aquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-020	CFSWP-020-SW	06/06/2016	N	T	P1 R1	176000	3.30	23.85	2865	167.67	757	10.732	193.4
CFSWP-020	CFSWP-020-SW	12/01/2016	N	T	P1 R2	256000	4.77	33.94	3894	270.16	1039	20.444	265.7
CFSWP-020	CFSWP-020-SW	03/16/2017	N	T	P1 R3	160000	3.01	21.80	2650	148.52	698	9.109	178.4
CFSWP-020	CFSWP-020-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	06/15/2017	N	T	P1 R4	160000	3.01	21.80	2650	148.52	698	9.109	178.4
CFSWP-020	CFSWP-020-SW	11/07/2017	N	T	SSPA	1740000	7.38	51.68	5612	476.82	1516	44.050	387.8
CFSWP-020	CFSWP-020-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	06/21/2018	N	T	P2 R1	155000	2.92	21.16	2582	142.63	680	8.625	173.7
CFSWP-020	CFSWP-020-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-020	CFSWP-020-SW	10/11/2018	N	T	P2 R2	144000	2.72	19.74	2431	129.87	639	7.599	163.2
CFSWP-021	CFSWP-021-SW	06/06/2016	N	T	P1 R1	168000	3.16	22.82	2758	158.03	728	9.907	186.0
CFSWP-021	CFSWP-021-SW	11/30/2016	N	T	P1 R2	304000	5.64	39.91	4482	336.22	1202	27.475	307.4
CFSWP-021	CFSWP-021-SW	03/15/2017	N	T	P1 R3	204000	3.82	27.41	3233	202.34	858	13.835	219.2
CFSWP-021	CFSWP-021-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-021	CFSWP-021-SW	06/15/2017	N	T	P1 R4	184000	3.45	24.87	2971	177.44	786	11.585	200.9
CFSWP-021	CFSWP-021-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-021	CFSWP-021-SW	06/19/2018	N	T	P2 R1	187000	3.51	25.25	3011	181.13	797	11.912	203.6
CFSWP-022	CFSWP-022-SW	06/06/2016	N	T	P1 R1	172000	3.23	23.34	2811	162.84	742	10.316	189.7
CFSWP-022	CFSWP-022-SW	04/03/2017	N	T	P1 R3	166000	3.12	22.57	2731	155.64	720	9.705	184.1
CFSWP-022	CFSWP-022-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-022	CFSWP-022-SW	06/20/2018	N	T	P2 R1	167000	3.14	22.70	2744	156.84	724	9.806	185.0
CFSWP-023	CFSWP-023-SW	04/03/2017	N	T	P1 R3	224000	4.18	29.93	3490	227.93	928	16.249	237.3
CFSWP-024	CFSWP-024-SW	06/15/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-024	CFSWP-024-SW	06/15/2017	N	T	P1 R4	50000	0.96	7.29	1022	33.78	261	1.232	66.6
CFSWP-025	CFSWP-025-SW	12/20/2016	N	T	P1 R2	206000	3.86	27.66	3259	204.87	865	14.069	221.0
CFSWP-025	CFSWP-025-SW	03/13/2017	N	T	P1 R3	204000	3.82	27.41	3233	202.34	858	13.835	219.2
CFSWP-025	CFSWP-025-SW	06/13/2017	N	DI	P1 R4	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	06/13/2017	N	T	P1 R4	176000	3.30	23.85	2865	167.67	757	10.732	193.4
CFSWP-025	CFSWP-025-SW	06/12/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	06/12/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-025	CFSWP-025-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-025	CFSWP-025-SW	10/10/2018	N	T	P2 R2	180000	3.38	24.36	2918	172.54	771	11.155	197.2
CFSWP-026	CFSWP-026-SW	10/31/2017	N	T	SSPA	107000	2.03	14.92	1906	88.99	497	4.560	126.9
CFSWP-026	CFSWP-026-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-026	CFSWP-026-SW	06/07/2018	N	T	P2 R1	75400	1.44	10.73	1431	56.99	369	2.497	94.3
CFSWP-026	CFSWP-026-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-026	CFSWP-026-SW	10/05/2018	N	T	P2 R2	92000	1.75	12.94	1684	73.42	437	3.517	111.6
CFSWP-027	CFSWP-027-SW	10/31/2017	N	T	SSPA	101000	1.92	14.13	1818	82.69	473	4.129	120.8
CFSWP-027	CFSWP-027-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-027	CFSWP-027-SW	06/06/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-027	CFSWP-027-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-027	CFSWP-027-SW	10/05/2018	N	T	P2 R2	98000	1.86	13.74	1773	79.57	461	3.920	117.8
CFSWP-028	CFSWP-028-SW	10/31/2017	N	T	SSPA	103000	1.96	14.39	1847	84.78	481	4.271	122.9
CFSWP-028	CFSWP-028-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-028	CFSWP-028-SW	06/06/2018	N	T	P2 R1	69500	1.33	9.94	1338	51.38	345	2.171	88.0
CFSWP-028	CFSWP-028-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-028	CFSWP-028-SW	10/04/2018	N	T	P2 R2	100000	1.90	14.00	1803	81.65	469	4.059	119.8
CFSWP-029	CFSWP-029-SW	11/01/2017	N	T	SSPA	230000	4.29	30.68	3567	235.73	949	17.005	242.7
CFSWP-029	CFSWP-029-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-029	CFSWP-029-SW	06/22/2018	N	T	P2 R1	214000	4.00	28.67	3362	215.05	893	15.021	228.3
CFSWP-029	CFSWP-029-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-029	CFSWP-029-SW	10/18/2018	N	T	P2 R2	224000	4.18	29.93	3490	227.93	928	16.249	237.3
CFSWP-030	CFSWP-030-SW	11/03/2017	N	T	SSPA	176000	3.30	23.85	2865	167.67	757	10.732	193.4
CFSWP-030	CFSWP-030-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Aquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-030	CFSWP-030-SW	06/22/2018	N	T	P2 R1	202000	3.78	27.15	3207	199.82	850	13.602	217.4
CFSWP-030	CFSWP-030-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-030	CFSWP-030-SW	10/18/2018	N	T	P2 R2	156000	2.94	21.28	2595	143.81	683	8.721	174.6
CFSWP-031	CFSWP-031-SW	11/03/2017	N	T	SSPA	329000	6.10	42.99	4782	371.81	1285	31.476	328.7
CFSWP-031	CFSWP-031-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-031	CFSWP-031-SW	06/22/2018	N	T	P2 R1	218000	4.08	29.17	3414	220.18	907	15.508	231.9
CFSWP-031	CFSWP-031-SW	10/18/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-031	CFSWP-031-SW	10/18/2018	N	T	P2 R2	200000	3.75	26.90	3181	197.31	843	13.371	215.6
CFSWP-032	CFSWP-032-SW	11/03/2017	N	T	SSPA	257000	4.79	34.07	3906	271.50	1043	20.582	266.6
CFSWP-032	CFSWP-032-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-032	CFSWP-032-SW	06/22/2018	N	T	P2 R1	226000	4.22	30.18	3516	230.52	935	16.499	239.1
CFSWP-032	CFSWP-032-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-032	CFSWP-032-SW	10/17/2018	N	T	P2 R2	208000	3.89	27.91	3285	207.41	872	14.304	222.8
CFSWP-033	CFSWP-033-SW	11/03/2017	N	T	SSPA	238000	4.44	31.69	3668	246.21	977	18.035	249.8
CFSWP-033	CFSWP-033-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-033	CFSWP-033-SW	06/22/2018	N	T	P2 R1	218000	4.08	29.17	3414	220.18	907	15.508	231.9
CFSWP-033	CFSWP-033-SW	10/17/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-033	CFSWP-033-SW	10/17/2018	N	T	P2 R2	256000	4.77	33.94	3894	270.16	1039	20.444	265.7
CFSWP-034	CFSWP-034-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-034	CFSWP-034-SW	06/07/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-034	CFSWP-034-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-034	CFSWP-034-SW	10/05/2018	N	T	P2 R2	80000	1.53	11.34	1502	61.46	388	2.765	99.2
CFSWP-035	CFSWP-035-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-035	CFSWP-035-SW	06/07/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-035	CFSWP-035-SW	10/05/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-035	CFSWP-035-SW	10/05/2018	N	T	P2 R2	80000	1.53	11.34	1502	61.46	388	2.765	99.2
CFSWP-036	CFSWP-036-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-036	CFSWP-036-SW	06/06/2018	N	T	P2 R1	67500	1.29	9.67	1307	49.50	336	2.064	85.9
CFSWP-036	CFSWP-036-SW	10/04/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-036	CFSWP-036-SW	10/04/2018	N	T	P2 R2	88000	1.68	12.41	1624	69.38	421	3.258	107.5
CFSWP-037	CFSWP-037-SW	06/06/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-037	CFSWP-037-SW	06/06/2018	N	T	P2 R1	57600	1.11	8.32	1148	40.45	294	1.572	75.1
CFSWP-037	CFSWP-037-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-037	CFSWP-037-SW	10/03/2018	N	T	P2 R2	89600	1.71	12.62	1648	70.99	428	3.360	109.2
CFSWP-038	CFSWP-038-SW	06/07/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-038	CFSWP-038-SW	06/07/2018	N	T	P2 R1	71500	1.37	10.21	1370	53.27	353	2.279	90.2
CFSWP-038	CFSWP-038-SW	10/03/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-038	CFSWP-038-SW	10/03/2018	N	T	P2 R2	91500	1.74	12.88	1677	72.92	435	3.484	111.1
CFSWP-039	CFSWP-039-SW	06/15/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-039	CFSWP-039-SW	06/15/2018	N	T	P2 R1	163000	3.07	22.18	2690	152.07	709	9.405	181.3
CFSWP-039	CFSWP-039-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-039	CFSWP-039-SW	10/11/2018	N	T	P2 R2	204000	3.82	27.41	3233	202.34	858	13.835	219.2
CFSWP-040	CFSWP-040-SW	06/15/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-040	CFSWP-040-SW	06/15/2018	N	T	P2 R1	155000	2.92	21.16	2582	142.63	680	8.625	173.7
CFSWP-041	CFSWP-041-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-041	CFSWP-041-SW	06/14/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-042	CFSWP-042-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-042	CFSWP-042-SW	06/14/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-043	CFSWP-043-SW	06/14/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-043	CFSWP-043-SW	06/14/2018	N	T	P2 R1	163000	3.07	22.18	2690	152.07	709	9.405	181.3
CFSWP-043	CFSWP-043-SW	06/18/2018	N	T	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-044	CFSWP-044-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-044	CFSWP-044-SW	06/11/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-044	CFSWP-044-SW	10/10/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA

Table 22. Calculation of Hardness-Specific DEQ-7 Acute Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Sample Location	Sample Name	Sample Date	Sample Type	Sample Fraction	Sampling Round	Hardness as Calcium Carbonate	MDEQ-7 Acute Aquatic Life Standards						
							Cadmium	Copper	Chromium, Tri	Lead	Nickel	Silver	Zinc
CFSWP-044	CFSWP-044-SW	10/10/2018	N	T	P2 R2	184000	3.45	24.87	2971	177.44	786	11.585	200.9
CFSWP-045	CFSWP-045-SW	06/11/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-045	CFSWP-045-SW	06/11/2018	N	T	P2 R1	163000	3.07	22.18	2690	152.07	709	9.405	181.3
CFSWP-045	CFSWP-045-SW	10/09/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-045	CFSWP-045-SW	10/09/2018	N	T	P2 R2	184000	3.45	24.87	2971	177.44	786	11.585	200.9
CFSWP-046	CFSWP-046-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-046	CFSWP-046-SW	06/19/2018	N	T	P2 R1	270000	5.02	35.69	4067	289.11	1087	22.405	278.0
CFSWP-047	CFSWP-047-SW	06/19/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-047	CFSWP-047-SW	06/19/2018	N	T	P2 R1	179000	3.36	24.23	2905	171.32	768	11.049	196.2
CFSWP-048	CFSWP-048-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-048	CFSWP-048-SW	06/20/2018	N	T	P2 R1	175000	3.29	23.72	2851	166.46	753	10.627	192.5
CFSWP-049	CFSWP-049-SW	06/20/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-049	CFSWP-049-SW	06/20/2018	N	T	P2 R1	226000	4.22	30.18	3516	230.52	935	16.499	239.1
CFSWP-050	CFSWP-050-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-050	CFSWP-050-SW	06/21/2018	N	T	P2 R1	183000	3.43	24.74	2958	176.21	782	11.477	199.9
CFSWP-051	CFSWP-051-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-051	CFSWP-051-SW	06/21/2018	N	T	P2 R1	187000	3.51	25.25	3011	181.13	797	11.912	203.6
CFSWP-052	CFSWP-052-SW	06/18/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-052	CFSWP-052-SW	06/18/2018	N	T	P2 R1	246000	4.59	32.69	3769	256.80	1005	19.090	256.9
CFSWP-053	CFSWP-053-SW	06/18/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-053	CFSWP-053-SW	06/18/2018	N	T	P2 R1	171000	3.21	23.21	2798	161.63	739	10.213	188.8
CFSWP-058	CFSWP-058-SW	06/21/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-058	CFSWP-058-SW	06/21/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-058	CFSWP-058-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-058	CFSWP-058-SW	10/11/2018	N	T	P2 R2	224000	4.18	29.93	3490	227.93	928	16.249	237.3
CFSWP-059	CFSWP-059-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-059	CFSWP-059-SW	06/22/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-059	CFSWP-059-SW	10/11/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-059	CFSWP-059-SW	10/11/2018	N	T	P2 R2	188000	3.53	25.38	3024	182.36	800	12.021	204.6
CFSWP-060	CFSWP-060-SW	06/22/2018	N	DI	P2 R1	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-060	CFSWP-060-SW	06/22/2018	N	T	P2 R1	159000	2.99	21.67	2636	147.34	695	9.012	177.5
CFSWP-060	CFSWP-060-SW	10/16/2018	N	DI	P2 R2	NA	NA	NA	NA	NA	NA	NA	NA
CFSWP-060	CFSWP-060-SW	10/16/2018	N	T	P2 R2	152000	2.86	20.77	2541	139.13	669	8.340	170.8

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-002	CFSWP-002	CFSWP-002	CFSWP-002	CFSWP-002
			Sample Name	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-002-SW	CFSWP-002-SW	CFSWP-002-SW	CFSWP-002-SW	CFSWP-002-SW
			Sample Date	09/16/2016	12/02/2016	04/04/2017	06/14/2017	06/07/2018	10/05/2018	09/16/2016	12/02/2016	04/04/2017	06/14/2017	06/07/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.5 J	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U	4.7	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U
Lead	*	*	ug/l	0.38 U	0.38 U	0.38 U	0.57 J	0.37 U	0.96 J	0.38 U	0.38 U	0.38 U	0.38 U	0.37 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.6 J	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U
Zinc	*	*	ug/l	7 U	7 U	7 U	8.8 J	5.4 U	6.1 J	7 U	7 U	7 U	7 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-002	CFSWP-002	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-004	CFSWP-004
			Sample Name	CFSWP-DUP9-SW	CFSWP-002-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-003-SW	CFSWP-004-SW	CFSWP-004-SW
			Sample Date	06/07/2018	10/05/2018	09/09/2016	12/01/2016	03/16/2017	06/14/2017	06/06/2018	10/04/2018	10/31/2017	09/09/2016	12/01/2016
			Sample Type	FD	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R1	P2 R2	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	SSPA	P1 R1	P1 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 J	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.9 U	1.9 U	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U	1.9 U	4.3	1.5 J	1.8 J
Lead	*	*	ug/l	0.37 U	0.37 U	0.38 U	0.38 U	0.63 J	0.5 J	0.37 U	0.37 U	1 J	0.48 J	2.9
Nickel	*	*	ug/l	1.3 U	1.3 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	1.6 J	1.4 U	1.4 U
Silver	*	*	ug/l	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U
Zinc	*	*	ug/l	5.4 U	5.4 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	9.3 J	7 U	7 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-005	CFSWP-005	CFSWP-005	CFSWP-005	CFSWP-005	CFSWP-005
			Sample Name	CFSWP-004-SW	CFSWP-004-SW	CFSWP-004-SW	CFSWP-004-SW	CFSWP-004-SW	CFSWP-005-SW	CFSWP-005-SW	CFSWP-005-SW	CFSWP-005-SW	CFSWP-005-SW	CFSWP-005-SW
			Sample Date	03/16/2017	06/14/2017	06/06/2018	10/04/2018	10/31/2017	09/09/2016	12/01/2016	03/16/2017	06/14/2017	06/06/2018	10/18/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R3	P1 R4	P2 R1	P2 R2	SSPA	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 J	1.3 U	1.3 U	1.3 U	1.6 J	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.4 U	1.9 U	4.4	12.3	1.6 J	1.4 U	1.4 U	1.4 U	1.9 U	1.9 U
Lead	*	*	ug/l	0.55 J	0.38 J	0.37 U	0.83 J	1.6	0.38 U	0.38 U	0.41 J	0.39 J	0.37 U	0.37 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.3 U	1.3 U	2.2 J	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U
Zinc	*	*	ug/l	7 U	7 U	5.4 U	5.4 U	19.1	19.9	7 U	7 U	7 U	5.4 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-005	CFSWP-005	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-007	CFSWP-007
			Sample Name	CFSWP-005-SW	CFSWP-DUP8-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-DUP13-SW	CFSWP-007-SW	CFSWP-007-SW
			Sample Date	11/01/2017	11/01/2017	09/09/2016	12/01/2016	03/16/2017	06/14/2017	06/06/2018	10/04/2018	10/04/2018	09/16/2016	12/02/2016
			Sample Type	N	FD	N	N	N	N	N	N	FD	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	SSPA	SSPA	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	P2 R2	P1 R1	P1 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.61 U	0.71 U	0.71 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	2 J	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	2.2 J	1.7 J	1.9 U	6.5 J	1.9 UJ	1.4 U	1.4 U
Lead	*	*	ug/l	0.38 U	0.38 U	0.38 U	0.38 U	1.2	0.7 J	0.37 U	0.37 U	0.37 U	0.38 U	0.38 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U
Zinc	*	*	ug/l	7 U	7 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	5.4 U	7 U	7 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-007	CFSWP-007	CFSWP-007	CFSWP-007	CFSWP-008	CFSWP-008	CFSWP-008	CFSWP-008	CFSWP-008	CFSWP-008	CFSWP-009
			Sample Name	CFSWP-007-SW	CFSWP-007-SW	CFSWP-007-SW	CFSWP-007-SW	CFSWP-008-SW	CFSWP-008-SW	CFSWP-008-SW	CFSWP-008-SW	CFSWP-008-SW	CFSWP-008-SW	CFSWP-009-SW
			Sample Date	03/16/2017	06/14/2017	06/07/2018	10/03/2018	09/16/2016	12/02/2016	04/04/2017	06/14/2017	06/07/2018	10/03/2018	06/07/2016
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R3	P1 R4	P2 R1	P2 R2	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	P1 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.72 U
Chromium, Total	*	*	ug/l	2 J	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.5 U
Copper	*	*	ug/l	3.4 J	1.4 J	1.9 U	2.1 J	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U	2.3 J	1.6 U
Lead	*	*	ug/l	1.2	0.68 J	0.52 J	0.37 U	0.38 U	0.38 U	0.38 U	0.38 U	0.59 J	0.37 U	0.44 U
Nickel	*	*	ug/l	1.4 J	1.4 U	1.3 U	1.3 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	1.6 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.5 U
Zinc	*	*	ug/l	7 U	7 U	5.4 U	5.4 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	6.5 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-009	CFSWP-009	CFSWP-009	CFSWP-010	CFSWP-010	CFSWP-010	CFSWP-010	CFSWP-011	CFSWP-011	CFSWP-011	CFSWP-011
			Sample Name	CFSWP-009-SW	CFSWP-009-SW	CFSWP-009-SW	CFSWP-010-SW	CFSWP-010-SW	CFSWP-010-SW	CFSWP-010-SW	CFSWP-011-SW	CFSWP-011-SW	CFSWP-011-SW	CFSWP-011-SW
			Sample Date	04/03/2017	06/12/2017	06/14/2018	06/07/2016	03/15/2017	06/12/2017	06/14/2018	06/07/2016	04/03/2017	06/12/2017	06/14/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R3	P1 R4	P2 R1	P1 R1	P1 R3	P1 R4	P2 R1	P1 R1	P1 R3	P1 R4	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.61 U	0.72 U	0.71 U	0.71 U	0.61 U	0.72 U	0.71 U	0.71 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.5 U	1.3 U	1.3 U	1.3 U	1.5 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.4 U	1.9 U	1.6 U	1.5 J	1.4 U	1.9 U	2.1 J	1.4 U	1.4 U	1.9 U
Lead	*	*	ug/l	0.38 U	0.38 U	0.37 U	0.44 U	0.54 J	0.38 U	0.37 U	0.44 U	0.38 U	0.38 U	0.37 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.3 U	1.6 U	1.4 U	1.4 U	1.3 U	1.6 U	1.4 U	1.4 U	1.3 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.4 U	1.5 U	1.3 U	1.3 U	1.4 U	1.5 U	1.3 U	1.3 U	1.4 U
Zinc	*	*	ug/l	7 U	7 U	5.4 U	6.5 U	7 U	7 U	7.1 J	6.5 U	7 U	7 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-012	CFSWP-012	CFSWP-012	CFSWP-012	CFSWP-012	CFSWP-013	CFSWP-013	CFSWP-013	CFSWP-013	CFSWP-013	CFSWP-013
			Sample Name	CFSWP-012-SW	CFSWP-012-SW	CFSWP-DUP5-SW	CFSWP-012-SW	CFSWP-012-SW	CFSWP-013-SW	CFSWP-DUP1-SW	CFSWP-013-SW	CFSWP-013-SW	CFSWP-013-SW	CFSWP-013-SW
			Sample Date	06/07/2016	04/03/2017	04/03/2017	06/12/2017	06/14/2018	06/07/2016	06/07/2016	11/30/2016	03/15/2017	06/12/2017	06/14/2018
			Sample Type	N	N	FD	N	N	N	FD	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R1	P1 R3	P1 R3	P1 R4	P2 R1	P1 R1	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.72 U	0.71 U	0.71 U	0.71 U	0.61 U	0.72 U	0.72 U	0.71 U	0.71 U	0.71 U	0.61 U
Chromium, Total	*	*	ug/l	1.5 U	1.3 U	1.3 U	1.3 U	1.3 U	1.5 U	1.5 U	1.4 J	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	4.1	1.4 U	1.4 U	1.4 U	1.9 U	2.2 J	11.7 J	6.2	1.4 U	1.4 U	1.9 U
Lead	*	*	ug/l	0.44 U	0.38 U	0.38 U	0.38 U	0.37 U	0.44 U	0.44 U	2.1	0.38 U	0.38 U	0.37 U
Nickel	*	*	ug/l	1.6 U	1.4 U	1.4 U	1.4 U	1.3 U	1.6 U	1.6 U	2.3 J	1.4 U	1.4 U	1.3 U
Silver	*	*	ug/l	1.5 U	1.3 U	1.3 U	1.3 U	1.4 U	1.5 U	1.5 U	1.3 U	1.3 U	1.3 U	1.4 U
Zinc	*	*	ug/l	6.5 U	7 U	7 U	7 U	5.4 U	6.5 U	6.5 U	18.9	7 U	14.1 J	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-014	CFSWP-015	CFSWP-015
			Sample Name	CFSWP-014-SW	CFSWP-014-SW	CFSWP-DUP3-SW	CFSWP-014-SW	CFSWP-Dup4-SW	CFSWP-014-SW	CFSWP-014-SW	CFSWP-014-SW	CFSWP-014-SW	CFSWP-015-SW	CFSWP-DUP2-SW
			Sample Date	08/29/2016	11/30/2016	11/30/2016	03/13/2017	03/13/2017	06/13/2017	06/11/2018	10/10/2018	10/16/2018	08/29/2016	08/29/2016
			Sample Type	N	N	FD	N	FD	N	N	N	N	N	FD
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R1	P1 R2	P1 R2	P1 R3	P1 R3	P1 R4	P2 R1	P2 R2	P2 R2	P1 R1	P1 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	NA	0.71 U	0.71 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	37.7 J	2.4 J	1.3 U	1.3 U	1.3 U	NA	1.3 U	1.3 U
Copper	*	*	ug/l	5.4	1.4 U	1.4 U	2.3 J	1.4 UJ	1.4 U	1.9 U	3.8 J	NA	1.4 U	1.4 U
Lead	*	*	ug/l	0.41 J	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.37 U	0.37 U	NA	0.38 U	0.38 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	NA	1.4 U	1.4 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	NA	1.3 U	1.3 U
Zinc	*	*	ug/l	16.4	7 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	NA	7 U	7 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-015	CFSWP-016	CFSWP-016	CFSWP-016
			Sample Name	CFSWP-015-SW	CFSWP-015-SW	CFSWP-015-SW	CFSWP-015-SW	CFSWP-DUP7-SW	CFSWP-015-SW	CFSWP-015-SW	CFSWP-015-SW	CFSWP-016-SW	CFSWP-016-SW	CFSWP-016-SW
			Sample Date	11/30/2016	12/20/2016	03/13/2017	06/13/2017	06/13/2017	06/11/2018	10/09/2018	10/16/2018	08/29/2016	11/30/2016	03/13/2017
			Sample Type	N	N	N	N	FD	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R2	P1 R2	P1 R3	P1 R4	P1 R4	P2 R1	P2 R2	P2 R2	P1 R1	P1 R2	P1 R3
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	NA	0.71 U	0.71 U	0.71 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	NA	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U	4.2	NA	1.4 U	1.4 U	1.4 U
Lead	*	*	ug/l	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.37 U	0.37 U	NA	0.38 U	0.38 U	0.38 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	NA	1.4 U	1.4 U	1.4 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	NA	1.3 U	1.3 U	1.3 U
Zinc	*	*	ug/l	7 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	NA	7 U	7 U	7 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-016	CFSWP-016	CFSWP-016	CFSWP-016	CFSWP-017	CFSWP-017	CFSWP-017	CFSWP-017	CFSWP-017	CFSWP-017	CFSWP-018
			Sample Name	CFSWP-016-SW	CFSWP-DUP6-SW	CFSWP-016-SW	CFSWP-016-SW	CFSWP-017-SW	CFSWP-017-SW	CFSWP-017-SW	CFSWP-017-SW	CFSWP-017-SW	CFSWP-017-SW	CFSWP-018-SW
			Sample Date	06/12/2017	06/12/2017	06/12/2018	10/09/2018	09/16/2016	12/02/2016	04/04/2017	06/14/2017	06/07/2018	10/03/2018	06/06/2016
			Sample Type	N	FD	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R4	P1 R4	P2 R1	P2 R2	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	P1 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.61 U	0.61 U	0.71 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.72 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	3.9 J
Copper	*	*	ug/l	1.9 J	1.4 U	1.9 U	2 J	1.4 U	1.4 U	1.4 U	1.4 U	1.9 U	7.3	2 J
Lead	*	*	ug/l	0.38 U	0.38 U	0.37 U	0.37 U	0.38 U	0.38 U	0.38 U	0.38 U	0.37 U	0.37 U	0.44 U
Nickel	*	*	ug/l	1.4 U	1.4 U	1.3 U	1.3 U	1.4 U	1.4 U	1.4 U	1.4 U	1.3 U	1.3 U	1.6 U
Silver	*	*	ug/l	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.5 U
Zinc	*	*	ug/l	13.5 J	7 UJ	5.4 U	5.4 U	7 U	7 U	7 U	7 U	5.4 U	5.4 U	6.5 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-018	CFSWP-018	CFSWP-018	CFSWP-018	CFSWP-018	CFSWP-019	CFSWP-019	CFSWP-019	CFSWP-019	CFSWP-019	CFSWP-019
			Sample Name	CFSWP-018-SW	CFSWP-018-SW	CFSWP-018-SW	CFSWP-018-SW	CFSWP-018-SW	CFSWP-019-SW	CFSWP-019-SW	CFSWP-019-SW	CFSWP-019-SW	CFSWP-019-SW	CFSWP-019-SW
			Sample Date	12/01/2016	04/03/2017	06/15/2017	06/21/2018	10/17/2018	06/06/2016	12/01/2016	04/03/2017	06/15/2017	06/21/2018	10/16/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	0.72 U	0.71 U	0.71 U	0.71 U	0.61 U	0.66 J
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	2.2 J	1.8 J	1.3 U	4.3	1.3 U	1.3 U	1.8 J
Copper	*	*	ug/l	9.8	1.9 J	5.3	5	**20.1**	3.3 J	1.6 J	1.8 J	1.4 U	1.9 U	**19.6**
Lead	*	*	ug/l	1.7	0.38 U	0.99 J	0.89 J	4.7	0.44 U	0.38 U	0.38 U	0.38 U	0.37 U	1.9
Nickel	*	*	ug/l	1.6 J	1.4 U	1.4 U	1.3 U	3.6 J	1.6 U	1.4 U	1.4 U	1.4 U	1.3 U	3.4 J
Silver	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.5 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U
Zinc	*	*	ug/l	18.2	7 U	15.2 J	9.4 J	37.4	6.5 U	7 U	7 U	7 U	5.4 U	25.5

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-019	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-021	CFSWP-021	CFSWP-021
			Sample Name	CFSWP-019-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-020-SW	CFSWP-021-SW	CFSWP-021-SW	CFSWP-021-SW
			Sample Date	11/07/2017	06/06/2016	12/01/2016	03/16/2017	06/15/2017	06/21/2018	10/11/2018	11/07/2017	06/06/2016	11/30/2016	03/15/2017
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	SSPA	P1 R1	P1 R2	P1 R3	P1 R4	P2 R1	P2 R2	SSPA	P1 R1	P1 R2	P1 R3
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.72 U	0.71 U	0.71 U	0.71 U	0.61 U	0.61 U	1 J	0.72 U	0.71 U	0.71 U
Chromium, Total	*	*	ug/l	5.9	1.5 U	1.3 U	1.3 U	1.3 U	1.3 U	2.8 J	27.2	1.5 U	3.4 J	1.3 U
Copper	*	*	ug/l	75.9	1.8 J	4	1.4 U	1.4 U	1.9 U	**12.9**	183	1.6 U	5.7	1.4 U
Lead	*	*	ug/l	8.3	0.44 U	0.91 J	0.38 U	0.38 U	0.37 U	2.4	35.2	0.44 U	4.5	0.38 U
Nickel	*	*	ug/l	10.7	1.6 U	1.4 U	1.4 U	1.4 U	1.3 U	3.9 J	51.7	1.6 U	3.9 J	1.4 U
Silver	*	*	ug/l	1.3 U	1.5 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U	1.3 U	1.5 U	1.3 U	1.3 U
Zinc	*	*	ug/l	86.3	6.5 U	7 U	7 U	7 U	5.4 U	12.1 J	179	6.5 U	19.2	7 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-021	CFSWP-021	CFSWP-022	CFSWP-022	CFSWP-022	CFSWP-023	CFSWP-024	CFSWP-025	CFSWP-025	CFSWP-025	CFSWP-025
			Sample Name	CFSWP-021-SW	CFSWP-021-SW	CFSWP-022-SW	CFSWP-022-SW	CFSWP-022-SW	CFSWP-023-SW	CFSWP-024-SW	CFSWP-025-SW	CFSWP-025-SW	CFSWP-025-SW	CFSWP-025-SW
			Sample Date	06/15/2017	06/19/2018	06/06/2016	04/03/2017	06/20/2018	04/03/2017	06/15/2017	12/20/2016	03/13/2017	06/13/2017	06/12/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P1 R4	P2 R1	P1 R1	P1 R3	P2 R1	P1 R3	P1 R4	P1 R2	P1 R3	P1 R4	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.71 U	0.61 U	0.72 U	0.71 U	0.61 U	0.71 U	**3**	0.71 U	0.71 U	0.71 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.5 U	1.3 U	1.3 U	1.3 U	2.7 J	1.3 U	8.9	1.3 U	1.3 U
Copper	*	*	ug/l	1.4 U	1.9 U	2.6 J	1.4 U	1.9 U	3.8 J	**16.5**	1.4 U	1.4 U	1.4 U	1.9 U
Lead	*	*	ug/l	0.66 J	0.37 U	0.44 U	0.38 U	0.37 U	0.38 U	**7.6**	0.38 U	0.38 U	0.38 U	0.37 U
Nickel	*	*	ug/l	2.1 J	1.3 U	1.6 U	1.4 U	1.3 U	1.9 J	**55.9**	1.4 U	1.4 U	1.4 U	1.3 U
Silver	*	*	ug/l	1.3 U	1.4 U	1.5 U	1.3 U	1.4 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U
Zinc	*	*	ug/l	9.1 J	5.4 U	6.5 U	7 U	5.4 U	7 U	**537**	7 U	7 U	7 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-025	CFSWP-026	CFSWP-026	CFSWP-026	CFSWP-027	CFSWP-027	CFSWP-027	CFSWP-028	CFSWP-028	CFSWP-028	CFSWP-029
			Sample Name	CFSWP-025-SW	CFSWP-026-SW	CFSWP-026-SW	CFSWP-026-SW	CFSWP-027-SW	CFSWP-027-SW	CFSWP-027-SW	CFSWP-028-SW	CFSWP-028-SW	CFSWP-028-SW	CFSWP-029-SW
			Sample Date	10/10/2018	06/07/2018	10/05/2018	10/31/2017	06/06/2018	10/05/2018	10/31/2017	06/06/2018	10/04/2018	10/31/2017	06/22/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R2	P2 R1	P2 R2	SSPA	P2 R1	P2 R2	SSPA	P2 R1	P2 R2	SSPA	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.61 U	0.61 U	0.61 U	0.71 U	0.61 U	0.61 U	0.71 U	0.61 U	0.61 U	0.71 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	3.5 J	1.9 U	7.5	2 J	1.9 U	**10.2**	1.4 U	1.9 U	2.6 J	1.9 J	1.9 U
Lead	*	*	ug/l	0.37 U	0.37 U	0.46 J	0.38 U	0.37 U	0.37 U	0.38 U	0.37 U	0.37 U	0.74 J	0.44 J
Nickel	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.4 U	1.3 U	1.3 U	1.4 U	1.3 U	1.3 U	1.4 U	1.3 U
Silver	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U	1.3 U	1.4 U
Zinc	*	*	ug/l	5.4 U	5.4 U	5.4 U	8.5 J	5.4 U	5.4 U	12.6 J	5.4 U	5.4 U	8.1 J	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-029	CFSWP-029	CFSWP-030	CFSWP-030	CFSWP-030	CFSWP-031	CFSWP-031	CFSWP-031	CFSWP-032	CFSWP-032	CFSWP-032
			Sample Name	CFSWP-029-SW	CFSWP-029-SW	CFSWP-030-SW	CFSWP-030-SW	CFSWP-030-SW	CFSWP-031-SW	CFSWP-031-SW	CFSWP-031-SW	CFSWP-032-SW	CFSWP-032-SW	CFSWP-032-SW
			Sample Date	10/18/2018	11/01/2017	06/22/2018	10/18/2018	11/03/2017	06/22/2018	10/18/2018	11/03/2017	06/22/2018	10/17/2018	11/03/2017
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R2	SSPA	P2 R1	P2 R2	SSPA	P2 R1	P2 R2	SSPA	P2 R1	P2 R2	SSPA
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.61 U	0.71 U	0.61 U	0.61 U	0.71 U	0.61 U	0.61 U	0.71 U	0.61 U	0.61 U	0.9 J
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.6 J	1.3 U	13.1	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	36.4
Copper	*	*	ug/l	5.3	1.4 U	3.3 J	2.8 J	24.7	2.1 J	15.9	3.1 J	1.9 U	2.7 J	67.7
Lead	*	*	ug/l	0.37 U	0.41 J	1.2 J	0.53 J	12.5	0.37 U	0.77 J	0.88 J	0.37 U	0.4 J	38.5
Nickel	*	*	ug/l	1.3 U	1.4 U	1.8 J	1.3 U	16.8	1.3 U	1.9 J	3.1 J	1.3 U	1.3 U	47
Silver	*	*	ug/l	1.4 U	1.3 U	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U	1.3 U
Zinc	*	*	ug/l	5.4 U	8.1 J	8.6 J	5.4 U	76.3	5.4 U	5.4 U	16.5	5.4 U	5.4 U	192

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-033	CFSWP-033	CFSWP-033	CFSWP-034	CFSWP-034	CFSWP-035	CFSWP-035	CFSWP-036	CFSWP-036	CFSWP-037	CFSWP-037
			Sample Name	CFSWP-033-SW	CFSWP-033-SW	CFSWP-033-SW	CFSWP-034-SW	CFSWP-034-SW	CFSWP-035-SW	CFSWP-035-SW	CFSWP-036-SW	CFSWP-036-SW	CFSWP-037-SW	CFSWP-037-SW
			Sample Date	06/22/2018	10/17/2018	11/03/2017	06/07/2018	10/05/2018	06/07/2018	10/05/2018	06/06/2018	10/04/2018	06/06/2018	10/03/2018
			Sample Type	N	N	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R1	P2 R2	SSPA	P2 R1	P2 R2	P2 R1	P2 R2	P2 R1	P2 R2	P2 R1	P2 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.61 U	0.61 U	0.71 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	5.5	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	2.4 J	3.8 J	13.8	1.9 U	7.5	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Lead	*	*	ug/l	0.37 J	0.37 U	5.6	0.37 U	0.37 U	0.37 U	0.37 U	0.43 J	0.37 U	0.37 U	0.37 U
Nickel	*	*	ug/l	1.3 U	1.3 U	7.6	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Silver	*	*	ug/l	1.4 U	1.4 U	1.3 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Zinc	*	*	ug/l	5.4 U	5.4 U	36.2	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-038	CFSWP-038	CFSWP-039	CFSWP-039	CFSWP-040	CFSWP-041	CFSWP-041	CFSWP-042	CFSWP-043	CFSWP-044	CFSWP-044
			Sample Name	CFSWP-038-SW	CFSWP-038-SW	CFSWP-039-SW	CFSWP-039-SW	CFSWP-040-SW	CFSWP-041-SW	CFSWP-DUP11-SW	CFSWP-042-SW	CFSWP-043-SW	CFSWP-044-SW	CFSWP-044-SW
			Sample Date	06/07/2018	10/03/2018	06/15/2018	10/11/2018	06/15/2018	06/14/2018	06/14/2018	06/14/2018	06/14/2018	06/11/2018	10/10/2018
			Sample Type	N	N	N	N	N	N	FD	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R1	P2 R2	P2 R1	P2 R2	P2 R1	P2 R1	P2 R1	P2 R1	P2 R1	P2 R1	P2 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.9 U	1.9 U	2.8 J	7.2	3.1 J	1.9 U	1.9 U	4.4	1.9 U	1.9 U	8.5 J
Lead	*	*	ug/l	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U
Nickel	*	*	ug/l	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Silver	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Zinc	*	*	ug/l	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-044	CFSWP-044	CFSWP-045	CFSWP-045	CFSWP-045	CFSWP-046	CFSWP-047	CFSWP-048	CFSWP-049	CFSWP-050	CFSWP-051
			Sample Name	CFSWP-044-SW	CFSWP-DUP14-SW	CFSWP-045-SW	CFSWP-045-SW	CFSWP-045-SW	CFSWP-046-SW	CFSWP-047-SW	CFSWP-048-SW	CFSWP-049-SW	CFSWP-050-SW	CFSWP-051-SW
			Sample Date	10/16/2018	10/10/2018	06/11/2018	10/09/2018	10/16/2018	06/19/2018	06/19/2018	06/20/2018	06/20/2018	06/21/2018	06/21/2018
			Sample Type	N	FD	N	N	N	N	N	N	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R2	P2 R2	P2 R1	P2 R2	P2 R2	P2 R1	P2 R1	P2 R1	P2 R1	P2 R1	P2 R1
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit											
Cadmium	*	*	ug/l	NA	0.61 U	0.61 U	0.61 U	NA	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U
Chromium, Total	*	*	ug/l	NA	1.3 U	1.3 U	1.3 U	NA	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	NA	6 J	1.9 U	7.3	NA	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Lead	*	*	ug/l	NA	0.37 U	0.37 U	0.37 U	NA	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U	0.37 U
Nickel	*	*	ug/l	NA	1.3 U	1.3 U	1.3 U	NA	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Silver	*	*	ug/l	NA	1.4 U	1.4 U	1.4 U	NA	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Zinc	*	*	ug/l	NA	5.4 U	5.4 U	5.4 U	NA	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 23. Comparisson of Hardness-Specific DEQ-7 Acute and Chronic Acquatic Life Standards for Surface Water
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

			Sample Location	CFSWP-052	CFSWP-053	CFSWP-058	CFSWP-058	CFSWP-059	CFSWP-059	CFSWP-059	CFSWP-060	CFSWP-060
			Sample Name	CFSWP-052-SW	CFSWP-053-SW	CFSWP-058-SW	CFSWP-058-SW	CFSWP-059-SW	CFSWP-DUP12-SW	CFSWP-059-SW	CFSWP-060-SW	CFSWP-060-SW
			Sample Date	06/18/2018	06/18/2018	06/21/2018	10/11/2018	06/22/2018	06/22/2018	10/11/2018	06/22/2018	10/16/2018
			Sample Type	N	N	N	N	N	FD	N	N	N
			Sample Fraction	T	T	T	T	T	T	T	T	T
			Sampling Round	P2 R1	P2 R1	P2 R1	P2 R2	P2 R1	P2 R1	P2 R2	P2 R1	P2 R2
Parameter	MDEQ-7 Chronic Aquatic Life Standards	MDEQ-7 Acute Aquatic Life Standards	Unit									
Cadmium	*	*	ug/l	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U	0.61 U
Chromium, Total	*	*	ug/l	1.3 U	1.3 U	1.3 U	2.4 J	1.3 U	4 J	1.3 U	1.3 U	1.3 U
Copper	*	*	ug/l	1.9 U	1.9 U	1.9 U	10.5	1.9 U	6.1 J	7.7	3.3 J	1.9 J
Lead	*	*	ug/l	0.37 U	0.37 U	0.37 U	2.1	0.37 U	2.7 J	0.88 J	0.58 J	0.37 U
Nickel	*	*	ug/l	1.3 U	1.3 U	1.3 U	3.3 J	1.3 U	4.3 J	1.9 J	1.3 U	1.3 U
Silver	*	*	ug/l	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Zinc	*	*	ug/l	5.4 U	5.4 U	5.4 U	10.8 J	5.4 U	18.6 J	7.8 J	8.7 J	5.4 U

Notes:

*Refer to Tables 21 and 22 for the hardness-specific criteria used for the MDEQ-7 Chronic and Acute Aquatic Life Standards

Shaded data indicates a detection above the hardness-specific critera

Table 24. Total Cyanide Mass Flux Estimate
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Flow Transect ID	Area	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Specific Discharge / Darcy Velocity (ft/day)	Effective Porosity (Unitless)	Groundwater Effective Velocity (ft/day)	Width of Plume (ft)	Saturated Thickness (ft)	1/2 Saturated Thickness (ft)	Plume Cross-Sectional Area (ft^2)	Plume Cross-Sectional Area with 1/2 Saturated Thickness (ft^2)	Q Discharge (gal/year)	Q Discharge with 1/2 Saturated Thickness (gal/year)	Cyanide Concentration (mg/ft^3)	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)
A1	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	69	66	33	4,546	2,273	15,537,756	7,768,878	4.25	24,174	12,087
A2	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	63	66	33	4,123	2,062	14,092,644	7,046,322	7.08	36,543	18,272
A3	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	42	66	33	2,770	1,385	9,466,045	4,733,022	9.91	34,365	17,182
A4	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	139	66	33	9,138	4,569	31,232,347	15,616,173	12.74	145,779	72,889
A5	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	52	66	33	3,439	1,720	11,754,355	5,877,177	21.24	91,440	45,720
A6	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	35	66	33	2,300	1,150	7,859,554	3,929,777	84.96	244,566	122,283
A7	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	161	66	33	10,618	5,309	36,289,793	18,144,896	141.60	1,882,053	941,026
A8	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	156	68	34	10,612	5,306	36,269,915	18,134,957	84.96	1,128,613	564,307
A9	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	240	66	33	15,707	7,853	53,680,478	26,840,239	21.24	417,595	208,797
A10	Center Landfill Area	0.044	227.82	10.081	30%	33.82	528	41	21	21,872	10,936	602,054,275	301,027,138	1.42	312,236	156,118
A11	East Landfill Area	0.044	227.82	10.081	30%	33.82	95	41	21	3,912	1,956	107,693,989	53,846,995	4.25	167,556	83,778
A12	East Landfill Area	0.044	227.82	10.082	30%	33.82	349	41	21	14,358	7,179	395,225,935	197,612,967	5.66	819,885	409,942
A13	East Landfill Area	0.044	227.82	10.082	30%	33.82	83	41	21	3,390	1,695	93,321,005	46,660,502	4.25	145,194	72,597
		Weighted Average:		5.88		19.15	2,012.54					1,414,478,090	707,239,045		5,449,998	2,724,999
B1	Between Landfills and Main Plant	0.006	222.29	1.284	42%	3.07	54	70	35	3,793	1,896	13,300,475	6,650,237	4.25	20,694	10,347
B2	Between Landfills and Main Plant	0.006	222.29	1.284	42%	3.07	61	70	35	4,262	2,131	14,945,288	7,472,644	7.08	38,754	19,377
B3	Between Landfills and Main Plant	0.005	222.29	1.169	42%	2.79	55	70	35	3,815	1,907	12,174,965	6,087,483	9.91	44,199	22,100
B4	Between Landfills and Main Plant	0.005	222.29	1.169	42%	2.79	143	70	35	10,080	5,040	32,167,256	16,083,628	12.74	150,143	75,071
B5	Between Landfills and Main Plant	0.003	252.59	0.638	42%	1.52	875	70	35	61,472	30,736	107,084,264	53,542,132	21.24	833,037	416,518
B6	Between Landfills and Main Plant	0.003	252.59	0.638	43%	1.47	265	69	35	18,403	9,201	32,057,343	16,028,672	28.32	332,510	166,255
B7	Between Landfills and Main Plant	0.006	252.59	1.394	43%	3.21	200	59	29	11,824	5,912	45,020,822	22,510,411	21.24	350,229	175,114
B8	Between Landfills and Main Plant	0.006	252.59	1.394	43%	3.21	94	59	29	5,545	2,772	21,111,370	10,555,685	12.74	98,539	49,269
B9	Between Landfills and Main Plant	0.006	252.59	1.394	43%	3.21	87	45	23	3,948	1,974	15,030,453	7,515,227	9.91	54,565	27,283
B10	Between Landfills and Main Plant	0.006	252.59	1.394	43%	3.21	364	45	23	16,491	8,246	62,789,788	31,394,894	7.08	162,819	81,410
B11	Between Landfills and Main Plant	0.006	252.59	1.394	43%	3.21	101	45	23	4,600	2,300	17,513,655	8,756,828	4.25	27,249	13,624
		Weighted Average:		0.99		2.33	2,299.86					373,195,680	186,597,840		2,112,737	1,056,369
C1	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	42.05	0.247	28%	0.90	121	71	36	8,578	4,289	5,778,040	2,889,020	4.25	8,990	4,495
C2	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	42.05	0.247	28%	0.90	322	71	36	22,935	11,467	15,448,194	7,724,097	7.08	40,059	20,029

Table 24. Total Cyanide Mass Flux Estimate
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Flow Transect ID	Area	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Specific Discharge / Darcy Velocity (ft/day)	Effective Porosity (Unitless)	Groundwater Effective Velocity (ft/day)	Width of Plume (ft)	Saturated Thickness (ft)	1/2 Saturated Thickness (ft)	Plume Cross-Sectional Area (ft^2)	Plume Cross-Sectional Area with 1/2 Saturated Thickness (ft^2)	Q Discharge (gal/year)	Q Discharge with 1/2 Saturated Thickness (gal/year)	Cyanide Concentration (mg/ft^3)	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)
C3	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	42.05	0.247	28%	0.90	155	71	36	11,025	5,512	7,425,828	3,712,914	9.91	26,958	13,479
C4	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.007	183.41	1.215	38%	3.19	512	71	36	36,447	18,223	120,897,166	60,448,583	12.74	564,295	282,147
C5	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	123.30	0.682	38%	1.79	1007	83	41	83,223	41,611	154,908,498	77,454,249	14.16	803,383	401,691
C6	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.018	22.18	0.410	38%	1.08	157	61	30	9,499	4,749	10,630,010	5,315,005	12.74	49,616	24,808
C7	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.018	22.18	0.410	38%	1.08	634	61	30	38,439	19,219	43,016,539	21,508,270	9.91	156,164	78,082
C8	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.018	22.18	0.410	38%	1.08	31	61	31	1,890	945	2,114,834	1,057,417	7.08	5,484	2,742
C9	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.018	22.18	0.410	38%	1.08	140	61	31	8,553	4,277	9,572,045	4,786,023	4.25	14,893	7,446
	Weighted Average:			0.60		1.63	3,079.45					369,791,153	184,895,577		1,669,841	834,920
D1	Southern Area (between Main Plant and Flathead River)	0.041	5.31	0.216	37%	0.59	137	80	40	10,955	5,477	6,473,710	3,236,855	4.2	10,072	5,036
D2	Southern Area (between Main Plant and Flathead River)	0.041	5.31	0.216	37%	0.59	653	80	40	52,049	26,025	30,758,724	15,379,362	7.1	79,760	39,880
D3	Southern Area (between Main Plant and Flathead River)	0.041	5.31	0.216	46%	0.47	173	80	40	13,827	6,914	8,171,214	4,085,607	9.9	29,664	14,832
D4	Southern Area (between Main Plant and Flathead River)	0.041	21.21	0.865	46%	1.88	1056	81	41	85,989	42,994	203,127,171	101,563,585	11.3	842,763	421,381
D5	Southern Area (between Main Plant and Flathead River)	0.006	20.23	0.116	46%	0.25	832	79	40	65,812	32,906	20,919,729	10,459,865	9.9	75,945	37,973
D6	Southern Area (between Main Plant and Flathead River)	0.006	47.44	0.273	46%	0.59	264	67	33	17,664	8,832	13,170,093	6,585,046	7.1	34,151	17,076
D7	Southern Area (between Main Plant and Flathead River)	0.006	14.16	0.082	46%	0.18	1020	57	28	58,057	29,028	12,921,701	6,460,850	4.2	20,104	10,052
	Weighted Average:			0.33		0.75	4,134.45					295,542,341	147,771,170		1,092,460	546,230

	Cyanide Mass Flux (Full Saturated Thickness) (mg/day)	Cyanide Mass Flux (½ Saturated Thickness) (mg/day)
Flow Transect A	**5,449,998**	**2,724,999**
Flow Transect B	**2,112,737**	**1,056,369**
Flow Transect C	**1,669,841**	**834,920**
Flow Transect D	**1,092,460**	**546,230**

Table 25. Fluoride Mass Flux Estimate
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Flow Transect ID	Area	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Specific Discharge / Darcy Velocity (ft/day)	Effective Porosity (Unitless)	Groundwater Effective Velocity (ft/day)	Width of Plume (ft)	Saturated Thickness (ft)	1/2 Saturated Thickness (ft)	Plume Cross-Sectional Area (ft^2)	Plume Cross-Sectional Area with 1/2 Saturated Thickness (ft^2)	Q Discharge (gal/year)	Q Discharge with 1/2 Saturated Thickness (gal/year)	Fluoride Concentration (mg/ft^3)	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
A1	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	45	66	33	2,953	1,476	10,091,140	5,045,570	42.5	157,003	78,502
A2	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	87	66	33	5,714	2,857	19,528,058	9,764,029	70.8	506,380	253,190
A3	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	40	66	33	2,652	1,326	9,062,758	4,531,379	113.3	376,008	188,004
A4	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	42	66	33	2,757	1,378	9,421,235	4,710,618	184.1	635,182	317,591
A5	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	138	66	33	9,123	4,562	31,180,970	15,590,485	453.1	5,174,720	2,587,360
A6	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	99	66	33	6,551	3,276	22,389,462	11,194,731	849.6	6,966,942	3,483,471
A7	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	32	66	33	2,117	1,058	7,234,490	3,617,245	453.1	1,200,619	600,309
A8	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	68	68	34	4,631	2,316	15,828,858	7,914,429	184.1	1,067,186	533,593
A9	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	142	66	33	9,335	4,667	31,903,230	15,951,615	113.3	1,323,646	661,823
A10	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	43	41	21	1,791	896	6,122,770	3,061,385	70.8	158,769	79,384
A11	West Landfill/Wet Scrubber Sludge Pond Area	0.052	24.21	1.252	42%	2.99	127	41	21	5,226	2,613	17,862,548	8,931,274	42.5	277,915	138,957
A12	Center Landfill Area	0.044	227.82	10.082	42%	24.07	156	41	21	6,410	3,205	176,440,150	88,220,075	28.3	1,830,099	915,050
A13	Center/East Landfill Area	0.044	227.82	10.082	42%	24.07	917	41	21	37,663	18,832	1,036,744,222	518,372,111	14.2	5,376,738	2,688,369
Weighted Average:				6.14		14.66	1,937.78					1,393,809,892	696,904,946		25,051,208	12,525,604
B1	Between Landfills and Main Plant	0.006	222.29	1.284	41%	3.16	183	70	35	12,786	6,393	44,840,761	22,420,380	42.48	697,656	348,828
B2	Between Landfills and Main Plant	0.006	222.29	1.284	41%	3.16	141	70	35	9,823	4,911	34,448,082	17,224,041	70.80	893,269	446,635
B3	Between Landfills and Main Plant	0.003	222.29	0.561	41%	1.38	1173	70	35	81,890	40,945	125,538,683	62,769,342	84.96	3,906,394	1,953,197
B4	Between Landfills and Main Plant	0.006	252.59	1.394	41%	3.43	107	59	30	6,296	3,148	23,971,474	11,985,737	70.80	621,601	310,801
B5	Between Landfills and Main Plant	0.006	252.59	1.394	41%	3.43	110	59	30	6,513	3,257	24,798,154	12,399,077	42.48	385,823	192,911
B6	Between Landfills and Main Plant	0.006	252.59	1.394	41%	3.43	515	45	23	23,197	11,598	88,320,584	44,160,292	9.91	320,632	160,316
Weighted Average:				0.94		2.31	2,229.82					341,917,738	170,958,869		6,825,376	3,412,688
C1	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	42.05	0.247	33%	0.75	706	71	36	50,205	25,102	33,816,792	16,908,396	4.25	52,614	26,307

Table 25. Fluoride Mass Flux Estimate

Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Flow Transect ID	Area	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Specific Discharge / Darcy Velocity (ft/day)	Effective Porosity (Unitless)	Groundwater Effective Velocity (ft/day)	Width of Plume (ft)	Saturated Thickness (ft)	1/2 Saturated Thickness (ft)	Plume Cross-Sectional Area (ft^2)	Plume Cross-Sectional Area with 1/2 Saturated Thickness (ft^2)	Q Discharge (gal/year)	Q Discharge with 1/2 Saturated Thickness (gal/year)	Fluoride Concentration (mg/ft^3)	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
C2	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	42.05	0.247	33%	0.75	1295	71	36	92,089	46,045	62,028,996	31,014,498	7.08	160,847	80,423
C3	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.006	56.03	0.310	33%	0.94	474	71	36	33,683	16,842	28,491,575	14,245,787	9.91	103,434	51,717
C4	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.020	183.41	3.657	33%	11.14	202	71	36	14,347	7,173	143,244,934	71,622,467	12.74	668,604	334,302
C5	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.020	183.41	3.657	33%	11.14	135	83	41	11,175	5,588	111,581,095	55,790,547	14.16	578,679	289,340
C6	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.034	22.18	0.750	33%	2.28	578	61	30	35,060	17,530	71,786,212	35,893,106	12.74	335,066	167,533
C7	Center of Site (North of Main Plant and South of North Percolation Ponds)	0.034	22.18	0.750	33%	2.28	109	61	30	6,599	3,299	13,510,640	6,755,320	9.91	49,048	24,524
		Weighted Average:		0.68		2.08	3,498.08					464,460,243	232,230,122		1,948,292	974,146
D1	Southern Area (between Main Plant and Flathead River)	0.041	5.31	0.216	37%	0.59	2337	80	40	186,446.48	93,223.24	110,181,284	55,090,642	42.48	1,714,259	857,129
D2	Southern Area (between Main Plant and Flathead River)	0.006	4.32	0.025	46%	0.05	1734	80	40	138,280.36	69,140.18	9,392,669	4,696,334	56.64	194,848	97,424
D3	Southern Area (between Main Plant and Flathead River)	0.006	14.16	0.082	46%	0.18	152	57	29	8,663.43	4,331.72	1,928,227	964,114	42.48	30,000	15,000
		Weighted Average:		0.13		0.36	4,222.83					121,502,179	60,751,090		1,939,107	969,554

	Fluoride Mass Flux (Full Saturated Thickness) (mg/day)	Fluoride Mass Flux (½ Saturated Thickness) (mg/day)
Flow Transect A	**25,051,208**	**12,525,604**
Flow Transect B	**6,825,376**	**3,412,688**
Flow Transect C	**1,948,292**	**974,146**
Flow Transect D	**1,939,107**	**969,554**

Table 26. Total Cyanide Velocity Estimate
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Flow Transect ID	Soil Adsorption Coefficient for Soil Organic Carbon (K_{oc}) (L/kg)*	Soil Adsorption Coefficient for Soil Organic Carbon (K_{oc}) (L/kg)**	Fraction of Soil Organic Carbon (f_{oc})	Distribution Coefficient (K_d) utilizing Low Range K_{oc}	Distribution Coefficient (K_d) utilizing High Range K_{oc}	Bulk Density (g/cm^3)	Total Porosity	Retardation Factor (R_f) utilizing Low Range K_d	Retardation Factor (R_f) utilizing High Range K_d	Groundwater Effective Velocity (ft/day)	Contaminant Velocity (V*) utilizing Low Range R_f	Contaminant Velocity (V*) utilizing High Range R_f
A1	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A2	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A3	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A4	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A5	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A6	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A7	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A8	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A9	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.99	2.49	1.57
A10	2	8.93	0.010	0.02	0.09	1.86	0.298	1.12	1.53	33.82	30.21	22.06
A11	2	8.93	0.019	0.04	0.17	1.86	0.298	1.24	2.08	33.82	27.23	16.25
A12	2	8.93	0.019	0.04	0.17	1.86	0.298	1.24	2.08	33.82	27.23	16.25
A13	2	8.93	0.019	0.04	0.17	1.86	0.298	1.24	2.08	33.82	27.23	16.25
						Flow Transect A Average		1.20	1.91	Weighted Average:	16.24	10.79
B1	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	3.07	2.55	1.61
B2	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	3.07	2.55	1.61
B3	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.79	2.32	1.47
B4	2	8.93	0.027	0.05	0.24	1.54	0.419	1.20	1.90	2.79	2.32	1.47
B5	2	8.93	0.024	0.05	0.22	1.54	0.419	1.18	1.80	1.52	1.29	0.85
B6	2	8.93	0.024	0.05	0.22	1.5	0.434	1.17	1.75	1.47	1.26	0.84
B7	2	8.93	0.027	0.05	0.24	1.5	0.434	1.19	1.84	3.21	2.70	1.75
B8	2	8.93	0.027	0.05	0.24	1.5	0.434	1.19	1.84	3.21	2.70	1.75
B9	2	8.93	0.013	0.03	0.12	1.5	0.434	1.09	1.41	3.21	2.94	2.28
B10	2	8.93	0.013	0.03	0.12	1.5	0.434	1.09	1.41	3.21	2.94	2.28
B11	2	8.93	0.013	0.03	0.12	1.5	0.434	1.09	1.41	3.21	2.94	2.28
						Flow Transect B Average		1.16	1.73	Weighted Average:	2.02	1.40
C1	2	8.93	0.013	0.03	0.11	1.92	0.275	1.18	1.80	0.90	0.76	0.50
C2	2	8.93	0.013	0.03	0.11	1.92	0.275	1.18	1.80	0.90	0.76	0.50
C3	2	8.93	0.013	0.03	0.11	1.92	0.275	1.18	1.80	0.90	0.76	0.50
C4	2	8.93	0.013	0.03	0.11	1.64	0.381	1.11	1.49	3.19	2.87	2.14
C5	2	8.93	0.027	0.05	0.24	1.64	0.381	1.23	2.05	1.79	1.45	0.87
C6	2	8.93	0.027	0.05	0.24	1.64	0.381	1.23	2.05	1.08	0.87	0.53
C7	2	8.93	0.013	0.03	0.12	1.64	0.381	1.11	1.51	1.08	0.96	0.71
C8	2	8.93	0.013	0.03	0.12	1.64	0.381	1.11	1.51	1.08	0.96	0.71
C9	2	8.93	0.013	0.03	0.12	1.64	0.381	1.11	1.51	1.08	0.96	0.71
						Flow Transect C Average		1.16	1.72	Weighted Average:	1.40	0.95
D1	2	8.93	0.004	0.01	0.04	1.68	0.366	1.04	1.17	0.59	0.57	0.51
D2	2	8.93	0.010	0.02	0.09	1.68	0.366	1.09	1.42	0.59	0.54	0.42
D3	2	8.93	0.017	0.03	0.15	1.43	0.460	1.10	1.46	0.47	0.43	0.32
D4	2	8.93	0.014	0.03	0.13	1.43	0.460	1.09	1.39	1.88	1.73	1.35
D5	2	8.93	0.012	0.02	0.10	1.43	0.460	1.07	1.32	0.25	0.24	0.19
D6	2	8.93	0.015	0.03	0.14	1.43	0.460	1.09	1.42	0.59	0.54	0.42
D7	2	8.93	0.019	0.04	0.17	1.43	0.460	1.12	1.52	0.18	0.16	0.12
						Flow Transect D Average		1.09	1.39	Weighted Average:	0.68	0.54
										AVERAGE	4.38	2.84

*USEPA, Technical Appendices for RSEI Version 2.1.2, August 2004, Technical Appendix B, Physicochemical Properties for TRI Chemicals and Chemical Categories

**USEPA, Chemistry Dashboard. https://comptox.epa.gov/dashboard/DTXSID6023991 (accessed August 26, 2019), Cyanide

Table 27. Summary of BHHRA ELCR and HI for Receptors by Exposure Scenario (BHHRA Table 9-36)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Timeframe	Receptor	ELCR	HI	Tables	
					Risk Calcs	Summaries
Main Plant Area	Current	Trespasser	6E-07	7E-03	7-1	9-1
	Future	Industrial Worker	***8E-06***	1E-01	7-2	9-2
		Construction Worker	8E-07	2E+00	7-3	9-3
		Trespasser	6E-07	7E-03	7-4	9-4
Main Plant Area ISM	Current	Trespasser	***4E-06***	3E-02	App I, Table I-1	App I, Table I-2
	Future	Industrial Worker	***2E-05***	4E+00	App I, Table I-3	App I, Table I-4
		Construction Worker	***2E-06***	***4E+00***	App I, Table I-5	App I, Table I-6
		Trespasser	***2E-06***	2E-02	App I, Table I-7	App I, Table I-8
North Percolation Pond Area	Current	Stormwater Management Worker	***1E-04***	8E-01	7-5	9-5
		Trespasser	***5E-05***	4E-01	7-6	9-6
	Future	Stormwater Management Worker	***1E-04***	8E-01	7-5	9-5
		Trespasser	***5E-05***	4E-01	7-6	9-6
Central Landfill Area	Current	Landfill Management Worker	***1E-05***	3E-01	7-7	9-7
		Trespasser	6E-07	2E-02	7-8	9-8
	Future	Landfill Management Worker	***7E-06***	2E-01	7-9	9-9
		Trespasser	6E-07	2E-02	7-8	9-8
Central Landfill Area ISM	Current	Landfill Management Worker	***3E-05***	3E-01	App I, Table I-9	App I, Table I-10
		Trespasser	***2E-06***	2E-02	App I, Table I-11	App I, Table I-12
	Future	Landfill Management Worker	***3E-05***	3E-01	App I, Table I-9	App I, Table I-10
		Trespasser	***2E-06***	2E-02	App I, Table I-13	App I, Table I-14
Industrial Landfill Area	Current	Landfill Management Worker	***1E-05***	2E-01	7-10	9-10
		Trespasser	***2E-06***	2E-02	7-11	9-11
	Future	Landfill Management Worker	***1E-05***	2E-01	7-10	9-10
		Trespasser	***2E-06***	2E-02	7-11	9-11
Eastern Undeveloped Area	Current	Trespasser	1E-07	1E-02	7-12	9-12
	Future	Industrial Worker	***2E-06***	9E-02	7-13	9-13
		Construction Worker	3E-07	***3E+00***	7-14	9-14
		Trespasser	1E-07	1E-02	7-12	9-12
North-Central Undeveloped Area	Current	Trespasser	1E-07	1E-02	7-15	9-15
	Future	Industrial Worker	***2E-06***	8E-02	7-16	9-16
		Construction Worker	3E-07	2E+00	7-17	9-17
		Trespasser	1E-07	1E-02	7-15	9-15
Western Undeveloped Area	Current	Trespasser	7E-08	9E-03	7-18	9-18
	Future	Resident (Adult)	***2E-05***	1E+00	7-19	9-19
		Resident (Child)	NA	3E+00	7-20	9-20
		Industrial Worker	1E-06	6E-02	7-21	9-21
		Construction Worker	1E-07	1E-01	7-22	9-22
		Trespasser	7E-08	9E-03	7-23	9-23
South Percolation Pond Area	Current	Stormwater Management Worker	1E-06	9E-02	7-24	9-24
		Trespasser	1E-07	3E-02	7-25	9-25
	Future	Stormwater Management Worker	1E-06	9E-02	7-24	9-24
		Trespasser	1E-07	3E-02	7-25	9-25
Flathead River Area	Current	Recreational Trespasser (Floater, adult)	1E-07	6E-03	7-26	9-26
		Recreational Trespasser (Floater, adolescent)	NA	1E-02	7-27	9-27
		Recreational Trespasser (Fisher, adult)	2E-07	5E-03	7-28	9-28
	Future	Recreational Trespasser (Floater, adult)	1E-07	6E-03	7-26	9-26
		Recreational Trespasser (Floater, adolescent)	NA	1E-02	7-27	9-27
		Recreational Trespasser (Fisher, adult)	2E-07	5E-03	7-28	9-28
Backwater Seep Sampling Area	Current	Stormwater Management Worker	7E-07	1E-01	7-29	9-29
		Trespasser	1E-07	3E-02	7-30	9-30
		Recreational Trespasser (Floater, adult)	2E-07	3E-02	7-31	9-31
		Recreational Trespasser (Floater, adolescent)	NA	6E-02	7-32	9-32
		Recreational Trespasser (Fisher, adult)	2E-07	3E-02	7-33	9-33
	Future	Stormwater Management Worker	7E-07	1E-01	7-29	9-29
		Trespasser	1E-07	3E-02	7-30	9-30
		Recreational Trespasser (Floater, adult)	2E-07	3E-02	7-31	9-31
		Recreational Trespasser (Floater, adolescent)	NA	6E-02	7-32	9-32
		Recreational Trespasser (Fisher, adult)	2E-07	3E-02	7-33	9-33
Western Undeveloped, Central Landfill, North-Central Undeveloped Areas	Current	Recreational Trespasser (ATV)	5E-07	1E-01	7-34	9-34
	Future	Recreational Trespasser (ATV)	5E-07	1E-01	7-34	9-34
Western Undeveloped, North Central Undeveloped Areas	Current	Recreational Trespasser (Hunter)	2E-07	1E-02	7-35	9-35
	Future	Recreational Trespasser (Hunter)	2E-07	1E-02	7-35	9-35
Upper Hydrogeologic Plume Area	Future	Resident (Adult)	***2E-04***	***8E+01***	App J, Table J-1	App J, Table J-2
		Resident (Child)	NA	***1E+02***	App J, Table J-3	App J, Table J-4
Below Upper Hydrogeologic Area	Future	Resident (Adult)	***4E-05***	***3E+00***	App J, Table J-5	App J, Table J-6
		Resident (Child)	NA	***4E+00***	App J, Table J-7	App J, Table J-8

For Carcinogenic Hazard		
	1E-07	ELCR<= 10-6
	5E-06	10-6 (de minimis) < ELCR <= 10-5 (MDEQ)
	8E-05	10-5 (MDEQ) < ELCR <= 10-4 (upper USEPA)
	2E-04	10-4 (upper USEPA) < ELCR

For Non-Carcinogenic Hazard		
	6E-01	HI <= 1.0
	3E+00	1.0 < HI <= 10, target-organ-specific HI < 1.0
	3E+00	1.0 < HI <= 10, target-organ-specific HI > 1.0
	6E+01	10 < HI <= 100
	3E+02	100 < HI

Note:
Table 9-36 from BHHRA (EHS Support, July 29, 2019)

Table 28. Summary of BERA Findings – Terrestrial Exposure Areas (BERA Table 8-1)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
Main Plant Area	Minimal Risk. Localized risk to soil invertebrates due to PAH exposure. Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=19) and HMW PAHs (HQ_{NOEC}=35.7). LOECs not identified for LMW and HMW PAHs. Refined EPCs > NOEC for LMW PAHs (HQ_{LOEC}=2.2) and HMW PAHs (HQ_{LOEC}=4.3). Negligible risk to other COPECs (maximum exposure < LOEC)	Negligible risk; maximum exposure < LOEC.	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to HMW PAHs (HQ_{LOAEL}=11.5 to 16.3) and BEHP (HQ_{LOAEL}=3.0 to 4.5) if foraging exclusively at maximum EPC. **Refined scenario:** Moderate Risk. Limited potential for adverse effects to birds exposed to HMW PAHs (HQ_{LOAEL}=1.4 to 2.0)	**Maximum scenario:** Low potential for adverse effects for mammals foraging exclusively within the exposure area; maximum short-tailed shrew exposure HMW PAHs exceeds LOAEL (HQ_{NOAEL}=2.9); all other COPEC/receptors HQ_{LOAEL}<1. **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1. **Small Ranging Receptors:** Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short-tailed shrew exposure > LOAEL at 5 of 90 stations and meadow vole exposure > LOAEL at 9 of 90 stations.	**Moderate**	Local impacts to soil invertebrate communities due to direct contact possible but localized. Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological exposure pathways limited under current, developed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.
Central Landfills Area	Negligible risk; Maximum EPCs < LOEC, except for copper (HQ_{LOEC}=13.7). Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=33) and HMW PAHs (HQ_{NOEC}=27). LOECs not identified for LMW and HMW PAHs. Refined EPC for copper (HQ_{LOEC}=1.4). Refined EPCs > NOEC for LMW PAHs (HQ_{LOEC}=3.0) and HMW PAHs (HQ_{LOEC}=3.0).	Negligible risk; maximum exposure < LOEC, except for copper; refined exposure estimate indicates slight exceedance of copper LOEC (HQ_{LOEC}=1.5).	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to copper, nickel, LMW PAHs, HMW PAHs, Aroclor 1254 and BEHP (HQ_{LOAEL}=1.3 to 17.0) if foraging exclusively at maximum EPC. **Refined scenario:** Moderate Risk**.** Potential for adverse effects to birds exposed to copper, HMW PAHs, and Aroclor 1254 (HQ_{LOAEL}=1.3 to 3.1) if foraging exclusively at refined EPC.	**Maximum scenario:** Negligible Risk. Low potential for adverse effects for mammals foraging exclusively within the exposure area; maximum short-tailed shrew exposure exceeds LOAEL for copper, nickel, PCB1254, HMW PAHs and meadow vole for selenium (HQ_{NOAEL}=1.6 to 5.7); all other COPEC/receptors HQ_{LOAEL}<1. **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1. **Small Ranging Receptors:** Minimal Risk. Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short tailed shrew exposure > LOAEL at 6 of 67 stations and meadow vole exposure < LOAEL.	**Moderate**	Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological exposure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.
Industrial Landfill Area	Minimal Risk. Limited risk due to PAH exposure. Maximum EPCs < LOECs for metals; maximum EPCs > NOECs for LMW PAHs (HQ_{NOE}C=7.0) and HMW PAHs (HQ_{NOEC}=13.4); LOECs not identified for LMW and HMW PAHs. Refined EPCs < LOECs for metals; refined EPCs > NOECs for LMW PAHs (HQ_{NOEC}=6.5) and HMW PAHs (HQ_{NOEC}=12.9).	Negligible risk. Maximum EPCs < LOEC, except for slight exceedances of nickel (HQ_{LOEC}=1.7) and vanadium (HQ_{LOEC}=2.1). Refined exposure estimate indicates slight exceedances of LOECs for nickel (HQ_{LOEC}=1.5) and vanadium (HQ_{LOEC}=1.9).	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to nickel and HMW PAHs (HQ_{LOAEL}=1.3 to 5.2) if foraging at maximum exposure exclusively within the Industrial Landfill Area. **Refined scenario:** Moderate Risk. Limited potential for adverse effects to birds exposure to refined EPCs for nickel and HMW PAHs (HQ_{LOAEL}=2.1 to 5.0).	**Maximum scenario:** Moderate Risk. nickel, vanadium, and HMW PAHs had HQ_{NOAEL} and HQ_{LOAEL} values greater than 1. **Refined scenario:** Moderate Risk. Nickel has HQ_{LOAEL} value > 1, but below 5. **Small Ranging Receptors:** Moderate risk. Two of the 6 sample locations exceeded the LOAEL benchmarks for the short-tailed shrew (nickel and PAHs).	**Moderate**	Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological exposure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

Table 28. Summary of BERA Findings – Terrestrial Exposure Areas (BERA Table 8-1)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
Eastern Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk. Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=4.1) and manganese (HQ_{LOEC}=3.6). Refined EPCs slightly exceed LOECs for barium (HQ_{LOEC}=2.2) and manganese (HQ_{LOEC}=1.3). Manganese comparable to background.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.0-1.4 (lead, nickel, vanadium, zinc, cyanide, and bis(2-ethylhexyl)phthalate) **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1; refined EPCs < NOAEL, except for BEHP exposure to yellow-billed cuckoo (HQ_{NOAEL}=1.2).	**Maximum scenario:** Negligible risk foraging exclusively within the exposure area; maximum short tailed short-tailed shrew exposure to nickel (HQ_{NOAEL}=1.7); other COPEC/receptors HQ_{NOAEL}<1 **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1; refined EPCs < NOAEL, except for nickel exposure to short-tailed shrew (HQ_{NOAEL}=1.0). **Small Ranging Receptors:** Negligible risk; < NOAEL for meadow vole for all constituents at 21 of 22 stations and < NOAEL for short-tailed shrew at 10 of 21 stations (max nickel HQ_{NOAEL}=1.7; HQ_{LOAEL} <1 for all other COPEC/receptors	**Negligible**	No further evaluation on the basis of terrestrial exposure.
North-Central Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=1.9) and manganese (HQLOEC=2.4). Refined EPCs slightly exceed LOECs for barium (HQ_{LOEC}=1.1) and manganese (HQ_{LOEC}=1.0). Manganese comparable to background.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.2 to 1.5 and bis(2-ethylhexyl)phthalate (HQ_{NOAEL}=3.5 to 5.2). **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1 .	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL} <1 for all receptors/COPECs. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all stations for meadow vole and short-tailed shrew for refined COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.

Table 28. Summary of BERA Findings – Terrestrial Exposure Areas (BERA Table 8-1)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
Western Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk. Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=2.1) and manganese (HQ_{LOEC}=2.0). Refined EPCs < LOEC, except for slight exceedance for barium (HQ_{LOEC}=1.2).	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum HQ_{NOAEL}=1.2 to 2.7. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}=1.3 for short-tailed shrew $TEC_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ_{NOAEL}<1. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}=1.1 for short-tailed shrew $TEC_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew, except $TEC_{2,3,7,8\text{-}TCDD}$ for short-tailed shrew (HQ_{NOAEL}=1.1; HQ_{LOAEL} <1)	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Flathead River Riparian Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.5. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}<1 for modeled COPEC/receptors **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Incremental Soil Sampling (ISS) Area	Moderate risk. Limited risk to soil invertebrates. Maximum EPCs > LOEC for copper (HQ_{LOEC}=1.7) and zinc HQ_{LOEC}=1.8). Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=74.6) and HMW PAHs (HQ_{NOEC}=68.3); LOECs not identified for LMW and HMW PAHs. Refined EPC > LOEC for copper (HQ_{LOEC}=1.4); refined EPCs > NOECs for LMW PAHs (HQ_{NOEC}=3.0) and HMW PAHs (HQ_{NOEC}=4.3); LOECs not identified for LMW and HMW PAHs.	Negligible risk; Maximum EPC slightly exceeds LOEC for barium (HQ_{LOEC}=1.2), copper (HQ_{LOEC}=1.8), selenium (HQ_{LOEC}=4.4), and zinc (HQ_{LOEC}=2.1). Refined EPCs < LOEC, except slight exceedance of copper (HQ_{LOEC}=1.5).	**Moderate**	Exposure evaluated as part of Central Landfills Area and Main Plant Area evaluations.	**Small Ranging Receptors:** Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short-tailed shrew exposure > LOAEL at 10 of 43 grids and meadow vole exposure > LOAEL at 1 of 43 grids.	**Moderate**	Impacts from PAHs and metals to local terrestrial plant and invertebrate communities via direct contact and small-ranging mammalian populations via direct and indirect ingestion possible. Ecological exposure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

Notes:
HQ: ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.
Table 8-1 from BERA (EHS Support, July 29, 2019)

Table 29. Summary of BERA Findings – Transitional Exposure Areas – Terrestrial Scenario (BERA Table 8-2)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
North Percolation Ponds	High Risk. Maximum EPCs > NOEC for LMW PAHs (HQNOEC=307 to 311) and HMW PAHs (HQNOEC=763); maximum EPCs for cyanide, fluoride, and metals < LOEC. Refined EPCs result in HQNOEC > 100 for LMW and HMW PAHs.	High Risk. HQLOEC > 1 based on maximum exposure to 7 metals, with HQLOEC values from 1.1 (zinc and selenium) to 9.2 (thallium). Refined EPCs > LOEC for nickel (HQLOEC=1.3), thallium (HQLOEC=3.8), and vanadium (HQLOEC=1.4). Exposure to LMW and HMW PAHs is uncertain due to lack of NOEC/LOEC benchmarks.	**High**	Maximum scenario: High Risk. Potential for adverse effects to birds exposed to cyanide, barium, nickel, selenium, vanadium, LMW PAHs, HMW PAHs, (HQLOAEL=1.1 to 704) if foraging at maximum exposure exclusively within the North Percolation Pond Refined scenario: High Risk. Potential for adverse effects to all avian receptors exposed to nickel, selenium, vanadium, LMW PAHs, and HMW PAHs based on exclusive foraging at refined EPCs (HQLOAEL=1.8 to 146.5).	Maximum scenario: High Risk. Potential for adverse effects to mammals exposed to nickel, LMW PAHs, HMW PAHs, (HQLOAEL=2.3 to 65) if foraging at maximum exposure exclusively within the North Percolation Pond Refined scenario: High Risk. Potential for adverse effects to the Canada lynx, grizzly bear, meadow vole, and short-tailed shrew exposed to nickel and HMW PAHs based on exclusive foraging at refined EPCs (HQLOAEL=2.3 to 23). HQLOAEL values below 1 for all receptors except the meadow vole (HMW PAHs) and short-tailed shrew (nickel and HMW PAHs) when area use factor included.	**High**	Greatest potential for adverse effects is associated with exposure to PAHs and metals, particularly in the North-East Pond. Risk due to direct contact and direct and indirect ingestion pathways is high. Further risk assessment may not be beneficial, particularly in the North-East Pond; evaluate future use of North Percolation Pond prior to developing ERA recommendations.
South Percolation Ponds	Negligible risk; Maximum EPCs < LOEC, except for copper (HQLOEC=1.3) and mercury (HQLOEC=2.8). Refined EPCs < LOEC.	Negligible risk; Maximum EPCs < LOEC, except for barium (HQLOEC=3.7) and copper (HQLOEC=1.4). Refined EPCs < LOEC, except for barium (HQLOEC=2.5).	**Negligible**	Maximum scenario: Minimal Risk. Low potential for adverse effects to birds exposed to copper and BEHP (HQLOAEL=1.6 to 1.7) if foraging at maximum exposure exclusively within the South Percolation Pond; all other COPEC/receptors HQLOAEL<1 Refined scenario: Minimal Risk. Low potential for adverse effects to American woodcock (HQLOAEL=1.2) and yellow-billed cuckoo (HQNOAEL=1.7) foraging at refined EPCs; all other COPEC HQLOAEL<1.	Maximum scenario: Negligible risk to mammals foraging exclusively within the exposure area; maximum HQLOAEL<1 Refined scenario: Negligible risk to mammals foraging exclusively within the exposure area; short-tailed shrew had HQNOAEL > 1 for cadmium, copper, and nickel, but all HQLOAEL<1 based on refined EPCs.	**Minimal**	No further evaluation on the basis of terrestrial exposure.
Cedar Creek Reservoir Overflow Ditch	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC, except for slight exceedances of barium (HQLOEC=1.1) and manganese (HQLOEC=1.5).	**Negligible**	Maximum scenario: Negligible risk to birds foraging exclusively within the exposure area; maximum HQNOAEL=1 (zinc for yellow-billed cuckoo). Refined scenario: Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs.	Maximum scenario: Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQLOAEL<1. Refined scenario: Negligible risk; HQLOAEL<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Northern Surface Water Feature	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC, except for slight exceedances of barium (HQLOEC=2.3).	**Negligible**	Maximum scenario: Negligible potential for adverse effects to terrestrial birds. All HQLOAEL<1 based on maximum EPCs. Refined scenario: Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs..	Maximum scenario: Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQLOAEL<1. Refined scenario: Negligible risk; HQLOAEL<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.

Table 29. Summary of BERA Findings – Transitional Exposure Areas – Terrestrial Scenario (BERA Table 8-2)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
North-Central Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=1.9) and manganese (HQLOEC=2.4). Refined EPCs slightly exceed LOECs for barium (HQ_{LOEC}=1.1) and manganese (HQ_{LOEC}=1.0). Manganese comparable to background.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.2 to 1.5 and bis(2-ethylhexyl)phthalate (HQ_{NOAEL}=3.5 to 5.2). **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1 .	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL} <1 for all receptors/COPECs. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all stations for meadow vole and short-tailed shrew for refined COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Western Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk. Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=2.1) and manganese (HQ_{LOEC}=2.0). Refined EPCs < LOEC, except for slight exceedance for barium (HQ_{LOEC}=1.2).	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum HQ_{NOAEL}=1.2 to 2.7. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}=1.3 for short-tailed shrew $TEC_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ_{NOAEL}<1. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}=1.1 for short-tailed shrew $TEC_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew, except $TEC_{2,3,7,8\text{-}TCDD}$ for short-tailed shrew (HQ_{NOAEL}=1.1; HQ_{LOAEL} <1)	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Flathead River Riparian Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.5. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}<1 for modeled COPEC/receptors **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Incremental Soil Sampling (ISS) Area	Moderate risk. Limited risk to soil invertebrates. Maximum EPCs > LOEC for copper (HQ_{LOEC}=1.7) and zinc HQ_{LOEC}=1.8). Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=74.6) and HMW PAHs (HQ_{NOEC}=68.3); LOECs not identified for LMW and HMW PAHs. Refined EPC > LOEC for copper (HQ_{LOEC}=1.4); refined EPCs > NOECs for LMW PAHs (HQ_{NOEC}=3.0) and HMW PAHs (HQ_{NOEC}=4.3); LOECs not identified for LMW and HMW PAHs.	Negligible risk; Maximum EPC slightly exceeds LOEC for barium (HQ_{LOEC}=1.2), copper (HQ_{LOEC}=1.8), selenium (HQ_{LOEC}=4.4), and zinc (HQ_{LOEC}=2.1). Refined EPCs < LOEC, except slight exceedance of copper (HQ_{LOEC}=1.5).	**Moderate**	Exposure evaluated as part of Central Landfills Area and Main Plant Area evaluations.	**Small Ranging Receptors:** Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short-tailed shrew exposure > LOAEL at 10 of 43 grids and meadow vole exposure > LOAEL at 1 of 43 grids.	**Moderate**	Impacts from PAHs and metals to local terrestrial plant and invertebrate communities via direct contact and small-ranging mammalian populations via direct and indirect ingestion possible. Ecological exposure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

Notes:
HQ: ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCLmean) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.
Table 8-2 from BERA (EHS Support, July 29, 2019)

Table 30. Summary of BERA Findings – Transitional Exposure Areas – Aquatic Scenario (BERA Table 8-3)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary				Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles	Overall Wildlife Risk	Birds	Mammals	Overall Wildlife Risk	
North Percolation Ponds	**Surface Water:** High Risk. Maximum fluoride exceed LOEC for invertebrates (HQ_{LOEC}=5.2 to 5.5) and fish/amphibian communities (HQ_{LOEC}=3.6 to 3.7); maximum metals concentrations exceed LOEC for aluminum, barium, cadmium, copper, zinc [HQ_{LOEC}=2.3 to 785 (unfiltered Al)]; maximum concentrations of 7 PAH compounds exceed NOEC (FCV) with HQ_{NOEC}=1.3-14.8. **Sediment:** High Risk. PAH $ESBTU_{34}$>1 at 24 of 30 stations; PAH $ESBTU_{34}$>10 at 13 of 30; Maximum EPCs exceed LOECs for cyanide (HQ_{LOEC}=137) and several metals, with HQ_{LOEC} values ranging from 1.2 (selenium) to 26.0 (nickel). Refined EPCs > LOEC for cyanide (HQ_{LOEC}=41.2) and lead (HQ_{LOEC}=7.5).			**High**	**Maximum scenario:** High Risk. Potential for adverse effects to birds exposed to cyanide, barium, nickel, selenium, vanadium, LMW PAHs, HMW PAHs, (HQ_{LOAEL}=1.1 to 704) if foraging at maximum exposure exclusively within the North Percolation Pond **Refined scenario:** High Risk. Potential for adverse effects to American dipper exposed to selenium, vanadium, LMW PAHs, and HMW PAHs and belted kingfisher exposed to HMW PAHs based on exclusive foraging at refined EPCs (HQ_{LOAEL}=1.4 to 284).	**Maximum scenario:** Negligible risk to mink foraging exclusively within the exposure area at maximum EPCs (HQ_{NOAEL}<1) **Refined scenario:** Negligible risk to mink foraging exclusively within the exposure area at refined EPCs (HQ_{NOAEL}<1)	**High**	Greatest potential for adverse effects via direct contact exposure to fluoride, metals, and PAHs in surface water and sediment, particularly in the North-East Pond. High risk associated with birds foraging in exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond; evaluate future use of North Percolation Pond prior to developing ERA recommendations.
South Percolation Ponds	**Surface Water:** Moderate Risk. Maximum EPCs > LOEC for total cyanide (HQ_{LOEC}=3.1 to 6.3), aluminum, barium (HQ_{LOEC}=8.0 to 20.2), copper, and iron (HQ_{LOEC}=2.3); sample-specific LOEC exceeded in for aluminum in 2/17 filtered samples (HQ_{LOEC}=1.0-3.1), aluminum in 2/26 unfiltered samples (HQ_{LOEC}=1.2 to 11.7), filtered copper in 1/17 samples (HQ_{LOEC}=1.1-1.2), unfiltered copper in 1/26 samples (HQ_{LOEC}=1.1). Refined EPCs > LOEC for cyanide (HQ_{LOEC}=2.4) and barium (HQ_{LOEC}=8.0 to 20.2). **Sediment:** Moderate Risk. Maximum EPCs > LOEC for cyanide (HQ_{LOEC}=16.4) and several metals (HQ_{LOEC}=1.1 to 5.0); Refined EPCs > LOEC for cyanide (HQ_{LOEC}=4.4), barium (HQ_{LOEC}=2.1), and copper (HQ_{LOEC}=1.4). AVS-SEM/f_{oc} not indicative of adverse effects to metals; **Pore water:** Moderate Risk. Aluminum and copper < LOEC in pore water samples; maximum EPC for barium exceeds LOEC (HQ_{LOEC}=10.8).			**Moderate**	**Maximum scenario:** Minimal Risk. Low potential for adverse effects to birds exposed to barium and copper (HQ_{LOAEL}=2.3 to 3.5) if foraging at maximum exposure exclusively within the South Percolation Pond; all other COPEC/receptors HQ_{LOAEL}<1 **Refined scenario:** Minimal Risk. Low potential for adverse effects to American dipper exposed to barium (HQ_{LOAEL}=2.3) foraging at refined EPCs; all other COPEC HQ_{LOAEL}<1 for American dipper and belted kingfisher.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}<1 **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; H_{QNOAEL}<1 based on refined EPCs.	**Minimal**	Greatest potential for adverse effects via direct contact exposure to cyanide, metals, and PAHs in surface water. Evaluate potential for minimizing stormwater discharge with elevated concentrations of cyanide, aluminum, and other COPECs to the South Percolation Ponds.
Cedar Creek Reservoir Overflow Ditch	**Surface Water:** Negligible risk. Maximum EPCs > LOEC for aluminum, barium (HQ_{LOEC}= 5.4 to 5.6), and manganese (HQ_{LOEC}= 1.6). Aluminum LOEC (NRWQC CMC) exceeded in 1 of 27 samples (HQ_{LOEC}=6.5); filtered aluminum < NOEC. Refined exposure to barium results in HQ_{LOEC}= 2.6 to 2.7. Barium concentrations consistent upstream to downstream across site, with the exception of Oct 2018 result at CFSWP-039, indicating potential upgradient conditions. **Sediment:** Minimal Risk. Limited potential for adverse effects to benthic invertebrates associated with exposure to cyanide, manganese, and PAHs. Maximum EPCs > LOEC for cyanide (HQ_{LOEC} = 1.5), manganese (HQ_{LOEC} = 1.5), and PAHs (ESBTU = 7.7 to 21.2) . PAH $ESBTU_{34}$ < 1 for all stations except CFSB-284 (tPAHs=7.4; low TOC=0.006%). Refined EPCs < 1 for all COPECs, except manganese (HQ_{LOEC} = 1.2).			**Minimal**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}=1.1 (barium for American dipper). **Refined scenario:** Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs.	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of aquatic exposure.

Table 30. Summary of BERA Findings – Transitional Exposure Areas – Aquatic Scenario (BERA Table 8-3)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary				Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles	Overall Wildlife Risk	Birds	Mammals	Overall Wildlife Risk	
Northern Surface Water Feature	**Surface Water:** Minimal Risk. Maximum EPCs > LOEC for aluminum and barium (HQ_{LOEC}=5.9 to 6.3); Aluminum LOEC (NRWQC CMC) exceeded in 2 of 16 samples (HQ_{LOEC}=1.2 to 1.9); filtered aluminum < NOEC. Refined EPC > LOEC for barium (HQ_{LOEC} = 3.8). **Sediment:** Minimal Risk. Maximum EPCsv > LOEC for barium (HQ_{LOEC} = 3.0) and manganese (HQ_{LOEC} = 1.5); maximum EPCs < LOEC for other COPECs. Refined EPC for barium > LOEC (HQ_{LOEC} = 2.0). PAH $ESBTU_{34}$ < 1 for all stations. **Pore water:** Minimal Risk. Maximum barium EPC > LOEC (HQ_{LOEC}=8.0); maximum EPCs > LOEC for other COPECs.			**Minimal**	**Maximum scenario:** Limited potential for adverse effects to American dipper foraging exclusively at maximum EPCs for barium (HQ_{LOAEL}=3.3) and selenium (HQ_{LOAEL}=3.4). HQ_{LOAEL}<1 for other receptors/COPECs based on maximum EPCs. **Refined scenario:** Limited potential for adverse effects to American dipper foraging exclusively at refined EPCs for barium (HQ_{LOAEL}=2.1)and selenium (HQ_{LOAEL}=1.2); HQ_{LOAEL}<1 for other receptors/COPECs based on refined EPCs.	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Minimal**	No further evaluation on the basis of aquatic exposure.

Notes:
HQ: ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.
Table 8-3 from BERA (EHS Support, July 29, 2019)

Table 31. Summary of BERA Findings – Aquatic Exposure Areas (BERA Table 8-4)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

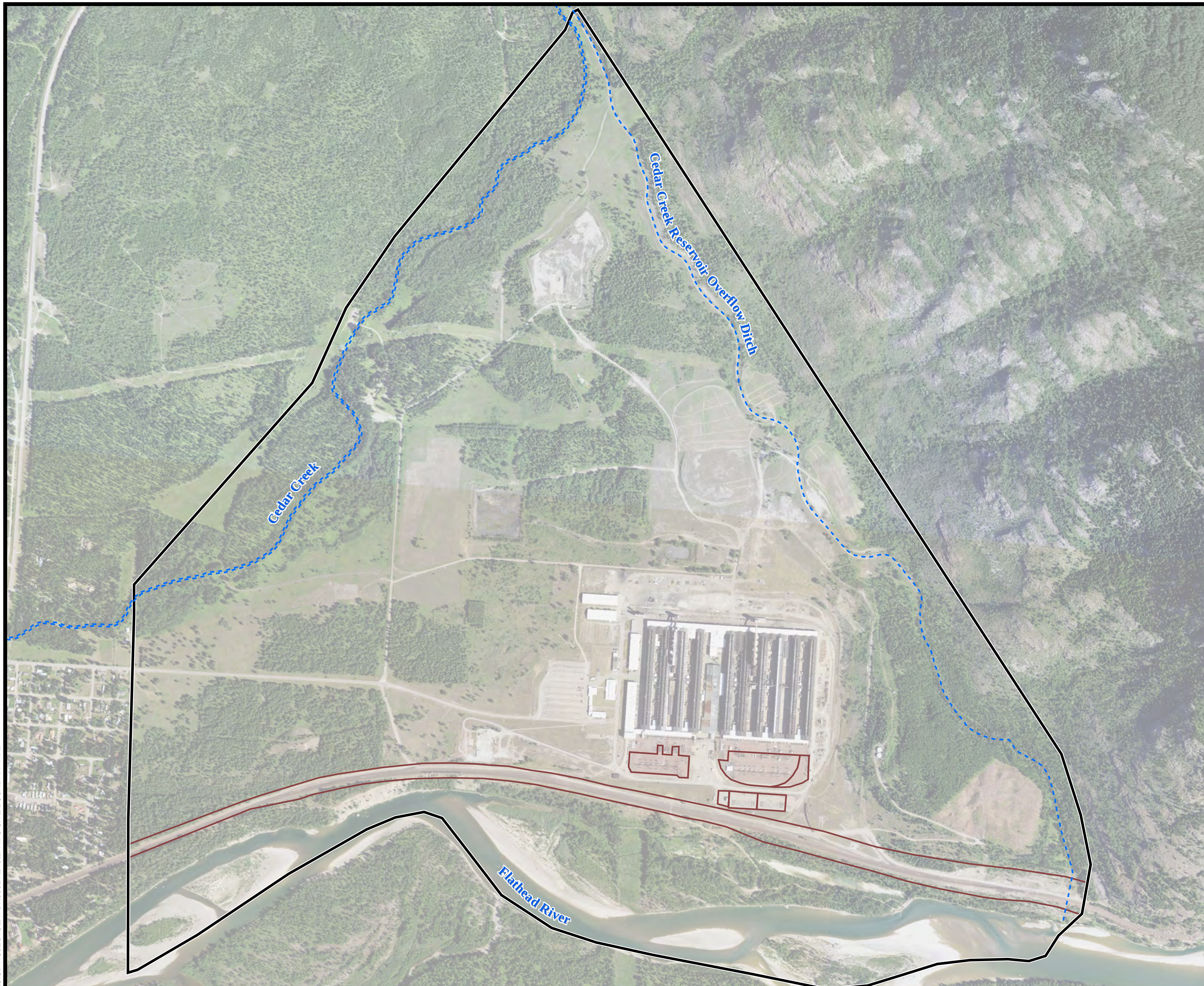
Exposure Area	Direct Contact Exposure Summary				Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles	Overall Wildlife Risk	Birds	Mammals	Overall Wildlife Risk	
Flathead River	**Surface Water:** Moderate risk. Total cyanide exceeds LOEC (acute) in maximum and refined exposure scenarios; free cyanide concentrations result in HQ_{LOEC} 1.1 to 1.2 based on refined exposure scenario. Refined exposure estimate for barium results in HQ_{LOEC}=2.7-3.0. Aluminum LOEC (NRWQC CMC) exceeded in 8 of 76 samples (HQ_{LOEC}=1.6 to 17.7); filtered aluminum < NOEC. **Sediment:** Minimal Risk. Potential exposure to cyanide associated with aqueous exposure to pore water; potential exposure to tPAHs primarily associated with sampling stations in the Backwater Seep Sampling Area with $ESBTU_{34}$ values < 1, except for CFSDP-036 on the Flathead River that had tPAH = 1.35 mg/kg with low TOC (0.01 %) **Pore water:** Moderate Risk. Maximum cyanide (free) exposure in Backwater Seep Sampling Area sampling stations exceed NOEC and LOEC (acute), with HQ_{NOEC} and HQ_{LOEC} of 12.0 and 2.8, respectively. Maximum exposure to barium results in HQLOEC=6.7. Negligible exposure to fluoride (maximum HQ_{NOEC}=1.7; HQ_{LOEC}<1).			**Moderate**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area at maximum EPCs; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	–	**Negligible**	Greatest potential for adverse effects via direct contact exposure is associated with exposure to cyanide, aluminum, and barium in surface water and pore water at stations in the Backwater Seep Sampling Area. Further evaluation of chronic, direct contact exposure to cyanide in surface water and pore water may be warranted.
Flathead River Excluding Backwater Seep Area	**Surface Water:** Minimal Risk. No exceedances of NOEC for total cyanide or free cyanide. Unfiltered aluminum exceeds LOEC (NRWQC CMC) in 3 of 40 samples (HQ_{LOEC}=3.5 to 17.7); filtered aluminum < NOEC. Refined exposure estimate for barium results in HQ_{LOEC}=2.1-2.4. **Sediment:** Minimal Risk. Potential exposure to tPAHs with $ESBTU_{34}$ values > 1 limited to CFSDP-036 (tPAH = 1.35 mg/kg; TOC 0.01 %); AVS-SEM/f_{oc} not indicative of adverse effects to metals; cyanide (free and total) < NOEC. **Pore water:** Minimal Risk. Maximum exposure to barium results in HQ_{LOEC}=6.7; barium concentrations consistent upgradient to downgradient, indicating concentrations are representative of upgradient/background conditions. Cyanide (free and total) < NOEC.			**Minimal**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area at maximum EPCs; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1 for all receptors/COPECs. Maximum EPC for HMW PAHs > NOAEL (HQ_{NOAEL}= 6.7). **Refined scenario:** Negligible risk based on refined EPCs (HQ_{NOAEL}<1).	**Negligible**	Potential for adverse effects is substantially lower in Flathead River sampling stations outside of the Backwater Seep Sampling Area. No further evaluation on the basis of ecological risk for the Flathead River outside of the Backwater Seep Sampling Area.

Table 31. Summary of BERA Findings – Aquatic Exposure Areas (BERA Table 8-4)
Columbia Falls Aluminum Company, LLC, Remedial Investigation Report, 2000 Aluminum Drive, Columbia Falls, MT

Exposure Area	Direct Contact Exposure Summary				Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles	Overall Wildlife Risk	Birds	Mammals	Overall Wildlife Risk	
Flathead River Riparian Channel	**Surface Water:** Moderate Risk. Total cyanide exceeds LOEC (NRWQC CMC) in maximum and refined exposure scenarios; free cyanide concentrations result in HQ_{LOEC} 2.0 to 2.8 based on refined exposure scenario. Refined exposure estimate for barium results in HQ_{LOEC}=6.9-16.1. Aluminum NOEC (NRWQC CCC) exceeded in 6 of 15 samples (HQ_{NOEC}=1.2-41.6); Aluminum LOEC (NRWQC CMC) exceeded in 3 of 15 samples (HQ_{LOEC}=1.8-10.7); filtered aluminum < LOEC. Unfiltered copper > NOEC and LOEC in 2 of 15 samples (HQ_{LOEC}=1.0-2.0); filtered copper < NOEC. **Sediment:** Minimal Risk. Potential exposure to cyanide associated with aqueous exposure to pore water; potential exposure to tPAHs primarily associated with CFSDP-029 nearest the Backwater Seep Sampling Area ($ESBTU_{34}$ = 4.0); $ESBTU_{34}$ values < 1 at other stations. **Pore water:** Moderate Risk**.** Cyanide (free) exceed LOEC (NRWQC CMC) in 3 of 6 samples (max HQ_{LOEC}=7.4 at CFSDP-029); Free cyanide exceeds NOEC in 4 of 6; Maximum barium EPC results in HQ_{LOEC}=10.1. Other COPECs < LOEC; PAHs < NOEC. Aluminum not identified as refined COPEC.			**Moderate**	Not evaluated as a separate wildlife exposure area.	Not evaluated as a separate wildlife exposure area.	**Not Applicable**	Greatest potential for adverse effects via direct contact exposure is associated with exposure to cyanide, aluminum, and barium in surface water and pore water. Further evaluation of chronic, direct contact exposure to cyanide in surface water and pore water may be warranted.
Cedar Creek	**Surface Water:** Negligible risk; Refined exposure estimate results in barium HQ_{LOEC}=2.7-2.8; however, barium concentrations consistent with background. Maximum cyanide EPC < LOEC. No other refined COPECs. **Sediment:** Negligible risk; Maximum exposure to cyanide, barium, manganese, and ESBTUs < LOEC; HQ_{NOEC} values range from 1.2 (manganese) to 2.4 (cyanide). **Pore water:**-Negligible risk; Maximum exposure to resulting in HQ_{LOEC} values of 6.9 and 1.2 for barium and manganese, respectively; however, barium concentrations consistent with upgradient/background conditions.			**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}=1.3 (selenium) **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum exposure to cadmium and selenium > NOAEL (HQ_{NOAEL}=2.0-2.4); maximum HQ_{LOAEL}<1. **Refined scenario**: Negligible risk based on refined EPCs (HQ_{NOAEL}<1).	**Negligible**	No further evaluation on the basis of ecological risk.

Notes:
HQ: ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.
Table 8-4 from BERA (EHS Support, July 29, 2019)

FIGURES



V:\GIS\PROJECTS\2476Y\0001Y\249\1. RIFS SITE BOUNDARY.MXD

Title:

RI/FS SITE BOUNDARY

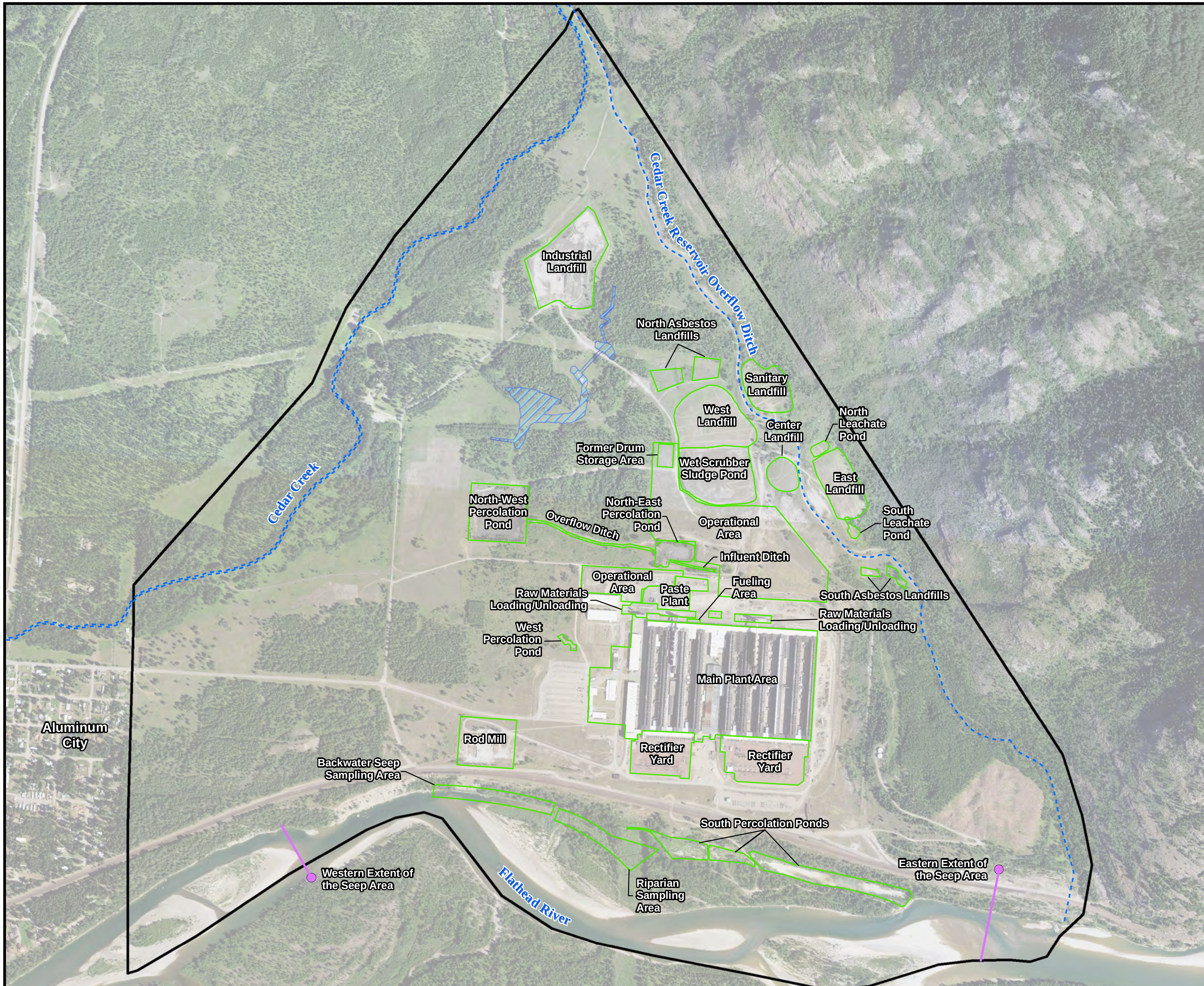
2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 09/23/19	FIGURE
Prepared by: M.S.R.	Scale: AS SHOWN	1
Project Mgr: L.J.	Project: 2476.0001Y008	
File: 1. RIFS Site Boundary.mxd		



N

LEGEND

- MARKER IDENTIFYING THE EXTENT OF THE SEEP AREA AS DEFINED IN THE MPDES PERMIT
- SITE FEATURES
- CREEK FEATURES
- NORTHERN SURFACE WATER FEATURE EXTENT
- SITE BOUNDARY

1,000 0 1,000'

Title:

SITE FEATURES

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 09/09/19	FIGURE
Prepared by: M.S.R.	Scale: AS SHOWN	2
Project Mgr: L.J.	Project: 2476.0001Y008	
File: 2. Site Features.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\249\2. SITE FEATURES.MXD

N

LEGEND

CREEK FEATURES
SITE BOUNDARY
1 MAIN PLANT AREA
2 NORTH PERCOLATION POND AREA
3 CENTRAL LANDFILLS AREA
4 INDUSTRIAL LANDFILL AREA
5 EASTERN UNDEVELOPED AREA
6 NORTH-CENTRAL UNDEVELOPED AREA
7 WESTERN UNDEVELOPED AREA
8 SOUTH PERCOLATION POND AREA
9 FLATHEAD RIVER AREA
9A BACKWATER SEEP SAMPLING AREA

1,000 0 1,000'

Title:

HUMAN HEALTH RISK ASSESSMENT EXPOSURE AREAS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

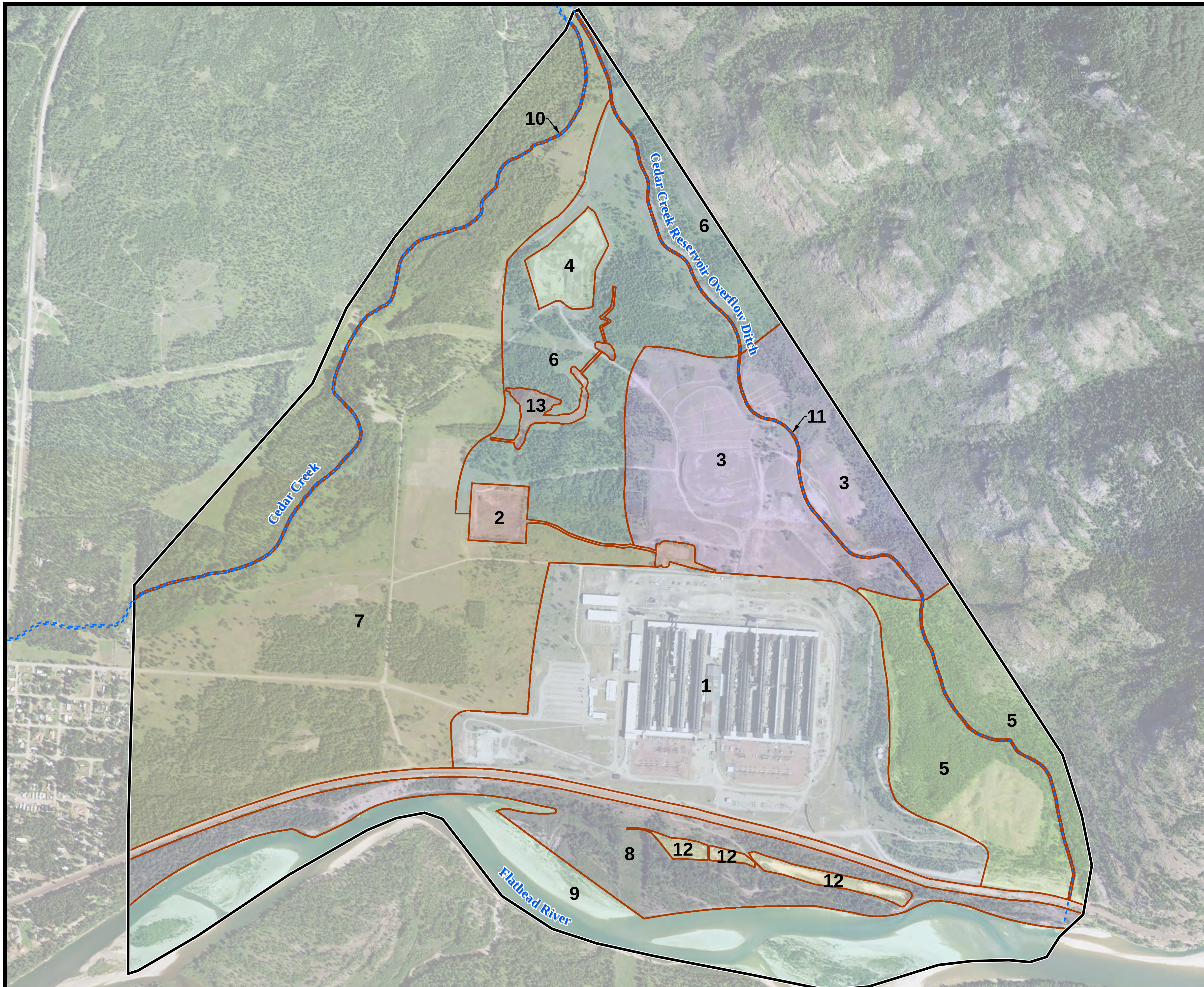
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 09/23/19	FIGURE
Prepared by: M.S.R.	Scale: AS SHOWN	3
Project Mgr: L.J.	Project: 2476.0001Y008	
File: 3. HH Risk Exposure Area.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\2491\3. HH RISK EXPOSURE AREA.MXD



LEGEND

	CREEK FEATURES
	SITE BOUNDARY
1	MAIN PLANT AREA
2	NORTH PERCOLATION POND AREA
3	CENTRAL LANDFILLS AREA
4	INDUSTRIAL LANDFILL AREA
5	EASTERN UNDEVELOPED AREA
6	NORTH-CENTRAL UNDEVELOPED AREA
7	WESTERN UNDEVELOPED AREA
8	FLATHEAD RIPARIAN AREA
9	FLATHEAD RIVER AREA
10	CEDAR CREEK
11	CEDAR CREEK RESERVOIR OVERFLOW DITCH
12	SOUTH PERCOLATION PONDS
13	NORTHERN SURFACE WATER FEATURE

Title:

ECOLOGICAL RISK ASSESSMENT EXPOSURE AREAS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

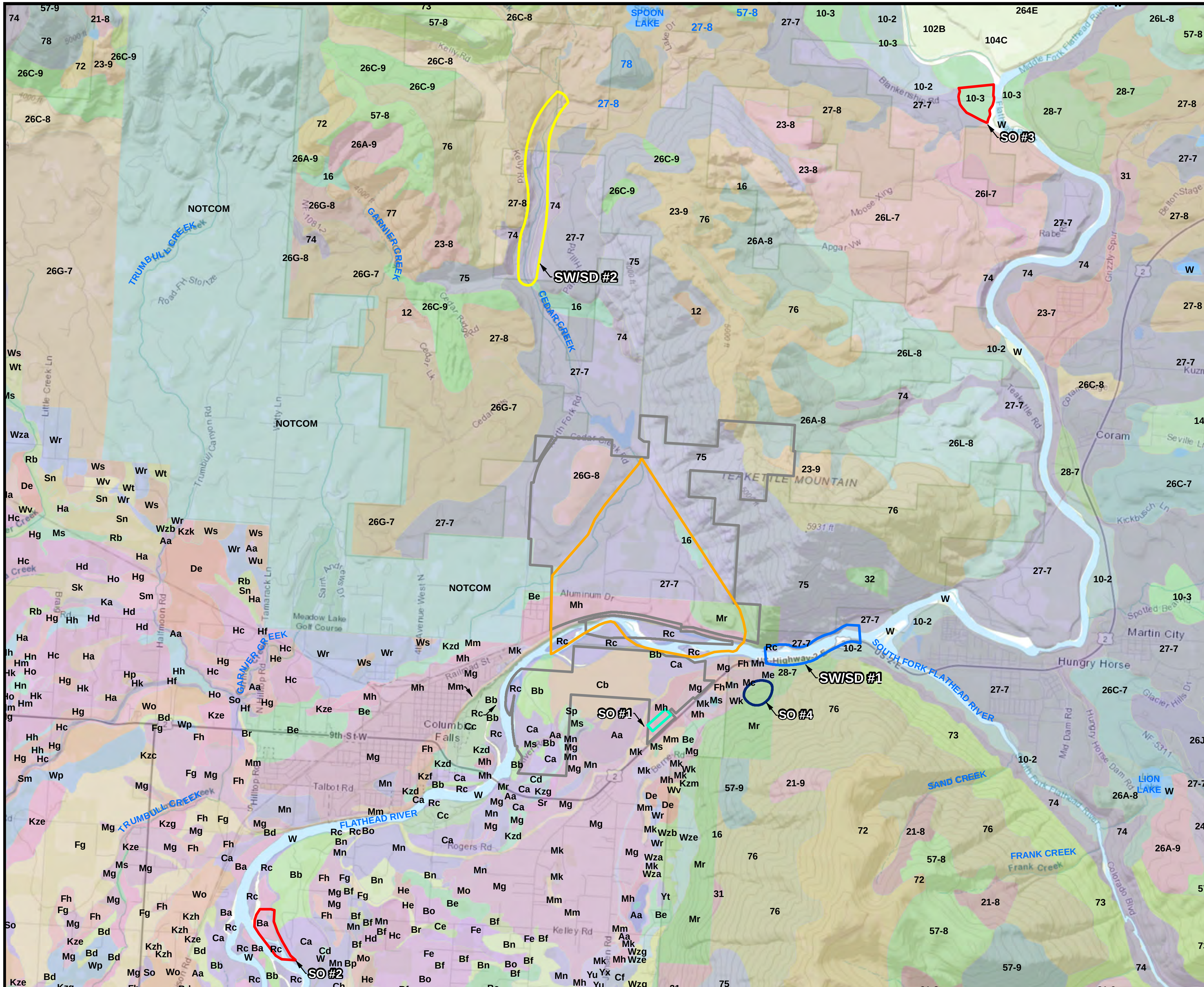
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 09/09/19	FIGURE
Prepared by: M.S.R.	Scale: AS SHOWN	4
Project Mgr: L.J.	Project: 2476.0001Y008	
File: 4. Eco Risk Exposure Area.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\249\4. ECO RISK EXPOSURE AREA.MXD



N

LEGEND

- SITE BOUNDARY
- APPROXIMATE CFAC OWNED PROPERTY
- SW/SD #1 — SURFACE WATER/SEDIMENT BACKGROUND REFERENCE AREA #1: UPGRADIENT FLATHEAD RIVER
- SW/SD #2 — SURFACE WATER/SEDIMENT BACKGROUND REFERENCE AREA #2: UPGRADIENT CEDAR CREEK
- SO #1 — SOIL BACKGROUND REFERENCE AREA #1: GLACIAL TILL AND ALLUVIUM
- SO #2 / 3 — SOIL BACKGROUND REFERENCE AREA #2/3: FLUVIAL DEPOSITS AND RIVERWASH
- SO #4 — SOIL BACKGROUND REFERENCE AREA #4: MOUNTAINOUS LAND WITH GLACIAL DEPOSITS

SOURCE

1. US DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE SOIL SURVEY

5,000 0 5,000'

Title:

BACKGROUND SOIL AND SURFACE WATER REFERENCE AREA LOCATIONS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

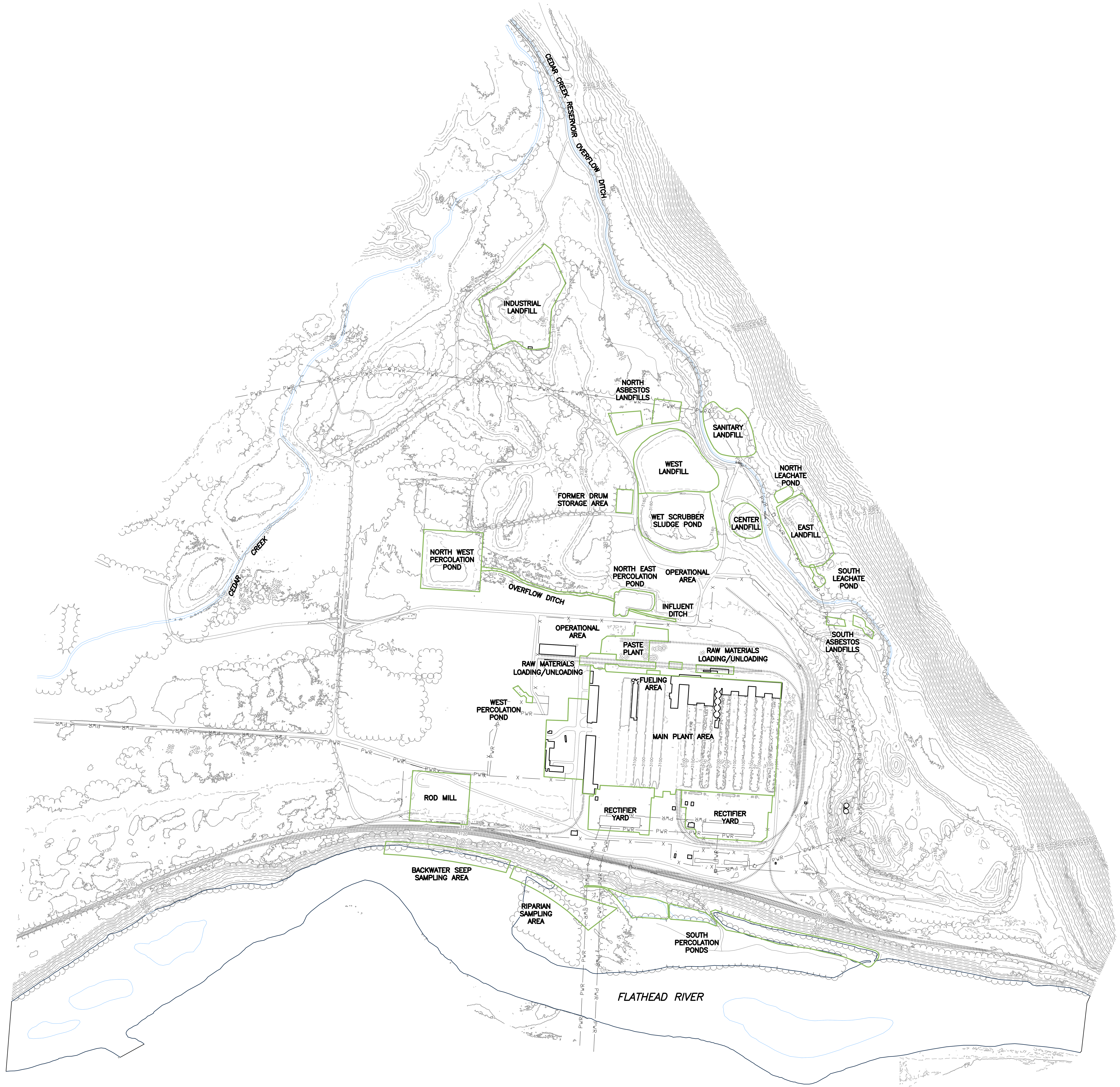
COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 09/09/19	FIGURE
Prepared by: M.S.R.	Scale: AS SHOWN	5
Project Mgr: L.J.	Project: 2476.0001Y008	
File: 5. Background Reference Sampling Areas.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\2495. BACKGROUND REFERENCE SAMPLING AREAS.MXD

PLATES



LEGEND

- MAJOR CONTOUR (5.0' INTERVAL)
- MINOR CONTOUR (1.0' INTERVAL)
- BUILDING
- ROAD/TRAIL
- WATER LINE (05/24/2018)
- TREE LINE
- FENCE
- RAILROAD
- OVERHEAD POWER
- POWER SUBSTATION/TOWER
- CULVERT OPENING
- CULVERT

N

500' 0 500'

Title:

TOPOGRAPHIC SURVEY
MAY 22, 2018

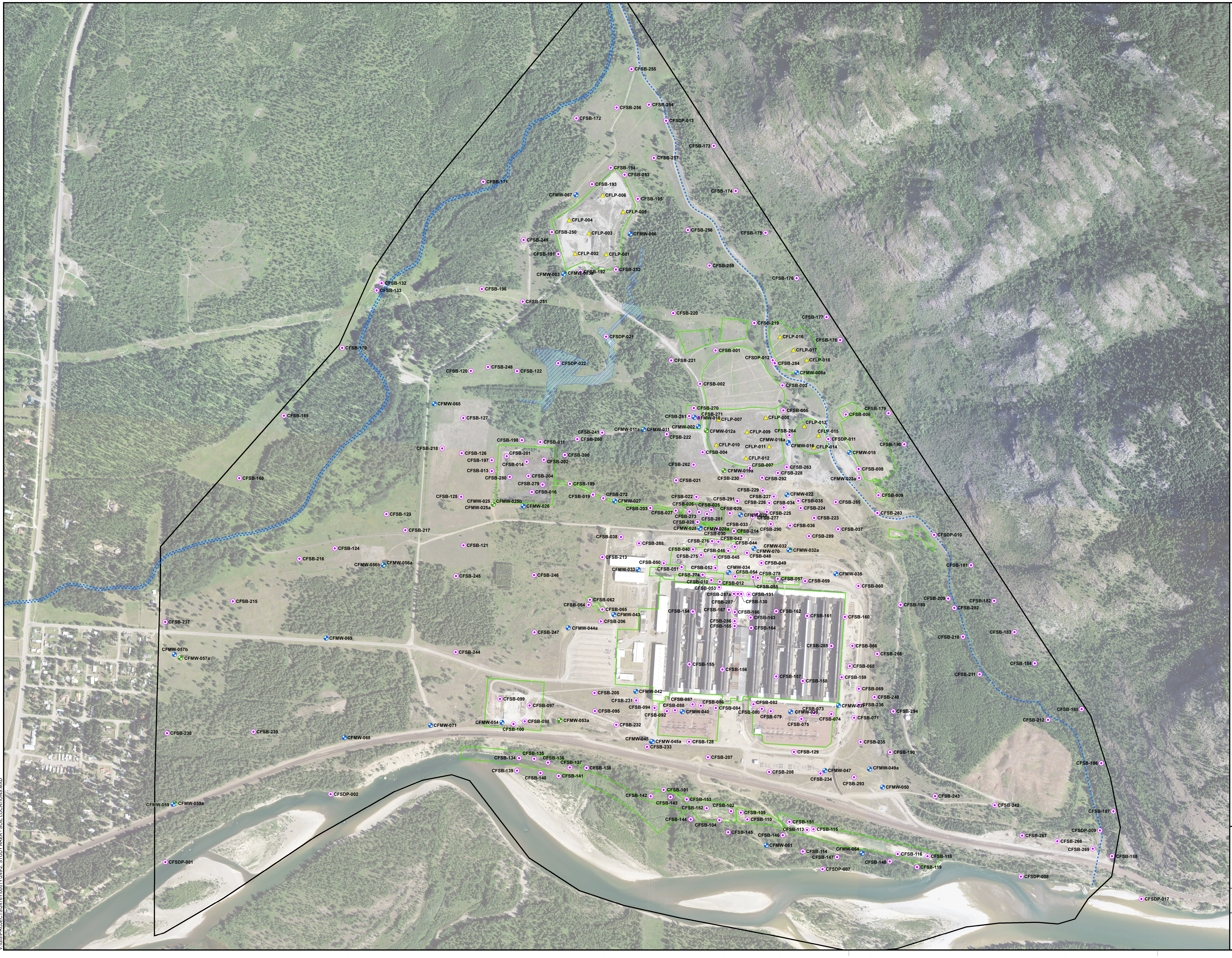
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: M.L.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	1
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.07.DWG		



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LEGEND

- MONITORING WELL LOCATIONS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
- MONITORING WELL LOCATIONS SCREENED IN UPPER HYDROGEOLOGIC UNIT
- SOIL BORING LOCATIONS
- LANDFILL CAP SOIL SAMPLE LOCATIONS
- CREEK FEATURES
- NORTHERN SURFACE WATER FEATURE EXTENT
- SITE FEATURES
- SITE BOUNDARY

425 0 425'

Title:

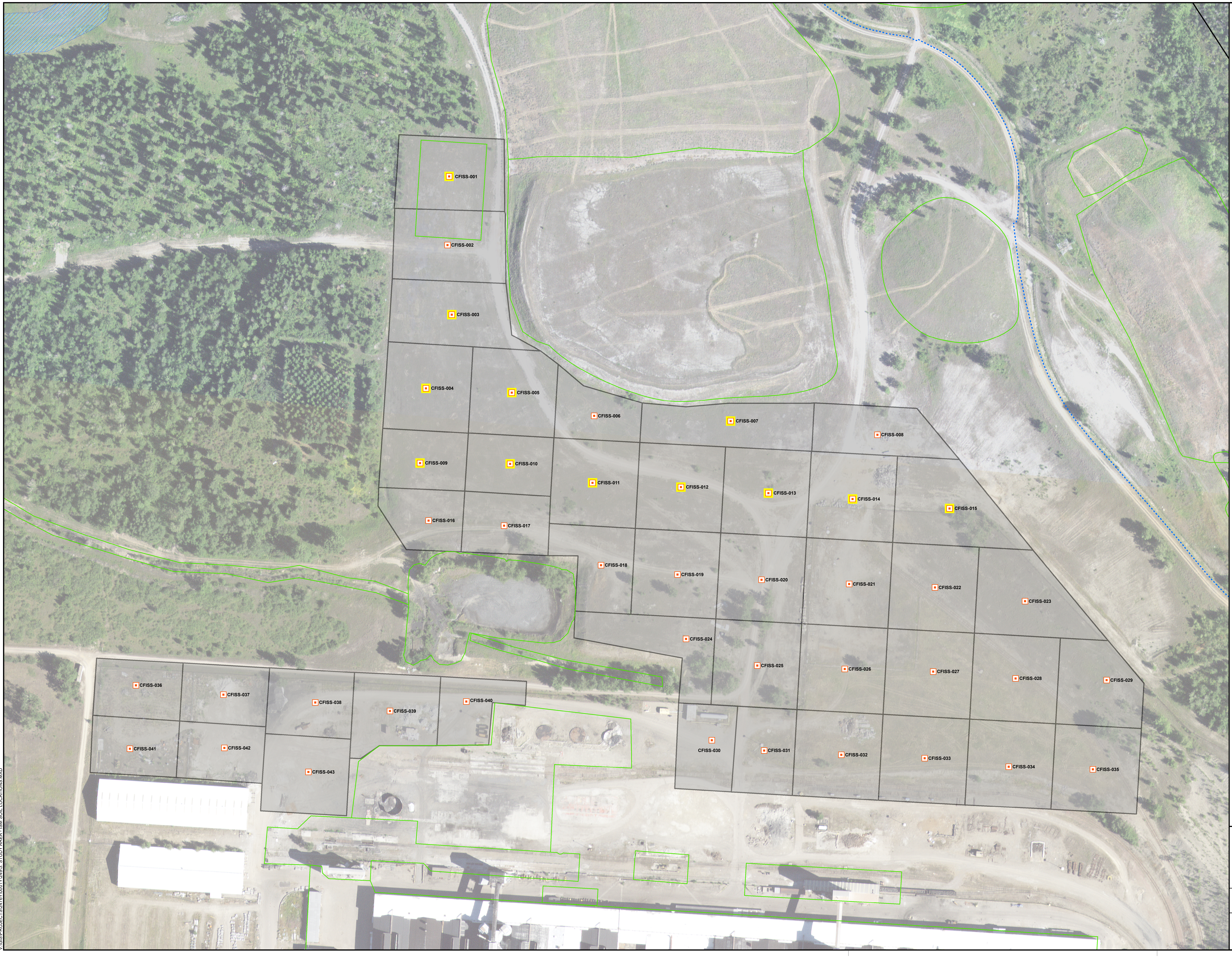
STUDY AREA SOIL SAMPLING LOCATIONS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

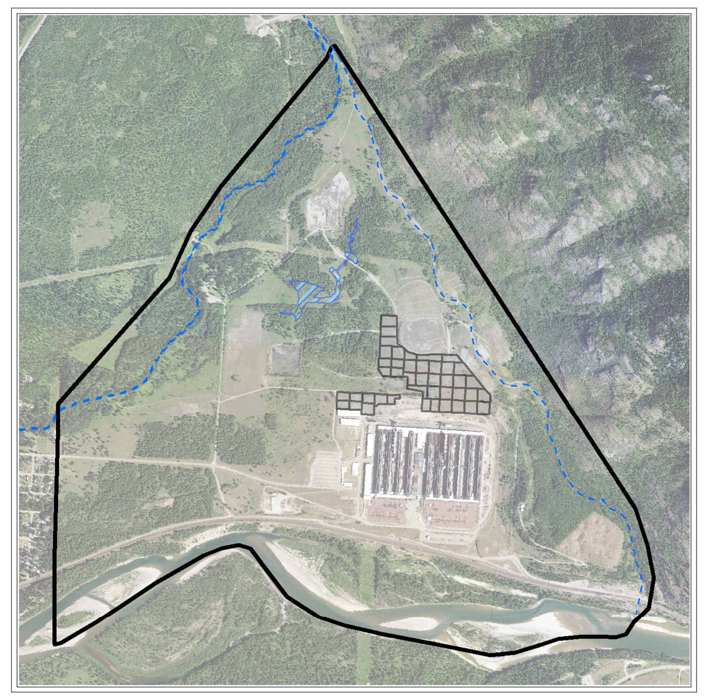
COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX	Compiled by: MB.L.	Date: 01/22/20	PLATE
	Prepared by: M.S.R.	Scale: AS SHOWN	2
	Project Mgr: L.J.	2476.0001Y008	
	File: 2. Study Area - Soil Locations.mxd		



N

LEGEND
- PHASE 1 ISM SOIL SAMPLES
- PHASE 2 ISM SOIL SAMPLES
- CREEK FEATURES
- OPERATIONAL GRID AREA
- NORTHERN SURFACE WATER FEATURE EXTENT
- SITE FEATURES
- SITE BOUNDARY



100 0 100'

Title:

STUDY AREA ISM SOIL SAMPLING LOCATIONS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

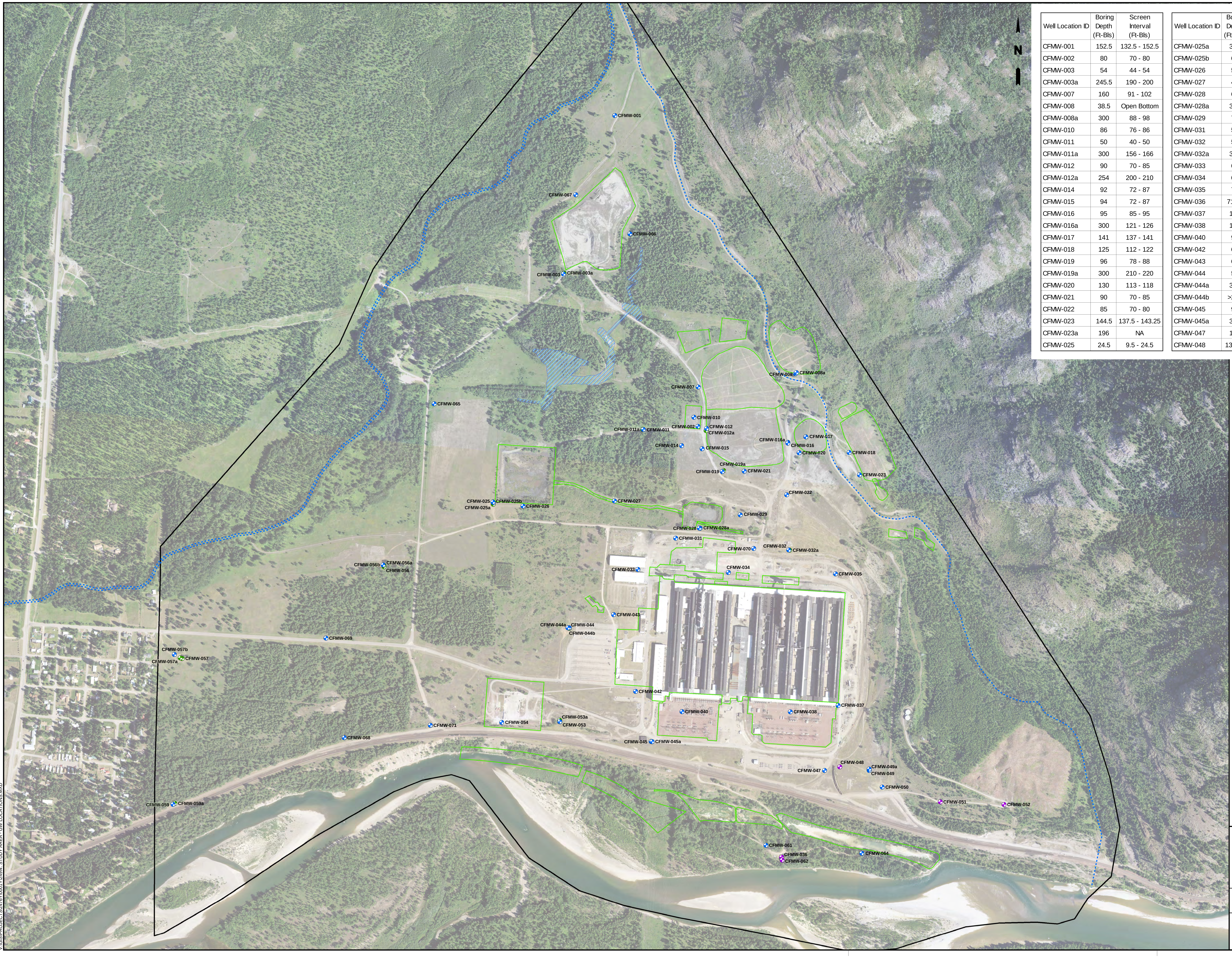
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 01/22/20	PLATE
Prepared by: M.S.R.	Scale: AS SHOWN	3
Project Mgr: L.J.	2476.0001Y008	
File: 3. Study Area - ISM Soil Locations.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\249\3. STUDY AREA - ISM SOIL LOCATIONS.MXD



Well Location ID	Boring Depth (Ft-Bls)	Screen Interval (Ft-Bls)
CFMW-001	152.5	132.5 - 152.5
CFMW-002	80	70 - 80
CFMW-003	54	44 - 54
CFMW-003a	245.5	190 - 200
CFMW-007	160	91 - 102
CFMW-008	38.5	Open Bottom
CFMW-008a	300	88 - 98
CFMW-010	86	76 - 86
CFMW-011	50	40 - 50
CFMW-011a	300	156 - 166
CFMW-012	90	70 - 85
CFMW-012a	254	200 - 210
CFMW-014	92	72 - 87
CFMW-015	94	72 - 87
CFMW-016	95	85 - 95
CFMW-016a	300	121 - 126
CFMW-017	141	137 - 141
CFMW-018	125	112 - 122
CFMW-019	96	78 - 88
CFMW-019a	300	210 - 220
CFMW-020	130	113 - 118
CFMW-021	90	70 - 85
CFMW-022	85	70 - 80
CFMW-023	144.5	137.5 - 143.25
CFMW-023a	196	NA
CFMW-025	24.5	9.5 - 24.5

Well Location ID	Boring Depth (Ft-Bls)	Screen Interval (Ft-Bls)
CFMW-025a	300	85 - 95
CFMW-025b	60	45 - 60
CFMW-026	50	35 - 45
CFMW-027	45	35 - 45
CFMW-028	60	50 - 60
CFMW-028a	300	110 - 120
CFMW-029	76	66 - 76
CFMW-031	50	35 - 50
CFMW-032	55	45 - 55
CFMW-032a	300	195 - 205
CFMW-033	60	50 - 60
CFMW-034	60	50 - 60
CFMW-035	70	60 - 70
CFMW-036	71.73	63.73 - 71.73
CFMW-037	100	90 - 100
CFMW-038	105	95 - 105
CFMW-040	90	80 - 90
CFMW-042	60	50 - 60
CFMW-043	60	50 - 60
CFMW-044	53	Open Bottom
CFMW-044a	300	100 - 110
CFMW-044b	>200	Open Bottom
CFMW-045	96	86 - 96
CFMW-045a	300	150 - 160
CFMW-047	120	110 - 120
CFMW-048	131.15	121.15 - 131.15

Well Location ID	Boring Depth (Ft-Bls)	Screen Interval (Ft-Bls)
CFMW-049	113	100 - 111
CFMW-049a	30	138 - 148
CFMW-050	120	110 - 120
CFMW-051	82.34	49.19 - 73.36
CFMW-052	86.83	66.07 - 86.83
CFMW-053	77	47 - 77
CFMW-053a	300	150 - 160
CFMW-054	85	75 - 85
CFMW-056	181.08	Open Bottom
CFMW-056a	294	125 - 135
CFMW-056b	50	40 - 50
CFMW-057	185.75	NA
CFMW-057a	300	128 - 138
CFMW-057b	40	30 - 40
CFMW-059	90	80 - 90
CFMW-059a	300	158 - 168
CFMW-061	25	13 - 23
CFMW-062	80	72.34 - 80.34
CFMW-064	30	20 - 30
CFMW-065	37	27 - 27
CFMW-066	35	25 - 35
CFMW-067	35	25 - 35
CFMW-068	85	75 - 85
CFMW-069	55	45 - 55
CFMW-070	60	50 - 60
CFMW-071	105	95 - 105

LEGEND

- MONITORING WELL LOCATIONS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
- MONITORING WELL LOCATIONS SCREENED IN UPPER HYDROGEOLOGIC UNIT
- FORMER PRODUCTION WELL LOCATIONS
- CREEK FEATURES
- NORTHERN SURFACE WATER FEATURE EXTENT
- SITE FEATURES
- SITE BOUNDARY

425 0 425'

Title:

STUDY AREA GROUNDWATER SAMPLING LOCATIONS

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

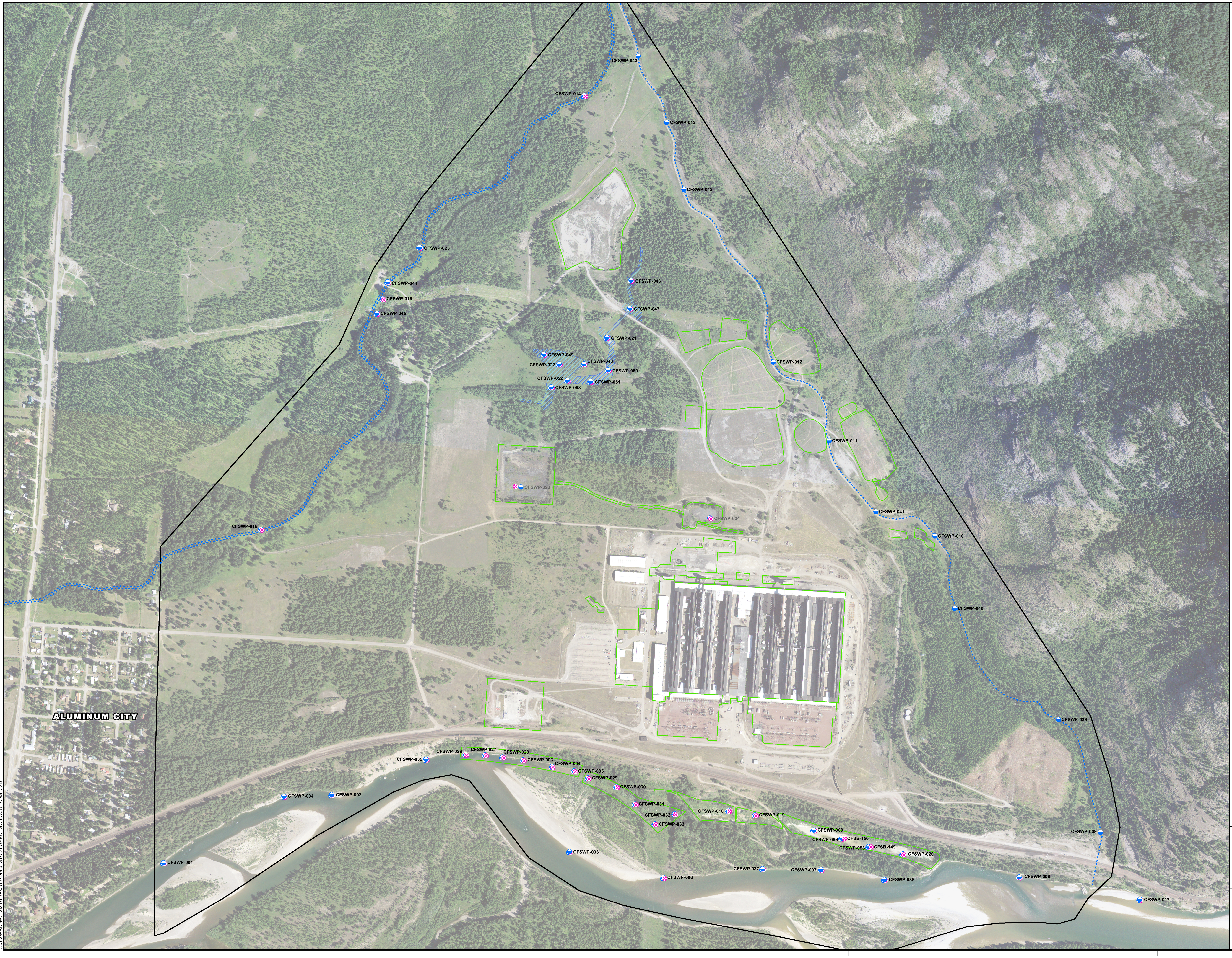
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: MB.L.	Date: 01/22/20	PLATE
Prepared by: M.S.R.	Scale: AS SHOWN	4
Project Mgr: L.J.	2476.0001Y008	
File: 4. Study Area - GW Locations.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\2494_STUDY AREA - GW LOCATIONS.MXD



N

LEGEND

- SURFACE WATER SAMPLE LOCATIONS
- POREWATER SAMPLE LOCATIONS
- SEDIMENT SAMPLE LOCATIONS
- CREEK FEATURES
- NORTHERN SURFACE WATER FEATURE EXTENT
- SITE FEATURES
- SITE BOUNDARY

425 0 425'

Title: **STUDY AREA SURFACE WATER, SEDIMENT, AND SEDIMENT POREWATER SAMPLING LOCATIONS**

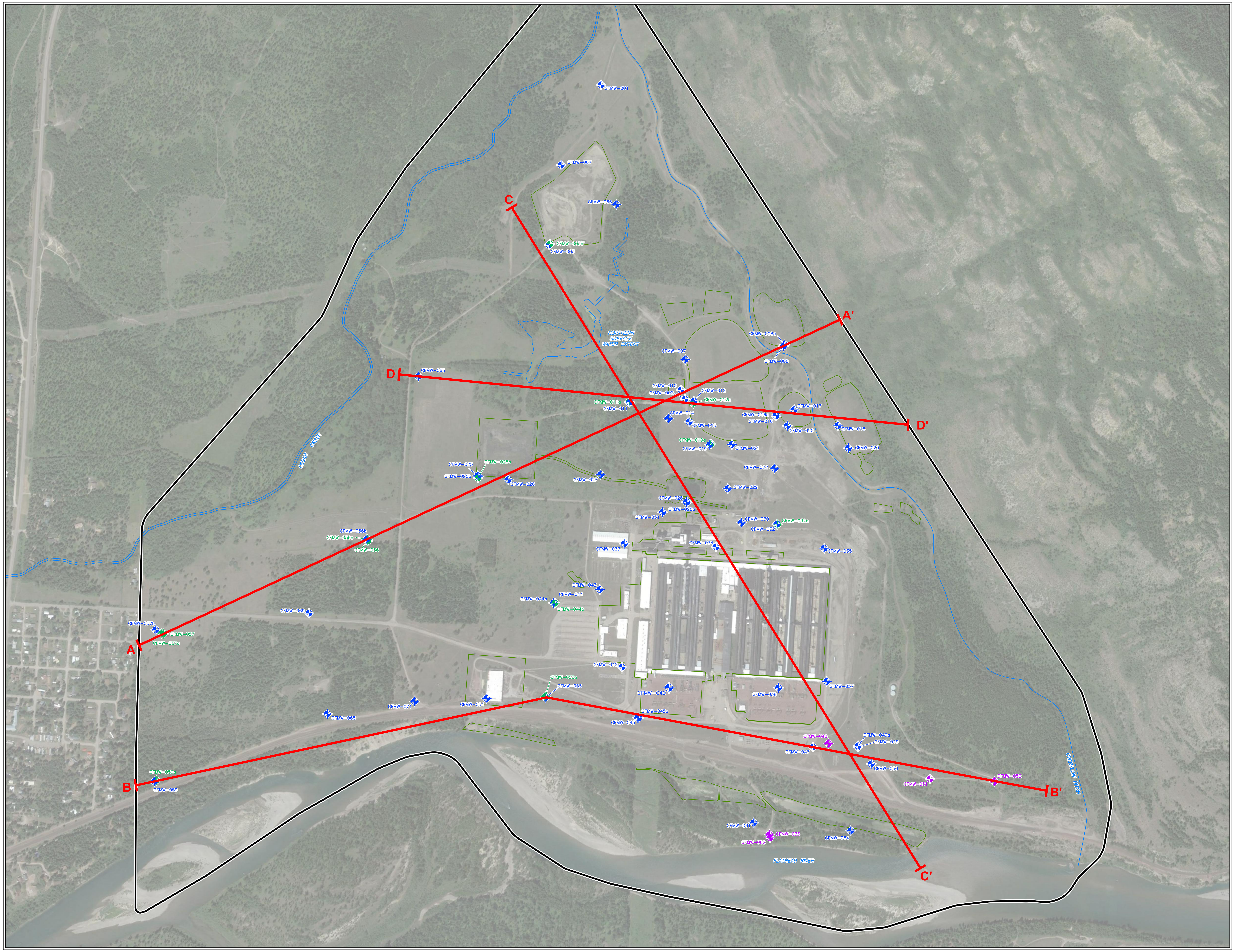
2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX	Compiled by: MB.L.	Date: 01/22/20	PLATE
	Prepared by: M.S.R.	Scale: AS SHOWN	5
	Project Mgr: L.J.	2476.0001Y008	
	File: 5. Study Area - SW Locations.mxd		

V:\GIS\PROJECTS\2476Y\0001Y\26\5. STUDY AREA - SW LOCATIONS.MXD



LEGEND

- RI/FS SITE BOUNDARY
- SURFACE WATER FEATURE
- SITE FEATURE
- CFMW-035 — LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
- CFMW-052 — LOCATION AND DESIGNATION OF FORMER PRODUCTION WELL
- CFMW-032a — LOCATION AND DESIGNATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
- A — TRANSECT LINE

N

425' 0 425'

Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION TRANSECTS

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

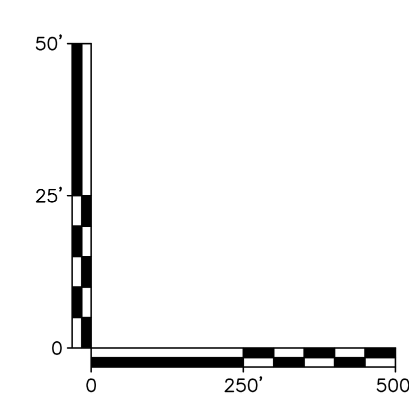
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX	Compiled by: L.J.	Date: 22JAN20	PLATE
	Prepared by: G.M.	Scale: AS SHOWN	6
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.08.DWG		

GEOLOGIC CROSS SECTION A–A'

HORIZONTAL SCALE: 1" = 250'
VERTICAL SCALE: 1" = 25'
VERTICAL EXAGGERATION = 10X

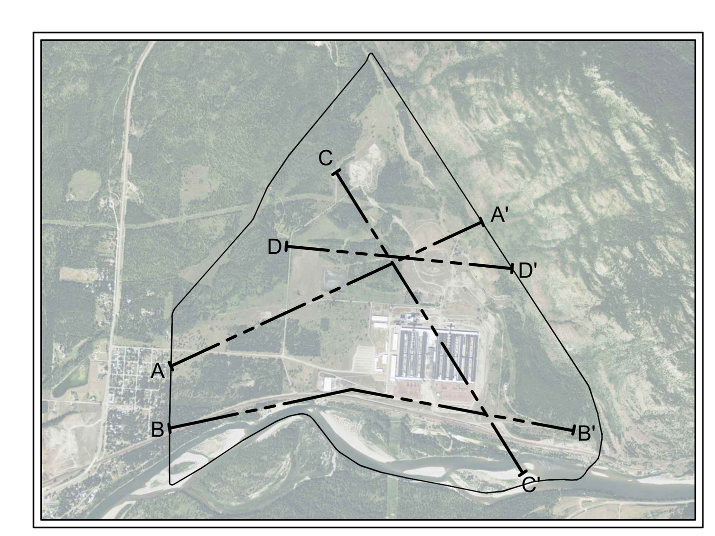


LEGEND

FINE TO COARSE SAND WITH VARYING AMOUNTS OF GRAVEL AND SILT (OUTWASH/ALLUVIUM)	BEDROCK
PRIMARILY SILT (TILL)	POTENTIOMETRIC HEAD GROUNDWATER ELEVATION
PRIMARILY CLAY WITH SOME SILT AND VARYING AMOUNTS OF SANDS AND GRAVELS (TILL)	MONITORING WELL GROUNDWATER SCREENED IN THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
FINE TO COARSE SAND AND SILT WITH VARYING AMOUNTS OF GRAVEL AND CLAY (TILL)	MONITORING WELL GROUNDWATER SCREENED BELOW THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT

NOTES

1. POTENTIOMETRIC HEAD GROUNDWATER ELEVATIONS ARE BASED ON JUNE 4/5, 2018 GAUGING DATA.
2. HISTORIC WELL LOGS FOR MONITORING WELLS CFMW–008 (TW–9), CFMW–057 (TW–12) AND CFMW–056 (TW–11) DID NOT PROVIDE WELL SCREEN INFORMATION.



Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION A-A'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	7
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.09.DWG		

GEOLOGIC CROSS SECTION B–B'

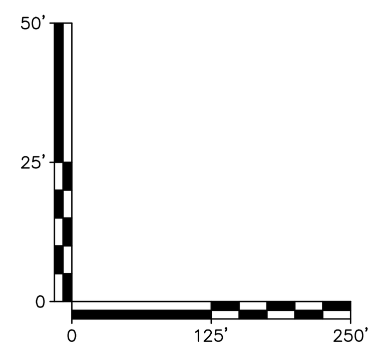
HORIZONTAL SCALE: 1" = 125'
VERTICAL SCALE: 1" = 25'
VERTICAL EXAGGERATION = 5X

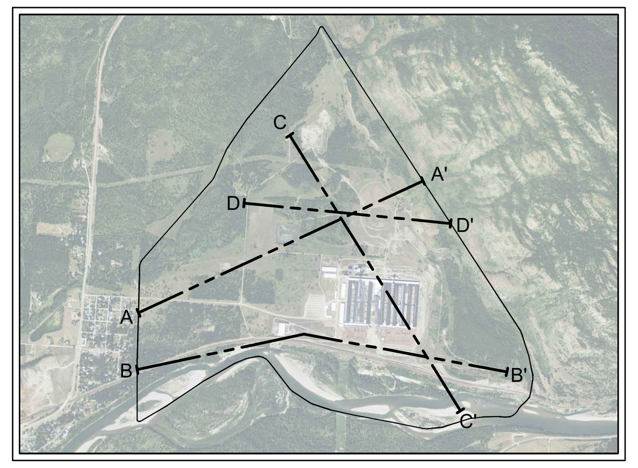
LEGEND

	FINE TO COARSE SAND WITH VARYING AMOUNTS OF GRAVEL AND SILT (OUTWASH/ALLUVIUM)
	PRIMARILY CLAY WITH SOME SILT AND VARYING AMOUNTS OF SANDS AND GRAVELS (TILL)
	PRIMARILY SILT (TILL)
	FINE TO COARSE SAND AND SILT WITH VARYING AMOUNTS OF GRAVEL AND CLAY (TILL)
	POTENTIOMETRIC HEAD GROUNDWATER ELEVATION
▼	MONITORING WELL GROUNDWATER SCREENED IN THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
▼	MONITORING WELL GROUNDWATER SCREENED BELOW THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT

NOTE

1. POTENTIOMETRIC HEAD GROUNDWATER ELEVATIONS ARE BASED ON JUNE 4/5, 2018 GAUGING DATA.
2. HISTORIC WELL LOGS FOR MONITORING WELLS CFMW–051 (PW–5) AND CFMW–052 (PW–4) PROVIDED INCORRECT WELL SCREEN INFORMATION.





Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION B-B'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COPANY, LLC

ROUX	Compiled by: L.J.	Date: 22JAN20	PLATE
	Prepared by: G.M.	Scale: AS SHOWN	8
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.10.DWG		

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GEOLOGIC CROSS SECTION C–C'

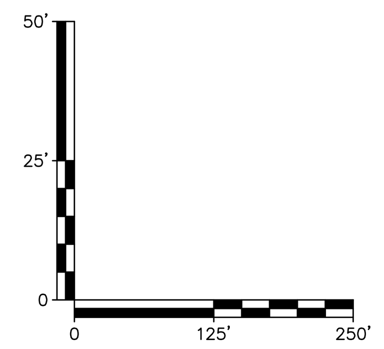
HORIZONTAL SCALE: 1" = 125'
VERTICAL SCALE: 1" = 25'
VERTICAL EXAGGERATION = 5X

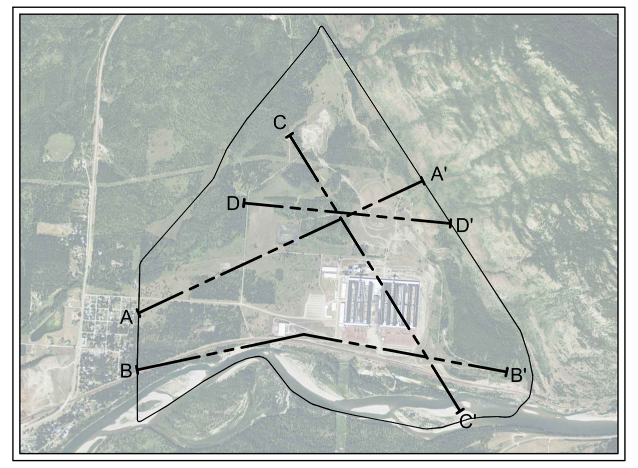
LEGEND

FINE TO COARSE SAND WITH VARYING AMOUNTS OF GRAVEL AND SILT (OUTWASH/ALLUVIUM)	POTENTIOMETRIC HEAD GROUNDWATER ELEVATION
PRIMARILY SILT (TILL)	MONITORING WELL GROUNDWATER SCREENED IN THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
FINE TO COARSE SAND AND SILT WITH VARYING AMOUNTS OF GRAVEL AND CLAY (TILL)	MONITORING WELL GROUNDWATER SCREENED BELOW THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
PRIMARILY CLAY WITH SOME SILT AND VARYING AMOUNTS OF SANDS AND GRAVELS (TILL)	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT

NOTE

POTENTIOMETRIC HEAD GROUNDWATER ELEVATIONS ARE BASED ON JUNE 4/5, 2018 GAUGING DATA.





Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION C-C'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COPANY, LLC

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	9
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.10.DWG		

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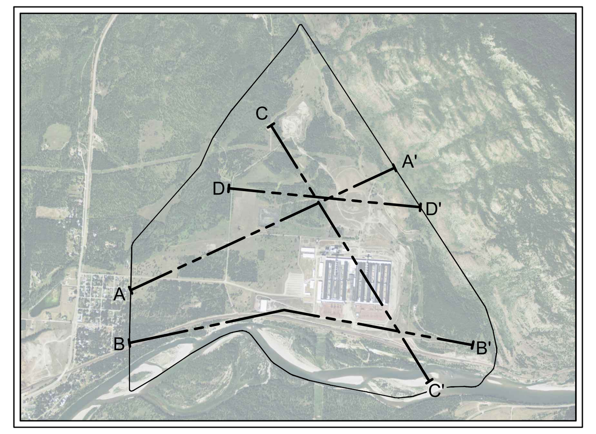
GEOLOGIC CROSS SECTION D–D'
HORIZONTAL SCALE: 1" = 125'
VERTICAL SCALE: 1" = 25'
VERTICAL EXAGGERATION = 5X

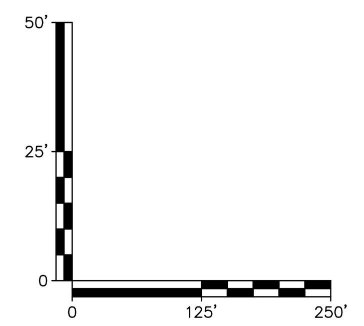
LEGEND

- FINE TO COARSE SAND WITH VARYING AMOUNTS OF GRAVEL AND SILT (OUTWASH/ALLUVIUM)
- PRIMARILY CLAY WITH SOME SILT AND VARYING AMOUNTS OF SANDS AND GRAVELS (TILL)
- FINE TO COARSE SAND AND SILT WITH VARYING AMOUNTS OF GRAVEL AND CLAY (TILL)
- BEDROCK
- POTENTIOMETRIC HEAD GROUNDWATER ELEVATION
- MONITORING WELL GROUNDWATER SCREENED IN THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
- MONITORING WELL GROUNDWATER SCREENED BELOW THE UPPER HYDROGEOLOGIC UNIT POTENTIOMETRIC SURFACE
- INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT

NOTE

POTENTIOMETRIC HEAD GROUNDWATER ELEVATIONS ARE BASED ON JUNE 4/5, 2018 GAUGING DATA.





Title:

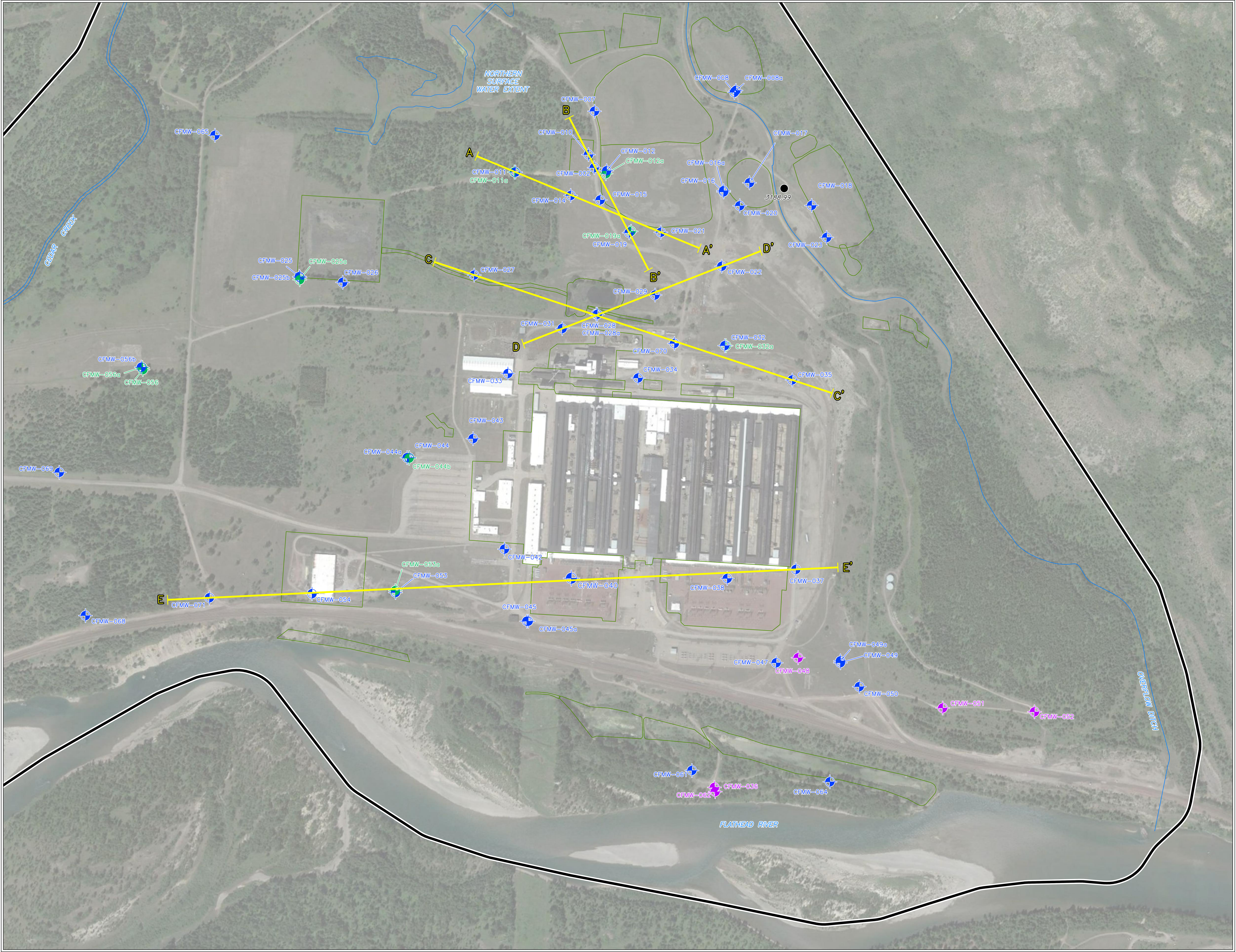
GENERALIZED HYDROGEOLOGIC CROSS SECTION D-D'

Prepared for:

COLUMBIA FALLS ALUMINUM COPANY, LLC

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	10
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.11.DWG		



LEGEND

- RI/FS SITE BOUNDARY
- SURFACE WATER FEATURE
- SITE FEATURE
- CFMW-035 — LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
- CFMW-052 — LOCATION AND DESIGNATION OF FORMER PRODUCTION WELL
- CFMW-032a — LOCATION AND DESIGNATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
- A — TRANSECT LINE

NOTE

MONITORING WELLS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT ARE NOT USED IN CONTOURING.

N

300' 0 300'

Title:

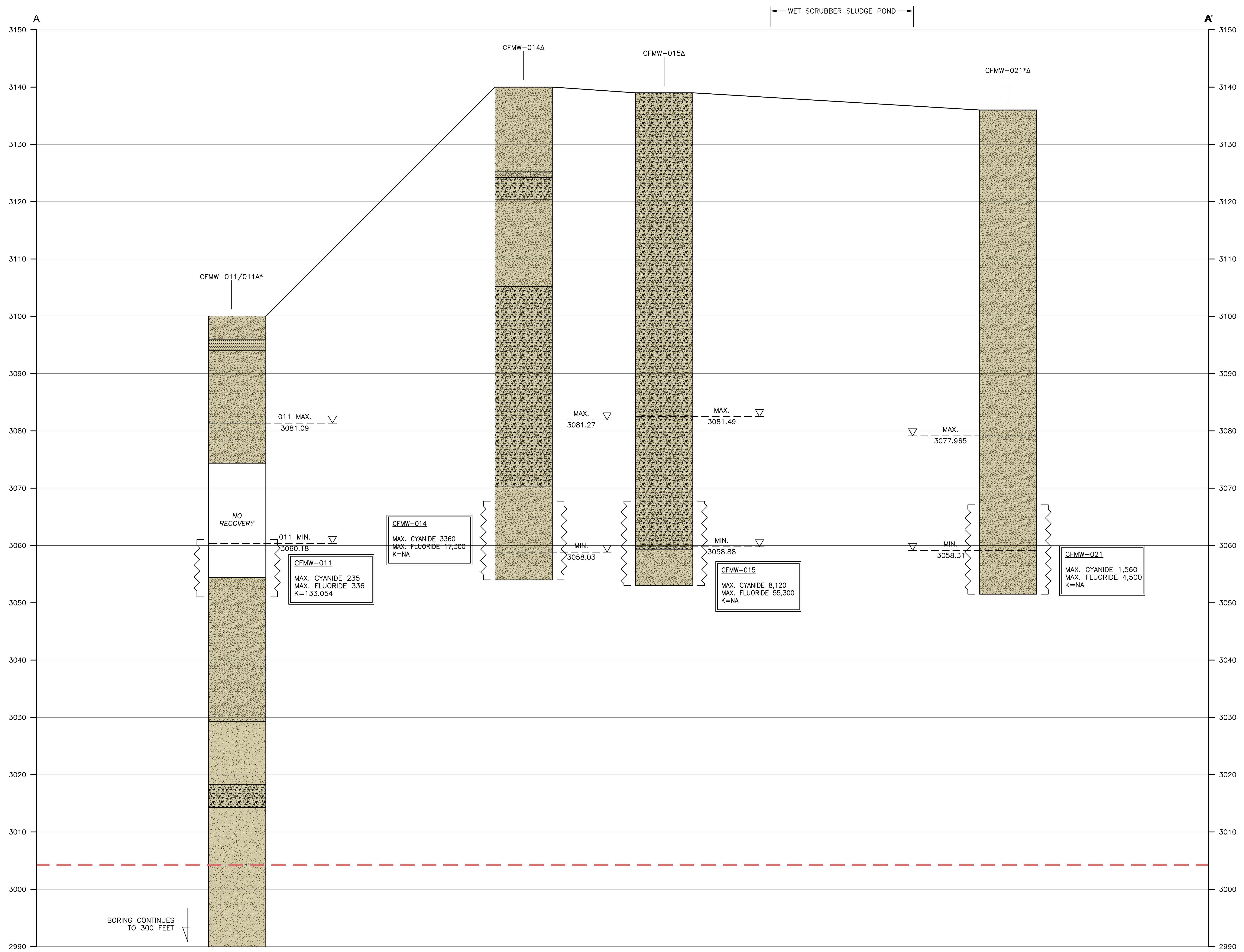
DETAILED HYDROGEOLOGIC CROSS SECTION TRANSECTS

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX	Compiled by: L.J.	Date: 22JAN20	PLATE
	Prepared by: G.M.	Scale: AS SHOWN	11
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.06.DWG		



HYDROGEOLOGIC CROSS SECTION A–A'

HORIZONTAL SCALE: 1" = 85'
VERTICAL SCALE: 1" = 10'

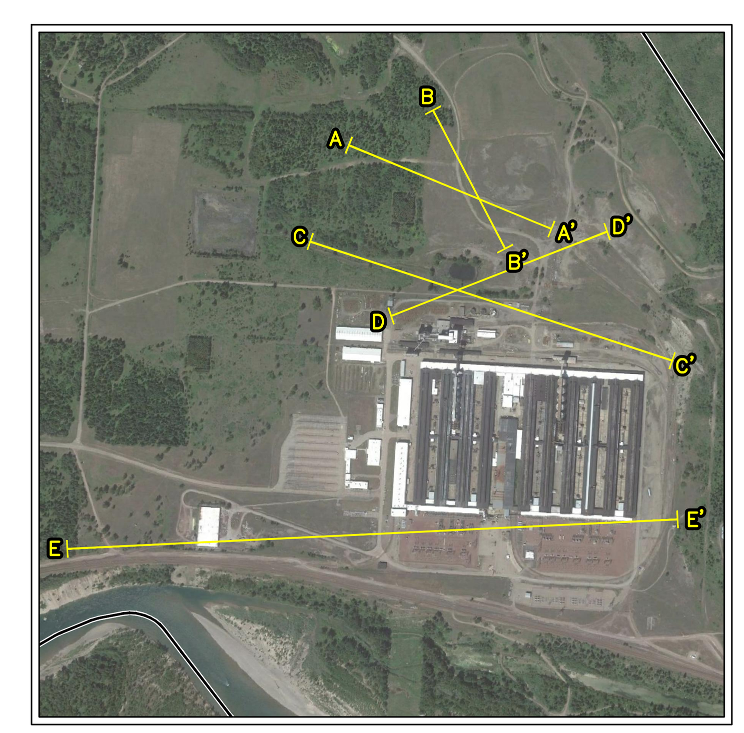
LEGEND

- USCS LOW PLASTICITY SILTY CLAY [CL–ML]
- USCS SILT (BSH) [ML]
- USCS SANDY SILT [MLS]
- USCS GRAVELLY SILT [MLG]
- USCS SILTY SAND [SM]
- USCS WELL–GRADED SAND WITH SILT [SW–SM]
- USCS POORLY–GRADED SAND WITH SILT [SP–SM]
- USCS WELL–GRADED SAND [SW]
- USCS WELL GRADED GRAVELLY SAND [SWG]
- USCS POORLY–GRADED SAND (BSH) [SP]
- USCS POORLY–GRADED GRAVELLY SAND [SPG]
- USCS WELL GRADED GRAVEL WITH SILT [GW–GM]
- USCS WELL–GRADED SANDY GRAVEL [GWS]
- USCS POORLY–GRADED SANDY GRAVEL [GPS]
- USCS WELL GRADED GRAVEL [GW]
- USCS POORLY–GRADED GRAVEL [GP]
- BOULDERS AND COBBLES [BLDRCBBL]

	DENOTES SCREEN
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT
	INFERRED GROUNDWATER ELEVATION IN UPPER HYDROGEOLOGIC UNIT
*	BUU WELL
Δ	PRE–EXISTING WELL
K	HYDRAULIC CONDUCTIVITY (FT/DAY)
NA	NOT AVAILABLE
MAX. CYANIDE	MAXIMUM CYANIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)
MAX. FLUORIDE	MAXIMUM FLUORIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)

NOTE

1. MAXIMUM AND MINIMUM GROUNDWATER ELEVATIONS ARE BASED UPON SIX ROUNDS OF GROUNDWATER GAUGING DATA.



SCALE: 1" = 1200'

Title:

DETAILED HYDROGEOLOGIC CROSS SECTION A-A'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: I.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	12
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.01.DWG		

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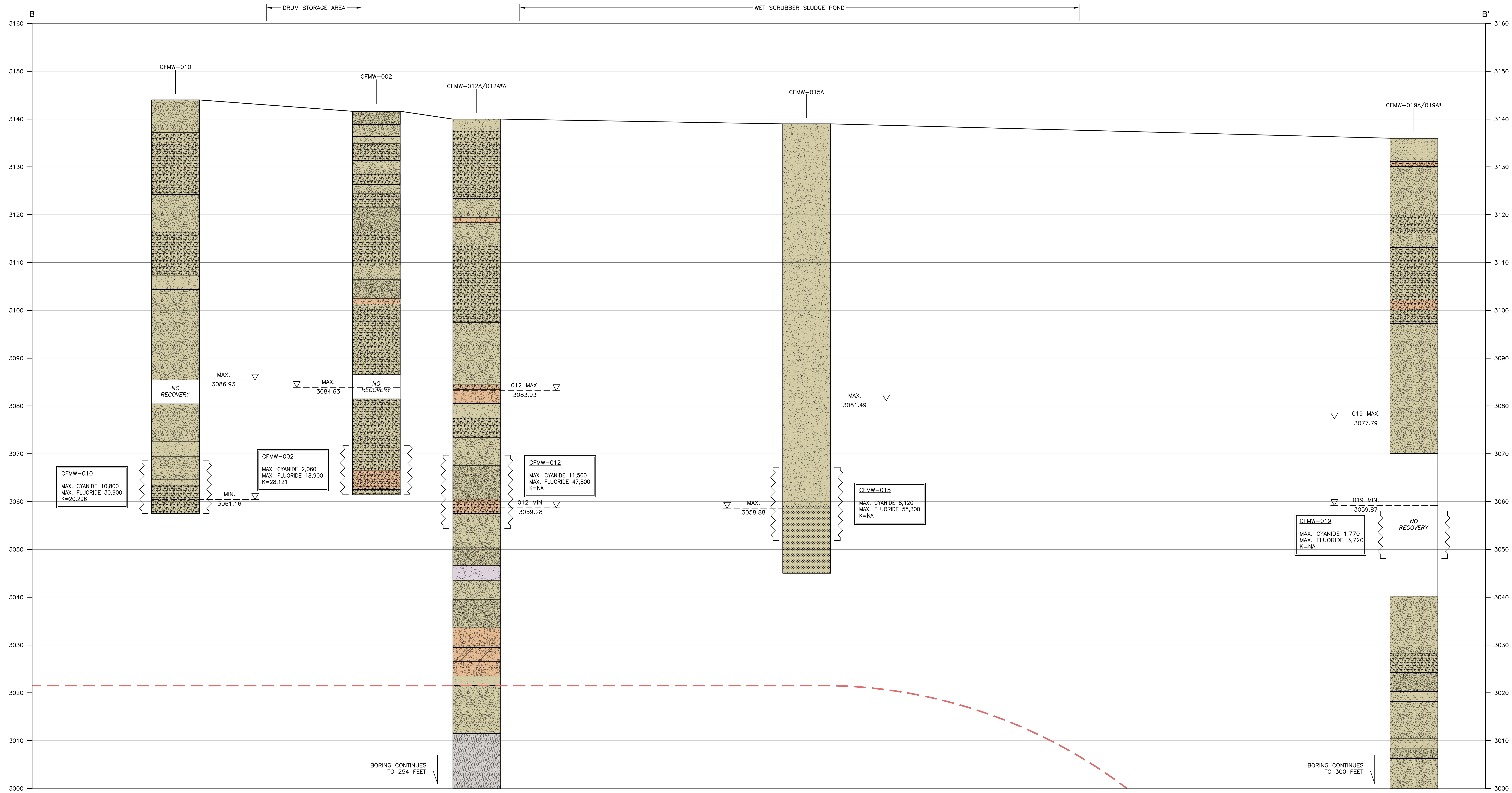


HYDROGEOLOGIC CROSS SECTION B–B'

HORIZONTAL SCALE: 1" = 25'
VERTICAL SCALE: 1" = 10'

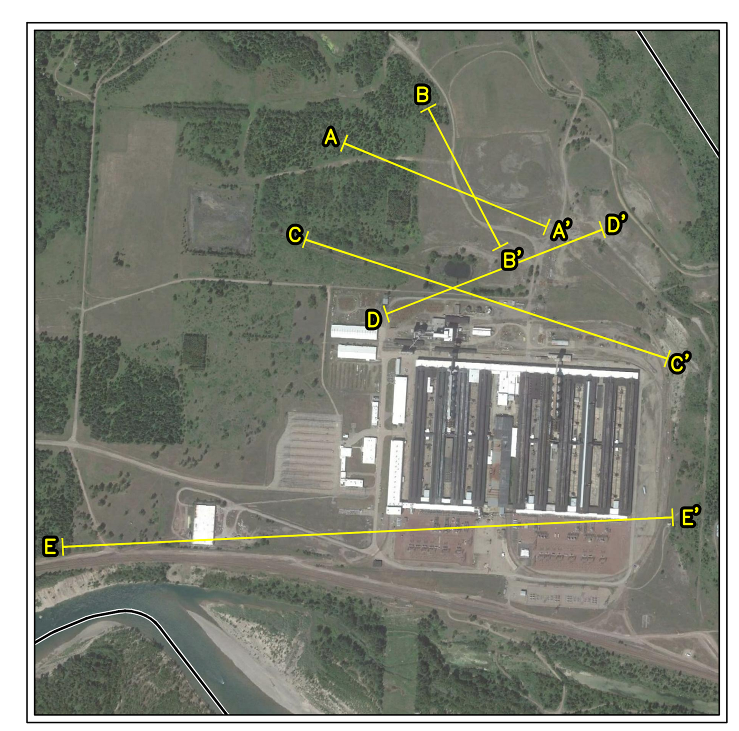
LEGEND

- USCS LOW PLASTICITY SILTY CLAY [CL–ML]
- USCS SILT (BSH) [ML]
- USCS SANDY SILT [MLS]
- USCS GRAVELLY SILT [MLG]
- USCS SILTY SAND [SM]
- USCS WELL–GRADED SAND WITH SILT [SW–SM]
- USCS POORLY–GRADED SAND WITH SILT [SP–SM]
- USCS WELL–GRADED SAND [SW]
- USCS WELL GRADED GRAVELLY SAND [SWG]
- USCS POORLY–GRADED SAND (BSH) [SP]
- USCS POORLY–GRADED GRAVELLY SAND [SPG]
- USCS WELL GRADED GRAVEL WITH SILT [GW–GM]
- USCS WELL–GRADED SANDY GRAVEL [GWS]
- USCS POORLY–GRADED SANDY GRAVEL [GPS]
- USCS WELL GRADED GRAVEL [GW]
- USCS POORLY–GRADED GRAVEL [GP]
- BOULDERS AND COBBLES [BLDRCBBL]

	DENOTES SCREEN
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT
∇	INFERRED GROUNDWATER ELEVATION IN UPPER HYDROGEOLOGIC UNIT
*	BUU WELL
Δ	PRE–EXISTING WELL
K	HYDRAULIC CONDUCTIVITY (FT/DAY)
NA	NOT AVAILABLE
MAX. CYANIDE	MAXIMUM CYANIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)
MAX. FLUORIDE	MAXIMUM FLUORIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)

NOTE

1. MAXIMUM AND MINIMUM GROUNDWATER ELEVATIONS ARE BASED UPON SIX ROUNDS OF GROUNDWATER GAUGING DATA.



SCALE: 1" = 1200'

Title: **DETAILED HYDROGEOLOGIC CROSS SECTION B-B'**

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for: COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	13
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.01.DWG		

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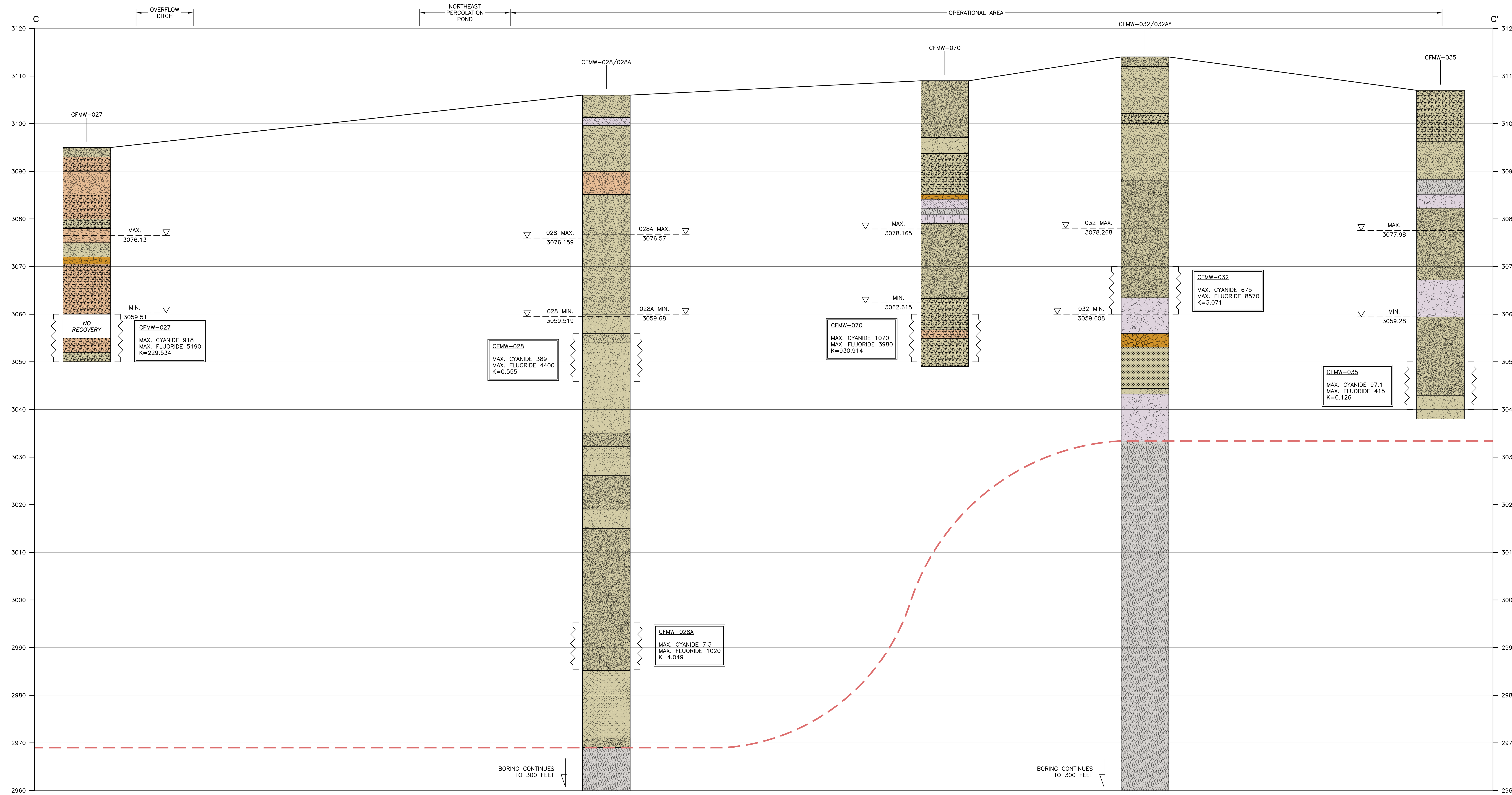


LEGEND

- USCS LOW PLASTICITY SILTY CLAY [CL-ML]
- USCS SILT (BSH) [ML]
- USCS SANDY SILT [MLS]
- USCS GRAVELLY SILT [MLG]
- USCS SILTY SAND [SM]
- USCS WELL-GRADED SAND WITH SILT [SW-SM]
- USCS POORLY-GRADED SAND WITH SILT [SP-SM]
- USCS WELL-GRADED SAND [SW]
- USCS WELL GRADED GRAVELLY SAND [SWG]
- USCS POORLY-GRADED SAND (BSH) [SP]
- USCS POORLY-GRADED GRAVELLY SAND [SPG]
- USCS WELL GRADED GRAVEL WITH SILT [GW-GM]
- USCS WELL-GRADED SANDY GRAVEL [GWS]
- USCS POORLY-GRADED SANDY GRAVEL [GPS]
- USCS WELL GRADED GRAVEL [GW]
- USCS POORLY-GRADED GRAVEL [GP]
- BOULDERS AND COBBLES [BLDRCBBL]

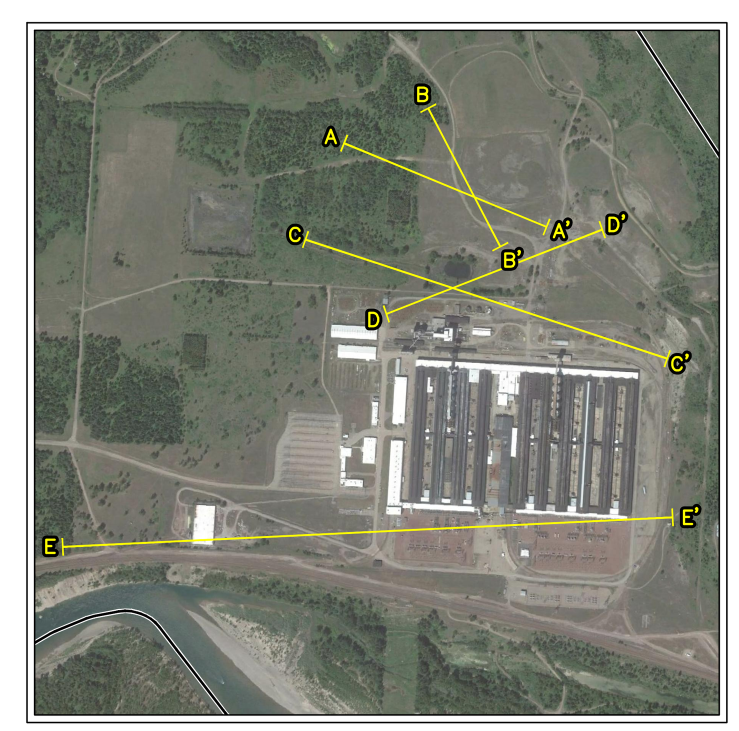
	DENOTES SCREEN
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT
	INFERRED GROUNDWATER ELEVATION IN UPPER HYDROGEOLOGIC UNIT
*	BUU WELL
K	HYDRAULIC CONDUCTIVITY (FT/DAY)
NA	NOT AVAILABLE
MAX. CYANIDE	MAXIMUM CYANIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)
MAX. FLUORIDE	MAXIMUM FLUORIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)

NOTE

1. MAXIMUM AND MINIMUM GROUNDWATER ELEVATIONS ARE BASED UPON SIX ROUNDS OF GROUNDWATER GAUGING DATA.

HYDROGEOLOGIC CROSS SECTION C-C'

HORIZONTAL SCALE: 1" = 85'
VERTICAL SCALE: 1" = 10'



SCALE: 1" = 1200'

Title: **DETAILED HYDROGEOLOGIC CROSS SECTION C-C'**

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for: COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	14
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.01.DWG		

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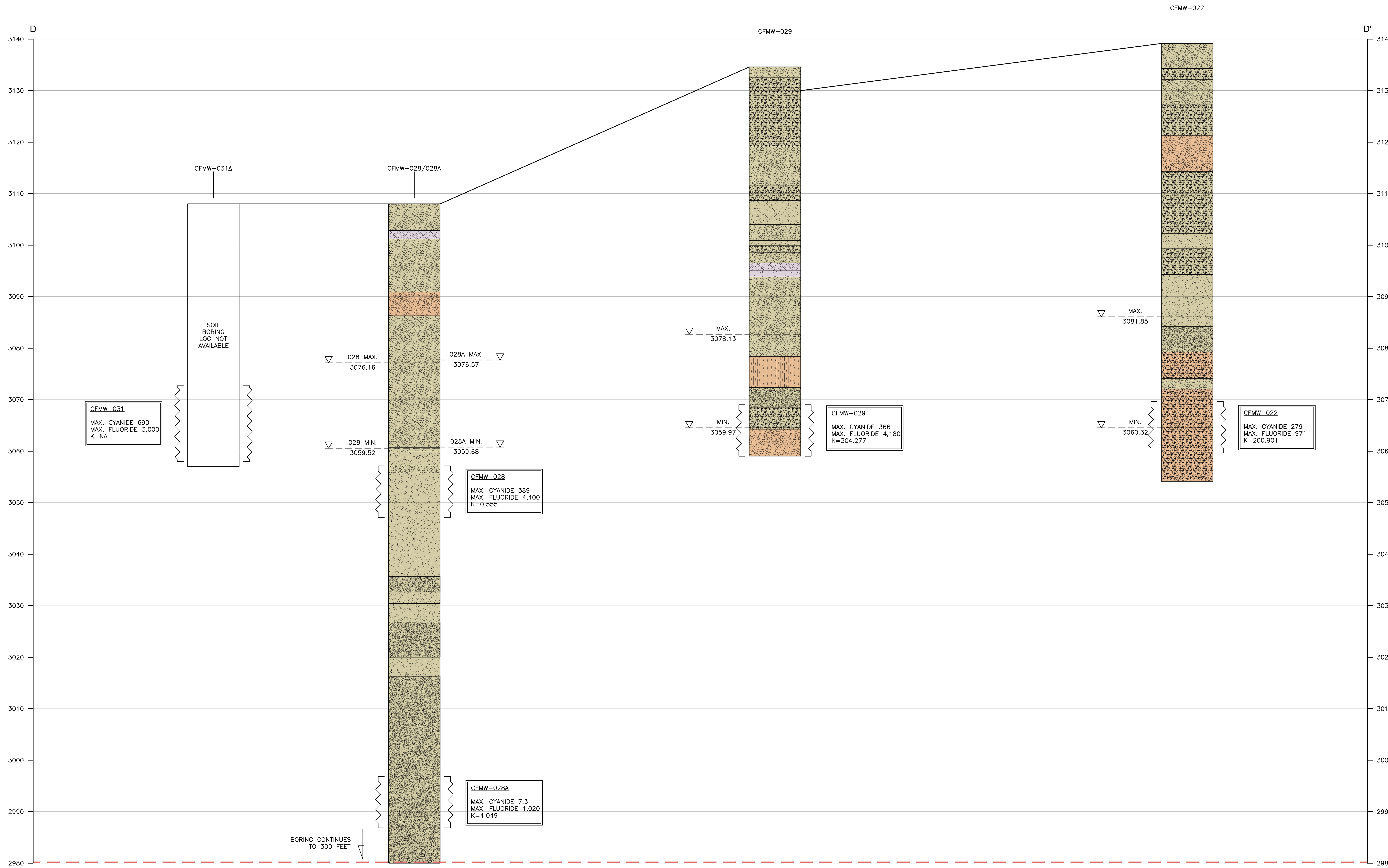


LEGEND

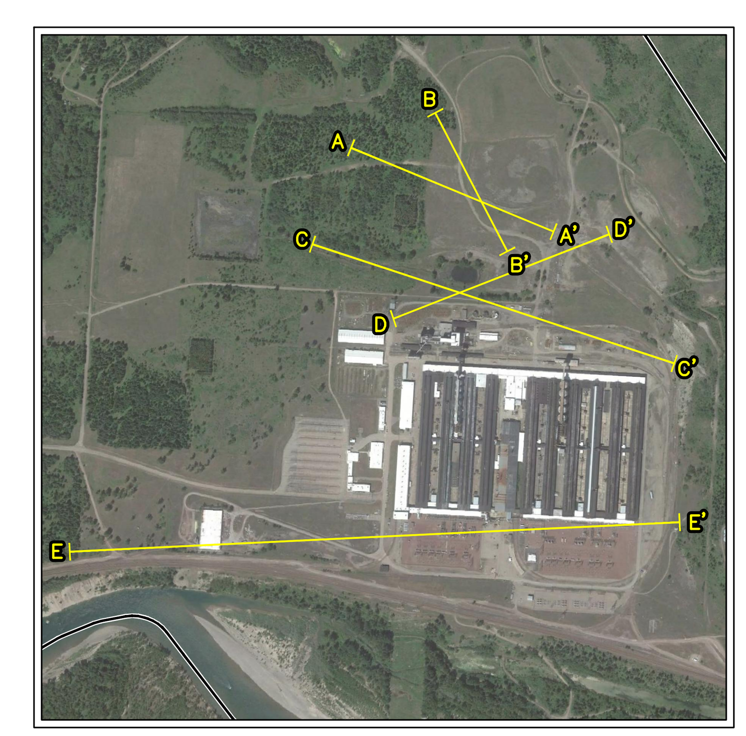
- USCS LOW PLASTICITY SILTY CLAY [CL-ML]
- USCS SILT (BSH) [ML]
- USCS SANDY SILT [MLS]
- USCS GRAVELLY SILT [MLG]
- USCS SILTY SAND [SM]
- USCS WELL-GRADED SAND WITH SILT [SW-SM]
- USCS POORLY-GRADED SAND WITH SILT [SP-SM]
- USCS WELL-GRADED SAND [SW]
- USCS WELL GRADED GRAVELLY SAND [SWG]
- USCS POORLY-GRADED SAND (BSH) [SP]
- USCS POORLY-GRADED GRAVELLY SAND [SPG]
- USCS WELL GRADED GRAVEL WITH SILT [GW-GM]
- USCS WELL-GRADED SANDY GRAVEL [GWS]
- USCS POORLY-GRADED SANDY GRAVEL [GPS]
- USCS WELL GRADED GRAVEL [GW]
- USCS POORLY-GRADED GRAVEL [GP]
- BOULDERS AND COBBLES [BLDRCBBL]

	DENOTES SCREEN
	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT
	GROUNDWATER ELEVATION IN UPPER HYDROGEOLOGIC UNIT
Δ	PRE-EXISTING WELL
K	HYDRAULIC CONDUCTIVITY (FT/DAY)
NA	NOT AVAILABLE
MAX. CYANIDE	MAXIMUM CYANIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)
MAX. FLUORIDE	MAXIMUM FLUORIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)

NOTES

1. MAXIMUM AND MINIMUM GROUNDWATER ELEVATIONS ARE BASED UPON SIX ROUNDS OF GROUNDWATER GAUGING DATA.
2. SOIL LITHOLOGY WAS NOT AVAILABLE FOR CFMW-031.

HYDROGEOLOGIC CROSS SECTION D-D'
HORIZONTAL SCALE: 1" = 65'
VERTICAL SCALE: 1" = 10'



SCALE: 1" = 1200'

Title:
DETAILED HYDROGEOLOGIC CROSS SECTION D-D'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:
COLUMBIA FALLS ALUMINUM COMPANY

ROUX	Compiled by: L.J.	Date: 22JAN20	PLATE
	Prepared by: G.M.	Scale: AS SHOWN	15
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.01.DWG		

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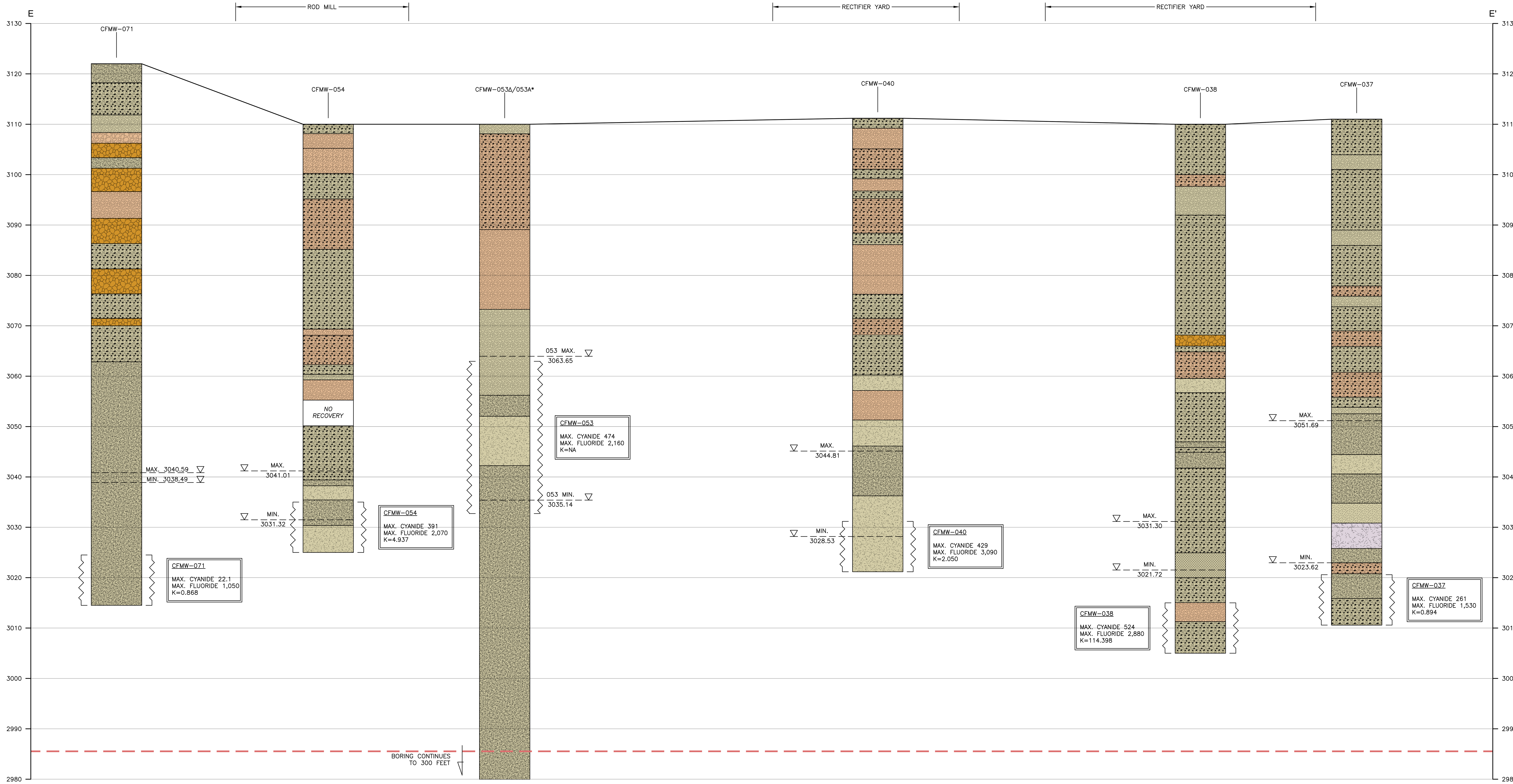


LEGEND

- USCS LOW PLASTICITY SILTY CLAY [CL–ML]
- USCS SILT (BSH) [ML]
- USCS SANDY SILT [MLS]
- USCS GRAVELLY SILT [MLG]
- USCS SILTY SAND [SM]
- USCS WELL–GRADED SAND WITH SILT [SW–SM]
- USCS POORLY–GRADED SAND WITH SILT [SP–SM]
- USCS WELL–GRADED SAND [SW]
- USCS WELL GRADED GRAVELLY SAND [SWG]
- USCS POORLY–GRADED SAND (BSH) [SP]
- USCS POORLY–GRADED GRAVELLY SAND [SPG]
- USCS WELL GRADED GRAVEL WITH SILT [GW–GM]
- USCS WELL–GRADED SANDY GRAVEL [GWS]
- USCS POORLY–GRADED SANDY GRAVEL [GPS]
- USCS WELL GRADED GRAVEL [GW]
- USCS POORLY–GRADED GRAVEL [GP]
- BOULDERS AND COBBLES [BLDRCBBL]

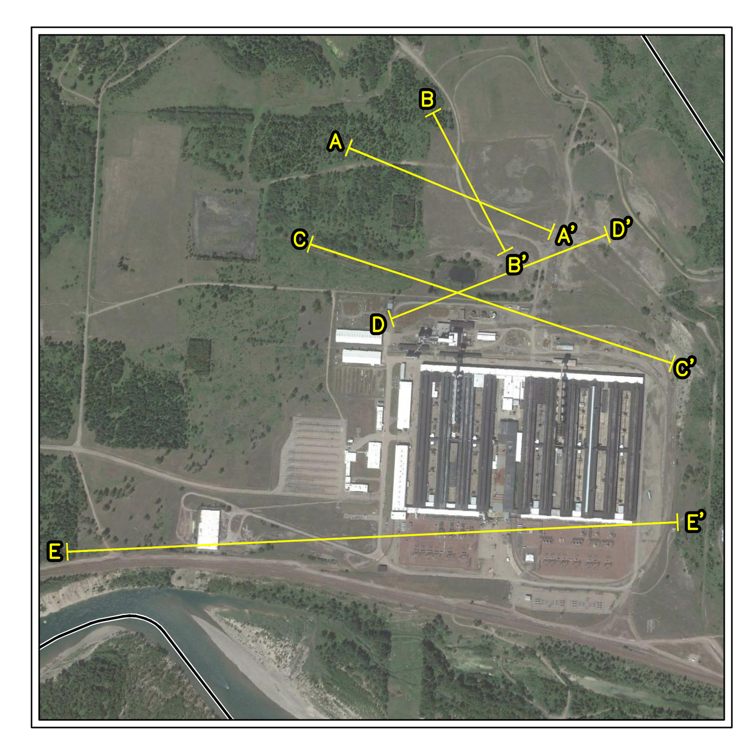
{ }	DENOTES SCREEN
— — —	INFERRED BASE OF UPPER HYDROGEOLOGIC UNIT
— — ▽ — —	GROUNDWATER ELEVATION IN UPPER HYDROGEOLOGIC UNIT
*	BUU WELL
Δ	PRE–EXISTING WELL
K	HYDRAULIC CONDUCTIVITY (FT/DAY)
NA	NOT AVAILABLE
MAX. CYANIDE	MAXIMUM CYANIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)
MAX. FLUORIDE	MAXIMUM FLUORIDE CONCENTRATION ACROSS SIX SAMPLING ROUNDS (ug/L)

NOTE

1. MAXIMUM AND MINIMUM GROUNDWATER ELEVATIONS ARE BASED UPON SIX ROUNDS OF GROUNDWATER GAUGING DATA.

HYDROGEOLOGIC CROSS SECTION E–E'

HORIZONTAL SCALE: 1" = 70'
VERTICAL SCALE: 1" = 10'



SCALE: 1" = 1200'

Title:

DETAILED HYDROGEOLOGIC CROSS SECTION E-E'

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	16
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.01.DWG		

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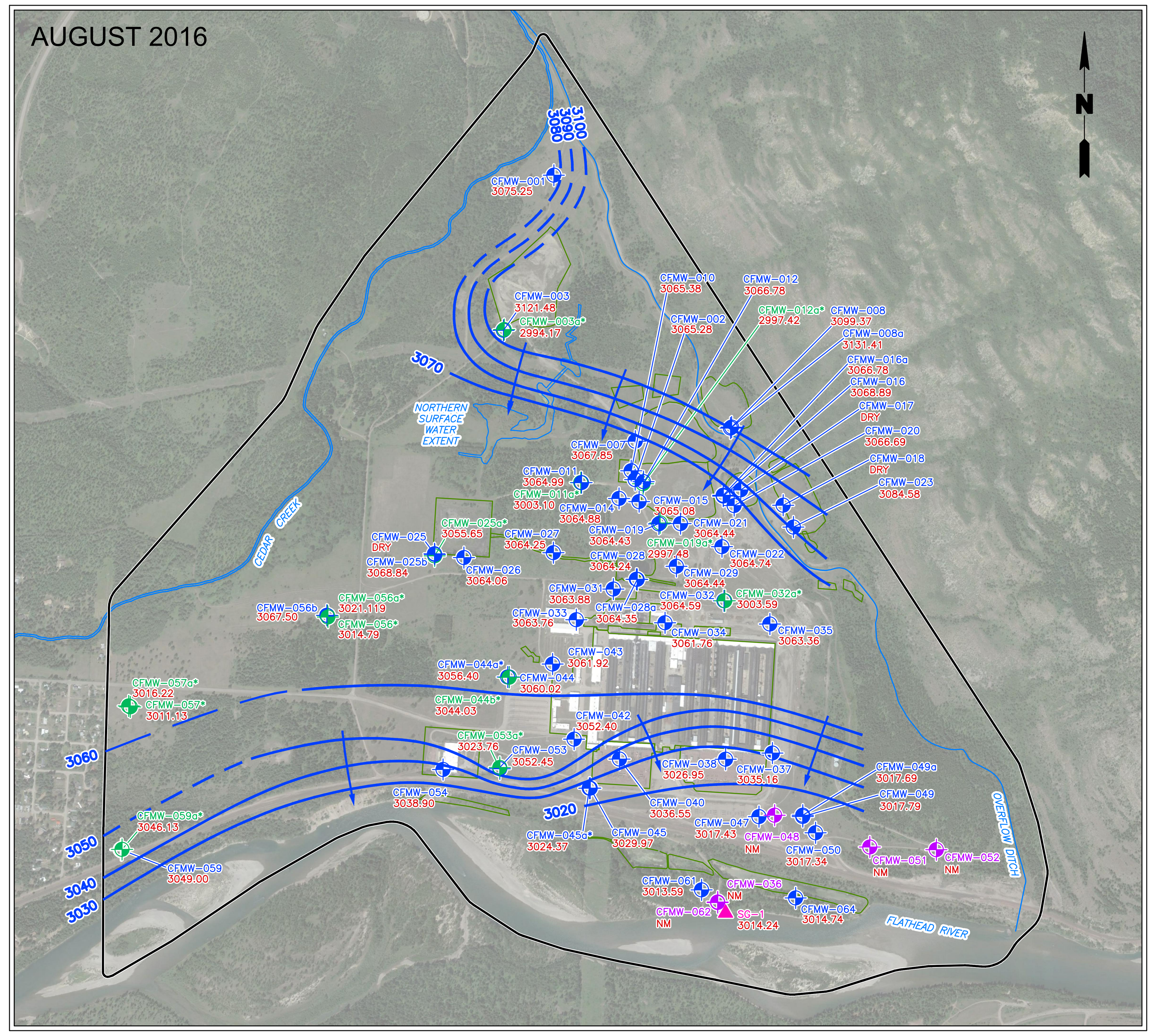
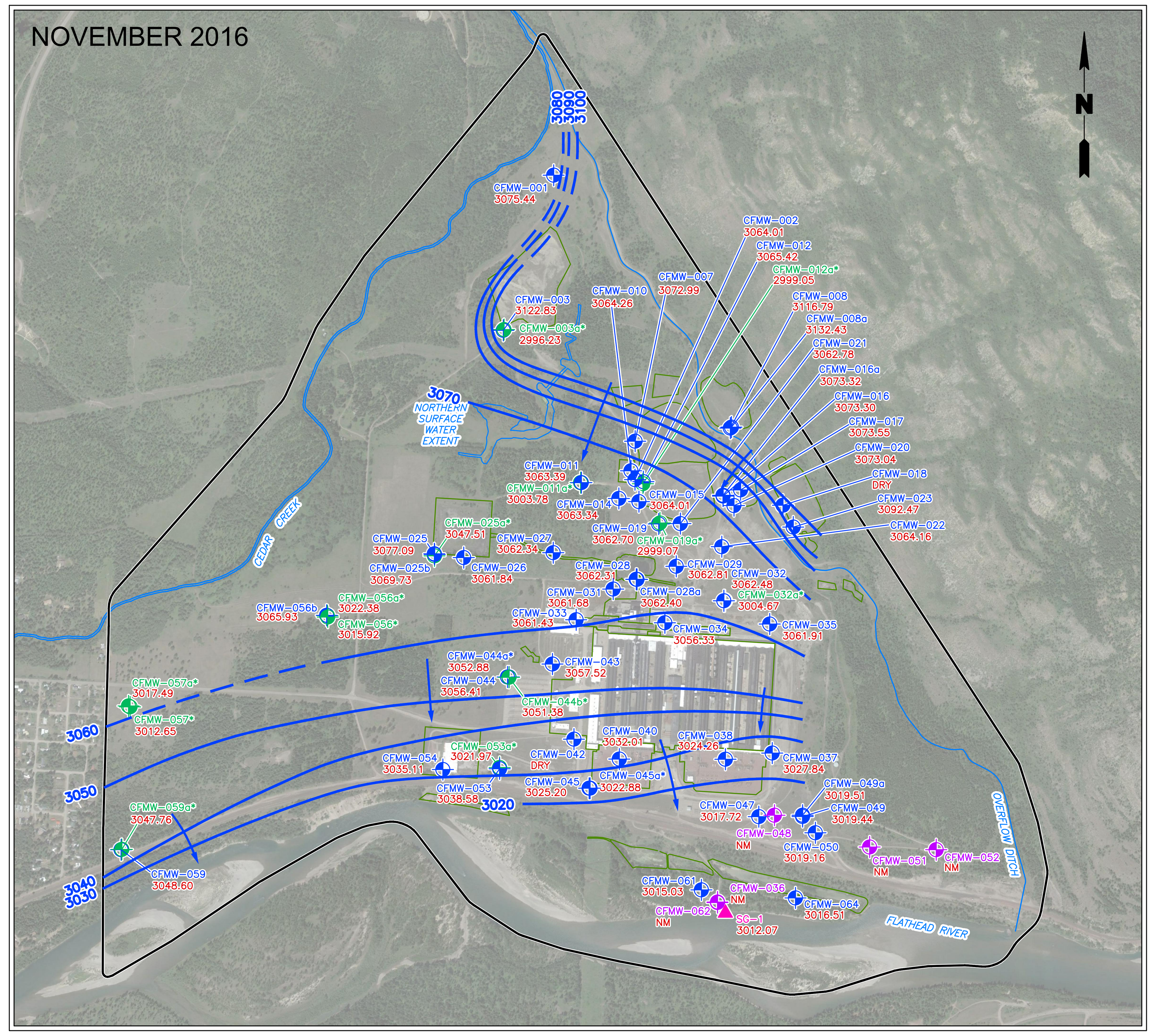
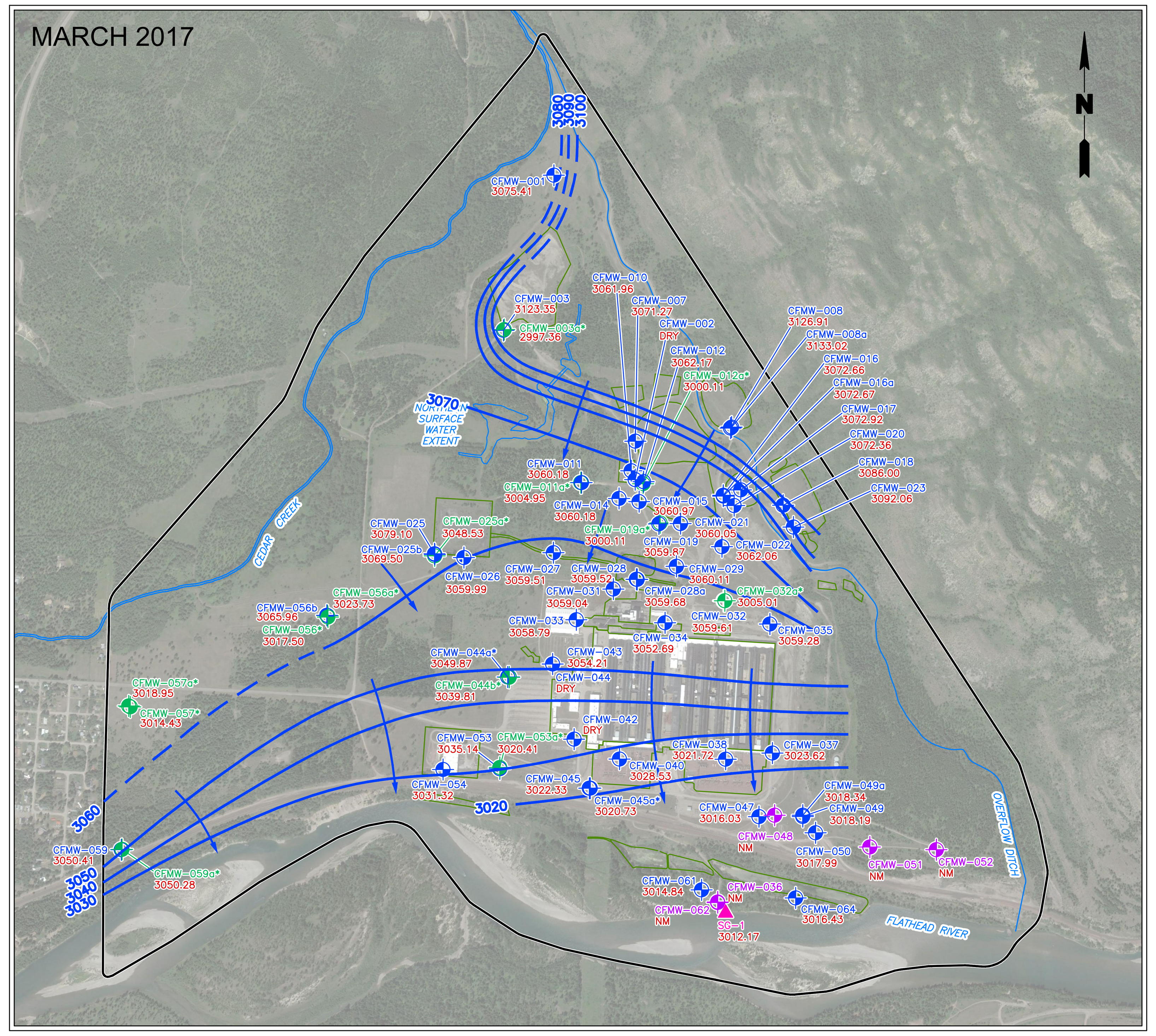
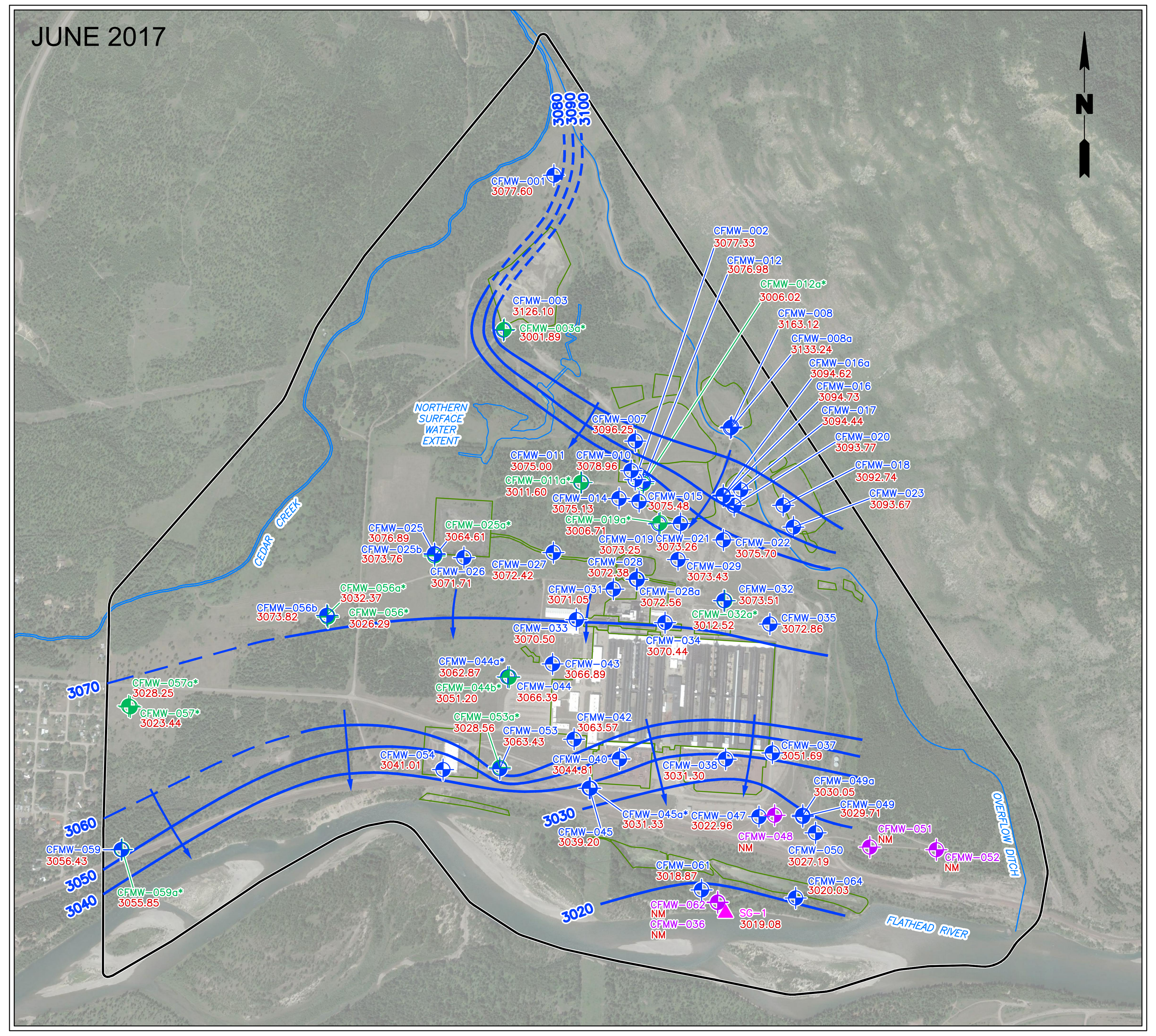
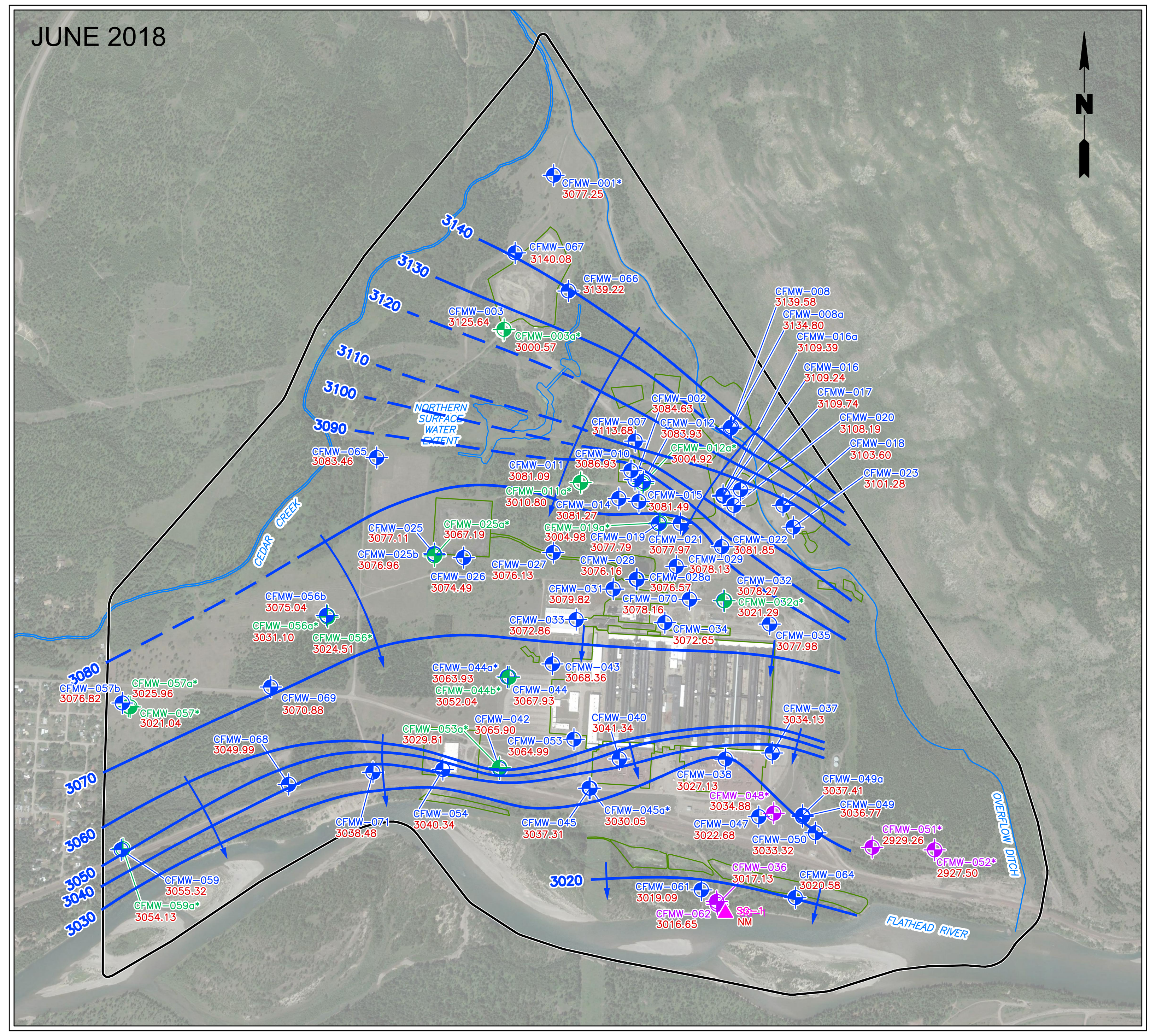
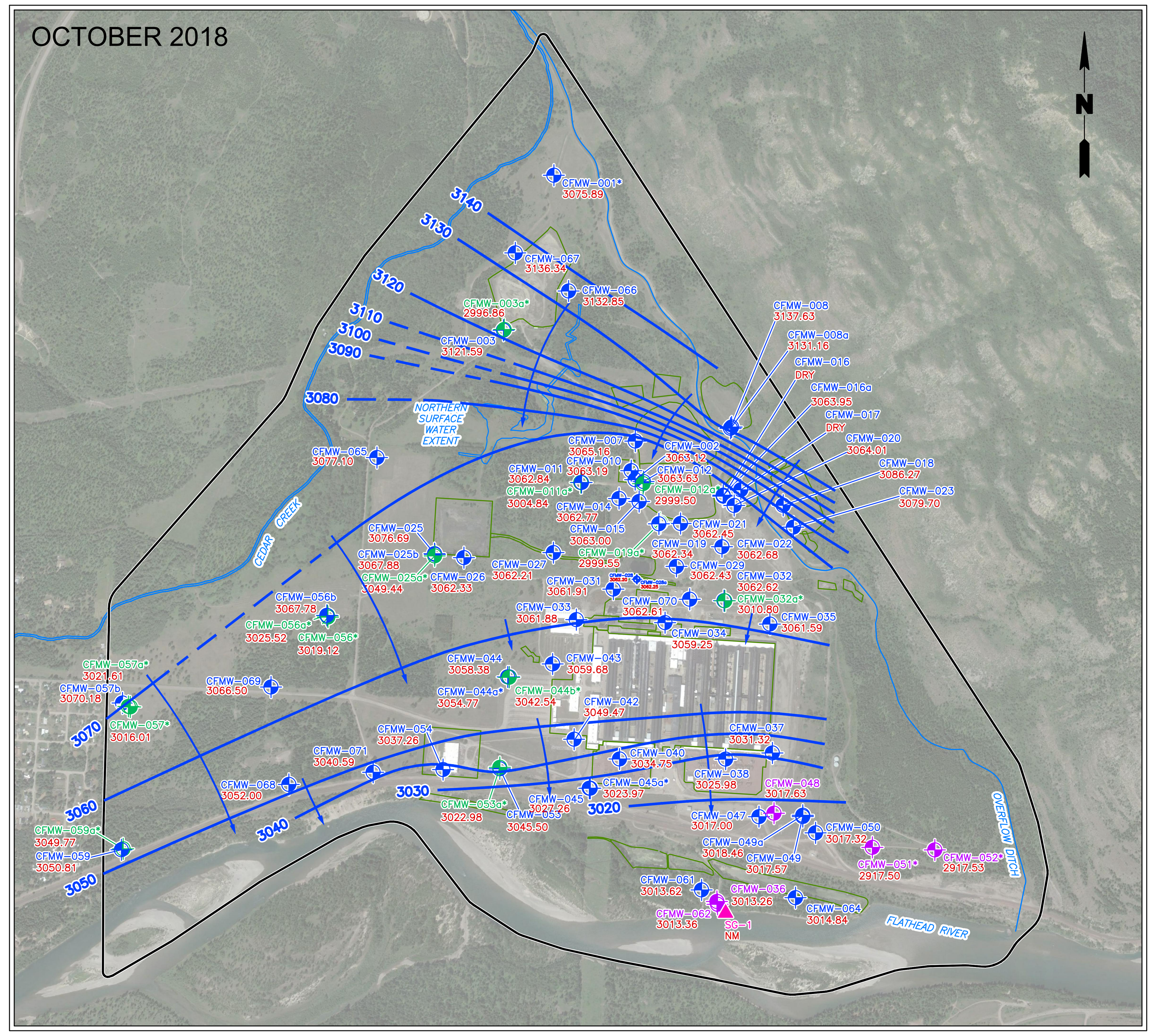












LEGEND

	RI/FS SITE BOUNDARY
	SURFACE WATER FEATURE
	SITE FEATURE
CFMW–035	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
CFMW–052	LOCATION AND DESIGNATION OF FORMER PRODUCTION WELL
CFMW–032a*	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
SG–1	LOCATION AND DESIGNATION OF SURFACE WATER STAFF GAUGE
3188.99	LOCATION WHERE SITE FEATURE WAS SURVEYED
3061.59	POTENTIOMETRIC SURFACE IN FEET ABOVE MEAN SEA LEVEL
NM	NOT MEASURED
DRY	INSUFFICIENT WATER TO COLLECT SAMPLE
*	NOT USED IN CONTOURING
3080	CONTOUR LINE OF EQUAL POTENTIOMETRIC SURFACE (DASHED WHERE INFERRED)
	INFERRED FLOW DIRECTION

NOTE

MONITORING WELLS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT ARE NOT USED IN CONTOURING.

N

1,000 0 1,000

Title:

POTENTIOMETRIC SURFACE CONTOUR MAP UPPER HYDROGEOLOGIC UNIT

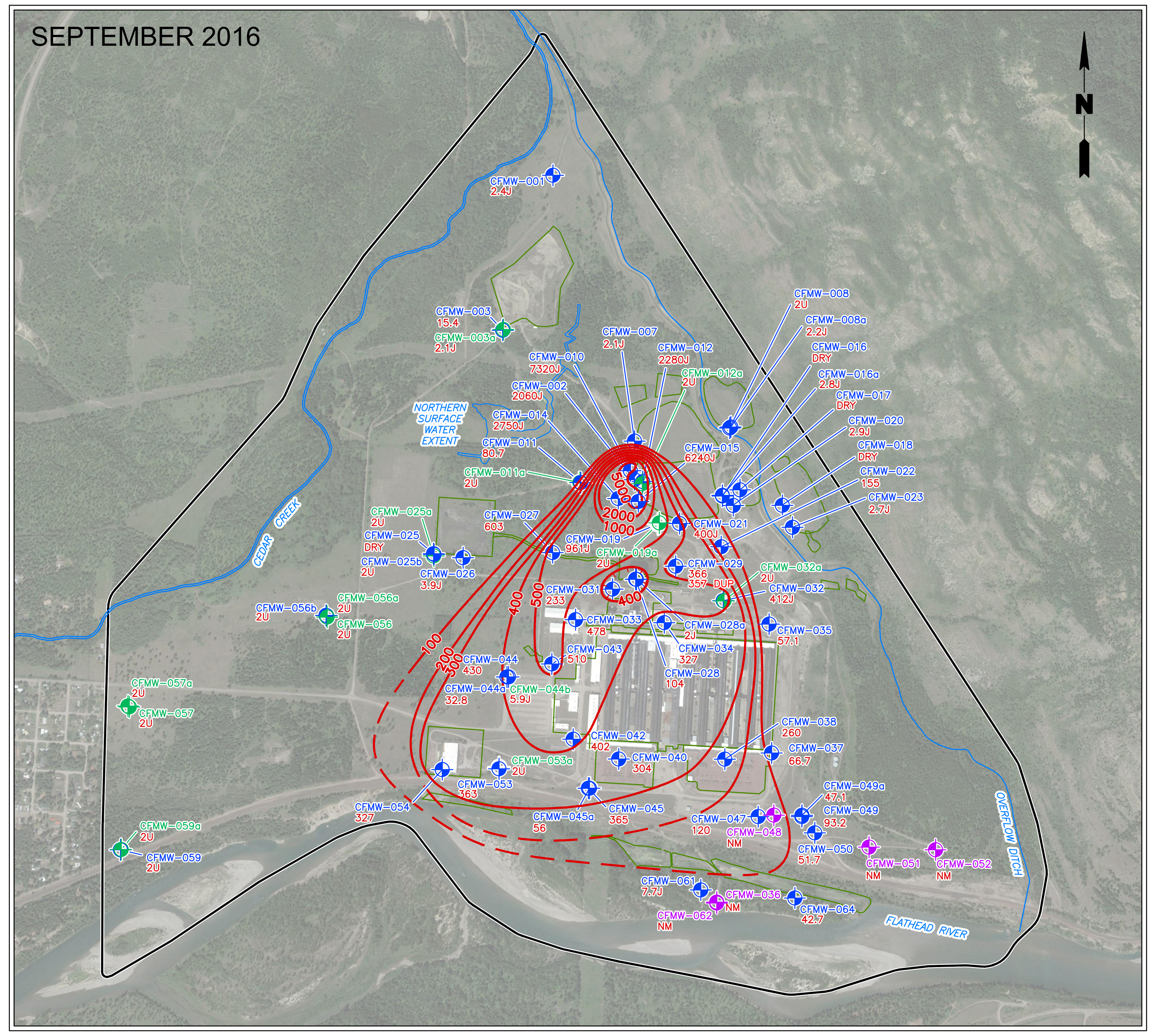
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

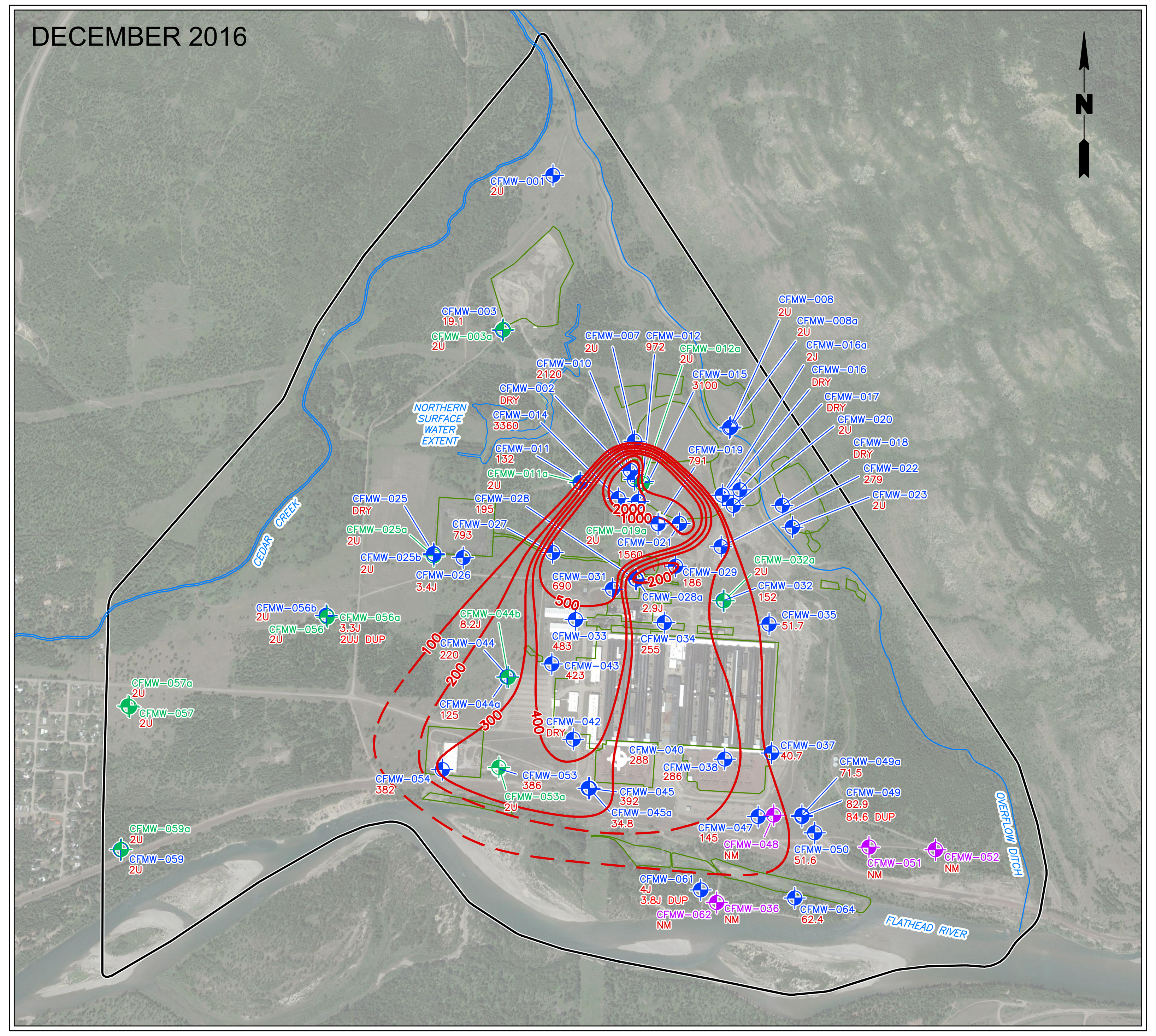
Prepared for:

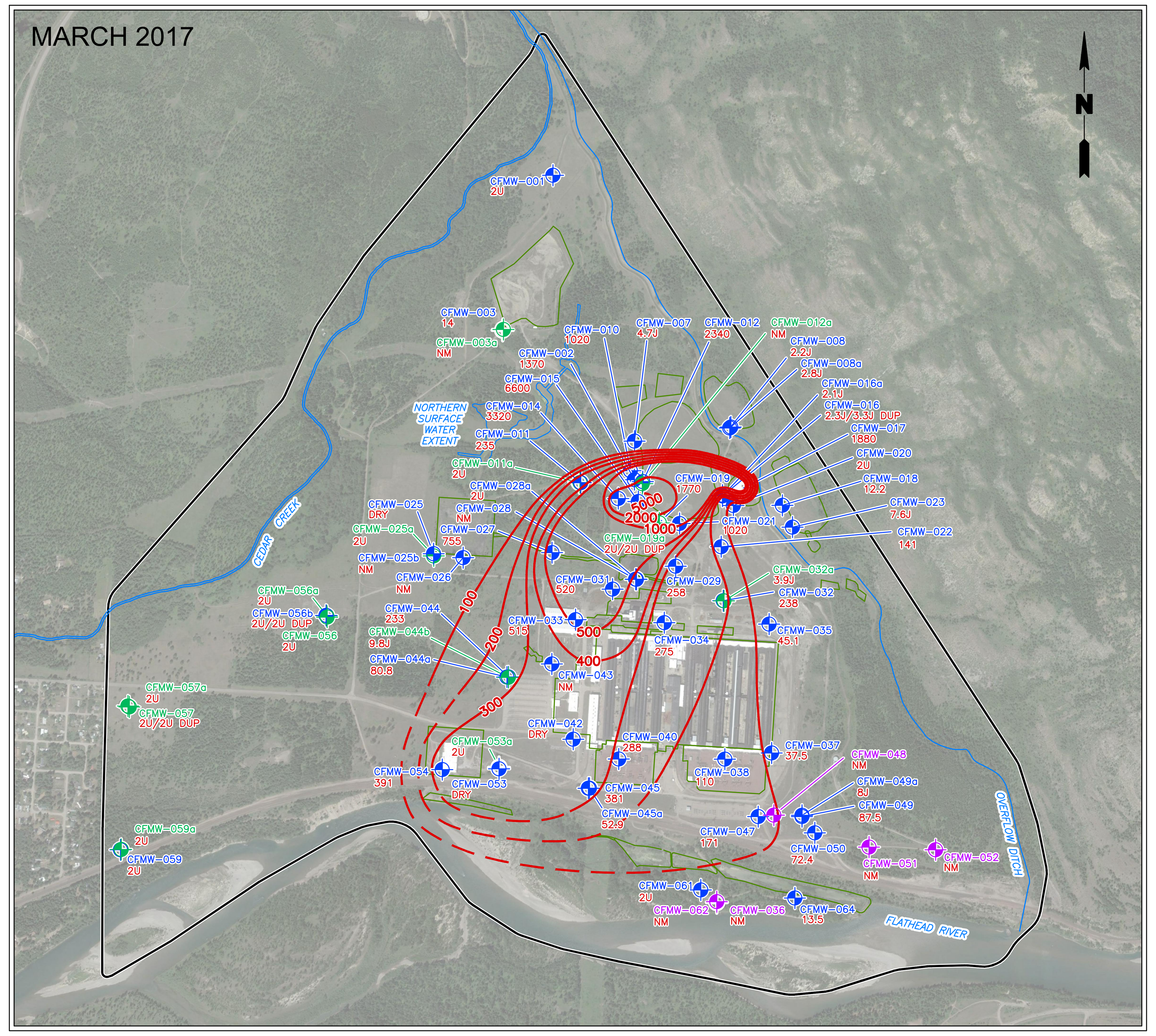
COLUMBIA FALLS ALUMINUM COMPANY

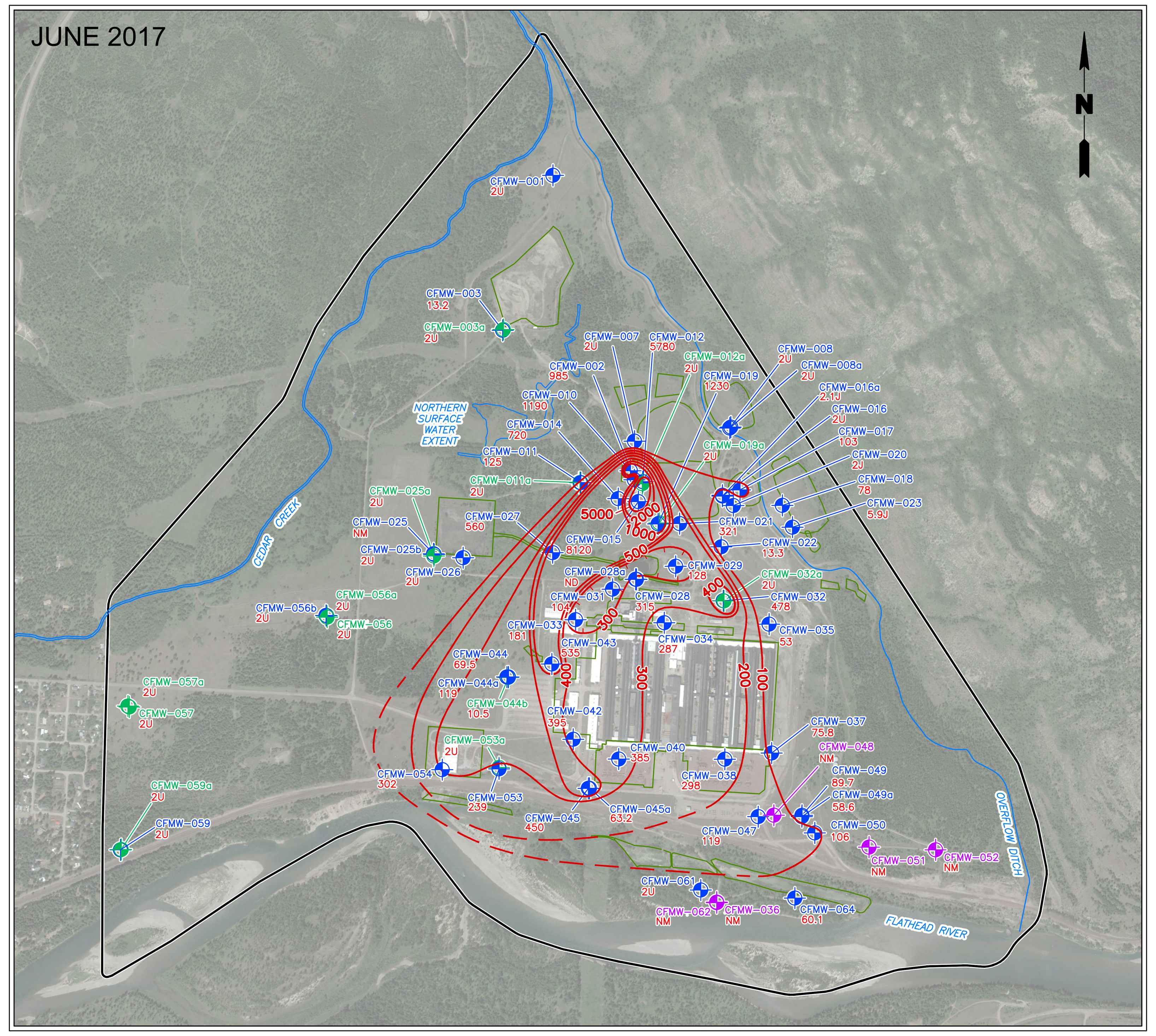
ROUX

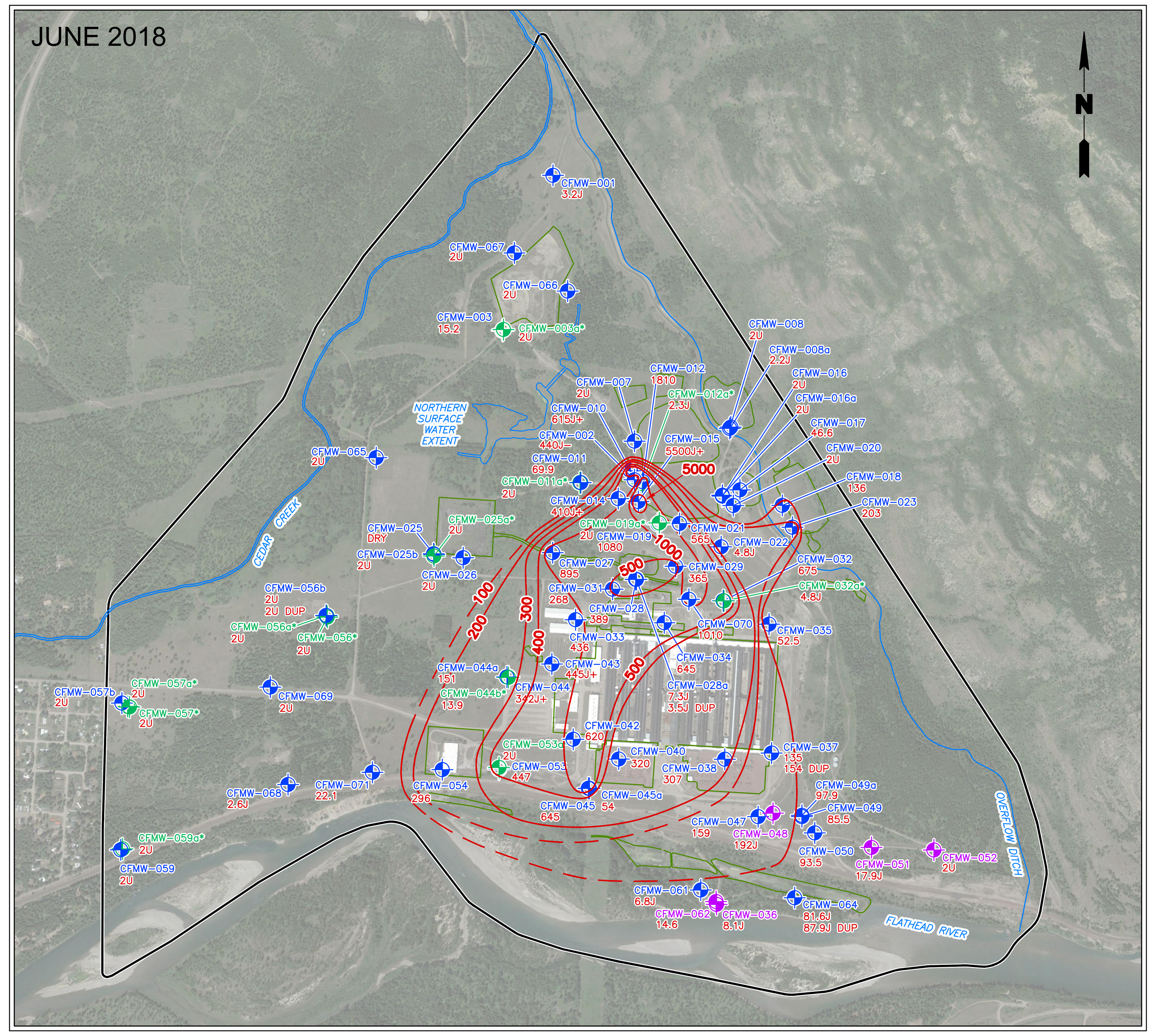
Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	17
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.12.DWG		

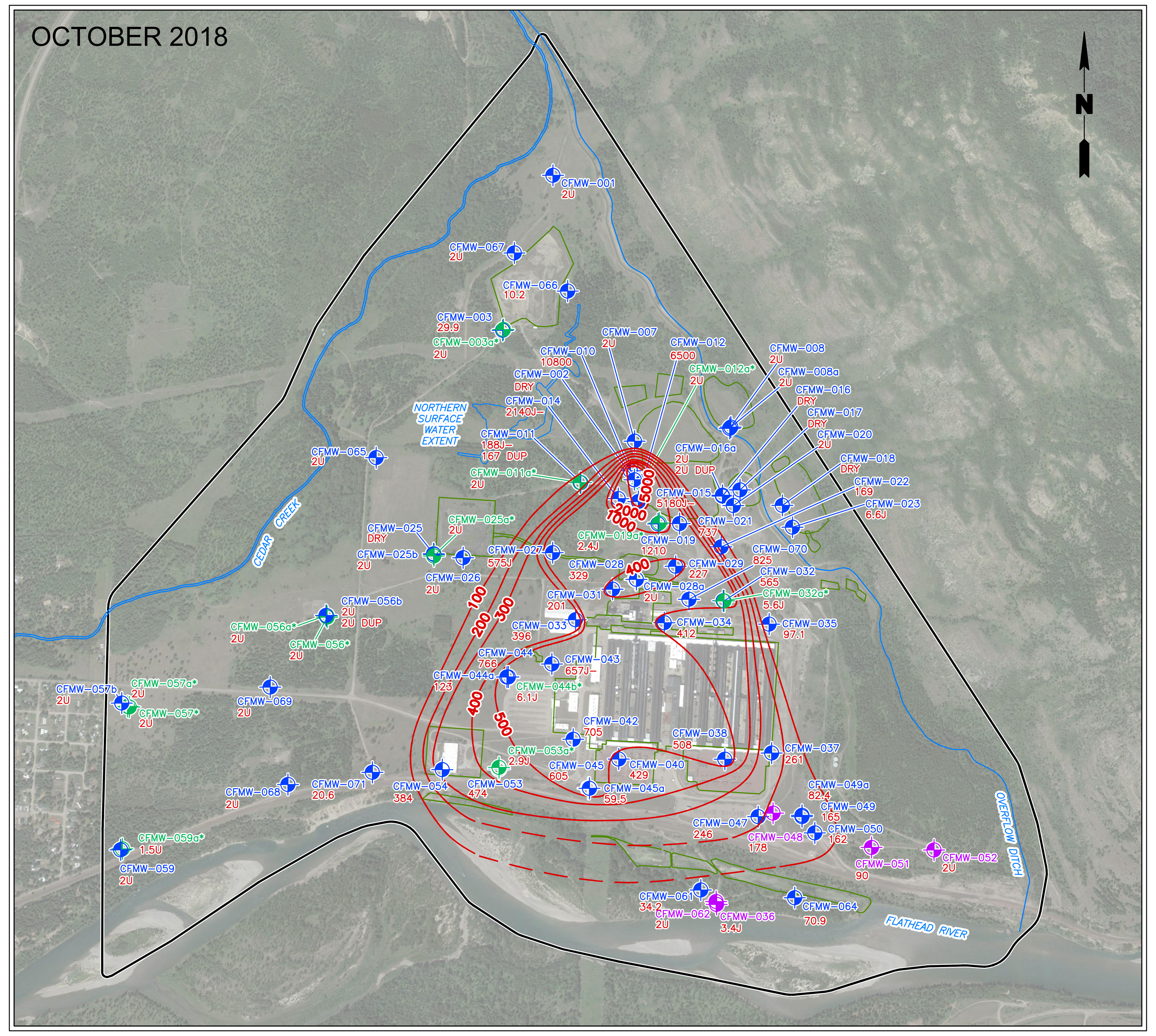












LEGEND

	RI/FS SITE BOUNDARY
	SURFACE WATER FEATURE
	SITE FEATURE
CFMW-035	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
CFMW-052	LOCATION AND DESIGNATION OF FORMER PRODUCTION WELL
CFMW-032a*	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
405	TOTAL CYANIDE CONCENTRATIONS IN GROUNDWATER (UNITS IN ug/L)
*	NOT USED IN CONTOURING
DUP	DUPLICATE SAMPLE
J	ESTIMATED VALUE
NM	NOT MEASURED
U	INDICATES THAT ANALYTE WAS NOT DETECTED AT THE LIMIT REPORTED
DRY	INSUFFICIENT WATER TO COLLECT SAMPLE
1000	CONTOUR LINE OF TOTAL CYANIDE CONCENTRATION (DASHED WHERE INFERRED)

NOTE

CONTOURS ARE FOR THE UPPER HYDROGEOLOGIC UNIT WELLS ONLY

N

1,000 0 1,000

Title:

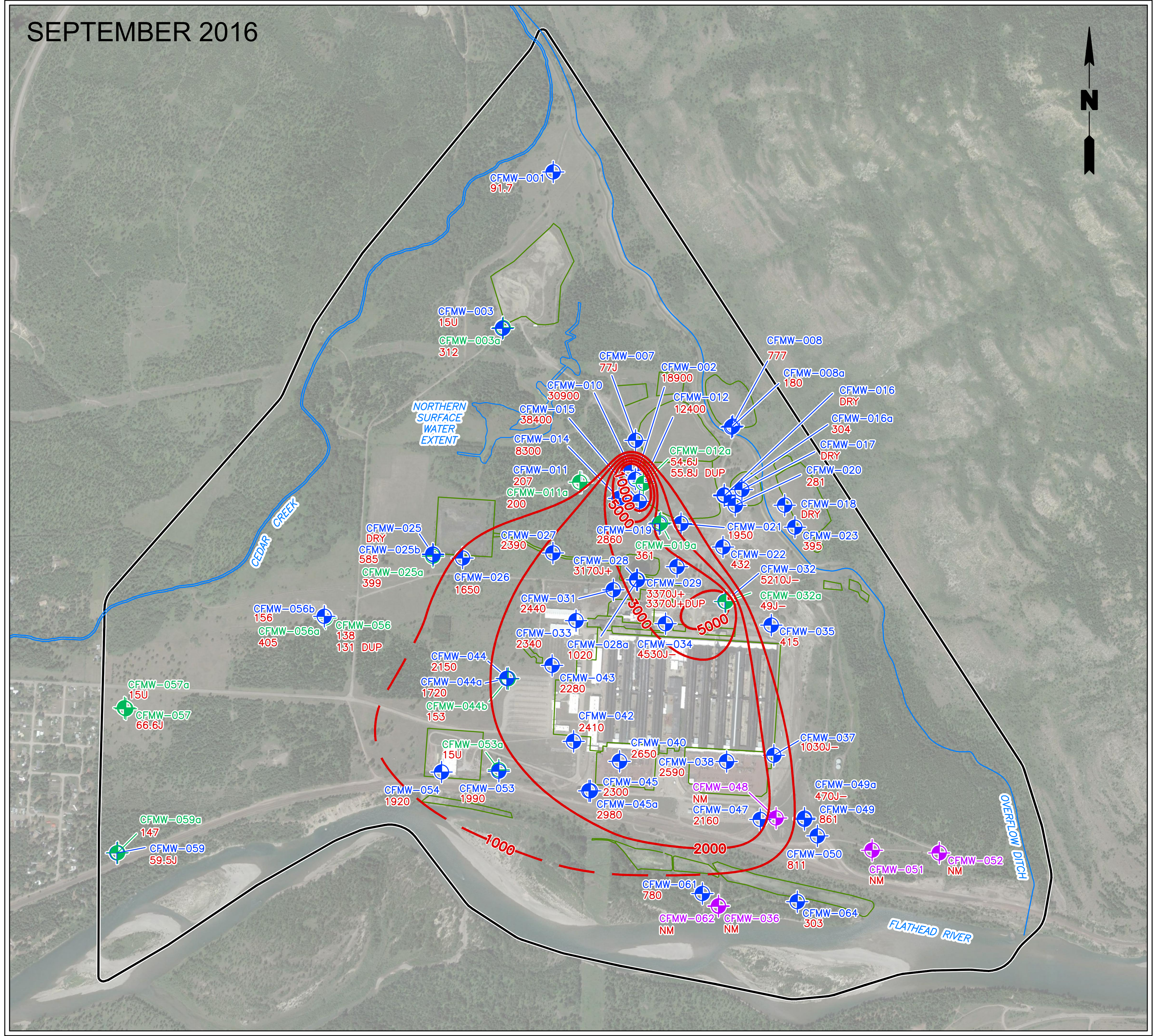
CONCENTRATIONS OF TOTAL CYANIDE IN GROUNDWATER

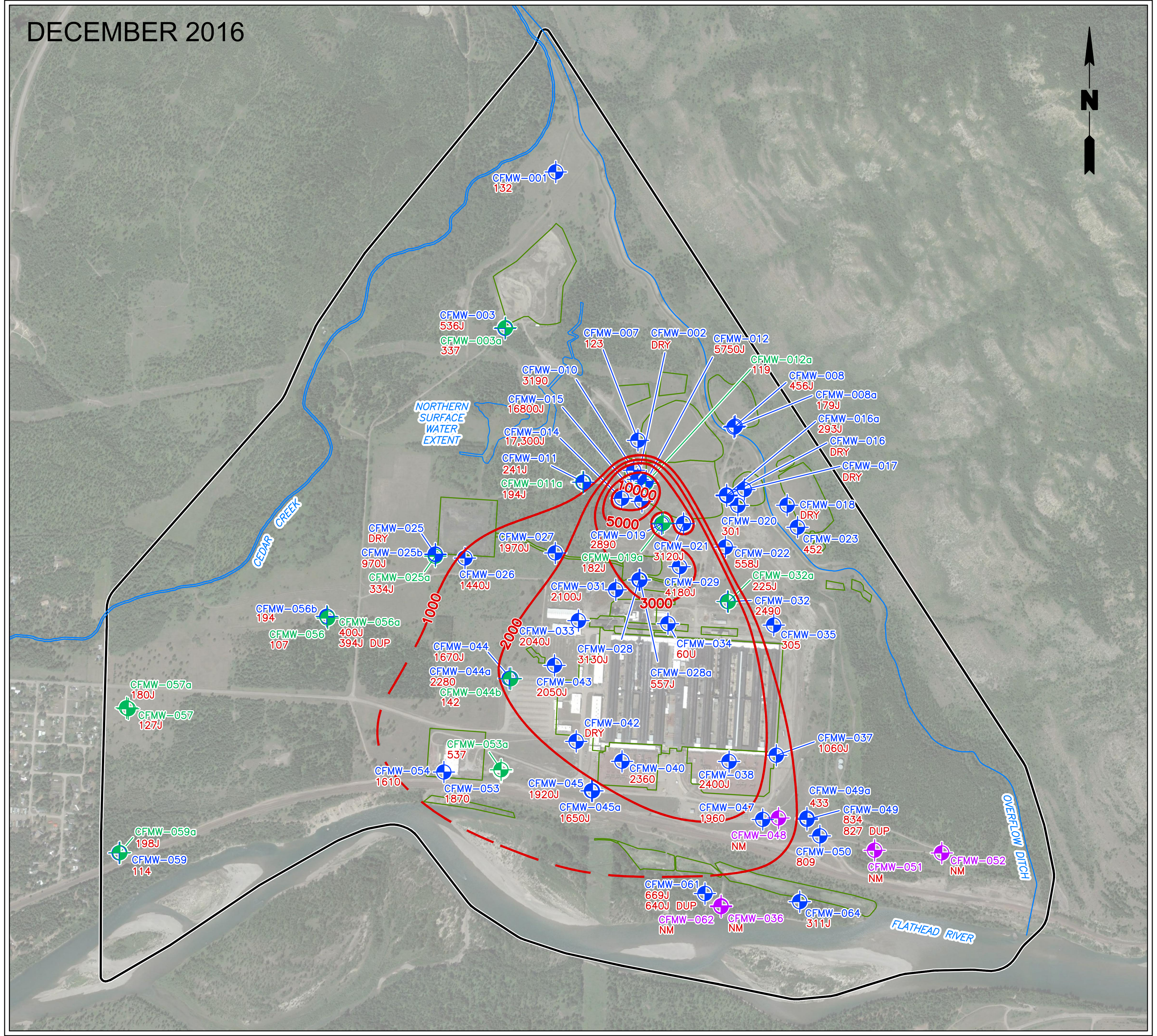
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

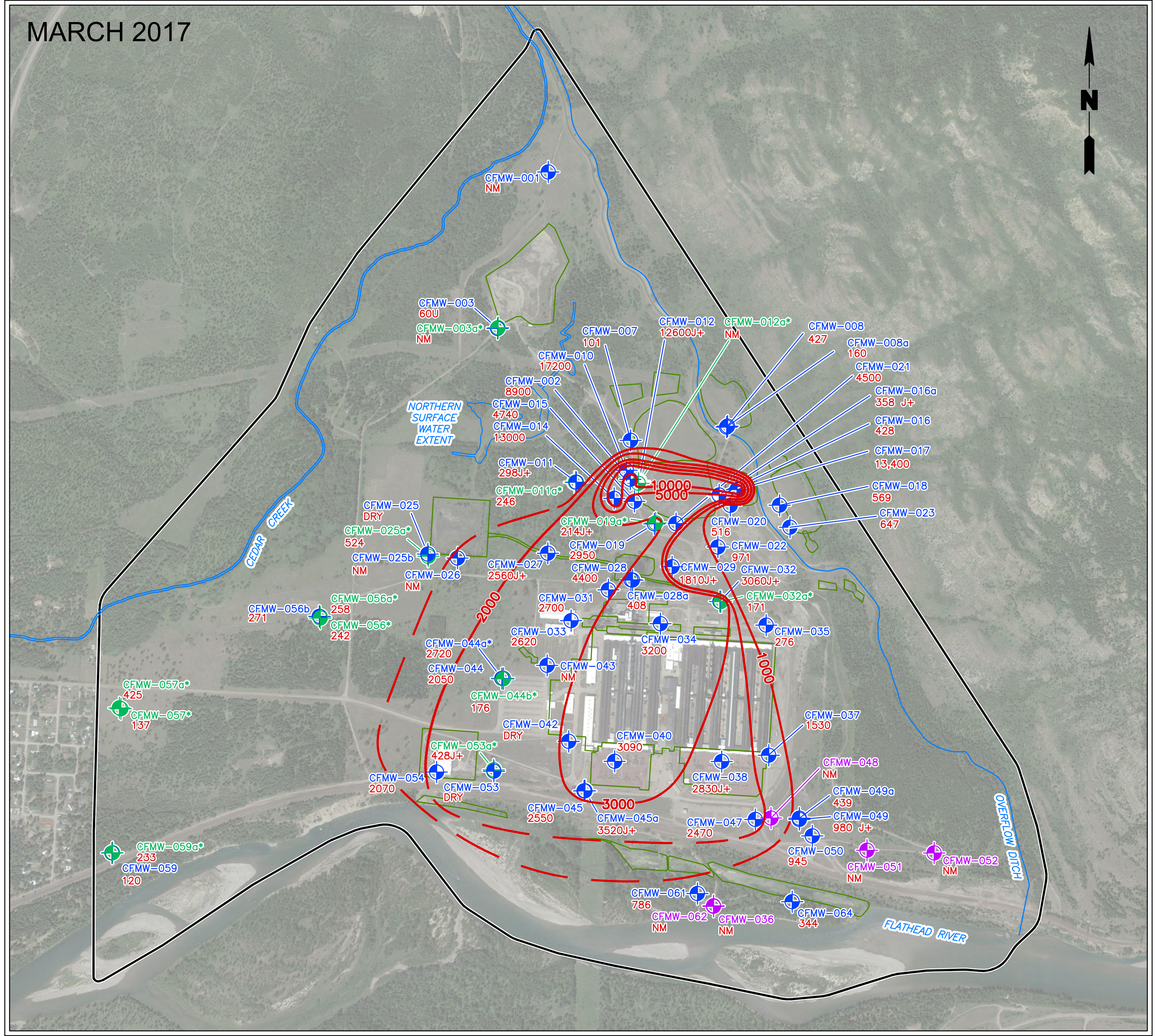
Prepared for:

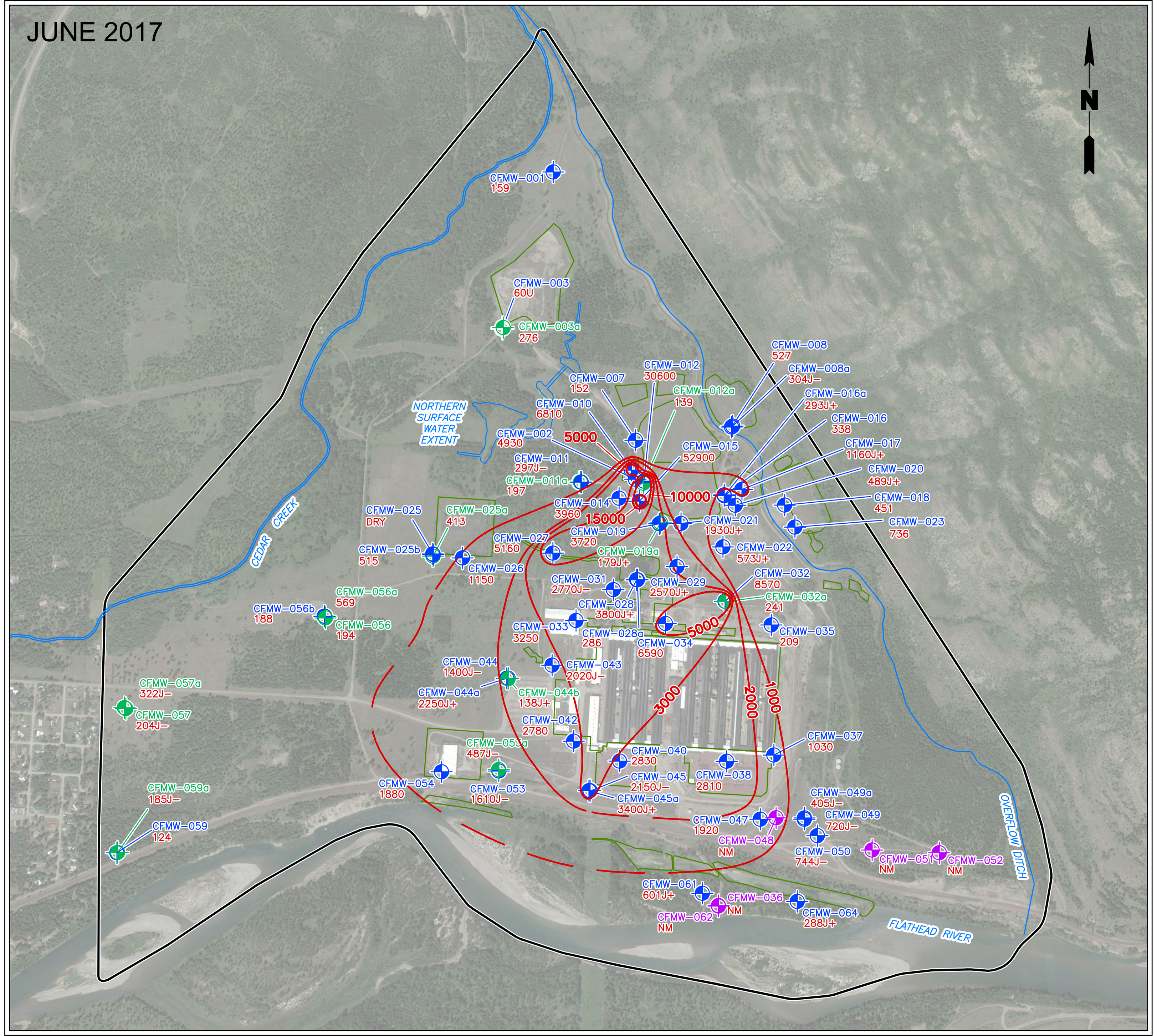
COLUMBIA FALLS ALUMINUM COMPANY

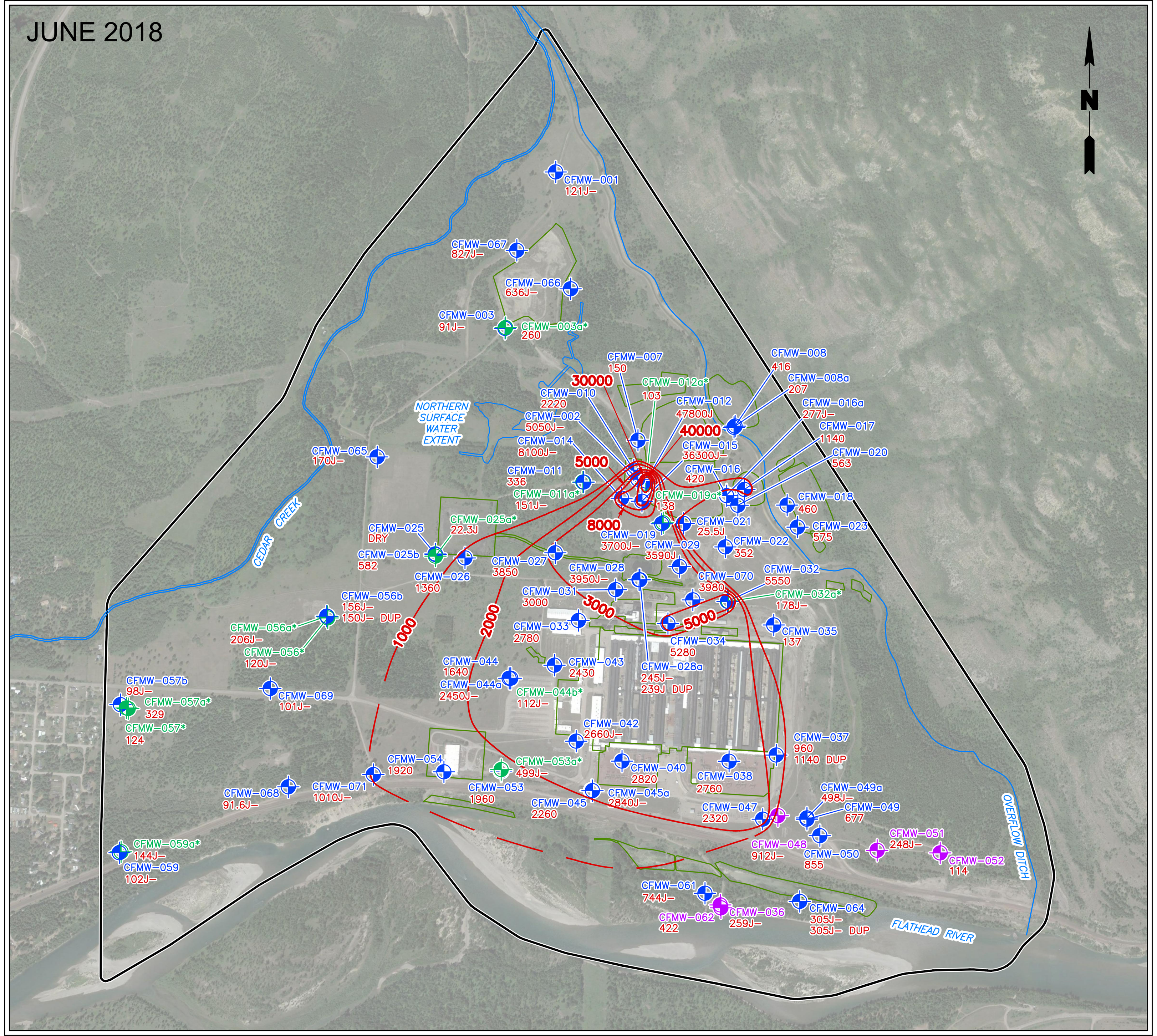
ROUX			PLATE
	Compiled by: L.J.	Date: 22JAN20	
	Prepared by: G.M.	Scale: AS SHOWN	18
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.13.DWG		

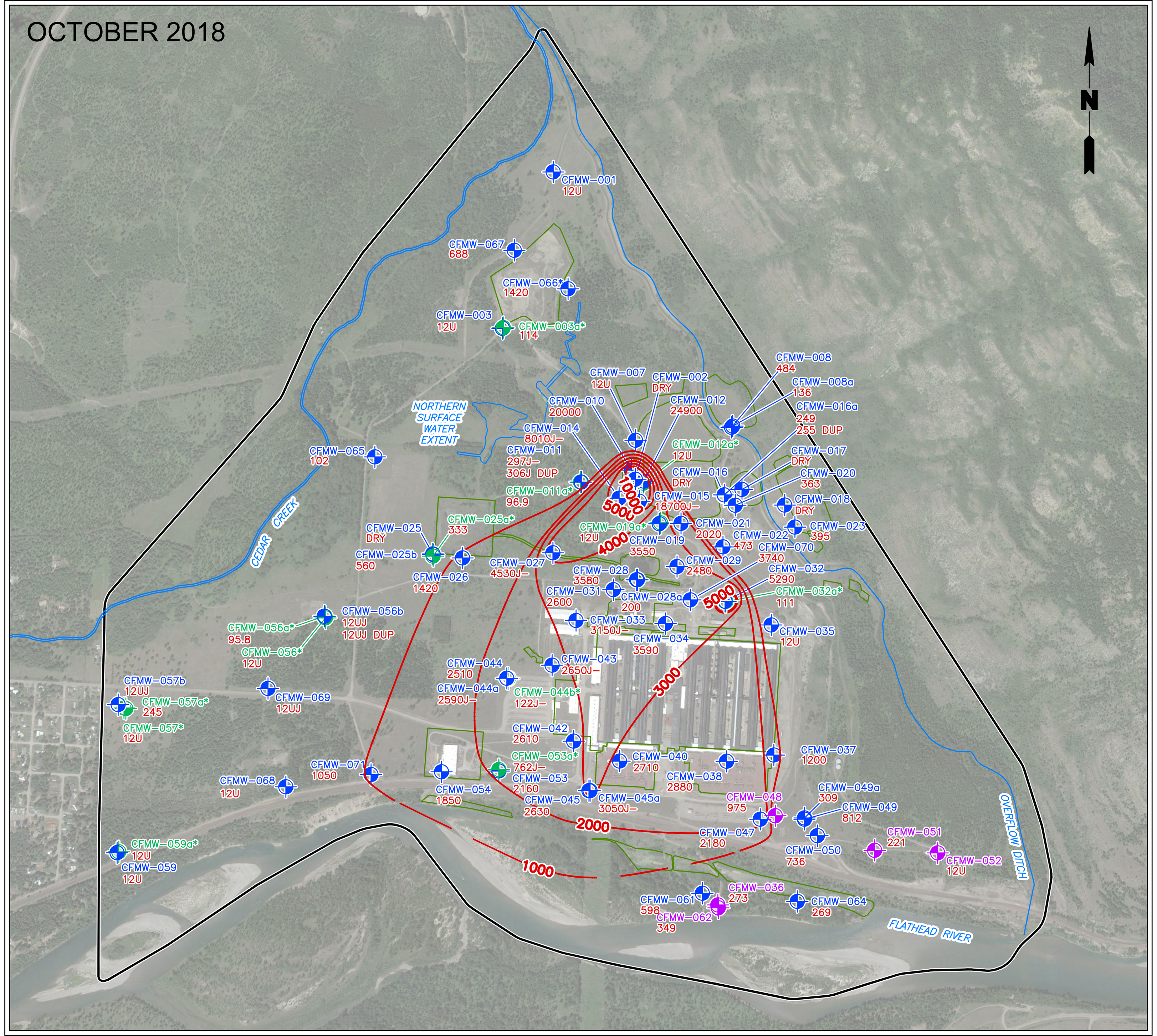












LEGEND

	RI/FS SITE BOUNDARY
	SURFACE WATER FEATURE
	SITE FEATURE
CFMW-035	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
CFMW-052	LOCATION AND DESIGNATION OF FORMER PRODUCTION WELL
CFMW-032a*	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
405	FLUORIDE CONCENTRATIONS IN GROUNDWATER (UNITS IN ug/L)
*	NOT USED IN CONTOURING
DUP	DUPLICATE SAMPLE
J	ESTIMATED VALUE
NM	NOT MEASURED
U	INDICATES THAT ANALYTE WAS NOT DETECTED AT THE LIMIT REPORTED
DRY	INSUFFICIENT WATER TO COLLECT SAMPLE
1000	CONTOUR LINE OF FLUORIDE CONCENTRATION (DASHED WHERE INFERRED)

NOTE

CONTOURS ARE FOR THE UPPER HYDROGEOLOGIC UNIT WELLS ONLY

N

1,000 0 1,000

Title:

CONCENTRATIONS OF TOTAL FLUORIDE IN GROUNDWATER

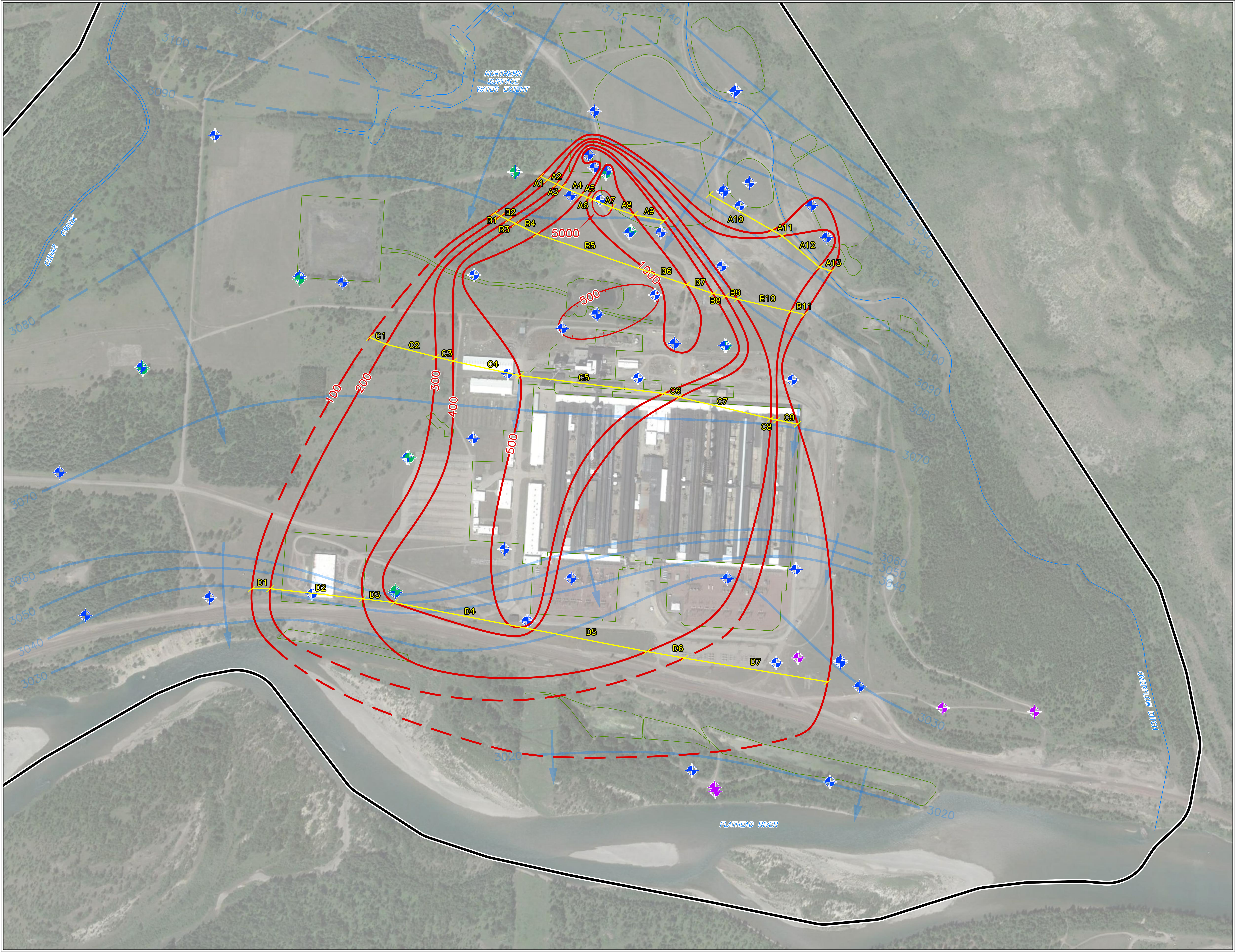
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	19
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.14.DWG		



LEGEND

RI/FS SITE BOUNDARY
SURFACE WATER FEATURE
SITE FEATURE
LOCATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
LOCATION OF FORMER PRODUCTION WELL
LOCATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
D7 FLOW TRANSECTS
100 CONTOUR LINE OF TOTAL CYANIDE CONCENTRATION (DASHED WHERE INFERRED)
3070 CONTOUR LINE OF EQUAL POTENTIOMETRIC SURFACE (DASHED WHERE INFERRED)
GROUNDWATER FLOW DIRECTION

NOTE

MONITORING WELLS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT ARE NOT USED IN CONTOURING.

N

300' 0 300'

Title:

FLOW TRANSECTS FOR TOTAL CYANIDE MASS FLUX ESTIMATES

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: L.J.	Date: 22JAN20	PLATE
Prepared by: G.M.	Scale: AS SHOWN	20
Project Mgr: M.R.	Project: 2476.0001Y008	
File: 2476.0001Y249.02.DWG		

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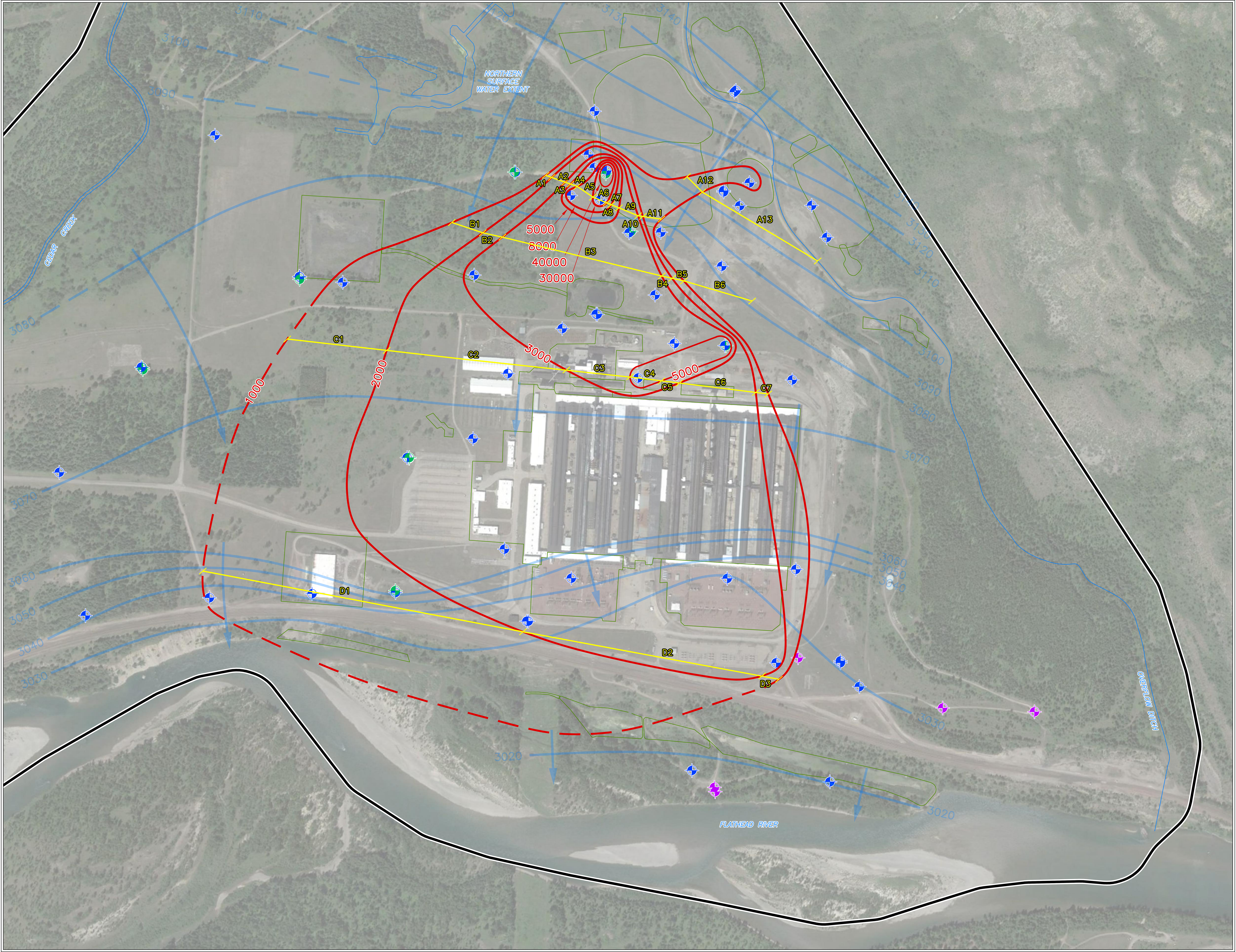

LEGEND

	RI/FS SITE BOUNDARY
	SURFACE WATER FEATURE
	SITE FEATURE
	LOCATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
	LOCATION OF FORMER PRODUCTION WELL
	LOCATION OF MONITORING WELL SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
D1	FLOW TRANSECTS
1000	CONTOUR LINE OF TOTAL FLUORIDE CONCENTRATION (DASHED WHERE INFERRED)
3070	CONTOUR LINE OF EQUAL POTENTIOMETRIC SURFACE (DASHED WHERE INFERRED)
	GROUNDWATER FLOW DIRECTION

NOTE

MONITORING WELLS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT ARE NOT USED IN CONTOURING.

N

300' 0 300'

Title:

FLOW TRANSECTS FOR FLUORIDE MASS FLUX ESTIMATES

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX			PLATE
	Compiled by: L.J.	Date: 22JAN20	21
	Prepared by: G.M.	Scale: AS SHOWN	
	Project Mgr: M.R.	Project: 2476.0001Y008	
	File: 2476.0001Y249.03.DWG		