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U.S. EPA REGION 8
HEARING CLERK

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION 8

IN THE MATTER OF:

Anaconda Aluminum Co. Columbia Falls
Reduction Plant Superfund Site

*a/k/a Columbia Falls Aluminum
Company Site*

Columbia Falls Aluminum Company, LLC

Respondent

Proceeding under Section 106(a)
of the Comprehensive Environmental
Response, Compensation, and Liability
Act, 42 U.S.C. § 9606(a).

U.S. EPA Region 8

CERCLA Docket No. CERCLA-08-2025-0005

**UNILATERAL ADMINISTRATIVE
ORDER FOR REMEDIAL DESIGN**

TABLE OF CONTENTS

I.	JURISDICTION AND GENERAL PROVISIONS.....	1
II.	PARTIES BOUND	1
III.	DEFINITIONS.....	1
IV.	FINDINGS OF FACT.....	3
V.	CONCLUSIONS OF LAW AND DETERMINATIONS	6
VI.	ORDER	7
VII.	OPPORTUNITY TO CONFER.....	7
VIII.	EFFECTIVE DATE	7
IX.	NOTICE OF INTENT TO COMPLY	8
X.	PERFORMANCE OF THE WORK	8
XI.	PROPERTY REQUIREMENTS	10
XII.	INSURANCE.....	12
XIII.	DELAY IN PERFORMANCE	12
XIV.	ACCESS TO INFORMATION	13
XV.	RECORD RETENTION	14
XVI.	ENFORCEMENT/WORK TAKEOVER	14
XVII.	RESERVATIONS OF RIGHTS	15
XVIII.	OTHER CLAIMS	15
XIX.	ADMINISTRATIVE RECORD	16
XX.	APPENDICES	16
XXI.	NOTICES AND SUBMISSIONS.....	16
XXII.	SEVERABILITY	17

I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Order (Order) is issued under the authority vested in the President of the United States by section 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. This authority was delegated to the Administrator of the United States Environmental Protection Agency (EPA) by Executive Order No. 12580, 52 Fed. Reg. 2923 (Jan. 23, 1987), and further delegated to the Regional Administrators by EPA Delegation Nos. 14-14-A and 14-14-B. This authority was further redelegated by the Regional Administrator of EPA Region 8 to the undersigned EPA officials.

2. This Order directs Respondent to develop certain Remedial Design components and prepare a supplemental Biological Assessment and perform consultation under the Endangered Species Act, requirements described in the Record of Decision (ROD) for the Anaconda Aluminum Co. Columbia Falls Reduction Plant Superfund Site (also known as the Columbia Falls Aluminum Company Superfund Site) near Columbia Falls, Montana (Site), dated January 10, 2025.

3. The EPA has notified the State of Montana (State) of this action pursuant to section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

II. PARTIES BOUND

4. This Order applies to and is binding upon Respondent and its successors and assigns. Any change in ownership or control of the Site or change in the business structure or organization of Respondent, including, but not limited to, any transfer of assets or real or personal property, will not alter Respondent's responsibilities under this Order.

5. Respondent must provide a copy of this Order to each contractor hired to perform the Work required by this Order and to each person representing Respondent with respect to the Site or the Work, and must condition all contracts entered into hereunder upon performance of the Work in conformity with the terms of this Order. Respondent or its contractors must provide written notice of the Order to all subcontractors hired to perform any portion of the Work required by this Order. Respondent must nonetheless be responsible for ensuring that its contractors and subcontractors perform the Work in accordance with the terms of this Order.

III. DEFINITIONS

6. Unless otherwise expressly provided in this Order, terms used in this Order that are defined in CERCLA or in regulations promulgated under CERCLA have the meaning assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Order or in its appendices, the following definitions apply solely for the purposes of this Order:

“Affected Property” means all real property within the Site as addressed by the ROD.

“Agencies” means the EPA and DEQ collectively.

“CERCLA” means the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. §§ 9601-9675.

“Day” or “day” means a calendar day. In computing any period of time under this Order, where the last day would fall on a Saturday, Sunday, or federal or State holiday, the period runs until the close of business of the next working day.

“DEQ” means the Montana Department of Environmental Quality.

“Effective Date” means the effective date of this Order as provided in Section VIII.

“EPA” means the United States Environmental Protection Agency.

“EPA Hazardous Substance Superfund” means the Hazardous Substance Superfund established by the Internal Revenue Code, 26 U.S.C. § 9507.

“NCP” means the National Oil and Hazardous Substances Pollution Contingency Plan, also called the National Contingency Plan, promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, codified at 40 C.F.R. Part 300, and any amendments thereto.

“Non-Respondent Owner” means any person, other than Respondent, that owns or controls any Affected Property, including RDT Holdings, LLC. The phrase “Non-Respondent Owner’s Affected Property” means Affected Property owned or controlled by Non-Respondent Owner.

“Order” means this Unilateral Administrative Order and all appendices attached hereto. In the event of conflict between this Order and any appendix, this Order controls.

“Paragraph” means a portion of this Order identified by an Arabic numeral or an upper- or lower-case letter.

“Parties” means the EPA and Respondent.

“Performance Standards” means the cleanup standards and other measures of achievement of the goals of the remedial action objectives, as set forth in the ROD.

“RCRA” means the Resource Conservation and Recovery Act, also known as the Solid Waste Disposal Act, as amended, 42 U.S.C. §§ 6901-6992.

“ROD” means the EPA Record of Decision relating to the Site signed on January 10, 2025, by the Regional Administrator, EPA Region 8, and all attachments thereto.

“Remedial Action” means the remedial action selected in the ROD.

“Remedial Design” means those activities to be undertaken by Respondent to develop final plans and specifications for the Remedial Action as stated in the SOW.

“Respondent” means the Columbia Falls Aluminum Company, LLC, its divisions and subsidiaries, and any predecessors or successors in interest.

“Section” means a portion of this Order identified by a Roman numeral.

“Site” means the Anaconda Aluminum Co. Columbia Falls Reduction Plant Superfund Site, also known as the Columbia Falls Aluminum Company Superfund Site, comprising approximately 1,340 acres, bounded by Cedar Creek Reservoir to the north, Teakettle Mountain to the east, Flathead River to the south, Cedar Creek to the west, and located approximately two miles northeast of the city of Columbia Falls, Flathead County, Montana, and depicted generally on the map attached as Appendix B.

“State” means the State of Montana.

“SOW” means the Statement of Work attached as Appendix A, which describes the activities Respondent must perform.

“Supervising Contractor” means the principal contractor retained by Respondent to supervise and direct the implementation of the Work under this Order.

“Transfer” means to sell, assign, convey, lease, mortgage, or grant a security interest in, or where used as a noun, a sale, assignment, conveyance, or other disposition of any interest by operation of law or otherwise.

“United States” means the United States of America and each department, agency, and instrumentality of the United States, including the EPA.

“Waste Material” means: (a) any “hazardous substance” under section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any “solid waste” under section 1004(27) of RCRA, 42 U.S.C. § 6903(27); and (d) any “hazardous or deleterious substance” under section 75-10-701(8), Montana Code Annotated.

“Work” means all activities Respondent is required to perform under this Order, except those required by Section XV (Record Retention).

IV. FINDINGS OF FACT

A. Site History

7. The Site is generally located approximately two miles northeast of Columbia Falls, Flathead County, Montana, in Township 3N, Range 20W, on the north side of the Flathead

River. It is comprised of about 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.

8. From 1955 until 2009, a primary aluminum reduction facility operated at the Site, contaminating soil, groundwater, and surface water. The Site contained an aluminum smelting or reduction facility that produced aluminum in carbon-lined “pots” heated to 960 degrees Celsius. Aluminum oxide was dissolved in a molten cryolite bath and was reduced to aluminum metal by electrons from direct current through the pot. The molten aluminum was then tapped from the pot and cast into ingots.

9. Features of the Site include, but are not limited to, percolation ponds, closed leachate ponds, a closed sludge pond, closed landfills, and an operational industrial landfill. To manage the variety of Site features, the Site is divided into six decision units: (1) Landfills Decision Unit 1; (2) Landfills Decision Unit 2; (3) Soil Decision Unit; (4) North Percolation Pond Decision Unit; (5) River Area Decision Unit; and (6) Groundwater Decision Unit.

10. Primary contaminants of concern include cyanide and fluoride. Additional contaminants include polycyclic aromatic hydrocarbons (PAHs) and metals, including aluminum, barium, cadmium, copper, iron, lead, nickel, selenium, thallium, vanadium, and zinc.

11. On November 30, 2015, in response to a release or a substantial threat of a release of hazardous substances at or from the Site, the EPA and Respondent entered into an Administrative Settlement Agreement and Order on Consent to perform a Remedial Investigation and Feasibility Study for the Site, CERCLA Docket No. 08-2016-0002 (RI/FS ASAOC), pursuant to 40 C.F.R. § 300.430.

12. On September 9, 2016, the EPA added the Site to the National Priorities List pursuant to CERCLA section 105, 42 U.S.C. §9605 (82 Fed. Reg. 62397).

13. In 2020, the EPA approved Respondent’s final Remedial Investigation Report for the Site prepared pursuant to the RI/FS ASAOC. The Remedial Investigation Report documented findings that (a) fluoride and cyanide are present in groundwater and percolation ponds, backwater seep, and riparian area and (b) PAHs and metals are present in soils. These contaminants present an unacceptable risk to human health and the environment, including unacceptable cancer risk for human populations such as trespassers and industrial workers and adverse effects for aquatic receptors.

14. In 2021, the EPA approved Respondent’s Feasibility Study for the Site prepared pursuant to the RI/FS ASAOC.

15. On July 21, 2020, the EPA and Respondent entered into an Administrative Settlement Agreement and Order on Consent to perform a removal action for the Site, CERCLA Docket No. 08-2020-0002. Respondent removed sediments from the South Percolation Ponds and returned the flow of the Flathead River to its northern channel. Respondent began work in October 2020 and EPA sent a Notice of Completion of the removal action in October 2021.

16. Pursuant to section 117 of CERCLA, 42 U.S.C. § 9617, the EPA published notice of the proposed plan for Remedial Action in 2023 in a major local newspaper of general circulation. The EPA made the proposed plan and supporting analysis and information available in an administrative record. The EPA provided an opportunity for written and oral comments from the public on the proposed plan and extended the initial 60-day public comment period by another 30 days. The comment period ran from June 1 to August 31, 2023. The EPA held a public meeting during the public comment period. A copy of the transcript of the public meeting, as well as the 134 comments the EPA received during the public comment period, is available to the public as part of the administrative record.

17. On January 10, 2025, the EPA issued the ROD for the Site with the State's concurrence, which embodies the EPA's decision, based on the administrative record, of the Remedial Action to be implemented at the Site. The ROD includes a responsiveness summary to the public comments. Notice of the final plan was published in accordance with section 117(b) of CERCLA, 42 U.S.C. § 9617(b).

18. The selected remedy uses a remedial strategy that emphasizes Sitewide consolidation and encapsulation of contaminant sources to eliminate exposure pathways, reduce the transfer of contaminants of concern to groundwater underlying the Site, and bring concentrations in seeps near the Flathead River into compliance with standards for ecological receptors.

B. Respondent's Ownership, Operation, and Corporate Succession

19. In 1985, the Atlantic Richfield Company (ARCO), corporate successor to Anaconda Aluminum Company and The Anaconda Company, sold the aluminum reduction plant to the Columbia Falls Aluminum Company (CFAC), a Montana corporation. CFAC was created as a subsidiary of the Montana Aluminum Investors Corporation, a group of investors headed by former ARCO executives. CFAC operated the plant upon taking control.

20. In 1989, the Montana Aluminum Investors Corporation merged into CFAC, with CFAC being the surviving corporation. CFAC succeeded to all liabilities and obligations of the merging company, which ceased existence after the merger.

21. In 1999, CFAC merged into a subsidiary of Glencore AG, Glencore Acquisition LLC, a Delaware corporation, surviving under the name, Columbia Falls Aluminum Company LLC (CFAC LLC). The non-surviving company (CFAC) ceased existence. CFAC LLC, a Delaware limited liability company, is currently active and in good standing and is named as Respondent in this Order.

22. Respondent or its predecessor operated the aluminum reduction plant from 1985 to 2009. Respondent produced an estimated 6,319,833,296 pounds of aluminum between October 1985 and 2009, when it stopped producing aluminum.

23. Respondent announced the permanent closure of the facility in 2015 and completed the decommissioning and removal of the industrial buildings and related structures in the third quarter of 2019.

24. Respondent continues to own portions of the Site and sold portions of the Site to RDT Holdings, LLC in 2025.

V. CONCLUSIONS OF LAW AND DETERMINATIONS

25. Based on the Findings of Fact set forth above and the administrative record, the EPA has determined that:

a. The Site is a “facility” as defined in section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

b. Respondent is a “person” as defined by section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

c. Respondent is a liable party under one or more provisions of section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

(1) Respondent is the “owner” and “operator” of the facility, as defined by section 101(20) of CERCLA, 42 U.S.C. § 9601(20), and within the meaning of section 107(a)(1) of CERCLA, 42 U.S.C. § 9607(a)(1).

(2) Respondent was the “owner” and “operator” of the facility at the time of disposal of hazardous substances at the facility, as defined by section 101(20) of CERCLA, 42 U.S.C. § 9601(20), and within the meaning of section 107(a)(2) of CERCLA, 42 U.S.C. § 9607(a)(2).

d. The contamination found at the Site, as identified in the Findings of Fact above, includes “hazardous substances” as defined by section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

e. The conditions described in the Findings of Fact above constitute an actual and threatened “release” of a hazardous substance from the facility as defined by section 101(22) of CERCLA, 42 U.S.C. § 9601(22).

f. The conditions at the Site may constitute a threat to public health or welfare or the environment, based on the factors set forth in the ROD.

g. Solely for purposes of section 113(j) of CERCLA, 42 U.S.C. § 9613(j), the remedy set forth in the ROD and the Work to be performed by Respondent constitutes a response action taken or ordered by the President for which judicial review is limited to the administrative record.

h. The conditions described in the Findings of Fact above may constitute an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from the facility within the meaning of section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

i. The actions required by this Order are necessary to protect the public health and welfare and the environment.

VI. ORDER

26. Based on the Findings of Fact, Conclusions of Law, and Determinations set forth above, and the administrative record, Respondent is hereby ordered to comply with this Order and any modifications to this Order, including, but not limited to, all appendices and all documents incorporated by reference into this Order.

VII. OPPORTUNITY TO CONFER

27. No later than 10 days after the Order is signed by the EPA, Respondent may, in writing, (a) request a conference with the EPA to discuss this Order, including its applicability, the factual findings and the determinations upon which it is based, the appropriateness of any actions Respondent is ordered to take, or any other relevant and material issues or contentions that Respondent may have regarding this Order, or (b) notify the EPA that it intends to submit written comments or a statement of position in lieu of requesting a conference.

28. If a conference is requested, Respondent may appear in person or by an attorney or other representative. Any such conference must be held no later than 5 days after the conference is requested. Any written comments or statements of position on any matter pertinent to this Order must be submitted no later than 5 days after the conference or 15 days after this Order is signed if Respondent does not request a conference. This conference is not an evidentiary hearing, does not constitute a proceeding to challenge this Order, and does not give Respondent a right to seek review of this Order. Any request for a conference or written comments or statements should be submitted to the EPA as provided in Section XXI (Notices and Submissions).

VIII. EFFECTIVE DATE

29. This Order is effective 10 days after the Order is signed by the EPA, unless a conference is requested or notice is given that written materials will be submitted in lieu of a conference in accordance with Section VII (Opportunity to Confer). If a conference is requested or such notice is submitted, this Order is effective on the 10th day after the day of the conference, or if no conference is requested, on the 10th day after written materials, if any, are submitted, unless the EPA determines that the Order should be modified based on the conference or written materials. In such event, the EPA will notify Respondent, within the applicable 10-day period, that the EPA intends to modify the Order. The modified Order is effective 5 days after it is signed by the EPA.

IX. NOTICE OF INTENT TO COMPLY

30. On or before the Effective Date, Respondent must notify the EPA in writing of Respondent's irrevocable intent to comply with this Order. Such written notice must be sent to the EPA as provided in Section XXI (Notices and Submissions).

31. Respondent's written notice must describe, using facts that exist on or prior to the Effective Date, any "sufficient cause" defense asserted by Respondent under sections 106(b) and 107(c)(3) of CERCLA, 42 U.S.C. §§ 9606(a) and 9607(c)(3). The absence of a response by the EPA to the notice required by this Section will not be deemed to be acceptance of Respondent's assertions. Failure of Respondent to provide such notice of intent to comply within this time period will, as of the Effective Date, be treated as a violation of this Order by Respondent.

X. PERFORMANCE OF THE WORK

32. **Compliance with Applicable Law.** Nothing in this Order limits Respondent's obligations to comply with the requirements of all applicable federal and state laws and regulations. Respondent must also comply with all applicable or relevant and appropriate requirements of all federal and state environmental laws as set forth in the ROD and the SOW.

33. Permits

a. As provided in section 121(e) of CERCLA, 42 U.S.C. § 9621(e), and section 300.400(e) of the NCP, no permit is required for any portion of the Work conducted entirely on-Site (i.e., within the areal extent of contamination or in very close proximity to the contamination and necessary for implementation of the Work). Where any portion of the Work that is not on-Site requires a federal or state permit or approval, Respondent must submit timely and complete applications and take all other actions necessary to obtain all such permits or approvals.

b. This Order is not, and will not be construed to be, a permit issued pursuant to any federal or state statute or regulation.

34. Coordination and Supervision

a. Project Coordinators

(1) Respondent's Project Coordinator must have sufficient technical expertise to coordinate the Work. Respondent's Project Coordinator may not be an attorney representing Respondent in this matter and may not act as the Supervising Contractor. Respondent's Project Coordinator may assign other representatives, including other contractors, to assist in coordinating the Work.

(2) The EPA has designated Allie Archer of the Superfund and Emergency Management Division in the Superfund Remedial Branch as EPA's Remedial Project

Manager (RPM). The EPA has the right to change its RPM. The EPA may designate other representatives, which may include its employees, contractors and/or consultants, to oversee the Work. EPA's RPM will have the same authority as a remedial project manager and/or an on-scene coordinator, as described in the NCP. This includes the authority to halt the Work and/or to conduct or direct any necessary response action when he or she determines that conditions at the Site constitute an emergency or may present an immediate threat to public health or welfare or the environment due to a release or threatened release of Waste Material.

(3) DEQ has designated Richard Sloan of DEQ as its State Project Manager. DEQ has the right to change its State Project Manager.

(4) Respondent's Project Coordinator must meet with EPA's RPM and the State Project Manager as described in the SOW.

b. **Supervising Contractor.** Respondent's proposed Supervising Contractor must have sufficient technical expertise to supervise the Work and a quality assurance system that complies with ASQ/ANSI E4:2014, "Quality management systems for environmental information and technology programs - Requirements with guidance for use" (American Society for Quality, February 2014).

c. **Procedures for Disapproval/Notice to Proceed**

(1) Respondent must designate, and notify the EPA, within 10 days after the Effective Date, of the names, titles, contact information, and qualifications of the Respondent's proposed Project Coordinator and Supervising Contractor, whose qualifications will be subject to EPA's review for verification based on objective assessment criteria (e.g., experience, capacity, technical expertise) and that they do not have a conflict of interest with respect to the project.

(2) After consultation with DEQ, the EPA will issue notices of disapproval or authorizations to proceed regarding the proposed Project Coordinator and Supervising Contractor, as applicable. If the EPA issues a notice of disapproval, Respondent must, within 30 days, submit to the EPA a list of supplemental proposed Project Coordinators and Supervising Contractors, as applicable, including a description of the qualifications of each. After consultation with DEQ, the EPA will issue a notice of disapproval or authorization to proceed regarding each supplemental proposed coordinator and contractor. Respondent may select any coordinator/contractor covered by an authorization to proceed and must, within 21 days, notify the EPA of Respondent's selection.

(3) Respondent may change its Project Coordinator and Supervising Contractor, as applicable, by following the procedures of Paragraphs 34.c(1) and 34.c(2).

35. **Performance of Work in Accordance with SOW.** Respondent must, in accordance with the SOW and all EPA-approved, conditionally-approved, or modified deliverables as required by the SOW: (a) develop the Remedial Design; and (b) prepare a supplemental Biological Assessment and perform consultation under the Endangered Species

Act under the guidance of, and subject to independent review by, the EPA. All deliverables required to be submitted for approval under the Order or SOW are subject to approval by the EPA, after consultation with DEQ, in accordance with the SOW.

36. **Emergencies and Releases.** Respondent must comply with the emergency and release response and reporting requirements under the SOW.

37. **Modification**

a. The EPA may, after consultation with DEQ, by written notice from the EPA RPM to Respondent, modify, or direct Respondent to modify, the SOW and/or any deliverable developed under the SOW, if such modification is necessary to achieve or maintain the Performance Standards or to carry out and maintain the effectiveness of the future Remedial Action, and such modification is consistent with the Scope of the Remedial Design components set forth in the SOW. Any other requirements of this Order may be modified in writing by signature of the appropriate delegated official of the EPA.

b. Respondent may submit written requests to modify the SOW and/or any deliverable developed under the SOW. If the EPA, after consultation with DEQ, approves the request in writing, the modification will be effective upon the date of such approval or as otherwise specified in the approval. Respondent must modify the SOW and/or related deliverables in accordance with EPA's approval.

c. No informal advice, guidance, suggestion, or comment by the EPA RPM or other EPA representatives, or by the State Project Manager or other State representatives, regarding reports, plans, specifications, schedules, or any other writing submitted by Respondent relieves Respondent of its obligation to obtain any formal approval required by this Order, or to comply with all requirements of this Order, unless it is formally modified.

d. Nothing in this Order, the attached SOW, any deliverable required under the SOW, or any approval by the EPA constitutes a warranty or representation of any kind by the EPA that compliance with the work requirements set forth in the SOW or related deliverable will achieve the Performance Standards.

XI. PROPERTY REQUIREMENTS

38. **Agreements Regarding Access and Non-Interference.**

a. Respondent must, with respect to any Non-Respondent Owner's Affected Property, use best efforts to secure from such Non-Respondent Owner an agreement, enforceable by Respondent, the EPA, and the State, providing that such Non-Respondent Owner: (i) provide the EPA, the State, and their representatives, contractors, and subcontractors with access at all reasonable times to such Affected Property to conduct any activity regarding the Order, including those listed in Paragraph 38.c (Access Requirements); and (ii) refrain from using such Affected Property in any manner that the EPA determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Material, or interfere with or

adversely affect the implementation, integrity, or protectiveness of the Remedial Action. Respondent must provide a copy of such access agreement(s) to the Agencies.

b. Respondent must with respect to Respondent's Affected Property: (i) provide the EPA, the State, and their representatives, contractors, and subcontractors with access at all reasonable times to such Affected Property to conduct any activity regarding the Order, including those listed in Paragraph 38.c (Access Requirements); and (ii) refrain from using such Affected Property in any manner that the EPA determines will pose an unacceptable risk to human health or to the environment due to exposure to Waste Material, or interfere with or adversely affect the implementation, integrity, or protectiveness of the Remedial Action.

c. **Access Requirements.** The following is a list of activities for which access is required regarding the Affected Property:

- (1) Monitoring the Work;
- (2) Verifying any data or information submitted to the EPA;
- (3) Conducting investigations regarding contamination at or near the Site;
- (4) Obtaining samples;
- (5) Assessing the need for, planning, or implementing additional response actions at or near the Site;
- (6) Assessing implementation of quality assurance and quality control practices as defined in the approved construction quality assurance quality control plan as provided in the SOW;
- (7) Implementing the Work pursuant to the conditions set forth in Paragraph 50 (Work Takeover);
- (8) Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Respondent or its agents, consistent with Section XIV (Access to Information);
- (9) Assessing Respondent's compliance with the Order; and
- (10) Determining whether the Affected Property is being used in a manner that is prohibited or restricted, or that may need to be prohibited or restricted under the Order.

39. **Best Efforts.** As used in this Section, "best efforts" means the efforts that a reasonable person in the position of Respondent would use so as to achieve the goal in a timely manner, including the cost of employing professional assistance and the payment of reasonable

sums of money to secure access agreements. If, within 30 days after the Effective Date, Respondent is unable to accomplish what is required through “best efforts,” it must notify the EPA, and include a description of the steps taken to comply with the requirements. If EPA deems it appropriate, it may assist Respondent, or take independent action, in obtaining such access. The EPA reserves the right to pursue cost recovery regarding all costs incurred by the United States in providing such assistance or taking such action, including the cost of attorney time and the amount of monetary consideration or just compensation paid.

40. In the event of any Transfer of the Affected Property, unless the EPA otherwise consents in writing, Respondent will continue to comply with its obligations under the Order, including its obligation to secure access regarding the Affected Property.

XII. INSURANCE

41. Not later than 15 days before commencing any on-site Work, Respondent must secure and maintain for one year pursuant to this Order commercial general liability insurance with limits of liability of \$1 million per occurrence, automobile insurance with limits of liability of \$1 million per accident, and umbrella liability insurance with limits of liability of \$5 million in excess of the required commercial general liability and automobile liability limits, naming the United States as an additional insured with respect to all liability arising out of the activities performed by or on behalf of Respondent pursuant to this Order. In addition, for the duration of the Order, Respondent must satisfy, or must ensure that its contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker’s compensation insurance for all persons performing Work on behalf of Respondent in furtherance of this Order. Within the same time period, Respondent must provide the EPA with certificates of such insurance and a copy of each insurance policy. Respondent must submit such certificate and copies of policies each year on the anniversary of the Effective Date. If Respondent demonstrates by evidence satisfactory to the EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering some or all of the same risks but in a lesser amount, then, with respect to that contractor or subcontractor, Respondent need provide only that portion of the insurance described above that is not maintained by the contractor or subcontractor. Respondent must ensure that all submittals to the EPA under this Paragraph identify the Site name and the EPA docket number for this action.

XIII. DELAY IN PERFORMANCE

42. Respondent must notify the EPA of any delay or anticipated delay in performing any requirement of this Order. Such notification must be made by telephone and email to the EPA RPM within 48 hours after Respondent first knew or should have known that a delay might occur. Respondent must adopt all reasonable measures to avoid or minimize any such delay. Within seven days after notifying the EPA by telephone and email, Respondent must provide to the EPA written notification fully describing the nature of the delay, the anticipated duration of the delay, any justification for the delay, all actions taken or to be taken to prevent or minimize the delay or the effect of the delay, a schedule for implementation of any measures to be taken to mitigate the effect of the delay, and any reason why Respondent should not be held strictly accountable for failing to comply with any relevant requirements of this Order. Increased costs

or expenses associated with implementation of the activities called for in this Order is not a justification for any delay in performance.

43. Any delay in performance of this Order that, in EPA's judgment, is not properly justified by Respondent under the terms of Paragraph 42 will be considered a violation of this Order. Any delay in performance of this Order will not affect Respondent's obligations to fully perform all obligations under the terms and conditions of this Order.

XIV. ACCESS TO INFORMATION

44. Respondent must provide to the EPA, upon request, copies of all records, reports, documents, and other information (including records, reports, documents, and other information in electronic form) (hereinafter referred to as "Records") within Respondent's possession or control or that of its contractors or agents relating to activities at the Site or to the implementation of this Order, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information regarding the Work. Respondent must also make available to the EPA, for purposes of investigation, information gathering, or testimony, its employees, agents, or representatives with knowledge of relevant facts concerning the performance of the Work.

45. Privileged and Protected Claims

a. Respondent may assert that all or part of a Record requested by the EPA is privileged or protected as provided under federal law, in lieu of providing the Record, provided Respondent complies with Paragraph 45.b, and except as provided in Paragraph 45c.

b. If Respondent asserts a claim of privilege or protection, it must provide the EPA with the following information regarding such Record: (1) its title; (2) its date; (3) the name, title, affiliation (e.g., company or firm), and address of the author, of each addressee, and of each recipient; (4) a description of the Record's contents; and (5) the privilege or protection asserted. If a claim of privilege or protection applies only to a portion of a Record, Respondent must provide the Record to the EPA in redacted form to mask the privileged or protected portion only. Respondent must retain all Records that it claims to be privileged or protected until the EPA has had a reasonable opportunity to dispute the privilege or protection claim and any such dispute has been resolved in the Respondent's favor.

c. Respondent may make no claim of privilege or protection regarding: (1) any data regarding the Site, including, but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, radiological, or engineering data, or the portion of any other Record that evidences conditions at or around the Site; or (2) the portion of any Record that Respondent is required to create or generate pursuant to this Order.

46. **Business Confidential Claims.** Respondent may assert that all or part of a Record provided to the EPA under this Section or Section XV (Record Retention) is business confidential to the extent permitted by and in accordance with section 104(e)(7) of CERCLA, 42 U.S.C. § 9604(e)(7), and 40 C.F.R. § 2.203(b). Respondent must segregate and clearly

identify all Records or parts thereof submitted under this Order for which Respondent asserts business confidentiality claims. Records claimed as confidential business information will be afforded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies Records when they are submitted to the EPA, or if the EPA has notified Respondent that the Records are not confidential under the standards of CERCLA § 104(e)(7) or 40 C.F.R. Part 2, Subpart B, the public may be given access to such Records without further notice to Respondent.

XV. RECORD RETENTION

47. During the pendency of this Order and for a minimum of 10 years after the EPA provides Notice of Work Completion pursuant to the SOW, Respondent must preserve and retain all non-identical copies of Records (including Records in electronic form) in its possession or control or that come into its possession or control that relate in any manner to its liability under CERCLA with respect to the Site. Respondent must also retain all Records that relate to the liability of any other person under CERCLA with respect to the Site. Respondent must retain, and instruct its contractors and agents to preserve, for the same period of time specified above, all non-identical copies of the last draft or final version of any Records (including Records in electronic form) now in its possession or control or that come into its possession or control that relate in any manner to the performance of the Work and must retain copies of all data generated during performance of the Work and not contained in the aforementioned Records to be retained. Each of the above record retention requirements applies regardless of any corporate retention policy to the contrary.

48. At the conclusion of this document retention period, Respondent must notify the Agencies at least 90 days prior to the destruction of any such Records, and, upon request by the EPA or the State, and except as provided in Paragraph 45, Respondent must deliver any such Records to the EPA or the State.

49. Within 30 days after the Effective Date, Respondent must submit a written certification to EPA's RPM that, to the best of its knowledge and belief, after thorough inquiry, it has not altered, mutilated, discarded, destroyed, or otherwise disposed of any Records (other than identical copies) relating to its potential liability regarding the Site since notification of potential liability by the United States or the State and that it has fully complied with any and all EPA requests for information regarding the Site pursuant to sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e), and section 3007 of RCRA, 42 U.S.C. § 6927, and state law. If Respondent is unable to so certify, it must submit a modified certification that explains in detail why it is unable to certify in full with regard to all Records.

XVI. ENFORCEMENT/WORK TAKEOVER

50. Any willful violation, or failure or refusal to comply with any provision of this Order may subject Respondent to civil penalties up to the maximum amount authorized by law. CERCLA § 106(b)(1), 42 U.S.C. § 9606(b)(1). As of the date of issuance of this Order, the statutory maximum amount is \$71,545 per violation per day. This maximum amount may increase in the future, as the EPA amends its civil penalty amounts through rulemaking pursuant

to the 1990 Federal Civil Penalties Inflation Adjustment Act (Public Law 101-410, codified at 28 U.S.C. § 2461), as amended by the 2015 Federal Civil Penalties Inflation Adjustment Act Improvement Act (section 701 of Public Law 114-74)). The maximum amount to be applied to this violation will be set as the most recent maximum amount set forth in 40 CFR section 19.4 as of the date that the U.S. District Court assesses any such penalty. In the event of such willful violation, or failure or refusal to comply, the EPA may unilaterally carry out the actions required by this Order, pursuant to section 104 of CERCLA, 42 U.S.C. § 9604, or may seek judicial enforcement of this Order pursuant to section 106 of CERCLA, 42 U.S.C. § 9606, or both. Respondent may also be subject to punitive damages in an amount up to three times the amount of any cost incurred by the United States as a result of such failure to comply, as provided in section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3).

XVII. RESERVATIONS OF RIGHTS

51. Nothing in this Order limits the rights and authorities of the EPA and the United States:

a. To take, direct, or order all actions necessary, including to seek a court order, to protect public health, welfare, or the environment or to respond to an actual or threatened release of Waste Material on, at, or from the Site;

b. To select further response actions for the Site in accordance with CERCLA and the NCP;

c. To seek legal or equitable relief to enforce the terms of this Order;

d. To take other legal or equitable action as they deem appropriate and necessary, or to require Respondent in the future to perform additional activities pursuant to CERCLA or any other applicable law;

e. To bring an action against Respondent under section 107 of CERCLA, 42 U.S.C. § 9607, for recovery of any costs incurred by the EPA or the United States regarding this Order or the Site;

f. Regarding access to, and to require land, water, or other resource use restrictions and institutional controls regarding the Site under CERCLA, RCRA, or other applicable statutes and regulations; or

g. To obtain information and perform inspections in accordance with CERCLA, RCRA, and any other applicable statutes or regulations.

XVIII. OTHER CLAIMS

52. By issuance of this Order, the United States and the EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondent. The United States or the EPA will not be deemed a party to any contract entered into by

Respondent or its directors, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out actions pursuant to this Order.

53. Nothing in this Order constitutes a satisfaction of or release from any claim or cause of action against Respondent or any person not a party to this Order, for any liability such person may have under CERCLA, other statutes, or common law, including but not limited to any claims of the United States under sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607.

54. Nothing in this Order constitutes preauthorization of a claim within the meaning of section 111 of CERCLA, 42 U.S.C. § 9611, or C.F.R. § 300.700(d).

55. No action or decision by the EPA pursuant to this Order gives rise to any right to judicial review, except as set forth in section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XIX. ADMINISTRATIVE RECORD

56. The EPA has established an administrative record that contains the documents that form the basis for the issuance of this Order, including, but not limited to, the documents upon which the EPA based the selection of the Remedial Action selected in the ROD. The EPA will make the administrative record available for review by appointment. Persons may request an appointment to review the administrative record by contacting the RPM.

XX. APPENDICES

57. The following appendices are attached to and incorporated into this Order:

“Appendix A” is the SOW.

“Appendix B” is the map of the Site.

XXI. NOTICES AND SUBMISSIONS

58. All approvals, consents, deliverables, modifications, notices, notifications, objections, proposals, reports and requests specified in this Order must be in writing unless otherwise specified. Whenever, under this Order, notice is required to be given, or a report or other document is required to be sent, it must be directed to the person(s) specified below at the address(es) specified below. The Agencies may change the person and/or address applicable to it by providing notice of such change to Respondent. All notices under this Section are effective upon receipt, unless otherwise specified. Except as otherwise provided, notice by email (if that option is provided below) or by regular mail in accordance with this Section satisfies any notice requirement of this Order.

As to the EPA:

via email to:
Allie Archer, RPM
Archer.Allie@epa.gov

and
Paige Wright, Attorney
Wright.Paige@epa.gov

and
Kayleen Castelli, Attorney
Castelli.Kayleen@epa.gov

Re: Site/Spill ID # A882

As to the State:

via email to:
Dick Sloan, State Project Manager
RSloan@mt.gov

and
Jon Morgan, Legal Counsel
JMorgan3@mt.gov

Re: Columbia Falls Reduction Plant
Superfund Site

XXII. SEVERABILITY

59. If a court issues an order that invalidates any provision of this Order or finds that Respondent has sufficient cause not to comply with one or more provisions of this Order, Respondent will remain bound to comply with all provisions of this Order not invalidated or determined to be subject to a sufficient cause defense by the court's order.

It is so ORDERED.

Signature page for Unilateral Administrative Order for Anaconda Aluminum Co. Columbia Falls
Reduction Plant Superfund Site

BY: **KENNETH
SCHEFSKI** Digitally signed by
KENNETH SCHEFSKI
Date: 2025.07.30
16:23:00 -06'00'

Kenneth C. Schefski
Regional Counsel
Region 8
U.S. Environmental Protection Agency

DATE: _____

BY: **AARON
URDIALES** Digitally signed by
AARON URDIALES
Date: 2025.07.30
16:34:29 -06'00'

Aaron Urdiales, Director
Superfund and Emergency Management Division
Region 8
U.S. Environmental Protection Agency

DATE: _____

STATEMENT OF WORK
to implement the
UNILATERAL ADMINISTRATIVE ORDER
for the
Anaconda Aluminum Co Columbia Falls Reduction Plant Superfund Site
also referred to as the Columbia Falls Aluminum Company Site
Remedial Design
Columbia Falls, State of Montana
July 2025

TABLE OF CONTENTS

1.	INTRODUCTION	3
2.	COORDINATION AND SUPERVISION	4
3.	REMEDIAL DESIGN	5
4.	REPORTING	7
5.	DELIVERABLES.....	7
6.	SCHEDULES	11
7.	STATE PARTICIPATION.....	15
8.	APPENDIXES	15
9.	REFERENCES	15

1. INTRODUCTION

1.1 Purpose of SOW. This Statement of Work (SOW) sets forth the procedures and requirements for implementing the Work obligations of Columbia Falls Aluminum Company, LLC for Endangered Species Act consultation, Predesign Investigation (PDI), and Cedar Creek Reservoir Ditch Lining Remedial Design and is incorporated into the Unilateral Administrative Order for Remedial Design (UAO) for the Anaconda Aluminum Co. Columbia Falls Reduction Plant Superfund Site (also known as the Columbia Falls Aluminum Company Superfund Site) near Columbia Falls, Montana (Site).

1.2 Structure of the SOW

- Section 2 (Coordination and Supervision) contains the provisions for selecting the Supervising Contractor and Project Coordinators regarding the Work.
- Section 3 (Remedial Design) sets forth the process for conducting Endangered Species Act consultation, the Pre-Design Investigations and developing the Cedar Creek Reservoir Ditch Lining Remedial Design, which includes the submission of specified primary deliverables.
- Section 5 (Reporting) sets forth Respondent's reporting obligations.
- Section 6 (Deliverables) describes the contents of the supporting deliverables and the general requirements regarding Respondent's submission of, and EPA's review of, approval of, comment on, and/or modification of, the deliverables.
- Section 7 (Schedules) sets forth the schedule for submitting the primary deliverables, specifies the supporting deliverables that must accompany each primary deliverable, and sets forth the schedule of milestones.
- Section 8 (State Participation) addresses Montana Department of Environmental Quality (DEQ) participation.
- Section 9 (References) provides a list of references, including URLs.

1.3 This SOW addresses the following actions either described in or necessary to implement certain parts of the Record of Decision:

- (a) Finalize Endangered Species Act consultation on behalf of the EPA;
- (b) Implementation of the PDI Workplan (described below) to generate data necessary for remedial design of the selected remedy described in Section 12 of the Record of Decision;
- (c) Complete remedial design to prepare to line the Cedar Creek Reservoir Overflow Ditch in the vicinity of West Landfill, Wet Scrubber Sludge Pond Landfill and the Center Landfill to minimize surface water infiltration into the groundwater; and
- (d) Engage in any other drilling, sampling or other work approved by the EPA and necessary to implement any other portion of the remedy in the Record of Decision.

- 1.4 The terms used in this SOW that are defined in CERCLA, in regulations promulgated under CERCLA, or in the UAO, have the meanings assigned to them in CERCLA, in such regulations, or in the UAO, except that the term “Paragraph” or “¶” means a paragraph of the SOW, and the term “Section” and “Subsection” means a section or subsection of the SOW, unless otherwise stated.

2. COORDINATION AND SUPERVISION

2.1 Project Coordinators

- (a) The Respondent Project Coordinator must have sufficient technical expertise to coordinate the Work. The Respondent Project Coordinator may not be an attorney representing Respondent in this matter and may not act as the Supervising Contractor. The Respondent Project Coordinator may assign other representatives, including other contractors, to assist in coordinating the Work. The Respondent Project Coordinator may not have a conflict of interest regarding the project.
- (b) The EPA has designated Allie Archer as the EPA Remedial Project Manager (RPM). The EPA may designate other representatives, which may include its employees, contractors, and/or consultants, to oversee the Work. The EPA RPM will have the same authority as a remedial project manager and/or an on-scene coordinator, as described in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This includes the authority to halt the Work and/or to conduct or direct any necessary response action when it is determined that conditions at the Site constitute an emergency or may present an immediate threat to public health or welfare or the environment due to a release or threatened release of Waste Material.
- (c) The DEQ has designated Richard Sloan as the State Project Manager. The DEQ may designate other representatives, including its employees, contractors and/or consultants to oversee the Work. For any meetings and inspections in which the EPA RPM participates, the State Project Manager also may participate. Respondent must notify the DEQ reasonably in advance of any such meetings or inspections.
- (d) The Respondent Project Coordinator must communicate with the EPA RPM and State Project Manager at least monthly.

- 2.2 **Supervising Contractor.** Respondent’s proposed Supervising Contractor must have sufficient technical expertise to supervise the Work and a quality assurance system that complies with the most recent version of *Quality Systems for Environmental Data and Technology Programs -- Requirements with Guidance for Use* (American National Standard), ANSI/ASQC E4 (Feb. 2014). Respondent’s Supervising Contractor may not have a conflict of interest regarding the project.

2.3 Procedures for Disapproval/Notice to Proceed

- (a) Respondent must designate, and notify the EPA, within 10 days after the Effective Date, of the name, title, contact information, and qualifications of the Respondent's proposed Project Coordinator and Supervising Contractor, whose qualifications are subject to EPA's review for verification based on objective assessment criteria (*e.g.*, experience, capacity, technical expertise) and who do not have a conflict of interest with respect to the project.
- (b) The EPA will issue notices of disapproval and/or authorizations to proceed regarding any proposed Project Coordinator and Supervising Contractor, as applicable. If the EPA issues a notice of disapproval, Respondent must, within 30 days, submit to the EPA a list of supplemental proposed Project Coordinators and/or Supervising Contractors, as applicable, including a description of the qualifications of each. Respondent may select any coordinator/contractor covered by an authorization to proceed and must, within 21 days, notify the EPA of Respondent's selection.
- (c) The EPA may disapprove the proposed Project Coordinator, the Supervising Contractor, or both, based on objective assessment criteria (*e.g.*, experience, capacity, technical expertise), if they have a conflict of interest regarding the project, or any combination of these factors.
- (d) Respondent may change its Project Coordinator and/or Supervising Contractor, or both, by following the procedures of ¶¶ 2.3(a) and 2.3(b).

3. REMEDIAL DESIGN

In order to expedite implementation of the Remedy for the Site, certain portions of the Remedy are addressed in this SOW to be conducted under the UAO.

3.1 Endangered Species Act Consultation.

- (a) In January 2021, Respondent prepared a biological assessment for a removal action at the Site (Biological Assessment), attached as Appendix A. Respondent must prepare a supplement to the Biological Assessment (Supplemental Biological Assessment) reflecting the decision selected in the Record of Decision. Respondent must provide a draft Supplemental Biological Assessment for EPA comment and approval before use in consultation with the U.S. Fish and Wildlife Service and seek guidance from the EPA throughout the consultation process.
- (b) Upon the issuance of EPA's letter to the U.S. Fish and Wildlife Service designating Respondent as a Non-Federal Representative pursuant to the Endangered Species Act, 50 CFR § 402.08, Respondent must engage in consultation activities as required by this Order, or at the request of the EPA or the U.S. Fish and Wildlife Service. Respondent must schedule a kick-off call or

calls with EPA, followed by a call or calls with the EPA and the U.S. Fish and Wildlife Service to discuss the scope of and process for consultation at the Site.

3.2 Pre-Design Investigations (PDIs). The purpose of the PDIs is to address data gaps by conducting additional field investigations:

- (a) Respondent must implement the PDI Work Plan (Appendix B).
- (b) Following the PDI investigation specified in the PDI Work Plan, Respondent must submit a Data Summary Report addressing all physical and chemical characterization data collected during the PDI for approval. Each Data Summary Report must include:
 - (1) Summary of the investigations performed;
 - (2) Summary of investigation results including a summary of all subsurface exploration data, including subsurface soil profile, exploration logs, laboratory or in situ test results, and groundwater information;
 - (3) Summary of validated data (*i.e.*, tables and graphics);
 - (4) Data validation reports and laboratory data reports;
 - (5) Any deviations from the Quality Assurance Project Plan (QAPP) or PDI Work Plans;
 - (6) Results of any statistical and modeling analyses conducted;
 - (7) Photographs documenting the work conducted; and
 - (8) Conclusions and recommendations for Remedial Design, including design parameters and criteria.
- (c) The EPA may require Respondent to supplement the PDI Data Summary Reports and perform additional pre-design studies.

3.3 Pre-final (95%) Remedial Design. Respondent must submit the Pre-final (95%) Cedar Creek Reservoir Overflow Ditch Remedial Design for EPA's comment and the Bid Documents for their information. The Pre-final Remedial Design must be a continuation and expansion of the previous design submittals and must address EPA's comments regarding the Preliminary (30%) Remedial Design. The Pre-final Remedial Design must include the drawings, specifications and plans required by the Preliminary 30% Remedial Design, modified as appropriate, and must include the plans for construction of the liner.

3.4 Final (100%) Remedial Design. Respondent must submit the Final (100%) Cedar Creek Reservoir Overflow Ditch Remedial Design for EPA approval. The Final Remedial Design must address EPA's comments on the Pre-final Remedial Design and

must include final versions of all Pre-final Remedial Design deliverables and must include the plans for construction of the liner.

4. REPORTING

4.1 Progress Reports. Commencing with the first month following issuance of the UAO, Respondent must submit progress reports to the EPA on a monthly basis during field work and otherwise quarterly, or as otherwise requested by the EPA. The reports must cover all activities that took place during the prior reporting period, including:

- (a) The actions that have been taken toward achieving compliance with the UAO;
- (b) A summary of all results of sampling, tests, and all other data received or generated by Respondent;
- (c) A description of all deliverables that Respondent submitted to the EPA; and
- (d) A description of any modifications to the work plans or other schedules that Respondent has proposed or that have been approved by the EPA.

4.2 Notice of Progress Report Schedule Changes. If the schedule for any activity described in the Progress Reports, including activities required to be described under ¶ 5.1(d), changes, Respondent must notify the EPA of such change at least seven days before performance of the activity.

5. DELIVERABLES

5.1 Applicability. Respondent must submit deliverables for EPA approval or for EPA comment as specified. If neither is specified, the deliverable does not require EPA's approval or comment. Paragraphs 6.2 (In Writing) through 6.4 (Technical Specifications) apply to all deliverables. Paragraph 6.5 (Certification) applies to any deliverable that is required to be certified. Paragraph 6.6 (Approval of Deliverables) applies to any deliverable that is required to be submitted for EPA approval.

5.2 In Writing. As provided in XXI of the UAO, all deliverables under this SOW must be in writing unless otherwise specified.

5.3 General Requirements for Deliverables. All deliverables must be submitted by the deadlines in the Remedial Design Schedule. Respondent must submit all deliverables to the EPA in electronic form. Technical specifications for sampling and monitoring data and spatial data are addressed in ¶ 6.4. All other deliverables must be submitted to the EPA in the electronic form specified by EPA RPM.

5.4 Technical Specifications

- (a) Sampling and monitoring data must be submitted in the most recent or the current at the time of generation standard EPA Region 8 Electronic Data Deliverable (EDD) format. Other delivery methods may be allowed, at the discretion of EPA

RPM, if electronic direct submission presents a significant burden or as technology changes.

- (b) Spatial data, including spatially-referenced data and geospatial data, should be submitted: (1) in the ESRI File Geodatabase format; and (2) as unprojected geographic coordinates in decimal degree format using North American Datum 1983 (NAD83) or World Geodetic System 1984 (WGS84) as the datum. If applicable, submissions should include the collection method(s). Projected coordinates may optionally be included but must be documented. Spatial data should be accompanied by metadata, and such metadata should be compliant with the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata and its EPA profile, the EPA Geospatial Metadata Technical Specification. An add-on metadata editor for ESRI software, the EPA Metadata Editor (EME), complies with these FGDC and EPA metadata requirements and is available at <https://edg.epa.gov/EME/>.
- (c) Each file must include an attribute name for each site unit or sub-unit submitted. Consult <https://www.epa.gov/geospatial/geospatial-policies-and-standards> for any further available guidance on attribute identification and naming.
- (d) Spatial data submitted by Respondent does not, and is not intended to, define the boundaries of the Site.

5.5 Certification. All deliverables that require compliance with this paragraph must be signed by the Respondent Project Coordinator, or other responsible official of Respondent, and must contain the following statement:

I certify under penalty of perjury that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

5.6 Approval of Deliverables

(a) Initial Submissions

- (1) After review of any deliverable that is required to be submitted for EPA approval under the UAO or the SOW, the EPA may: (i) approve, in whole or in part, the submission; (ii) approve the submission upon specified conditions; (iii) disapprove, in whole or in part, the submission; or (iv) any combination of the foregoing.

- (2) The EPA also may modify the initial submission to cure deficiencies in the submission if: (i) the EPA determines that disapproving the submission and awaiting a resubmission would cause substantial disruption to the Work; or (ii) previous submission(s) have been disapproved due to material defects and the deficiencies in the initial submission under consideration indicate a bad faith lack of effort to submit an acceptable deliverable.
- (b) **Resubmissions.** Upon receipt of a notice of disapproval under ¶ 6.6(a) (Initial Submissions), or if required by a notice of approval upon specified conditions under ¶ 6.6(a), Respondent must, within 30 days or such longer time as specified by the EPA in such notice, correct the deficiencies and resubmit the deliverable for approval. After review of the resubmitted deliverable, the EPA may:
 - (1) approve, in whole or in part, the resubmission; (2) approve the resubmission upon specified conditions; (3) modify the resubmission; (4) disapprove, in whole or in part, the resubmission, requiring Respondent to correct the deficiencies; or (5) any combination of the foregoing.
- (c) **Implementation.** Upon approval, approval upon conditions, or modification by the EPA under ¶ 6.6(a) (Initial Submissions) or ¶ 6.6(b) (Resubmissions), of any deliverable, or any portion thereof: (1) such deliverable, or portion thereof, will be incorporated into and enforceable under the UAO; and (2) Respondent must take any action required by such deliverable, or portion thereof.
- (d) If: (1) an initially submitted deliverable contains a material defect and the conditions are met for modifying the deliverable under ¶ 6.6(a)(2); or (2) a resubmitted deliverable contains a material defect; then the material defect constitutes a lack of compliance for purposes of this Paragraph.

5.7 Supporting Deliverables. Respondent must submit each of the following supporting deliverables for EPA approval, except as specifically provided. Respondent must develop the deliverables in accordance with all applicable regulations, guidances, and policies (see Section 9 (References)). Respondent must update each of these supporting deliverables as necessary or appropriate during the course of the Work, as requested by the EPA.

- (a) **Health and Safety Plan.** The Health and Safety Plan describes all activities to be performed to protect on site personnel and area residents from physical, chemical, and all other hazards posed by the Work. Respondent must develop the Health and Safety Plan in accordance with EPA's *Emergency Responder Health and Safety Manual* and Occupational Safety and Health Administration (OSHA) requirements under 29 C.F.R. §§ 1910 and 1926. The Health and Safety Plan should cover Remedial Design activities. The EPA does not approve the Health and Safety Plan but will review it, and comment as necessary, to ensure that all necessary elements are included and that the plan provides for the protection of human health and the environment.

- (b) **Emergency Response Plan.** The Emergency Response Plan must describe procedures to be used in the event of an accident or emergency at the Site (for example, power outages, water impoundment failure, treatment plant failure, slope failure, etc.). The Emergency Response Plan must include:
- (1) Name of the person or entity responsible for responding in the event of an emergency incident;
 - (2) Plan and date(s) for meeting(s) with the local community, including local, State, and federal agencies involved in the cleanup, as well as local emergency squads and hospitals;
 - (3) Spill Prevention, Control, and Countermeasures Plan (if applicable), consistent with the regulations under 40 C.F.R. part 112, describing measures to prevent, and contingency plans for, spills and discharges;
 - (4) Notification activities in accordance with ¶ 4.5(b) (Release Reporting) in the event of a release of hazardous substances requiring reporting under CERCLA § 103 or EPCRA § 304; and
 - (5) A description of all necessary actions to ensure compliance with ¶ 4.5 of the SOW in the event of an occurrence during the performance of the Work that causes or threatens a release of Waste Material from the Site that constitutes an emergency or may present an immediate threat to public health or welfare or the environment.
- (c) **Field Sampling Plan.** The Field Sampling Plan addresses all sample collection activities. The Field Sampling Plan must be written so that a field sampling team unfamiliar with the project would be able to gather the samples and field information required. Respondent must develop the Field Sampling Plan in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies*, EPA/540/G 89/004 (Oct. 1988).
- (d) **Quality Assurance Project Plan (QAPP).** The QAPP must include a detailed explanation of Respondent's quality assurance, quality control, and chain of custody procedures for all treatability, design, compliance, and monitoring samples. Respondent must develop the QAPP in accordance with EPA Directive CIO 2105.1 (Environmental Information Quality Policy, 2021), the most recent version of *Quality Management Systems for Environmental Information and Technology Programs – Requirements with Guidance for Use*, ASQ/ANSI E-4 (Feb. 2014, and *Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA Office of Environmental Information (Dec. 2002). Respondent will submit the QAPP to EPA for approval along with the completed *EPA Region 8 QAPP Review Crosswalk* CIO 2105-S-02 (QA/S-2) (May 2024). Respondent must collect, produce, and evaluate all environmental information at the Site in accordance with the approved QAPP.

- (e) **Construction Quality Assurance Plan (CQAP).** The purpose of the CQAP is to describe planned and systemic activities, including during Remedial Design, to verify that Remedial Action construction has satisfied all plans, specifications, and related requirements, including quality objectives. The CQAP must:
- (1) Identify, and describe the responsibilities of, the organizations and personnel implementing the CQAP;
 - (2) Describe the Performance Standards required to be met to achieve Completion of the Remedial Action;
 - (3) Describe the activities to be performed: (i) to provide confidence that Performance Standards will be met; and (ii) to determine whether Performance Standards have been met;
 - (4) Describe verification activities, such as inspections, sampling, testing, monitoring, and production controls, under the CQAP;
 - (5) Describe industry standards and technical specifications used in implementing the CQAP;
 - (6) Describe procedures for tracking construction deficiencies from identification through corrective action;
 - (7) Describe procedures for documenting all CQAP activities; and
 - (8) Describe procedures for retention of documents and for final storage of documents.

6. SCHEDULES

- 6.1 Applicability and Revisions.** All deliverables and tasks required under this SOW must be submitted or completed by the deadlines or within the time durations listed in the Remedial Design Schedule set forth below. Respondent may submit proposed revised Remedial Design Schedules for EPA approval. Upon EPA's approval, the revised Remedial Design Schedules supersede the Remedial Design Schedules set forth below, and any previously-approved Remedial Design Schedule.

6.2 Remedial Design Schedule

	Description of Deliverable, Task	¶ Ref.	Deadline	EPA Approval or Comment
	Supplemental Biological Assessment	3.1(a)	30 days after Effective Date	Approval by EPA
	Kick-off meeting with the EPA for re-engaging on consultation	3.1(b)	15 days after Effective Date	
	Kick-off meeting for re-engaging in consultation with the U.S. Fish and Wildlife Services and the EPA	3.1(b)	30 days after Effective Date	
	Soil DU3 Further Delineation PDI Report	3.2(b)	120 days after PDI Field Work: Soil DU3/NPP	Approval
	NPP Sediment Evaluation PDI Report	3.2(b)	120 days after PDI Field Work: Soil DU3/NPP	Approval
	Asbestos Cover PDI Report	3.2(b)	120 days after PDI Field Work: Asbestos Cover Evaluation	Approval
	Slurry Wall Geotechnical Design PDI Report	3.2(b)	120 days after end of PDI Field Work: Slurry Wall/WSSP/Industrial Geotechnical	Approval
	WSSP Landfill Settlement PDI Report	3.2(b)	120 days after end of PDI Field Work: Slurry Wall/WSSP/Industrial Geotechnical	Approval
	Industrial Landfill Evaluation PDI Report	3.2(b)	120 days after end of PDI Field Work: Slurry Wall/WSSP/Industrial Geotechnical	Approval
	Groundwater Modeling PDI Report	3.2(b)	120 days after end of PDI Field Work: Slurry Wall/WSSP/Industrial Geotechnical	Approval

	Groundwater Plume Sampling Report	3.2(b)	120 days after end of PDI Field Work: Groundwater Profiling	Approval
2	Pre-final (95%) Remedial Design: Cedar Creek Reservoir Ditch Lining and Bid Documents	3.3	15 days after the UAO Effective Date	Comment on Pre- Final Remedial Design. Bid Documents for information only.
3	Final (100%) Remedial Design: Cedar Creek Reservoir Ditch Lining	3.4	30 days after EPA comments on Pre-final (95%) Remedial Design	Approval

7. STATE PARTICIPATION

- 7.1 Copies.** Respondent must, at any time it sends a deliverable to EPA, send a copy of such deliverable to the DEQ. EPA will, at any time it sends a notice, authorization, approval, disapproval, or certification to Respondent, send a copy of such document to DEQ.
- 7.2 Review and Comment.** EPA approval or disapproval of Remedial Design deliverables will only be given after DEQ has a reasonable opportunity for review and comment on the deliverable. DEQ will have a reasonable opportunity for review and comment prior to:
- (a) Any EPA notice to proceed under ¶ 2.3 (Procedures for Disapproval/Notice to Proceed); and
 - (b) Any EPA approval or disapproval under ¶ 6.6 (Approval of Deliverables) of any deliverables that are required to be submitted for EPA approval.

8. APPENDIXES

- 8.1** The following appendix is attached to and incorporated into this SOW:

“Appendix A” is the 2021 Biological Assessment.

“Appendix B” is the PDI Work Plan.

9. REFERENCES

- 9.1** The following regulations and guidance documents, among others, apply to the Work. Any item for which a specific URL is not provided below is available on one of the three EPA web pages listed in ¶ 9.2:
- (a) A Compendium of Superfund Field Operations Methods, OSWER 9355.0-14, EPA/540/P-87/001a (Aug. 1987).
 - (b) CERCLA Compliance with Other Laws Manual, Part I: Interim Final, OSWER 9234.1-01, EPA/540/G-89/006 (Aug. 1988).
 - (c) Guidance for Conducting Remedial Investigations and Feasibility Studies, OSWER 9355.3-01, EPA/540/G-89/004 (Oct. 1988).
 - (d) CERCLA Compliance with Other Laws Manual, Part II, OSWER 9234.1-02, EPA/540/G-89/009 (Aug. 1989).
 - (e) Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, OSWER 9355.5-01, EPA/540/G90/001 (Apr.1990).

- (f) Guidance on Expediting Remedial Design and Remedial Actions, OSWER 9355.5-02, EPA/540/G-90/006 (Aug. 1990).
- (g) Guide to Management of Investigation-Derived Wastes, OSWER 9345.3-03FS (Jan. 1992).
- (h) Permits and Permit Equivalency Processes for CERCLA On-Site Response Actions, OSWER 9355.7-03 (Feb. 1992).
- (i) Guidance for Conducting Treatability Studies under CERCLA, OSWER 9380.3-10, EPA/540/R-92/071A (Nov. 1992).
- (j) National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, 40 C.F.R. part 300 (Oct. 1994).
- (k) Guidance for Scoping the Remedial Design, OSWER 9355.0-43, EPA/540/R-95/025 (Mar. 1995).
- (l) Remedial Design/Remedial Action Handbook, OSWER 9355.0-04B, EPA/540/R-95/059 (June 1995).
- (m) EPA Guidance for Data Quality Assessment, Practical Methods for Data Analysis, QA/G-9, EPA/600/R-96/084 (July 2000).
- (n) Comprehensive Five-year Review Guidance, OSWER 9355.7-03B-P, EPA/540-R-01-007 (June 2001).
- (o) Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA Office of Environmental Information (Dec. 2002) <https://www.epa.gov/quality/guidance-quality-assurance-project-plans-epa-qag-5>.
- (p) Institutional Controls: Third-Party Beneficiary Rights in Proprietary Controls, OECA (Apr. 2004).
- (q) EPA Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4, EPA/240/B-06/001 (Feb. 2006).
- (r) EPA Requirements for Quality Management Plans, QA/R-2, EPA/240/B-01/002 (Mar. 2001, reissued May 2006).
- (s) EPA National Geospatial Data Policy, CIO Policy Transmittal 05-002 (Aug. 2005), <https://www.epa.gov/geospatial/epa-national-geospatial-data-policy>.
- (t) Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER 9283.1-33 (June 2009).
- (u) Principles for Greener Cleanups (Aug. 2009), <https://www.epa.gov/greenercleanups/epa-principles-greener-cleanups>.

- (v) Providing Communities with Opportunities for Independent Technical Assistance in Superfund Settlements, Interim (Sep. 2009).
- (w) Close Out Procedures for National Priorities List Sites, OLEM 9320.2-23 (June 2022).
- (x) Groundwater Road Map: Recommended Process for Restoring Contaminated Groundwater at Superfund Sites, OSWER 9283.1-34 (July 2011).
- (y) Recommended Evaluation of Institutional Controls: Supplement to the “Comprehensive Five-Year Review Guidance,” OSWER 9355.7-18 (Sep. 2011).
- (z) Construction Specifications Institute’s 2020, available from the Construction Specifications Institute, <http://www.csinet.org/masterformat>.
- (aa) Updated Superfund Response and Settlement Approach for Sites Using the Superfund Alternative Approach, OSWER 9200.2-125 (Sep. 2012)
- (bb) Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites, OSWER 9355.0-89, EPA/540/R-09/001 (Dec. 2012), <https://semspub.epa.gov/work/HQ/175446.pdf>.
- (cc) Institutional Controls: A Guide to Preparing Institutional Controls Implementation and Assurance Plans at Contaminated Sites, OSWER 9200.0-77, EPA/540/R-09/02 (Dec. 2012), <https://semspub.epa.gov/work/HQ/175449.pdf>.
- (dd) EPA’s Emergency Responder Health and Safety Manual, OSWER 9285.3-12 (July 2005 and updates), https://www.epaosc.org/_HealthSafetyManual/manual-index.htm.
- (ee) Broader Application of Remedial Design and Remedial Action Pilot Project Lessons Learned, OSWER 9200.2-129 (Feb. 2013).
- (ff) Groundwater Remedy Completion Strategy: Moving Forward with the End in Mind, OSWER 9200.2-144 (May 2014).
- (gg) Quality Management Systems for Environmental Information and Technology Programs -- Requirements with Guidance for Use, ASQ/ANSI E-4 (February 2014), available at <https://webstore.ansi.org/>.
- (hh) Guidance for Management of Superfund Remedies in Post Construction, OLEM 9200.3-105 (Feb. 2017), <https://www.epa.gov/superfund/superfund-post-construction-completion>.
- (ii) Advanced Monitoring Technologies and Approaches to Support Long-Term Stewardship (July 20, 2018), <https://www.epa.gov/enforcement/use-advanced-monitoring-technologies-and-approaches-support-long-term-stewardship>.

- (jj) Superfund Community Involvement Handbook, OLEM 9230.0-51 (March 2020). More information on Superfund community involvement is available on the Agency's Superfund Community Involvement Tools and Resources web page at <https://www.epa.gov/superfund/superfund-community-involvement-tools-and-resources>.
- (kk) EPA directive CIO 2105.1 (Environmental Information Quality Policy, 2021), https://www.epa.gov/sites/production/files/2021-04/documents/environmental_information_quality_policy.pdf.

9.2 A more complete list may be found on the following EPA web pages:

- (a) Laws, Policy, and Guidance at <https://www.epa.gov/superfund/superfund-policy-guidance-and-laws>;
- (b) Search Superfund Documents at <https://www.epa.gov/superfund/search-superfund-documents>; and
- (c) Test Methods Collections at: <https://www.epa.gov/measurements/collection-methods>.

9.3 For any regulation or guidance referenced in the UAO or SOW, the reference will be read to include any subsequent modification, amendment, or replacement of such regulation or guidance. Such modifications, amendments, or replacements apply to the Work only after Respondent receive notification from the EPA of the modification, amendment, or replacement.

Appendix A

to the

UNILATERAL ADMINISTRATIVE ORDER FOR REMEDIAL DESIGN STATEMENT OF WORK

**Anaconda Aluminum Co. Columbia Falls Reduction Plant Superfund Site
a/k/a Columbia Falls Aluminum Company Site
Columbia Falls, Montana**



**Biological Assessment:
Columbia Falls Aluminum Company
South Ponds Remediation Project
Phase 2**

Prepared For

**Columbia Falls Aluminum Company
and
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January 2021

Table of Contents

I.	Introduction	1
	A. Purpose	1
	B. Proposed Action	1
II.	Project Description	2
	A. Project Elements	2
	B. Schedule	3
	C. Conservation Measures	5
III.	Action Area	6
	A. General Geographic Area	6
	B. Project Specific Area	6
	C. Baseline Activity Levels	6
IV.	Species/Critical Habitat Considered	7
	A. Federally Listed Species with Potential Presence	7
	B. Identified Species	8
	Methods	8
	Results	8
	Meltwater Lednian Stonefly	8
	Canada Lynx Critical Habitat	9
	Whitebark Pine	9
	Wolverine	9
V.	Effects Analysis	9
	Bull Trout	10
	Species Description	10
	Status and Distribution	10
	Life History and Habitat Requirements	12
	Reasons for Decline	14
	Environmental Baseline/Occurrence in the Project Area	15
	Actions/Impacts and Cumulative Effects	18
	Recommended Conservation and Coordination Measures	20
	Determination of Effect – Bull Trout	21
	Determination of Effect – Bull Trout Critical Habitat	22
	PCE's for Designated Bull Trout Critical Habitat	23

TABLE OF CONTENTS

Yellow-billed Cuckoo.....	28
Species Description.....	28
Status and Distribution	28
Life History and Habitat Requirements	28
Reasons for Decline	29
Environmental Baseline/Occurrence in the Project Area.....	29
Actions/Impacts and Cumulative Effects.....	29
Recommended Conservation and Coordination Measures	30
Determination of Effect	30
Spalding's Campion	31
Species Description.....	31
Status and Distribution	31
Life History and Habitat Requirements	31
Reasons for Decline	32
Environmental Baseline/Occurrence in the Project Area.....	32
Actions/Impacts and Cumulative Effects.....	32
Recommended Conservation and Coordination Measures	33
Determination of Effect	33
Grizzly Bear	34
Species Description.....	34
Status and Distribution	34
Life History and Habitat Requirements	35
Reasons for Decline	36
Environmental Baseline/Occurrence in the Project Area.....	36
Actions/Impacts and Cumulative Effects.....	36
Recommended Conservation and Coordination Measures	37
Determination of Effect	37
Canada Lynx.....	39
Species Description.....	39
Status and Distribution	39
Life History and Habitat Requirements	39
Reasons for Decline	40
Environmental Baseline/Occurrence in the Project Area.....	41
Actions/Impacts and Cumulative Effects.....	41

TABLE OF CONTENTS

Recommended Conservation and Coordination Measures	41
Determination of Effect	42
VI. Literature Cited	44
VII. List of Contacts Made and Preparers.....	50

List of Figures

Figure 2.1: USGS Hydrograph	4
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List of Tables

Table 4.1: Flathead County, Montana List of Threatened, Endangered, Proposed and Candidate Species	7
Table 5.1: Bull Trout Regulatory Actions and Management Guidance.....	10
Table 5.2: PCEs for Bull Trout Critical Habitat and Associated Matrix Habitat Indicators.....	16
Table 5.3: Analysis of the Current Functionality of PCEs and Expected Effects of the Project – Flathead River	17

Appendices

Appendix A: Figures	
Appendix B: Agency Correspondence and Data Files	

I. Introduction

A. Purpose

The purpose of this Biological Assessment (BA) report is to assess the effects of the proposed action on federally listed threatened, endangered, candidate, and proposed species that have the potential to occur within the action area of the Columbia Falls Aluminum Company (CFAC) South Ponds Remediation Project Phase 2.

This project will be performed under the supervision of the US Environmental Protection Agency (EPA) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Pursuant to Section 121e under the CERCLA program, a project can be undertaken without the need to obtain permits from federal state, or local agencies. EPA guidance on implementing projects at CERCLA sites 1) requires parties implementing such projects to follow the substantive requirements of applicable statutes and rules, and, 2) strongly encourages parties to consult with federal, state, and local agencies that would otherwise have permitting authority over a project.

B. Proposed Action

The South Ponds were constructed in the early 1960's by damming the side channel of the Flathead River of the north bank. The South Ponds were used for collection of wastewater and storm water from the CFAC facility during its time in operation. The CFAC Site was placed on the Superfund National Priority List (NPL) in 2016 and has been undergoing remedial investigation since that time. The CFAC operations have ceased and the facility has undergone demolition. Therefore, the South Ponds are no longer needed for water management at the facility.

The Flathead River, adjacent to the South Ponds, has been laterally migrating north towards the South Ponds and threatened to re-capture its historic side channel. As a result, stabilizations including a sheet pile wall and riprap revetments have been installed since 2016 to maintain the South Ponds. The bank of the Flathead River is currently in contact with the sheet pile wall and riprap revetment, and runoff in 2018 overtopped the river bank but did not breach the stabilizations.

CFAC and EPA have concluded that the best way to prevent the contaminated sediments and other man-made structures from being captured by the river is to remove them from the channel migration zone as soon as possible. With the removal action complete, the area can be returned to a natural condition.

The Flathead River's natural route of migration is through the South Ponds area. The goal of this Early Action is to prevent certain contaminated sediments located in the South Ponds from being captured by such migration. This is being accomplished by remediation of the South Ponds, removal of man-made structures in the floodplain, and removal of revetments near and on the bank of the Flathead River.

The project activities will occur in 2 distinct phases:

1. **Phase 1** (completed December 2020/January 2021): Remediation of the South Ponds by removal of contaminated soils and man-made structures in the floodplain. Phase 1 completion documentation is provided in **Appendix B**.
2. **Phase 2**: Removal of steel sheet pile wall and some rock riprap revetments near/on the bank of the Flathead River, thus returning the South Ponds area to a more natural condition.

The U.S. Fish and Wildlife Service (USFWS) was consulted on March 2, 2020 for comment on Phase 1 and Phase 2 of the project as described above. It was determined that Phase 2 of the project would require the completion of a BA due to the proximity to the active channel of the Flathead River. This BA report focuses only on the effects of Phase 2 on federally listed threatened, endangered, candidate, and proposed species that have the potential to occur within the action area of the CFAC South Ponds Remediation Project Phase 2.

II. Project Description

A. Project Elements

The project will involve the following elements:

1. Removal of all sheet pile walls
2. Removal of riprap above the low water mark of the Flathead River
3. Removal of a portion of the existing access road and associated culvert
4. Removal of concrete floor panels to the extent possible from the Flathead River and its banks.

Sheet Pile Removal (Full)

Approximately 135 linear feet of 50-foot sheet pile will be removed from the floodplain. This will be accomplished with a crane and vibratory hammer. Channel disturbance will be limited to vibration from the hydraulic vibratory hammer in the immediate vicinity of the sheet pile. It is unlikely that this area would be physically isolated from the active channel of the Flathead River. Installation of work area isolation materials and their subsequent removal would likely create more instream and channel bottom disturbance than the removal work itself. A temporary work platform may be created on the west side of the sheet pile wall in an upland area in order to provide a stable work platform for the crane. This will be left up to the discretion of the contractor.

Riprap Removal (Partial)

Approximately 160 linear feet (350-400 cubic yards) of riprap will be removed from the bank line. Removal of riprap will occur down to elevation of 3,015, the assumed low-water river elevation at the time of proposed construction. This will be accomplished by using an excavator with a “thumb” to pick up riprap off the bank and place it in an upland stockpile or

in haul trucks. Willow plantings will be placed along the slope of the riprap removal at a minimum of five per lineal foot. The excavator will be staged on the high ground adjacent to the riprap revetment. It is unlikely that this excavation area would be physically isolated from the active channel of the Flathead River. Installation of work area isolation materials and their subsequent removal would likely create more instream and channel bottom disturbance than the removal work itself.

Concrete Floor Panel Removal (Partial)

There are several (approximately 50) remaining floor panels that were used in historic bank stabilization efforts that have migrated into the active channel of the Flathead River. These panels are approximately 6'x8' concrete slabs with a metal frame. Only floor panels that are easily removed from the existing bank with equipment that is already present on site will be removed. Removal of floor panels will be limited to visible floor panels in order to minimize temporary impacts to the Flathead River.

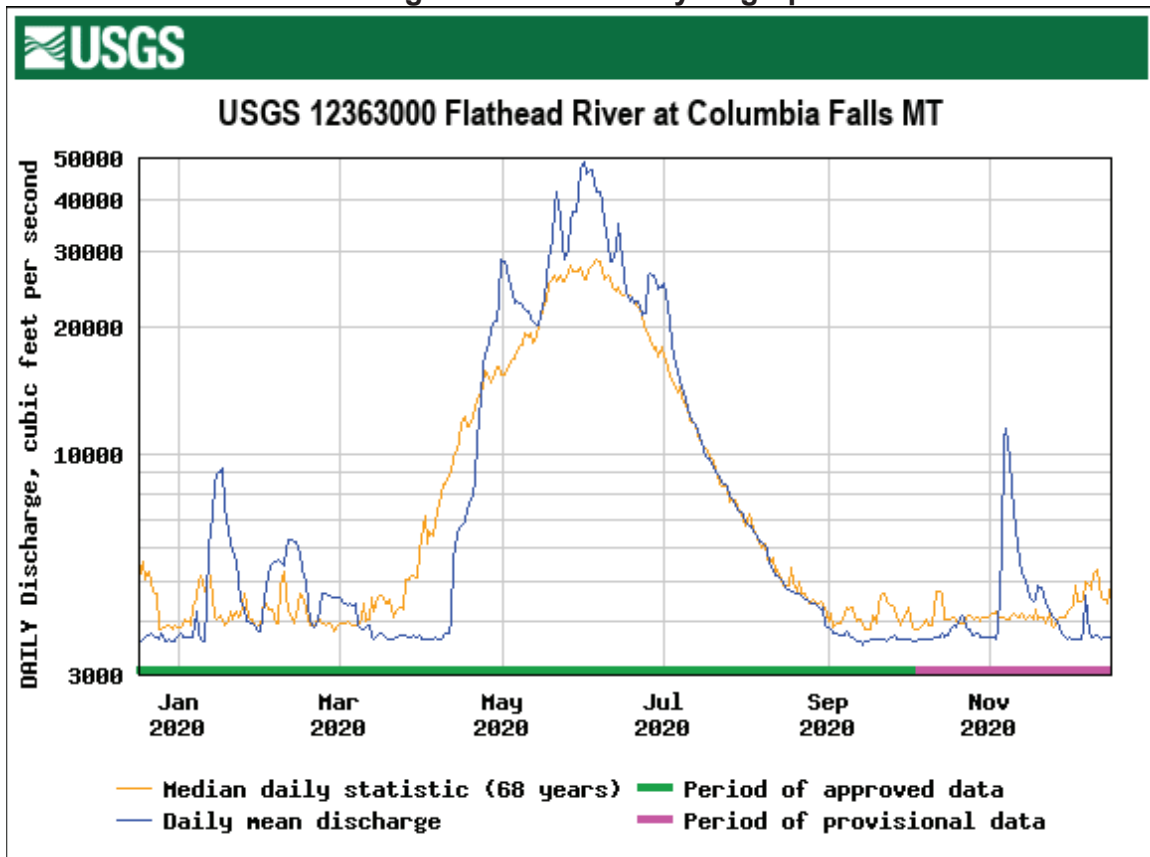
Access Road Embankment and Culvert Removal (Full)

The access road embankment and culverts will be removed in order to reconnect Ponds 1 and 2. This will be the final earth work completed. If there is water in the ponds at the time, this work area will be isolated from the wetted channel of the ponds. The access road will be cut back to a proposed elevation of approximately 3,015.

B. Schedule

The proposed activities schedule options were discussed with the USFWS on December 17, 2020. U.S. Geographical Survey (USGS) river flow data was accessed for hydrograph data nearest to the project area (USGS 2020) for reference.

Figure 2.1 – USGS Hydrograph



As identified in the hydrograph above, low flows for the Flathead River occur between approximately September and April on average. The typical in-stream work window for bull trout is July 1 – September 30. However, USFWS advised that other work windows during periods of low flow are options. Therefore, the proposed work window for Phase 2 is between January and April 2020.

Several of the activities will occur concurrently. Total length of construction timing is estimated between 30-45 days. However, this schedule is weather and water level condition dependent. Below is a list that outlines the basic work sequence:

1. Removal of the sheet pile wall.
2. Remove floor panels to the extent possible while minimizing in stream work.
3. Remove riprap to the defined extent.
4. Stabilize disturbed banks and island area with willow plantings in the riprap removal vicinity.
5. Remove and regrade access road berm separating ponds 1 & 2.
6. Stabilize disturbed ground along pond banks north of south ponds.

C. Conservation Measures

Conservation measures will be incorporated into the design of this project.

The Flathead River is designated critical habitat and an important spawning migration corridor for bull trout. The USFWS recommends the following conservation measures (adapted from Service 2020a):

- In rivers and streams, foraging, migrating, and overwintering habitat in-channel disturbance should be limited to the periods between July 1 and September 30.
 - *In discussion with USFWS on December 17, 2020, USFWS advised that other windows of low flow were options for construction timing.*
- All work should be performed in the dry when possible.
- Any work in rivers and streams should be completed by working from the top of bank or the work areas should be isolated from flowing or open water using cofferdams, silt curtains, sandbags or other approved means to keep suspended sediment from entering flowing or open water, unless not isolating the area and working in the channel would result in less habitat disturbance.
- Site clearing, staging areas, access routes, and stockpile areas should be conducted and located in a manner that minimizes overall disturbance, minimizes disturbance to riparian vegetation, and precludes erosion into stream channels.
- Sediment barriers should be placed around potentially disturbed sites to prevent sediment from entering a stream directly or indirectly, including by way of roads and ditches.
- A supply of erosion control materials (silt fence and straw bales) should be kept on hand to respond to sediment emergencies. Sterile straw or certified “weed free” straw should be used to prevent introduction of noxious weeds.
- All equipment fueling, maintenance, and staging areas should be located in non-wetland areas landward of the ordinary high water mark of the waterbody unless no other option is available. When no option is available, these activities should occur at the greatest distance possible perpendicular from any water body to adequately avoid and minimize potential impacts.
- All equipment used for in-channel work should be cleaned of external oil, grease, dirt, mud, plan material or other debris, which may harbor invasive plants or animals; and leaks repaired; prior to arriving at the project site. All equipment should be inspected before unloading at site. Any leaks or accumulations of grease should be corrected before entering streams or areas that drain directly in to streams or wetlands.

A number of conservation measures have been developed regionally in order to reduce potential conflicts with grizzly bears. While no specific conservation measures have been identified for the Canada lynx, it is thought that the grizzly bear conservation measures will also play a role in mitigating potential impacts to the Canada lynx. These conservation measures include those recommended by the USFWS (located in **Appendix B**):

- Promptly clean up any project related spills, litter, garbage, debris, etc.

- Store all food, food related items, petroleum products, antifreeze, garbage, personal hygiene items, and other attractants inside a closed, hard-sided vehicle, or commercially manufactured bear resistant container.
- Remove garbage from the project site daily and dispose of it in accordance with all applicable regulations.
- Personal firearms are prohibited on the project site. The use of bear spray as necessary to deter bears is allowed.
- Notify the Project Manager of any animal carcasses found in the project area.
- Notify the Project Manager of any grizzly bears observed in the vicinity of the project.

III. Action Area

A. General Geographic Area

The CFAC property is approximately 1,340 acres historically used as an aluminum reduction facility. The South Ponds area is approximately 10 acres of land located at the southern end of the CFAC property. The South Ponds area is located approximately 2.5 miles east-northeast of Columbia Falls, Montana along the Flathead River (Figure 1).

B. Project Specific Area

The action area is depicted in Figure 1 located in Appendix A of this report. The action area encompasses the areas of proposed construction as well as the access road and staging area.

The action area for bull trout is fully contained within the active channel of the Flathead River and the potential reach of mobile sediment from implementing the proposed action. The action area for the remaining species is defined by a more activity specific area including material removal area, equipment noise, dust and physical ground disturbance.

C. Baseline Activity Levels

The South Ponds were constructed in the early 1960's by damming the side channel of the Flathead River on the north bank. The South Ponds were used for collection of wastewater and storm water from the CFAC facility during its time in operation. The CFAC Site was placed on the Superfund National Priority List in 2016 and has been undergoing remedial investigation since that time. The CFAC operations have ceased and the facility has undergone demolition. Therefore, the South Ponds are no longer needed for water management at the facility.

Phase 1 of the project involved the removal of contaminated sediments within the South Ponds and removal of structures within the floodplain of the Flathead River. Sediment samples have been recorded in a grid sequence to confirm contaminant removal throughout the South Ponds. A report/memo stating the contamination has been removed to the extent necessary under approval by the EPA is included in **Appendix B**.

IV. Species/Critical Habitat Considered

A. Federally Listed Species with Potential Presence

Threatened and Endangered (T&E) species include those species that have been federally-listed or are proposed for federal listing by the USFWS as threatened or endangered. According to the Endangered Species Act (ESA) of 1973, threatened species are defined as “any species which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range,” and endangered species are defined as “any species which is in danger of extinction throughout all or a significant portion of its range.” Pursuant to Section 7 of the ESA, any action that is funded, authorized, or conducted by a federal agency must be reviewed for its effects on federally-listed species or designated critical habitat. The purpose of a BA is to evaluate the potential effects of the action on listed and proposed species and designated and proposed species and designated and proposed critical habitat and determine whether any such species or habitat are likely to be adversely affect the action (50CFS 402.12(a)).

The June 10, 2020 USFWS Flathead County, Montana List of Threatened, Endangered, Proposed and Candidate Species currently lists bull trout (*Salvelinus confluentus*), grizzly bear (*Ursus arctos horribilis*), Spalding’s Campion (*Silene spaldingii*), Canada lynx (*Lynx canadensis*), yellowed-billed cuckoo (*Coccyzus americanus*), wolverine (*Gulo gulo luscus*), meltwater lednian stonefly (*Lednia tumana*), and whitebark pine (*Pinus albicaulis*) as potentially occurring in Flathead County (USFWS 2020b). See the table below for summary.

Table 4.1 – Flathead County, Montana List of Threatened, Endangered, Proposed and Candidate Species

Common Name	Scientific Name	Status	Critical Habitat in Action Area	Potential to occur in Action Area
Bull trout	<i>Salvelinus confluentus</i>	Threatened	Yes	Yes
Spalding’s Campion	<i>Silene spaldingii</i>	Threatened	No	No
Yellow-billed cuckoo (western pop.)	<i>Coccyzus americanus</i>	Threatened	No	No
Canada lynx	<i>Lynx Canadensis</i>	Threatened	No	Yes
Grizzly bear	<i>Ursus arctos horribilis</i>	Threatened	No	Yes
Wolverine	<i>Gulo gulo luscus</i>	Proposed (removed on 10/13/20)	No	Yes
Meltwater lednian stonefly	<i>Lednia tumana</i>	Threatened	No	No
**Whitebark pine	<i>Pinus albicaulis</i>	Proposed	No	No

* The Wolverine has been withdrawn from the proposed species list as of October 13, 2020 (Federal Register FWS-R6-ES-2016-0106)

**The Whitebark Pine status has been proposed as a threatened species as of December 2, 2020 (Federal Register 85 FR 77408)

B. Identified Species

Methods

To confirm the presence or absence of any protected species in or within the vicinity of the action area, information on T&E species potentially affected by this proposed project was requested of USFWS biologists, US Forest Service, and Montana Fish Wildlife and Parks (MFWP) biologists. A response was received from the USFWS on April 30, 2020. Additionally, species occurrence data was requested and received from Montana Natural Heritage Program (MNHP). Montana Fish Wildlife and Parks did not respond to the request for information. Correspondence and data files are provided in **Appendix B**.

A reconnaissance-level on-site evaluation of the action area, as defined by areas noted in **Figure 1** (located in Appendix A), was performed in July 2020 by Breanne Carr (Environmental Scientist) to examine and accurately assess the property for the potential for occurrence of T&E species and/or their suitable habitat. The analysis included an evaluation of the potential impacts to federally listed species within the action area.

Results

The USFWS provided the following information in their April 30, 2020 response letter (located in **Appendix B**):

- Whitebark pine and meltwater lednian stonefly are not expected to occur within the project area.
- The Flathead River is designated critical habitat for the bull trout.
- Spalding's campion has been documented within Flathead County to the south of the Project area near Flathead Lake.
- Yellow-billed cuckoos have been observed in Flathead County near Whitefish.
- Grizzly bears, Canada lynx, and wolverines are wide-ranging species and could occasionally move through the general project area but are not expected to occur commonly in the immediate project vicinity.

Below is a brief analysis of the species not expected to occur within the project area based on data provided by the agencies noted above and an on-site investigation of the action area of potential effect defined above for these species.

Meltwater Lednian Stonefly (Threatened)

Based on the absence of suitable habitat characteristics (small alpine streams, but only those closely linked to glacial melt), the occurrence of the meltwater lednian stonefly within the project area is not likely (MNHP 2020a). Correspondence from the USFWS (located in **Appendix B**) also stated that the meltwater lednian stonefly is not expected to occur within the project area. Therefore, the proposed project activities will have **no effect** on the meltwater lednian stonefly.

Canada Lynx Critical Habitat

The CFAC facility is not located within Critical Habitat for the Canada lynx, according to the IPaC report (**Appendix B**). Additionally, a shapefile of Canada Lynx critical habitat was downloaded and displayed on the **Figure 3** map in Appendix A. Based on the absence of project activities within federally designated critical habitat and that any effects of the proposed action would not extend the six miles to the nearest designated critical habitat for the Canada lynx, it has been determined that project activities will have **no effect** on critical habitat for the federally listed Canada lynx.

Whitebark Pine

The whitebark pine primarily exists in sub-alpine terrain, which is not representative of the action area, as defined above and in **Figure 1**. Additionally, the USFWS stated that whitebark pine habitat does not exist within the project area and no whitebark pine was observed during the pedestrian survey of the action area. MNHP indicated that the whitebark pine occurs within 1-mile of the project area. Based on the absence of suitable habitat characteristics and the lack of observation of the species during field investigations of the action area, the occurrence of the whitebark pine within the action area is not expected. Whitebark pine will not be directly impacted by the proposed action. Any effects of the proposed action are not expected to indirectly affect individuals of this species documented within a mile of the action area. It has been determined that project activities are **not likely to jeopardize the continued existence of** the whitebark pine identified as a proposed species that occurs in Flathead County, Montana because neither the species nor its habitat is found in the action area. If the whitebark pine becomes federally listed during the analysis of this report, the determination of **no effect** will be appropriate. Therefore, no further analysis of the whitebark pine is provided in this document.

Wolverine

The wolverine was removed from the proposed species list on October 13, 2020 (USFWS 2020d). Therefore, the proposed project was not evaluated for impacts to the wolverine and is not discussed further in this BA.

V. Effects Analysis

After analysis of information on species of concern from MNHP and the review of data from regulatory agencies discussed above, it was concluded that the bull trout, yellow-billed cuckoo, Spalding's campion, grizzly bear, and Canada lynx may potentially be impacted by the proposed project. The following sections on these species provides information that addresses: 1) species description; 2) status and distribution; 3) life history and habitat requirements; 4) reasons for decline; 5) environmental baseline/occurrence in project area; 6) actions/impacts and cumulative effects; 7) recommended conservation and coordination measures; and 8) determination of effect.

Bull trout

Species Description

Bull trout are members of the char subgroup of the salmon family (salmonidae). The char subgroup also includes the dolly varden (*Salvelinus malma*), lake trout (*Salvelinus namaycush*), and Arctic char (*Salvelinus alpinus*). Bull trout inhabiting streams can weigh up to 4 pounds, and those that reside in lakes and reservoirs can weigh more than 20 pounds. Char are differentiated from other salmonids by the presence of light-colored spots on a darker background, the absence of spots on the dorsal fin, smaller scales, and differences in skeletal structure. Bull trout have small pale yellow to crimson spots on a darker background, which ranges from olive green to brown above and fades to white on the belly (USFWS 1998a).

Status and Distribution

Bull trout were historically found in many river systems of the Pacific Northwest (NRCS 2011). Distribution of bull trout is believed to be restricted to cold and relatively pristine headwater basins where spawning and rearing occur. Bull trout have been recorded in the northwestern U.S. and parts of British Columbia, Canada. The distribution of bull trout in the U.S. includes: northern California, Oregon, Washington, Idaho, western Montana, and Nevada. The largest contiguous populations are believed to be associated with the mountains of north-central Idaho and northwestern Montana (Lee et al. 1997).

In Montana, west of the continental divide, bull trout are found throughout the Clark Fork, Kootenai, and Columbia River drainages. Montana's Saskatchewan River drainage contains the only population of bull trout that occurs east of the continental divide in the U.S. (MBTRT 2000).

In June 1998a, USFWS listed bull trout populations as threatened throughout their range in the coterminous United States under the ESA. Critical habitat was designated in 2005 and revised in 2010. The bull trout also is identified as a threatened species by the USFS, a special status species by the BLM, and a Montana state species of concern with a global rank of G3 and a state rank of S2 (MNHP 2020a). In response to the declining bull trout population, new bull trout regulatory actions and management guidance documents for the Clark Fork River area have been developed (Table 5.1).

Table 5.1. Bull Trout Regulatory Actions and Management Guidance

Year	Regulatory Action/Management Guidance	Oversight Agency
1998	Bull Trout listed as Threatened under the ESA	USFWS
2000	Montana Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin	MFWP
2002	Bull Trout Draft Recovery Plan; Clark Fork River Recovery Unit	USFWS
2005	Designation of Critical Habitat	USFWS
2010	Revised Designation of Critical Habitat	USFWS
2013	Conservation Strategy for Bull Trout on USFS lands in Western Montana	USFS/USFWS

Year	Regulatory Action/Management Guidance	Oversight Agency
2013	Standard Local Operating Procedures for Endangered Species (SLOPES) for Selected Nationwide Permit Activities Affecting Bull Trout in Western Montana and Northern Idaho	USACE/USFWS

In 2000, the state-appointed Montana Bull Trout Restoration Team (MBTRT) and Montana Bull Trout Scientific Group (MBTSG) identified 12 different restoration and conservation areas (RCA) in four major drainages, in the *Montana Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin (Restoration Plan)* (MBTRT 2000). The RCAs were based on the current pattern of distribution and fragmentation of bull trout populations in Montana, which includes: the lower, middle, and upper Clark Fork River; Rock Creek; Bitterroot River; Blackfoot River; Flathead River; South Fork Flathead River; Swan River; and the lower, middle, and upper Kootenai River (MBTRT 2000). In each of these RCAs, core areas (those areas that support the strongest remaining bull trout populations) and nodal habitats (streams, rivers, and lakes containing critical over-wintering areas and migratory corridors) have been identified. The *Restoration Plan's* purpose is to complement the federal recovery process with voluntary state restoration efforts. The project area occurs within an important spawning migration corridor for bull trout (USFWS 2020).

In 2002, the USFWS released the Bull Trout Draft Recovery Plan (BTRP) to “ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species’ native range so that the species can be delisted (USFWS 2002). The MBTRP identified 27 bull trout recovery units based on shared genetic traits and management jurisdictions. The Flathead River is part of the Flathead Lake core area within the Flathead Recovery Subunit of the Clark Fork Recovery Unit (USFWS 2002). The MBTRP states that abundance criteria for the Flathead Lake core area will be met when each of the least 10 populations contain more than 100 fish and abundance of adult bull trout exceeds 2,500 fish in Flathead Lake.

On September 26, 2005, the USFWS designated critical habitat for the population of bull trout in the coterminous United States (USFWS 2005c). On October 18, 2010, the USFWS revised the 2005 designated critical habitat final rule for bull trout in 32 critical habitat units for the coterminous United States. The revised designation totals approximately 19,729 miles of streams and 488,251 acres of lakes in Idaho, Montana, Oregon, Washington, and Nevada. In Montana, the critical habitat designation covers approximately 3,056 miles of stream and 221,471 acres of lakes or reservoirs. The Flathead Recovery Subunit occurs within the Clark Fork River Basin Critical Habitat Unit 31. Critical Habitat Unit 31 covers approximately 3,328 miles of stream and 295,587 acres of lakes or reservoirs in Montana, Idaho, and Washington (USFWS 2010). The project area occurs within the Flathead Lake core area of Critical Habitat Unit 31 and includes Flathead Lake, the Flathead River, and the North and Middle Forks of the Flathead River (USFWS 2013c).

Life History and Habitat Requirements

Bull trout have three distinct life forms: resident, fluvial, and adfluvial. Resident bull trout populations spend their entire life in small headwater streams. Fluvial bull trout are migratory populations that reside in larger rivers and spawn in smaller tributary streams. Adfluvial populations are migratory and reside in lakes and reservoirs, then return to tributary streams to spawn. Bull trout reach maturity in 5 to 7 years and may spawn annually or biennially (Pratt 1985). Spawning occurs from late August to November, but usually after mid-September in low gradient third and fourth order streams (Carnefix 2003). The majority of bull trout spawning in Montana occur in a small percentage of the total stream habitat (Carnefix 2003). Bull trout are sensitive to high sediment levels in their spawning streams, as fine sediment can clog the interstitial spaces in the substrate and suffocate the developing embryos before they hatch.

Habitat requirements for the spawning bull trout include cold unpolluted water, clean gravel, cobble substrate with high permeability, streams influenced by groundwater, and gentle stream slopes (USFWS 2002). Water temperature requirements for spawning has to be below 46°F, and substrate must be a gravel/cobble with low levels of fine substrate particles (smaller than 0.25 inch in diameter) (Carnefix 2003). Eggs are deposited as deep as 10 inches below the streambed surface. Bull trout eggs require an incubation period of 4 to 5 months before hatching occurs in late winter or early spring, depending on water temperature (Carnefix 2003). Bull trout fry emerge and remain in the substrate interstices of low velocity streams for 1 to 4 years while feeding on aquatic macroinvertebrates. Juvenile outmigration typically occurs from June through August. Sub-adult and adult bull trout are primarily piscivorous, but will also feed on amphibians and rodents (MNHP 2020a).

Habitat Relationships

Water Temperature

Water temperature is one of the most important variables affecting salmonids, influencing timing of migration, spawning, egg maturation, growth, and emergence (Bjornn 1991). Bull trout have more specific stream temperature requirements than other salmonids (Carnefix 2003). Bull trout require cold water temperatures of 39.2 to 48.2 degrees Fahrenheit for spawning; fry emergence occurs from 35.6 to 39.2 degrees Fahrenheit; and sub-adults and adults inhabit streams with a maximum temperature of 59 degrees Fahrenheit (Goetz 1989). Water quality data for the Flathead River above Flathead Lake was obtained from the U.S. EPA WATERS Geoviewer (EPA 2020) and from USGS (2020). Temperature in the Flathead River near Columbia Falls was measured at USGS Station 12363000. Water temperatures in the project area from October through April are between 36 degrees Fahrenheit and 45 degrees Fahrenheit. Water temperatures rise in the spring where temperatures average from approximately 44 degrees Fahrenheit in May to approximately 48 degrees Fahrenheit in June. Water temperatures are warmest in July and August when the average temperatures are approximately 50 degrees Fahrenheit and 65 degrees Fahrenheit, respectively. The proposed project is not likely to improve or degrade existing water temperature conditions.

Cover

Stream cover in the form of water depth, turbulence, boulders, large woody debris (LWD), undercut banks, and overhanging riparian vegetation is an important component for salmonids at all life stages. Predation on salmonids and water temperature are influenced by the amount of cover within stream reaches, and stream cover has a direct effect on the suitability of a stream to support salmonid populations. LWD, defined as woody material greater than 20 inches in diameter and 35 feet in length, is one of the most important sources of habitat and cover for salmonids in streams (Bisson et al. 1987).

Channel Form and Stability

Bull trout utilize third and fourth order streams with low gradients for spawning. Spawning areas are usually characterized by gradients of less than 2 percent, water depths of 4 to 24 inches, and stream velocities of 0.3 to 2.0 feet per second (Carnefix 2003). Streams with stable banks, in-stream and overhead cover, complex channels, and a high number of quality pools are required for adequate bull trout habitat (Platts 1986). Stable and vegetated stream banks reduce the amount of fine bedload sediment entering channels. Increasing the amount of fine sediment in a stream increases substrate embeddedness, and clogs interstitial spaces, which reduces the transport of dissolved oxygen to incubating eggs.

Lake Form and Stability

Bull trout adfluvial populations are found in lakes and reservoirs. Rapid growth and maturation occur in large water bodies, as their diets shift from insects to fish. Bull trout are generally found at the bottom of lakes. During summer, bull trout occupy the coldest layer of deep lakes (upper hypolimnion), but may forage in shallower waters. River and lake transition zones appear to be particularly important habitats for spawning and migration (MBTRT 2000).

Spawning and Rearing Substrates

Substrate composition is an important factor for the survivability of bull trout eggs and fry. Bull trout utilize clean gravel and cobble substrate for spawning with less than 12 percent fine sediment (smaller than 0.25 inch in diameter) in streambed gravels, and less than 20 percent surface fines. Reach embeddedness must be less than 20 percent (Carnefix 2003). Spawning areas are usually less than 2 percent in gradient (Fraley and Shepard 1989), and water depths range from 0.3 to 2.0 feet and average 1.0 foot (Fraley et al. 1981). Incubation and fry emergence success depends on the conditions of gravel, surface flow, and water temperature. Spawning gravel with reduced fines (<35 to 40 percent fine sediment) and organic material is more suitable for incubating embryos (Rieser and Wesche 1979). For incubation and fry emergence, water temperature should be around 35.5 to 39 degrees Fahrenheit and no higher than 46.5 degrees Fahrenheit (Weaver and White 1985). Fry emergence coincides with spring runoff and ground water influence (Weaver and Fraley 1991). Bull trout juveniles will readily disperse from the redd area and use most of the suitable and accessible stream areas within a drainage in order to reach maturity (Leider et al. 1986). Water temperature, habitat quality, and cover (substrate and large woody debris) determine distribution and abundance of juvenile bull trout (Fraley and Shepard 1989). Juveniles rarely are found in streams with temperatures above 59 degrees Fahrenheit and excess

sediment reduces useable rearing habitat and macroinvertebrate production (Fraley and Shepard 1989).

Migratory Corridors

Channel stability, substrate composition, cover, water temperature, and migratory corridors are important for fluvial and adfluvial adult and young fish rearing and movement in streams (Rieman and McIntyre 1993). Deep pools with abundant cover (boulder substrate, woody debris, and undercut banks) and water temperatures below 59 degrees Fahrenheit are important habitat components for stream resident bull trout (Goetz 1989). Fluvial bull trout over-winter in pool and run (habitat that is deep, fast with a defined thalweg and little surface agitation) habitats (Elle et al. 1994). Most fluvial bull trout remained in the same habitat type after entering the main river from tributaries (Elle et al. 1994). Large rivers such as the Flathead River (used as migratory corridors for fluvial and adfluvial bull trout), large oxbow lakes, groundwater influenced floodplain ponds, and sloughs adjacent to the main channel are important habitat components during all seasons (Cavallo 1997). Lakes and reservoirs are very important for adfluvial bull trout, as they are the primary habitat for rearing and growth of young and adults (Leathe and Graham 1982). Adequate migration corridors for bull trout are identified as reaches that meet requirements for in-stream and overhead cover, clean gravel substrates, water temperatures, pool frequency, width-depth ratios, and are connected (MBTSG 1998). Bull trout migration in the project area has been limited due to degraded habitat and physical barriers like dams (MNHP 2020a). Migratory corridors, within tributary streams, larger rivers and lake systems are necessary for maintaining bull trout populations (Carnefix 2003).

Reasons for Decline

The factors that have been identified as contributing to declines of bull trout populations across the state include: habitat degradation and loss due to land and water management practices; isolation and fragmentation of populations by both structural (e.g., dams) and environmental (e.g., thermal or pollution) barriers; introduction of non-native fishes resulting in competition, predation and hybridization threats; historical eradication efforts; poisoning to remove non-game species; historical overharvest; and ongoing poaching and accidental harvest due to misidentification (Carnefix 2003).

Expansion of non-native species, like the long-lived lake trout, is the single largest human-caused threat for most of the adfluvial bull trout core populations (Fredenberg 2002; Fredenberg 2008). Lake trout out-compete bull trout and are considered the primary cause of bull trout decline in Flathead watershed (USFWS 2002). Lake trout were introduced into Flathead Lake in 1905. *Mysis relicta* shrimp were introduced into the Flathead watershed in the late 70s by MFWP to provide a food source for introduced kokanee salmon. By the mid-80s the *Mysis* population had increased exponentially and caused a marked population shift in Flathead Lake (USFWS 2005b). The shrimp provided a new and remarkably abundant food source for bottom feeders and directly contributed to the lake trout population explosion in Flathead Lake (Weaver et al. 2006). The increase in the lake trout population has been directly correlated with a decrease in bull trout in the entire Flathead watershed, including Glacier National Park (Fredenberg 2002).

Environmental Baseline/Occurrence in the Project Area

Flathead River

Water surface elevations in the project area are dependent on flows from the North Fork, Middle Fork, and South Forks of the Flathead River. The South Fork Flathead River is controlled by the Hungry Horse Dam. Rainfall and snow runoff upstream of the project area are highly variable throughout the year, resulting in the Flathead River in the project area being subject to flooding. The sheet pile wall serving as a dam for the South Ponds area restricts some of the potential flooding. Flood waters are currently able to enter the South Ponds but cannot flow through the project area and naturally release back into the Flathead River.

The portion of Flathead River that occurs within the project area is identified by the MFWP and USFWS as nodal habitat (MFWP 2020). Bull trout in this area are predominantly adfluvial fish that reside in Flathead Lake and migrate out of the lake to spawn. Flathead Lake is considered a core area that is 'at risk' because the limited or declining numbers of bull trout in this core area are vulnerable to extirpation (USFWS 2005b). Population estimates for the adfluvial bull trout population in Flathead Lake vary from less than 1,000 (USFWS 2005a) to 6,000 fish (Deleray 1999). In any case, the current population is at least 50 percent lower than it was before 1980 (Weaver et al. 2006).

The project area lies between River Mile points 145.8 and 147.2. Data from MFWP indicate that bull trout may be present in common abundance and use the river primarily for migrating (MFWP 2020). Bull trout begin migrating from Flathead Lake in April and May and work their way upstream. Some may travel up to 140 miles to reach their natal stream. By late June and July, adult bull trout reach the Middle and North Forks of the Flathead River where they reside in deep holes and runs until moving into tributaries during the spawning season in September (Fraley and Shepard 1989). Juvenile outmigration occurs from June through August, with peak numbers in the main stem occurring in the fall months (McMullin and Graham 1981). Bull trout may be present in the project area throughout the year with the lowest numbers occurring during the hottest months.

Bull trout require cold water temperatures and strongly prefer reaches where the estimated mean August temperature is less than 50 degrees Fahrenheit (D'Angelo and Muhlfeld 2013). The average water temperatures in the project area during July and August are 59 to 62 degrees Fahrenheit (USGS 2020); these temperatures exceed the limit for providing suitable bull trout habitat. It is unlikely that bull trout inhabit the project area during those months but may be present at other times.

Bull Trout Critical Habitat

As previously mentioned, the Flathead River has been designated as bull trout critical habitat core area supporting nodal habitat within the reach associated with the project area. Review of the following table (Table 5.2) provides a description of the bull trout critical habitat primary constituent elements (PCEs) and compares the relationship between habitat indicators and the PCEs. This matrix crosswalk provides information supporting the rationale that the PCEs for bull trout critical habitat are thoroughly addressed and evaluated when the bull trout matrix analysis is utilized. The

matrix crosswalk also recognizes that the environmental baseline and determination of effect for bull trout consist of both biological and habitat components that are addressed in the PCEs listed in the revised Final Rule designating bull trout critical habitat (USFWS 2013b).

Table 5.2. PCEs for Bull Trout Critical Habitat and Associated Matrix Habitat Indicators

PCE #	PCE Description	Associated Matrix Habitat Indicators
1	Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.	- Floodplain connectivity - Change in peak/base flows - Substrate embeddedness - Increase in drainage network - Increase in road density and location - Streambank condition - Riparian conservation areas - Chemical contamination/nutrients
2	Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.	- Temperature - Sediment - Chemical contamination/nutrients - Physical barriers - Change in peak/base flow - Average wetted width/maximum depth ratio - Refugia
3	An abundant food base, including terrestrial organisms or riparian origin, aquatic macroinvertebrates, and forage fish.	- Floodplain connectivity - Riparian conservation areas - Pool frequency and quality - Substrate embeddedness - Temperature - Sediment - Chemical contaminants and nutrients
4	Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure.	- Large wood debris - Pool frequency and quality - Average wetted width/maximum depth ratio - Large pools - Off-channel habitat - Streambank condition - Riparian conservation areas - Floodplain connectivity - Disturbance history - Disturbance regime - Refugia
5	Water temperatures ranging from 2 to 15° C (36 to 59°F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.	- Temperature - Refugia - Pool frequency and quality - Large pools - Average wetted width/maximum depth ratio - Change in peak/base flows - Streambank condition - Floodplain connectivity - Road density and location - Riparian conservation areas

PCE #	PCE Description	Associated Matrix Habitat Indicators
6	Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 in) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.	- Sediment - Substrate embeddedness - Large woody debris - Pool frequency and quality - Streambank condition
7	A natural hydrograph, including peak, high, low and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.	- Change in peak/base flows - Floodplain connectivity - Increase in drainage network - Road density and location - Disturbance history - Riparian conservation areas - Disturbance regime
8	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.	- Floodplain connectivity - Changes in peak/base flows - Drainage network increase - Disturbance history - Disturbance regime - Temperature - Sediment - Chemical contaminants
9	Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.	- NA

Table 5.3 provides an assessment of the current functionality of each PCE within the project area and includes a determination of the effect that construction activities may have on existing conditions.

Table 5.3. Analysis of the Current Functionality of PCEs and Expected Effects of the Project – Flathead River

	Environmental Baseline			Short-Term Effects of the Action	Long-Term Effects of the Action
PCE#	Functioning Appropriately	Functioning At Risk	Functioning at Unacceptable Risk	Restore, Maintain, or Degrade	Restore, Maintain, or Degrade
1	X			Maintain	Maintain
2	X			Maintain	Maintain
3	X			Maintain	Maintain
4	X			Maintain	Maintain
5	X			Maintain	Maintain

	Environmental Baseline			Short-Term Effects of the Action	Long-Term Effects of the Action
PCE#	Functioning Appropriately	Functioning At Risk	Functioning at Unacceptable Risk	Restore, Maintain, or Degrade	Restore, Maintain, or Degrade
6	X			Maintain	Maintain
7		X		Maintain	Maintain
8	X			Degrade	Restore
9			X	Maintain	Maintain

After analysis of the PCEs and associated habitat indicators for the reach of the Flathead River associated with the proposed project, it was determined that the existing environmental baseline (functionality of PCEs) will not be restored or degraded with the implementation of project activities as only temporary impacts to the Flathead River are anticipated (Table 5.3).

Actions/Impacts and Cumulative Effects

Direct Effects

Direct effects are impacts caused by specific actions that occur at the same time and place as the action and have immediate effects on the species or its habitat. Examples of direct effects include construction equipment crossing over a redd and destroying eggs or road-fill being deposited directly into a stream. In-stream projects can potentially have direct impacts on bull trout in five ways: 1) direct mortality of individual fish at all life stages; 2) major disturbance of fish in the project area; 3) major temporary displacement of fish species in the vicinity of the project area; 4) major elimination of supporting aquatic and/or riparian habitat in the project area; and 5) project activities causing substantial, long-term reductions in water quality due to excessive sedimentation and the introduction of toxic substances.

Streambank Disturbance

There will be the removal artificial riprap, sheet piles, and floor panels that are easily within reach of existing equipment on-site. Adjacent woody riparian vegetation and banks upstream and downstream of the project area will remain undisturbed by construction activities, and thereby retain overhead canopy cover that would provide shading, and the availability of large woody debris and organic materials to enter the river system. The proposed project will initially destabilize small amounts of bank near the area where the bank is being restored to a more natural condition. Geotextile fabric and willow plantings will be used along the disturbed bank line to provide natural bank stability. This will assist in naturalizing and stabilizing the banks to prevent water quality degradation upon completion of construction activities. The existing bank-full width is not anticipated to change as a result of the proposed project.

Summary of Direct Effects

The project area is primarily a migratory corridor with deep water habitat features for bull trout present up and downstream. No major disturbances to aquatic or riparian habitat or long-term reductions in water quality are expected with the proposed project. The removal of artificial bank stabilization techniques is anticipated to cause bull trout to avoid the project area. Conservation measures listed below will be written into the project contract in order to minimize the potential for impacts.

Following the completion of project construction activities, impacts to bull trout or bull trout critical habitat are not anticipated to occur. A reduction in water quality due to temporary sedimentation to Flathead River is possible. However, only minimal short-term and no long-term effects are anticipated to occur following careful implementation of the BMPs outlined in the conservation measures.

After analysis of the available site-specific information, it is concluded that direct effects to adult and sub-adult bull trout are possible. However, since the area is not used for spawning the proposed project will have no direct effect on incubation, fry emergence, or juvenile rearing of bull trout in the Flathead River watershed.

Relative to the proposed project, the data indicate that bull trout may be present year-round, except during the hottest summer months when water temperature exceeds their tolerance threshold. No spawning occurs in the project area and the proposed project will have no impact on incubation or fry emergence.

Indirect Effects

Indirect effects are impacts that occur later in time and space. Examples of indirect effects include degrading aquatic habitat and water quality to the point that fish survival and/or production is substantially reduced. Indirect effects, with the exception of direct mortality of fish, are the same as direct effects but are less severe and immediate in observable impacts to sensitive fish species and their habitat. Indirect effects can manifest after completion of project activities and can change long-term human use and resource condition. Because the overall goal of the project is to return the floodplain to a more natural state, no indirect effects have been identified to potentially affect the bull trout.

Cumulative Effects

Cumulative effects are the combined impacts related to multiple activities or actions that occur over time. The Montana Department of Transportation (MDT) Future Project Schedule and the Flathead County Capital Improvements Plan for Fiscal Years 2021-2025 were referenced to determine if any existing or upcoming projects have the potential to cause cumulative effects in the action area. No projects are proposed to occur in early 2021 near the action area that could cause cumulative impacts.

No additional projects are known to be planned in the foreseeable future. The authors of this report may not be aware of other action taken or proposed by Flathead County, other local entities, private developers, or private citizens in or near the project area.

Recommended Conservation and Coordination Measures

Impacts to bull trout and general aquatic resources from the proposed project activities are possible. However, impacts will be short-term and insignificant assuming proper conservation practices are implemented during and after construction activities. The following conservation measures will be considered for the proposed project:

- Maintain water quality and limit sedimentation of adjacent property, lakes, streams, rivers, ponds, wetlands, or other surface water according to MDEQ's authorization to discharge under the MPDES of the EPA's authorization to discharge under the NPDES and other associated water quality discharge permits. BMPs will be employed to prevent excess sediment into the Flathead River.
- All in-stream work should be kept to the minimum amount practicable. No construction equipment should be allowed to operate within the active channel unless otherwise permitted to do so. When practicable, in-stream construction activities should occur during low flows. Complete in-stream work expeditiously in the shortest amount of time practicable.
- The removal of the bank stabilization armoring is designed to promote natural sediment and debris transport and maximize connectivity of the stream-floodplain system.
- USFWS recommends in-channel or riparian disturbance be conducted in times where the river is at low flow.
- USFWS recommends that as much of the bank stabilization material is removed "in the dry".
- All waste fuels, lubricating fluids, herbicides, and other chemicals will be collected and disposed of in a manner that ensures that no adverse environmental impact will occur. Construction equipment will be inspected daily to ensure hydraulic, fuel, and lubrication systems are in good condition and free of leaks to prevent these materials from entering the river. Vehicle servicing and refueling areas, fuel storage areas, and construction staging and materials storage areas will be sited a minimum of 50 feet from ordinary high water and wetlands. Ensure that spilled fluids or stored materials do not enter any stream or wetland.
- Structures designed to minimize sediment and pollutant runoff from sensitive areas such as vehicle and fuel storage areas and erosion control structures shall be visually monitored daily, especially following precipitation events, to ensure these structures are functioning properly.
- Upon locating dead, injured or sick bull trout, notification must be made within 24 hours to the USFWS Montana Field Office at (406) 449-5225. Record information relative to the date, time, and location of dead or injured bull trout when found, and possible cause of injury or death of each fish.

Determination of Effect – Bull Trout

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

1. Are there any proposed/listed plant or animal species and/or proposed/designated critical habitat in the proposed project area?
NO.....No Effect
YES.....Go to 2
2. Will the proposed action(s) have “any effect whatsoever”¹ on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
NO.....No Effect
YES.....Go to 3
3. Does the proposed action(s) have potential to: result in “take”² of any proposed/listed plant or animal species?
NO.....Go to 4
YES.....Likely to adversely affect
4. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed plant or animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, anticipated project impacts, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project **may affect but not likely to adversely affect** bull trout.

Rationale for Determination

This determination was based on the following factors:

¹ “any effect whatsoever” includes small effects, effects that are unlikely to occur, and beneficial effects (all of which are recognized as “may affect” determinations). A “no effect” determination is only appropriate if the proposed action will literally have no effect whatsoever on the species and/or critical habitat- not a small affect, an effect that is unlikely to occur, or a beneficial effect.

² The ESA (Section 3) defines take as “to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct”. The USFWS (USFWS 1998) further defines “harm” as “significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering”, and “harass” as “actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering.”

- This proposed project will result in temporary impacts to the Flathead River with the removal of man-made stabilization structures. Short-term sediment pulses, while not expected to reach harmful levels, could cause short-term behavioral affects or avoidance of the project area.
- Adult bull trout travel through the project area when headed to their natal spawning tributaries upriver and move downriver through the project area following spawning. It is unlikely that bull trout will be present in the river channel while the proposed project activities are taking place.

Determination of Effect – Bull Trout Critical Habitat

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

1. Are there any proposed/listed plant or animal species and/or proposed/designated critical habitat in the proposed project area?
 NO.....No Effect
YES.....Go to 2
2. Will the proposed action(s) have “any effect whatsoever” on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
 NO.....No Effect
YES.....Go to 3
3. Does the proposed action(s) have potential to: result in “take” of any proposed/listed plant or animal species?
NO.....Go to 4
 YES.....Likely to adversely affect
4. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed plant or animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
 YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, anticipated project benefits, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project is **not likely to adversely affect** designated bull trout critical habitat. This determination was based on the following factors:

- The proposed project will result in temporary and permanent impacts to the Flathead Riverbank with the removal of man-made bank stabilization techniques and reconnecting a historic side channel. Reconnecting an historic side-channel of the Flathead River and removing man-made bank stabilization armoring will have a negligible impact to this river reach. These activities will restore the localized channel setting to a more natural environment.
- The project occurs at an EPA Superfund Site where historic settling ponds necessitated substantial bank armoring to protect the Flathead River system from contaminants. These contaminants have since been removed and this channel can now safely be restored.
- Work will be conducted during periods of low flow and when bull trout are not expected to be in the Flathead River channel (February/March).

Primary Constituent Elements (PCE's) for designated bull trout critical habitat:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The analysis of *changes in peak/base flow* addresses subsurface water connectivity and *substrate embeddedness* address inter-gravel flows. *Increase in drainage network* and *road density and location* address potential changes to groundwater sources and subsurface water connectivity. *Streambank condition*, *floodplain connectivity*, and *riparian conservation areas* address groundwater influence. *Chemical contamination/nutrients* address concerns regarding groundwater quality.

The proposed project will not affect any existing springs, seeps, or ground water sources within the project corridor. The proposed project is anticipated to impact less than 300 feet of river bank. Adjacent wetlands and riparian habitat will remain undisturbed and will continue to provide subsurface connectivity. The proposed project will not affect peak or base flows entering the project area. Changes to *substrate embeddedness* in the project vicinity over the long term are not expected. Overall impacts to this PCE relative to bull trout critical habitat will be negligible. The proposed project will maintain this PCE in both the short- and long-term.

2. Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

Physical, biological or chemical barriers to migration are addressed directly through water quality habitat indicators, including *temperature*, *sediment*, *chemical contamination/nutrients* and *physical barriers*. The analysis of these indicators assesses whether barriers have been created

due to impacts such as high temperatures or high concentrations of turbidity or contaminants. Analysis of *change in peak/base flows* and *average wetted width/maximum depth ratio* assess whether changes in flow might create a seasonal barrier to migration. An analysis of *refugia* considers the habitat's ability to support strong, well distributed, and connected populations for all life stages and forms of bull trout.

The proposed project is not situated within any known spawning or juvenile rearing habitat for bull trout. The project area provides foraging, migrating, and overwintering habitat. In-stream construction activity and short-term turbidity would have temporary effects or cause avoidance of the project area by bull trout. Therefore, the proposed project may degrade existing conditions in the short-term. However, no long-term effects for this PCE are anticipated; the proposed project will maintain existing conditions for this PCE over the long-term.

3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macro-invertebrates, and forage fish.

Floodplain connectivity and *riparian conservation areas* provide habitat to aquatic invertebrates, which in turn provide a forage base for bull trout and other fish species. Changes in *temperature*, *sediment*, *chemical contaminants* and *nutrients* affect aquatic invertebrate production within floodplain and riparian areas. These invertebrates in turn, provide a forage base for bull trout. The combined analyses of all the matrix habitat indicators and the other seven PCEs provide information to assess whether there is an abundant food base in the analysis area. Therefore, any impairment to the food base will be addressed by way of summarizing the biological and habitat indicators. By eliminating the sediment loading into the river/reservoir system, benthic and macro-invertebrate production will likely be maintained or may be improved in the localized area.

The proposed project should not be detrimental to the food base within the Flathead River as there will only be temporary disruptions to the aquatic invertebrate community during the removal of man-made riverbank armoring. The upstream and downstream areas will still contribute to the aquatic and terrestrial invertebrate food base in the immediate project vicinity during the construction period. Small forage fish species will temporarily leave the area during construction activities but should return once removal disturbances along the riverbank are completed. Impacts to the food base should be negligible.

The removal of a minor amount of armoring along the riverbank setting will somewhat reduce the number of terrestrial insects and organic matter within the immediate area; however, these impacts are negligible. Aquatic organisms upstream and downstream of the project area should still contribute to the productivity and food chain support during the construction period. Post construction activities for the area include the restoration of *streambank condition* with replacement seeding and plantings of willows.

These temporary impacts to the forage base within the project area should have no effect on bull trout, nor will adversely affect the continued existence of bull trout within the Flathead River. This PCE will be maintained in both the short- and long-term.

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure.

Large woody debris increases channel complexity and creates pools and undercut banks, so the analysis of the current amounts and sources of *large woody debris* available for recruitment is pertinent to this PCE. *Pool frequency and quality* considers the number of pools per mile as well as the amount of cover and temperature of water in the pools. *Average wetted width/maximum depth ratio* is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. *Large pools*, consisting of a wide range of water depths, velocities, substrates and cover, are typical of high-quality habitat and are a key component of channel complexity. Analysis of *off-channel* habitat describes side-channels and other off-channel areas. *Streambank condition* analyzes the stability of the banks, including features such as undercut banks. The analysis of *riparian conservation areas*, *floodplain connectivity*, *disturbance history*, and *disturbance regime* include the maintenance of habitat and channel complexity, the recruitment of *large woody debris*, and the connectivity to off-channel habitats or side channels. Complex habitats provide *refugia* for bull trout and in turn, analysis of *refugia* assesses complex stream channels. All of these habitat indicators consider the numerous characteristics of in-stream bull trout habitat and quantify critical components that are fundamental to creating and maintaining complex in stream habitat over time.

The proposed work occurs in a portion of the Flathead River that comprises poor quality habitat due to its setting within an EPA Superfund Site. Existing debris such as hard armoring and floor panels will be removed. No impacts to *large woody debris* recruitment are anticipated. *Streambank condition* will be restored along the impacted bank. This PCE will be maintained in the short-term but will be restored in the long-term.

5. Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.

This PCE is addressed directly by the analysis of *temperature*. It is also addressed through consideration of *refugia*, which by definition is high quality habitat of appropriate temperature. Availability of *refugia* is also considered in analysis of *pool frequency and quality* and *large pools*. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, i.e., low ratios indicate deeper water, which in turn indicates possible refugia. This indicator in conjunction with *change in peak/base flows* is an indicator of potential temperature and *refugia* concerns particularly during low flow periods. *Streambank condition*, *floodplain connectivity*, *road density and location* and *riparian conservation areas* address the components of shade and groundwater influence, both of which are important factors of water temperature. Stable streambanks and intact riparian areas, which include part of the floodplain,

typically support adequate vegetation to maintain thermal cover to streams during low flow periods.

According to ARM §17.30.623, temperatures in B-1 class waters like the Flathead River are allowed a 1 °F increase above naturally occurring water temperatures within a temperature range of 32 to 66 °F (0 to 18.9 °C). If naturally-occurring water temperatures are greater than 66.5 °F (19.2 °C) then the maximum allowable increase in water temperature is 0.5 °F. On average, water temperatures in the project area from November through March are 39 °F (3.9 °C) or less. Water temperatures rise in the spring where temperatures average from approximately 45.7 °F (7.6 °C) in April to approximately 55 °F (12.8 °C) in June. The proposed project will have no effect on water temperature.

The proposed project will maintain existing conditions relative to this PCE in the short-term but is expected to restore conditions in the long-term.

6. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 in.) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.

The analyses for *sediment* and *substrate embeddedness* assess substrate composition and stability in relation to the various life stages of the bull trout as well as the sediment transportation and deposition. *Large woody debris* and *pool frequency and quality* affect sediment transport and redistribution within a stream and assessment of these indicators will clarify substrate composition and amounts. Analysis of *streambank condition* will provide insight into the amount of fine sediment contribution.

The proposed project area is not used by bull trout for spawning or rearing; therefore, it will have no effect on egg and embryo survival or fry emergence. The proposed project will increase *pool frequency and quality* which may enhance survival of juvenile bull trout. The proposed project will return the *streambank condition* to a more natural condition. The *streambank condition* will be restored along the riverbank. The proposed project will maintain existing conditions relative to this PCE in both the short- and long-term.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.

The analysis of *change in peak/base flows* considers changes in hydrograph amplitude or timing with respect to watershed size, geology, and geography. Analyses of *floodplain connectivity*, *increase in drainage network*, *road density and location*, *disturbance history*, and *riparian conservation areas* provides further information regarding possible interruptions in the natural stream hydrology. *Floodplain connectivity* considers the hydrologic linkage of off-channel areas

with the main channel. Roads and vegetation management both have effects strongly linked to a stream's hydrograph. *Disturbance regime* ties this information together to consider how a watershed reacts to disturbance and the time required to recover back to pre-disturbance conditions.

The proposed project will have no effect on peak or base flows of the Flathead River. The proposed project will maintain existing conditions relative to this PCE in both the short- and long-term.

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Floodplain connectivity considers the hydrologic linkage of off-channel areas with the main channel. The analysis of *change in peak/base flows* considers changes in hydrograph amplitude or timing with respect to watershed size, geology, and geography. An analysis of *drainage network increase* provides further information regarding possible interruptions in the natural stream hydrology. Roads and vegetation management both have effects strongly linked to a stream's hydrograph. *Disturbance history and regime* ties this information together to consider how a watershed reacts to disturbance and the time required to recover back to pre-disturbance conditions. Physical, biological, or chemical barriers are addressed through *temperature, sediment, and chemical contaminants*. The analysis of these indicators assess whether barriers have been created due to impacts such as high temperatures, high turbidity, or contamination.

Temporary displacement of fish in the proposed project area can occur from an increase in sediment or other changes in the river caused by construction activities. This impact could result in reductions in the short-term use by fish in the project area. Newcombe and Jensen (1996) showed that short- or long-term construction effects upon fish are based upon suspended sediment mg/L over time expressed as duration in hours or days. In-stream construction activities will be done in an expedient manner so as to minimize potential effects to local bull trout populations or individuals. It is expected that bull trout, if present during the construction period, will avoid the area by utilizing adjacent suitable habitat upstream and downstream of the proposed project.

Increased sediment can affect adult and juvenile bull trout by changing behavior, reducing available habitat, increasing stress, and reducing food supply. Salmonid fishes will generally avoid areas of turbid water. In streams where turbidity is elevated over a long distance for a long period of time, this can result in reaches of stream devoid of fish (Thomas 1999).

Fish densities and available adjacent habitat are such that there should be suitable habitat upstream and downstream of the project area to support temporary use should any bull trout in the project area need to avoid the construction area. Bull trout could return to the area after activities stop since adjacent habitat within Flathead River and its tributaries is capable of supporting fish. Short-term increases in *sediment* are anticipated to cause a short-term degradation of this PCE while existing conditions will be maintained in the long-term.

9. Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

Expansion of non-native species is the single largest human-caused threat for most of the bull trout core populations (Fredenberg 2002; Fredenberg 2008). An increase in stream temperatures, sediment levels, and fragmentation as a result of legacy mining and/or logging has caused a decrease in pool quality and complexity. These changes have enabled introduced brook trout and brown trout populations to expand and maintain a competitive advantage over bull trout (USFS 2013). In the mainstem Flathead River, brown trout not only directly compete with bull trout but may also hybridize with them. Lake trout present similar problems for bull trout in Flathead Lake.

Proposed project activities are not anticipated to have a significant effect on fish population distribution. The proposed project is anticipated to maintain existing conditions for this PCE in both the short- and long-term.

Yellow-billed cuckoo

Species Description

The yellow-billed cuckoo is a slender bird with a patterned tail, yellow feet, and white throat and breast. Other characteristics include plain grayish-brown head with a primarily yellow bill, and feet similar to that of woodpeckers as two outer toes point backwards and two inner toes point forward (USFWS 2020f).

Status and Distribution

The yellow-billed cuckoo is a migratory species, and winters in South America and breeds in North America. Once thought to breed in most of the western United States and Canada, the species no longer breeds in western Canada, Washington, Oregon and Montana. The species is also considered very rare in Utah, Colorado and Wyoming (USFWS 2020f).

The USFWS released an updated proposed rule to designate critical habitat for the western distinct population segment (DPS) of the yellow-billed cuckoo on February 27, 2020. In total, approximately 493,665 acres of habitat are being proposed in Arizona, California, Colorado, Idaho, New Mexico, Texas, and Utah (USFWS 2020e). No designated critical habitat has been proposed for Montana.

Life History and Habitat Requirements

Yellow-billed cuckoos migrate north from South America in the spring to breeding grounds in the southwestern United States. Preferred breeding habitat includes open woodland with thick undergrowth, parks, deciduous riparian woodland. In the west, the yellow-billed cuckoo nest in tall cottonwood and willow riparian woodlands. Nests are found in trees, shrubs, of vines and average 1 to 3 meters above ground (MNHP 2020a). No information is available for feeding habitats in Montana but across its range, their main diet is caterpillars (MNHP 2020a).

Reasons for Decline

The USFWS noted the primary factors that threaten the yellow-billed cuckoo includes loss and degradation of habitat for the species from altered watercourse hydrology, livestock overgrazing, encroachment from agriculture, and conversion of native habitat (USFWS 2020e).

Environmental Baseline/Occurrence in the Project Area

Recorded sightings of yellow-billed cuckoos in Montana are rare and there are no documented breeding records. Occurrences in Montana are likely transient migratory birds passing through the state (MNHP 2020a). Previous sightings have occurred in Whitefish and Lake County, however, the most recent sightings are greater than 20 years old. Suitable habitat for the species may occur within the riparian vegetation in the project area.

Actions/Impacts and Cumulative Effects

Direct Effects

Direct effects are impacts caused by specific actions that occur at the same time and place as the action and have immediate effects on the species or its habitat.

As the project area is in a riparian floodplain, some key habitat components for the yellow-billed cuckoo do occur within the action area. However, no individuals have been documented in the area in over 20 years and none were identified during the species survey of the property. Any species in the area may be temporarily disrupted during construction due to noise and construction equipment.

Indirect Effects

Indirect effects are defined as those effects that are caused by or will result from the proposed action and are later in time but are still reasonably certain to occur [50 CFR §402.02]. After removal of hard bank stabilization is completed, the riparian floodplain will be returned to natural river processes. No indirect effects to yellow-billed cuckoo are expected to occur.

The long-term goal of the proposed project is to return the riparian floodplain back to the influence of the Flathead River. This action is not expected to have a long-term permanent impact on the yellow-billed cuckoo.

Cumulative Effects

As no significant direct or indirect adverse effects on the yellow-billed cuckoo are expected, no cumulative effects are anticipated.

Recommended Conservation and Coordination Measures

There are no recommended conservation and coordination measures identified for the yellow-billed cuckoo.

Determination of Effect

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

1. Are there any proposed/listed animal species and/or proposed/designated critical habitat in the proposed project area?
NO.....No Effect
YES.....Go to 2
2. Will the proposed action(s) have “any effect whatsoever” on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
NO.....No Effect
YES.....Go to 3
3. Does the proposed action(s) have potential to: result in “take” of any proposed/listed animal species?
NO.....Go to 4
YES.....Likely to adversely affect
4. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project ***may affect, but is not likely to adversely affect*** the yellow-billed cuckoo.

Rationale for Determination

The proposed project is not anticipated to adversely affect the yellow-billed cuckoo for the following reasons:

- If yellow-billed cuckoo(s) happen to be near the project area at time of commencement, construction activities may temporarily impact this species through noise, human activity, and operation of construction equipment.
- This noise and activity may result in a behavioral response in that the bird may move around the project area due to the disturbance of human activity.
- Due to the limited scope and footprint of the proposed action, any effects on yellow-billed cuckoos are considered discountable and insignificant.

- No yellow-billed cuckoos have been documented in or near the action area in over 20 years.

Spalding's Campion

Species Description

Spalding's campion is a perennial wildflower with a simple root crown. There are few to many flowers in a leafy, somewhat open inflorescence. The leaves have long hair and can be sticky. The tubular calyx is approximately 15 mm long and can also be sticky. Spalding's campion flowers July through August and the dried flower/fruitlet stock can be visible until the fall (MNHP 2020a).

Status and Distribution

Spalding's campion is ranked globally as G2 (imperiled), ranked in Montana as S2 (imperiled), and listed by the USFWS as threatened. The USFWS listed Spalding's campion as threatened under the ESA on October 10, 2001. A recovery plan was developed for Spalding's campion in 2007 by the USFWS.

Spalding's campion is a perennial forb restricted to the Palouse Prairie and the Pacific Northwest Bunchgrass grasslands in eastern Oregon and Washington, north-central Idaho, and northwestern Montana (USFWS 2007). Spalding's campion prefer mesic slopes, flats, or depressions in grassland, sagebrush-steppe, or open pine forest with vegetation dominated rough fescue, Idaho fescue, or native perennial grasses (USFWS 2007). This plant generally grows in deep loamy soils and in mesic, moist sites such as northern slopes and swales (USFWS 2007). Populations have been found on flat to 70 percent slopes and from approximately 1,200 to 5,300 feet in elevation (USFWS 2007).

In Montana, Spalding's campion is only known from a handful of locations in the northwest part of the state including the Tobacco Plains Area, Lost Trail National Wildlife Refuge, the Niarada Area, and on Wild Horse Island in Flathead Lake (MNHP 2020a). There was one documented historic plant identified near Columbia Falls.

Life History and Habitat Requirements

The life history of Spalding's campion is summarized in the USFWS 2007 recovery plan. This plant is a long-lived perennial that may live up to 20 years or more. Adult plants emerge in the spring (May) as either a rosette, stemmed plant or both. Stemmed plants may remain vegetative or become reproductive from July to August. Plants wither from September to October and overwinter as a root-stalk.

Reasons for Decline

Large-scale ecological change in the Palouse region over the past several decades include agricultural conversion, changes in fire frequency, and hydrologic alterations. All of these result

in the decline of Spalding's campion (Tisdale 1961). More than 98 percent of Palouse prairie habitat has been lost or modified (USFWS 2007).

Environmental Baseline/Occurrence in the Project Area

Spalding's campion has not been documented within the action area. Additionally, a plant survey occurred in July 2020, during the species' flowering period, and no Spalding's campion were found. Spalding's campion is known from a handful of sites in Flathead County, including a population on Wildhorse Island in Flathead Lake. The project area lacks undisturbed bunchgrass communities typical of Palouse ecosystems that support Spalding's campion. Soils in the project area are characteristic of river deposits, not a deep loamy soil that the plants prefer.

Actions/Impacts and Cumulative Effects

Direct Effects

Direct effects are impacts caused by specific actions that occur at the same time and place as the action and have immediate effects on the species or its habitat.

As the project area is in a riparian floodplain, key habitat components for the Spalding's campion do not occur in the affected project area. Construction activities will result in disturbed soils in the action area that will be reseeded after construction is complete. No Spalding's campion plants were identified during the plant survey in July 2020. Therefore, no direct effects on the Spalding's campion are expected.

Indirect Effects

Indirect effects are defined as those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur [50 CFR §402.02]. After removal of hard bank stabilization is completed, the riparian floodplain will be returned to natural river processes. No indirect effects to the Spalding's campion are anticipated.

The long-term permanent effect of the proposed project is to return the riparian floodplain back to the influence of the Flathead River. It is not expected that this have a negative impact on the Spalding's campion.

Cumulative Effects

As no significant direct or indirect adverse effects on the Spalding's campion are expected, no cumulative effects are anticipated.

Recommended Conservation and Coordination Measures

There are no recommended conservation and coordination measures identified for the Spalding's campion.

Determination of Effect

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

1. Are there any proposed/listed animal species and/or proposed/designated critical habitat in the proposed project area?
 NO.....No Effect
YES.....Go to 2

2. Will the proposed action(s) have “any effect whatsoever” on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
 NO.....No Effect
YES.....Go to 3

3. Does the proposed action(s) have potential to: result in “take” of any proposed/listed animal species?
NO.....Go to 4
 YES.....Likely to adversely affect

4. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
 YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project **may affect, but is not likely to adversely affect** the Spalding’s campion.

Rationale for Determination

The proposed project is not anticipated to affect the Spalding’s campion for the following reasons:

- No Spalding’s campion plants were identified in the action area during the plant survey in July 2020.
- The habitat within the action area is not likely to support Spalding’s campion based on their preferred habitat description.
- Due to the limited scope and footprint of the proposed action, any effects on Spalding’s campion plants are considered discountable and insignificant.

Grizzly bear

Species Description

The grizzly bear is the largest carnivore in Montana (Foresman 2012). The grizzly bear has a distinctive rounded face with small rounded ears and a prominent nose. The facial profile is concave, and there is a noticeable hump above the shoulders. The claws of adult grizzlies are approximately four inches in length and are slightly curved (MNHP 2020a). The color of grizzlies vary greatly, but in Montana the most prevalent coloration is medium to dark brown underfur, with brown legs, hump and underparts, and light to medium grizzling on the head, back, and a light patching behind the front legs (Foresman 2012). The size of grizzly bears is variable depending on the season, but the average adult is approximately 73 inches long, and the average weight for males is 441 pounds and 287 pounds for females. The grizzly bear is often confused with the more common black bear, but its distinct facial features, shoulder hump, and light colored tips of its fur make differentiation possible at close distances (Foresman 2012).

Status and Distribution

The grizzly bear is listed as threatened under the ESA with the USFWS, the US Forest Service, and the Bureau of Land Management. They are a State of Montana Species of Concern with a state rank of S2S3 and a global rank of G4 (MNHP 2020a).

Grizzly bears historically inhabited parts of Eurasia and most of central and western North America as far south as Mexico. In North America, the grizzly bear range currently extends from Alaska across the Yukon and Northwest Territory through British Columbia and Alberta to parts of the northwestern US. Populations of grizzly bears occurring in the U.S. inhabit six distinct regions of Washington, Idaho, Montana, and Wyoming (Foresman 2012). Most individuals that occur in Montana live in four of the six identified recovery zones: the Northern Continental Divide in northwest Montana; the Greater Yellowstone in southwestern Montana, northwestern Wyoming and eastern Idaho; the Bitterroot in western Montana and northern Idaho; and Cabinet-Yaak in northwest Montana.

The action area occurs within the grizzly bear Northern Continental Divide Ecosystem (NCDE) recovery zone. The NCDE is comprised of over 6 million acres of land that extends from the Canadian border to approximately Highway 200. It includes Glacier National Park, parts of Five National Forests (Flathead, Helena, Kootenai, Lewis and Clark, and Lolo), parts of the Blackfeet and Flathead Indian Reservations, as well as state and private land. A study published by Kendall et. al. in 2009 estimated 765 grizzly bears were present in the NCDE, with the greatest densities occurring in Glacier National Park. Additional population studies estimated the NCDE grizzly bear population was increasing at a rate of 2.3 percent a year. Studies by Costello et. al. supported a similar population growth increase and estimated the NCDE grizzly population in 2015 was 982 bears (Costello et. al. 2016). If the current grizzly bear population increase is similar to these studies, the estimated grizzly bear population in the NCDE in 2021 would be an estimated 1,125 bears.

Life History and Habitat Requirements

Grizzly bears exhibit a life span of approximately 25 years or more if in captivity (MNHP 2020a). Grizzly bears will breed every 2 to 3 years, with mating season occurring from May through July.

Grizzly bears are polygamous, and several males may fight over a female for breeding purposes. Anywhere from one to four cubs are born in the winter den (in Montana the average is 2.8) and weigh on average 1.1 pounds. The newborn cubs are helpless at birth and are nursed for the first 1.5 to 2.5 years, growing rapidly. The young will remain with their mother for the next two winters, and usually achieve adult size in 4 to 6 years (MNHP 2020a). Grizzly bears hibernate during denning in well-drained areas on slopes that receive heavy snowfall. The bears will stay up to 7 months in these dens, leaving the dens in March or April (Foresman 2012).

Grizzly bears are not truly migratory, but often exhibit discrete elevational movements from spring to fall following seasonal food source availability. Grizzly bears usually are present at lower elevations in the spring and at higher elevations in the late summer and into the winter, but this is highly dependent on the type of food sources available within a particular home range. Grizzly bears have large home ranges averaging 296.5 square miles for males and 48.23 square miles for females, documented in a study conducted in the Swan Mountains of Montana (MNHP 2020a).

Historically, the grizzly bear was primarily a plains species that occurred in high densities throughout most of eastern Montana, but are currently restricted to more remote, forested areas. In Montana, grizzly bears utilize a wide variety of habitat types depending on seasons and local characteristics. These habitats include: meadows, seeps, riparian zones, mixed shrub fields, closed timber, open timber, side-hill parks, snow chutes, and alpine slab-rock (MNHP 2020a). Movements of grizzly bears within their home range are primarily dependent on the availability of food sources. Food availability and human development/access dictate how grizzly bears use the landscape within their home range (Scarlett 2020). Den sites typically occur at higher elevations that have a slope of 28 to 35 degrees, with an aspect that maintains deep snow (Foresman 2012).

The NCDE is entirely contained within Montana. Approximately 78 percent of the recovery area is federally owned, 7 percent is tribally owned, 10 percent is privately owned, and 1 percent is water or owned by local government. Thirty percent of lands inside the NCDE are designated wilderness areas (MFWP 2013).

Grizzly bears are characterized as opportunistic and adaptable omnivores whose diet consists of greater than 50 percent vegetation. Grizzly bears have long claws for digging and exploiting vegetative food sources, an adaption that evolved as a result of their diet. Grizzly bears also feed on carrion, fish, large and small mammals, insects, fruit, grasses, bark, roots, mushrooms, and garbage. Whitebark pine seeds are an important dietary component for the grizzly bear (MNHP 2020a).

Reasons for Decline

The primary reason for the decline of the grizzly bear in the lower 48 states is the loss of suitable habitat, habitat fragmentation, and extermination of grizzly bears by humans (USFWS 1993). Mortality causes within the NCDE mainly stem from an increase in human activity. Activities such

as motorized vehicles, trains, natural resource extraction, ranching, and recreation can all have a negative impact on the grizzly bear.

Environmental Baseline/Occurrence in the Project Area

The Action Area is located within the Northern Continental Divide Recovery Zone but located just outside of the Grizzly Bear Distribution Area (Figure 3) according to the USFS geospatial data (USFS 2020).

The proposed project area is located adjacent to the Flathead River and with U.S. Highway 2 located on the south side of the river. The surrounding land to the north consists of property formerly used as an aluminum processing plant and an active railroad exists just to the north of the action area. The action area lies on an “island” of the Flathead River with few ingress or egress routes, all of which require crossing of the railroad or the Flathead River. Grizzly bears could potentially move through the surrounding mountainous area to the north between Glacier National Park and Flathead National Forest.

Actions/Impacts and Cumulative Effects

Direct Effects

Direct effects are impacts caused by specific actions that occur at the same time and place as the action and have immediate effects on the species or its habitat.

As the project area is a riparian floodplain, key habitat components for the grizzly bear do not occur in the affected project area. It is expected that grizzly bear could occur as rare transients in the project area as they move between more suitable habitat at higher elevations and appropriate forest composition. Noise from construction activities may elicit a behavioral response from the grizzly bear, in that if moving through the project area during construction, the animal may move around the project area due to increased levels of disturbance and human activity.

Indirect Effects

Indirect effects are defined as those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur [50 CFR §402.02]. After removal of hard bank stabilization is completed, the riparian floodplain will be returned to natural river processes.

The long-term permanent effect of the proposed project is to return the riparian floodplain back to the influence of the Flathead River. It is not expected that this have a negative impact on the grizzly bear.

Cumulative Effects

Cumulative effects are the combined impacts related to multiple activities or actions that occur over time. The Montana Department of Transportation (MDT) Future Project Schedule and the Flathead County Capital Improvements Plan for Fiscal Years 2021-2025 were referenced to

determine if any existing or upcoming projects have the potential to cause cumulative effects in the action area. No projects are proposed to occur in early 2021 near the action area that could cause cumulative impacts.

No additional projects are known to be planned in the foreseeable future. The authors of this report may not be aware of other action taken or proposed by Flathead County, other local entities, private developers, or private citizens in or near the project area.

Recommended Conservation and Coordination Measures

Conservation measures for the proposed actions are proposed to avoid and minimize potential impacts to grizzly bears, and should consist of monitoring of the project area for the presence of the species prior to and throughout the duration of construction activities. To summarize, conservation measures will include adherence to all local, state, and federal food storage orders and work in grizzly bear area mitigation measures, as enumerated in Section II (C) above.

Please refer to the Conservation Measures section above for a comprehensive list of all recommended conservation and coordination measures.

Determination of Effect

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

5. Are there any proposed/listed animal species and/or proposed/designated critical habitat in the proposed project area?
NO.....No Effect
YES.....Go to 2

6. Will the proposed action(s) have “any effect whatsoever” on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
NO.....No Effect
YES.....Go to 3

7. Does the proposed action(s) have potential to: result in “take” of any proposed/listed animal species?
NO.....Go to 4
YES.....Likely to adversely affect

8. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project **may affect, but is not likely to adversely affect** the grizzly bear.

Rationale for Determination

The proposed project is not anticipated to adversely affect the grizzly bear for the following reasons:

- If grizzly bear(s) happen to be near the project area at time of commencement, construction activities may temporarily impact this species through noise, human activity, and operation of construction equipment.
- This noise and activity may result in a behavioral response in that the bear may move around the project area due to the disturbance of human activity.
- The project will not impact key components of grizzly bear habitat and will not constitute a barrier to grizzly bear movement in the permanent long-term condition.
- Due to the limited scope and footprint of the proposed action, any effects on grizzly bear are considered discountable and insignificant.
- Construction in the project area is proposed during January-April when grizzly bears are still in a dormant stage and should not be traversing the area.

Canada Lynx

Species Description

Canada lynx is a medium-sized felid. Canada lynx are typically 22 pounds for the males and 17.5 pounds for the females with an average length of 36.5 inches for males and 35 inches for females. The color of the Canada lynx is yellowish-gray to grayish-brown with a white abdomen and throat. Their bodies are short and compact with long legs and a short tail with an entirely black tip. The back of the Canada lynx' ears are darker than the body with a whitish spot in the center with long black tufts off the end. Canada lynx have a ruff surrounding their face except directly under the snout (Foresman 2012). Canada lynx have large, round, heavily furred feet that are highly adapted for deep snow (MNHP 2020a).

The Canada lynx and the bobcat (*Lynx rufus*) are the only two medium-sized felids in Montana. From a distance the Canada lynx and the bobcat may be confused, but are discernible at closer range (Foresman 2012).

Status and Distribution

Canada lynx populations declined as a result of open season harvests with no bag limit in Montana and Idaho. The populations were so low that the harvest season for the Canada lynx closed in 1999 in Montana and 1997 in Idaho (USFWS 2000). As of April 24, 2000, the Canada lynx are listed by the USFWS as a threatened species, and are a Montana species of concern with a global ranking of G5 and a state rank of S3 (USFWS 2000, MNHP 2020a).

The Canada lynx is distributed across northern North America from western Alaska to eastern Newfoundland. The distribution and abundance of lynx are closely associated with those of their primary prey species, the snowshoe hare (*Lepus americanus*), and populations cycle with those of the snowshoe hare (MNHP 2020a). Both of these species are generally confined to northern forest environments.

Life History and Habitat Requirements

Canada lynx breed between February and April and give birth following an approximate 62- to 74-day gestation period (MNHP 2020a). The litter size ranges from one to five kittens, and the kittens typically stay with the mother from 9 to 11 months of age (Foresman 2012). Adult females will produce one litter every 1 to 2 years and the young stay with the mother until the next mating season (MNHP 2020a). Den sites tend to be in mature or old-growth stands with a high density of downed logs (MNHP 2020a). Large woody debris such as downed logs and windfalls provide for den sites with security and thermal cover for kittens (USFWS 2000).

Canada lynx are typically non-migratory animals. However, Canada lynx are known to move large distances when prey becomes scarce. The Canada lynx home range size varies by the animal's gender, abundance of prey, season, and the density of lynx populations (USFWS 2000). Documented home ranges can vary from 3 to 300 square miles. When snowshoe hares are scarce, Canada lynx may abandon home ranges and wander in search of prey.

Canada lynx typically occur in mesic coniferous boreal, sub-boreal, and western montane forests that are subject to snowy winters and support a prey base of snowshoe hare (Ruediger et al. 2000). Canada lynx are most likely to occur in areas that receive deep snow, for which the lynx is highly adapted (USFWS 2000). Snowshoe hares use forests with dense understories that provide cover from predators, forage, and protection during extreme weather conditions. Although earlier successional forest stages have greater understory structure and density, mature forests provide habitat for snowshoe hares when trees succumb to disease, fire, or insects. These events create large amounts of deadfall, and suitable habitat for snowshoe hares (USFWS 2000).

The Canada lynx concentrate their hunting activities in habitats where the snowshoe hare activity is high. Most of the Canada lynx occurrences in the Northern Rocky Mountains are in the 4,920- to 6,560-foot elevation range (USFWS 2000). Populations of Canada lynx in the western U.S. occupy habitat types consisting of logdepole pine, subalpine fir, Engelmann spruce, and quaking aspen. Other habitat types utilized by lynx include: Douglas fir, grand fir (*Abies grandis*), western larch (*Larix occidentalis*), and in extreme northwestern Montana and Idaho, western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) (Ruediger et al. 2000).

The Canada lynx forage primarily on snowshoe hares, which comprise approximately 35 to 97 percent of their diet (MNHP 2020a). Another important food source for lynx is the red squirrel (*Sciurus vulgaris*), which serves as a primary food source when snowshoe hare populations are reduced (MNHP 2020a). Other food sources for lynx include: flying squirrels (*Glaucomys* spp.), ground squirrels (*Spermophilus* spp.), porcupines (*Erethizon dorsatum*), beavers (*Castor*

canadensis), mice (*Onychomys* spp.), voles (*Microtus* spp.), shrews (*Sorex* spp.), blue grouse (*Dendragapus obscurus*), ruffed grouse (*Bonasa umbellus*), and ungulates as prey or carrion (Ruediger et al. 2000).

Lynx require contiguous habitat with ground and overhead cover for hunting and security (MNHP 2020a). Lynx usually do not cross and tend to avoid large created or natural openings (Ruediger et al. 2000). In winter months, Lynx prefer to forage in spruce-fir forests with high horizontal cover, abundant hares, deep snow, and large-diameter trees. During the summer months, lynx also prefer high-horizontal cover, however switch to a higher density of smaller diameter tree that provide shade for rest-sites during the heat of the day (Squires et al. 2006). Lynx require either adjacent or contiguous habitat corridors for denning and foraging. Appropriate travel corridors consist of closed canopy regions greater than 6.5 feet in height that are interposed between foraging and denning habitats (Foresman 2012).

Reasons for Decline

In all regions within the range of Canada lynx in the contiguous United States, timber harvest, recreation, and their related activities are the predominant land use affecting lynx habitat. The primary factor that caused the Canada lynx to be listed was the lack of guidance for conservation of Canada lynx and snowshoe hare habitat in USFS National Forest Land and Resource Plans and BLM Land Use Plans given that a substantial amount of Canada lynx habitat in the contiguous United States is federally managed. This lack of guidance allowed the continued degradation of Canada lynx habitat on Federal lands through timber management and other Federal activities. Causes of mortality in Montana include human activities (trapping or shooting), predation, starvation, and unknown causes (Squires et al. 2006).

Environmental Baseline/Occurrence in Project Area

The action area lacks the high-elevation mesic coniferous boreal, subboreal, and western forest habitat typically preferred by lynx in Montana. The nearest suitable habitat is located in the higher elevation mountainous areas surrounding the area.

Actions/Impacts and Cumulative Effects

Direct Effects

Direct effects are impacts caused by specific actions that occur at the same time and place as the action and have immediate effects on the species or its habitat.

As the project area is a riparian floodplain, key habitat components for Canada lynx do not occur in the affected project area. It is expected that Canada lynx could occur as rare transients in the project area as they move between more suitable habitat at higher elevations and appropriate forest composition. Noise from construction activities may elicit a behavioral response from Canada lynx, in that if moving through the project area during construction, the animal may move around the project area due to increased levels of disturbance and human activity.

Indirect Effects

Indirect effects are defined as those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur [50 CFR §402.02].

After removal of hard bank stabilization is completed, the riparian floodplain will be returned to natural river processes. No indirect effects to the lynx are expected to occur.

Cumulative Effects

As no significant direct or indirect adverse effects on the Canada lynx are expected, no cumulative effects are anticipated.

Recommended Conservation and Coordination Measures

No specific conservation measures are recommended at this time with respect to the Canada lynx. While no specific conservation measures have been identified for the Canada lynx or the wolverine, it is thought that the grizzly bear conservation measures will also play a role in mitigating potential impacts to the Canada lynx and the wolverine.

Determination of Effect

Dichotomous Key for Making ESA Determination of Effect (USFWS 1998b)

1. Are there any proposed/listed animal species and/or proposed/designated critical habitat in the proposed project area?
NO.....No Effect
YES.....Go to 2
2. Will the proposed action(s) have “any effect whatsoever” on the species; designated or proposed critical habitat; seasonally or permanently occupied habitat; or unoccupied habitat necessary for the species survival or recovery?
NO.....No Effect
YES.....Go to 3
3. Does the proposed action(s) have potential to: result in “take” of any proposed/listed animal species?
NO.....Go to 4
YES.....Likely to adversely affect
4. Does the proposed action(s) have potential to cause an adverse effect to any proposed/listed animal species habitat, such as: adverse effects to critical habitat constituent elements or segments; impairing the suitability of seasonally or permanently occupied habitat; or impairing or degrading unoccupied habitat necessary for the survival or recovery of the species locally?
NO.....Not likely to adversely affect
YES.....Likely to adversely affect

Based on the above information, implementation of recommended conservation measures, analyses of existing conditions and habitat requirements, and the Dichotomous Key for Determination of Effect, it is determined that implementation of the proposed project **may affect, but is not likely to adversely affect** the Canada lynx.

Rationale for Determination

The proposed project is not anticipated to adversely affect the Canada lynx for the following reasons:

- No suitable habitat exists in the action area.
- Canada lynx critical habitat does not exist within the action area.
- The proposed project would not result in the alteration, degradation, or removal of potential Canada lynx habitat.
- Construction activities would result in a temporary increase in noise levels; however, the short-term noise increase is not anticipated to reach levels that would harm Canada lynx.
- Construction activities may result a behavioral response from a Canada lynx, in that the animal may move around the project area due to the disturbance and human activity.
- Due to the limited scope and footprint of the proposed action, any effects on Canada lynx are considered discountable and insignificant.

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VIII. List of Contacts Made and Preparers

Agencies Contacted

Montana Department of Fish, Wildlife, and Parks
490 North Meridian Rd
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Helena, MT 59620-1800

U.S. Fish and Wildlife Service
Montana Ecological Services Field Office
Attn: Jodi Bush, Field Supervisor
585 Shepard Way
Helena, MT 59601

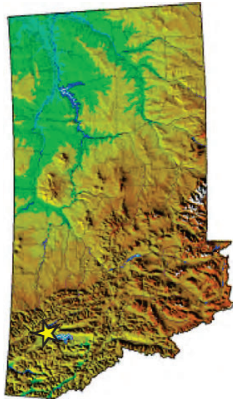
U.S. Fish and Wildlife Service
Additional Email and Phone Correspondence:
 Jacob Martin, Assistant Field Supervisor
 Ben Conard, Deputy Office Supervisor
 Kevin Aceituno, Fish and Wildlife Biologist

BA Preparers

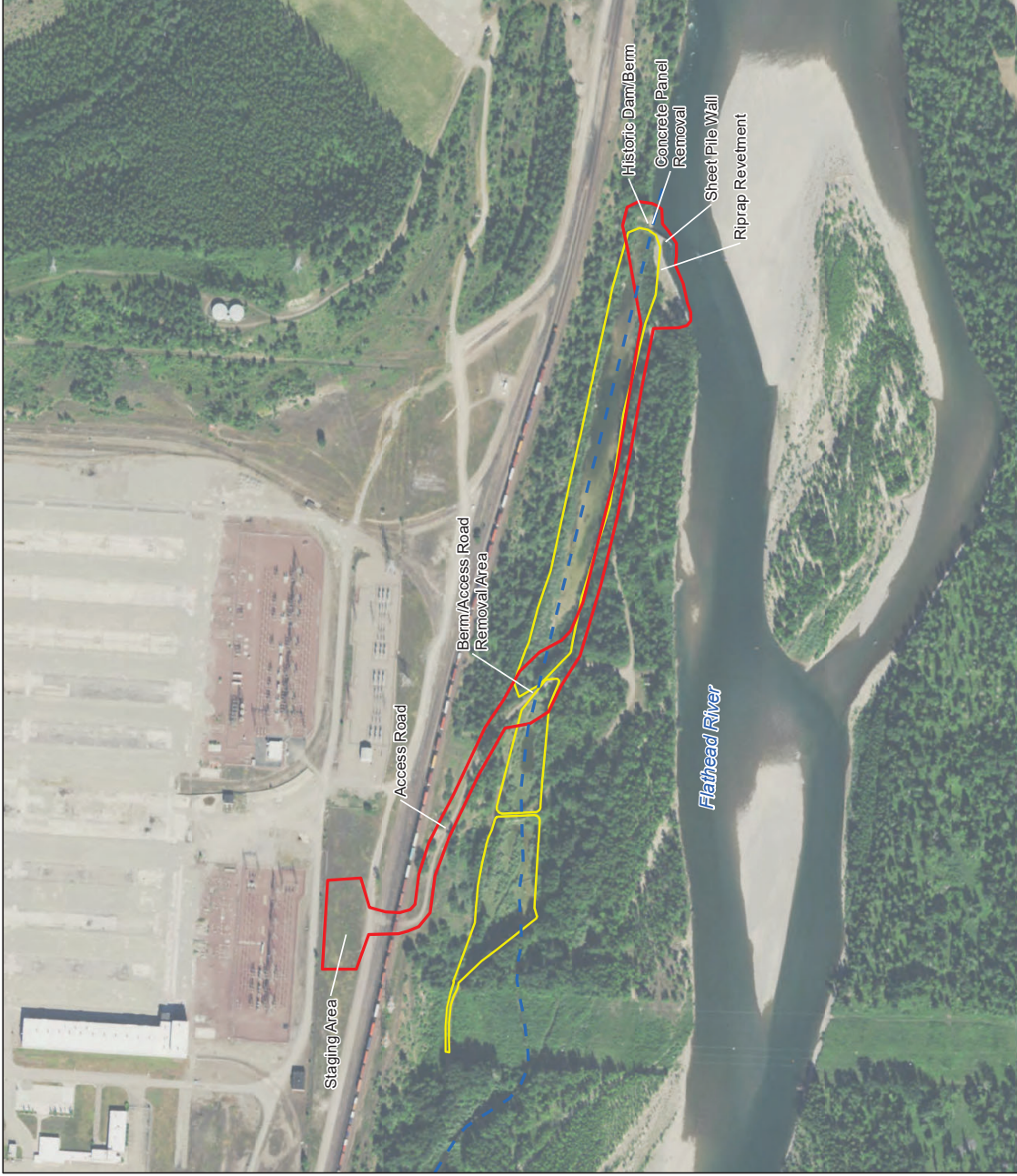
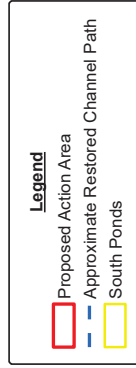
Christine Percy, Environmental Scientist
Morrison-Maierle, Inc.

Breanne Carr, Environmental Scientist
Morrison-Maierle, Inc.

APPENDIX A – FIGURES



SOUTH PONDS REMEDIATION PROJECT PHASE II **COLUMBIA FALLS ALUMINUM COMPANY, LLC** **FLATHEAD COUNTY, MONTANA**



Morrison
Maierle
 engineers, surveyors, planners, scientists
 125 Southwood Loop
 Kalispell, MT 59901
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 APPR. BY: LDC
 DATE: 1/22/2020

SOUTH PONDS REMEDIATION PROJECT PHASE II
 FLATHEAD CO MT
 PROJECT NO.
 5402.002.03
 FIGURE NUMBER
FIG. 1



Legend

- Proposed Action Area
- Bull Trout Critical Habitat
- Lynx Critical Habitat



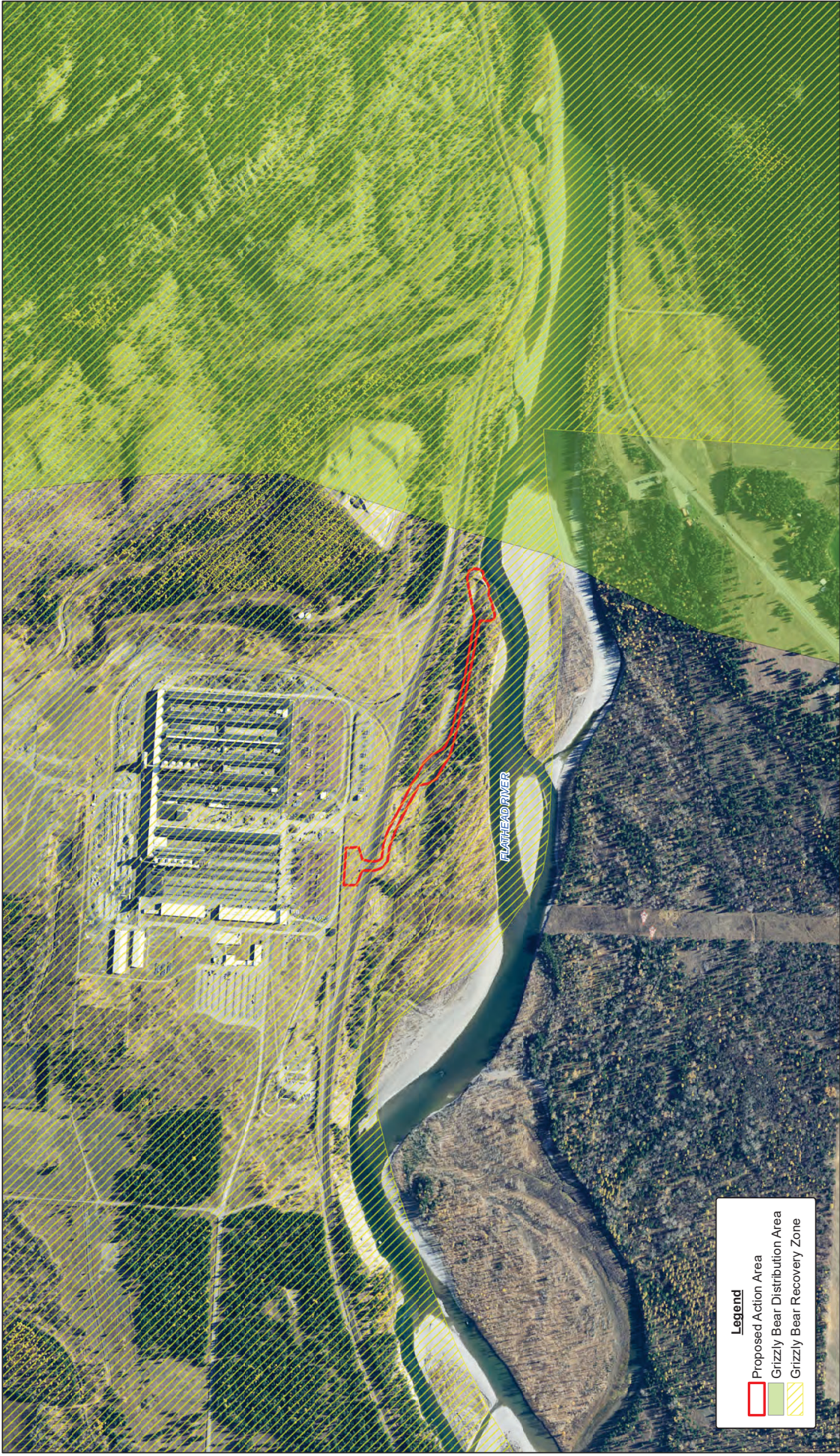
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APPR. BY: LDC
DATE: 1/22/2020

SOUTH PONDS REMEDIATION PROJECT PHASE II		MT	PROJECT NO. 5402.002.03
FLATHEAD CO			FIGURE NUMBER FIG. 2
T&E CRITICAL HABITAT MAP			

\\morrisonmaierle\Projects\5402 Columbia Falls Aluminum Company\5402.002.03\5402.002.03 Critical Habitat Map.mxd



APPENDIX B – AGENCY CORRESPONDENCE AND DATA FILES



United States Department of the Interior

Fish and Wildlife Service

Ecological Services
Montana Field Office
585 Shepard Way, Suite 1
Helena, Montana 59601-6287
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ENDANGERED, THREATENED, PROPOSED AND CANDIDATE SPECIES MONTANA COUNTIES* Endangered Species Act

June 10, 2020

C = Candidate

LT = Listed Threatened

LE = Listed Endangered

P = Proposed

PCH = Proposed Critical Habitat

CH = Designated Critical Habitat

XN = Experimental non-essential population

*Note: Generally, this list identifies the counties where one would reasonably expect the species to occur, not necessarily every county where the species is listed

County/Scientific Name	Common Name	Status
BEAVERHEAD		
<i>Spiranthes diluvialis</i>	Ute Ladies' Tresses	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
BIG HORN		
<i>Mustela nigripes</i>	Black-footed Ferret	LE
BLAINE		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Mustela nigripes</i>	Black-footed Ferret	LE
<i>Charadrius melodus</i>	Piping Plover	LT
BROADWATER		
<i>Spiranthes diluvialis</i>	Ute Ladies' Tresses	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
CARBON		
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Zapada glaciar</i>	Western Glacier Stonefly	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C

County/Scientific Name	Common Name	Status
CARTER		
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
CASCADE		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
CHOUTEAU		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
CUSTER		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
DANIELS		
<i>Grus americana</i>	Whooping Crane	LE
<i>Charadrius melodus</i>	Piping Plover	LT
DAWSON		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
DEER LODGE		
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
FALLON		
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
<i>Charadrius melodus</i>	Piping Plover	LT
FERGUS		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C

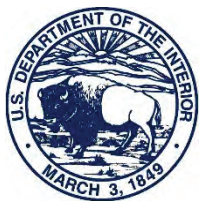
County/Scientific Name	Common Name	Status
FLATHEAD		
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Silene spaldingii</i>	Spalding's Campion	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Coccyzus americanus</i>	Yellow-billed cuckoo (western pop.)	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Lednia tumana</i>	Meltwater Lednian Stonefly	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
GALLATIN		
<i>Spiranthes diluvialis</i>	Ute Ladies' Tresses	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
GARFIELD		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
GLACIER		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Lednia tumana</i>	Meltwater Lednian Stonefly	LT
<i>Zapada glacier</i>	Western Glacier Stonefly	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
GOLDEN VALLEY		
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
GRANITE		
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
HILL		
JEFFERSON		
<i>Spiranthes diluvialis</i>	Ute Ladies' Tresses	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
JUDITH BASIN		
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C

County/Scientific Name	Common Name	Status
LAKE		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Howellia aquatilis</i>	Water Howellia	LT
<i>Silene spaldingii</i>	Spalding's Campion	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Coccyzus americanus</i>	Yellow-billed cuckoo (western pop.)	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Lednia tumana</i>	Meltwater Lednian Stonefly	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
LEWIS AND CLARK		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
LIBERTY		
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
LINCOLN		
<i>Acipenser transmontanus</i>	White Sturgeon (Kootenai River Pop.)	LE
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Silene spaldingii</i>	Spalding's Campion	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
MADISON		
<i>Spiranthes diluvialis</i>	Ute Ladies' Tresses	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
McCONE		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
MEAGHER		
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
MINERAL		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C

County/Scientific Name	Common Name	Status
MISSOULA		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Howellia aquatilis</i>	Water Howellia	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Coccyzus americanus</i>	Yellow-billed cuckoo (western pop.)	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
MUSSELSHELL		
PARK		
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
PETROLEUM		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Calidris canutus rufa</i>	Red Knot	LT
PHILLIPS		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Mustela nigripes</i>	Black-footed Ferret	LE, XN
<i>Grus americana</i>	Whooping Crane	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Calidris canutus rufa</i>	Red Knot	LT
PONDERA		
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
POWDER RIVER		
<i>Grus americana</i>	Whooping Crane	LE
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
POWELL		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
PRAIRIE		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
<i>Charadrius melodus</i>	Piping Plover	LT

County/Scientific Name	Common Name	Status
RAVALLI		
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Coccyzus americanus</i>	Yellow-billed cuckoo (western pop.)	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
RICHLAND		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
ROOSEVELT		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
ROSEBUD		
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Grus americana</i>	Whooping Crane	LE
SANDERS		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Silene spaldingii</i>	Spalding's Campion	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
SHERIDAN		
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Grus americana</i>	Whooping Crane	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Calidris canutus rufa</i>	Red Knot	LT
SILVER BOW		
<i>Salvelinus confluentus</i>	Bull Trout	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
STILLWATER		
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C

County/Scientific Name	Common Name	Status
SWEET GRASS		
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
TETON		
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Charadrius melodus</i>	Piping Plover	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
TOOLE		
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C
TREASURE		
<i>No listings at this time</i>		
VALLEY		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Charadrius melodus</i>	Piping Plover	LT, CH
<i>Calidris canutus rufa</i>	Red Knot	LT
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
WHEATLAND		
<i>Lynx canadensis</i>	Canada Lynx	LT
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Pinus albicaulis</i>	Whitebark Pine	C
WIBAUX		
<i>Scaphirhynchus albus</i>	Pallid Sturgeon	LE
<i>Sterna antillarum athalassos</i>	Interior Least Tern	LE
<i>Grus americana</i>	Whooping Crane	LE
<i>Myotis septentrionalis</i>	Northern Long-eared Bat	LT
<i>Charadrius melodus</i>	Piping Plover	LT
YELLOWSTONE		
<i>Grus americana</i>	Whooping Crane	LE
<i>Calidris canutus rufa</i>	Red Knot	LT



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Montana Ecological Services Field Office
585 Shepard Way, Suite 1
Helena, Montana 59601-6287



In Reply Refer to:
FWS/IR05/IR07
06E11000-2020-TA-0367

April 30, 2020

Christine Pearcy
Morrison Maierle
2880 Technology Boulevard West
P.O. Box 1113
Bozeman, Montana 59771

Dear Ms. Pearcy:

Thank you for your letter, dated March 2, 2020, and received March 5, 2020, requesting U.S. Fish and Wildlife Service (Service) comment on an early action remediation project at the Anaconda Aluminum Company Columbia Falls Reduction Plant (Project). The Project is proposed by the Columbia Falls Aluminum Company, LLC (CFAC), under supervision of the U.S. Environmental Protection Agency (EPA). The Project would include: 1) a remediation phase in which sediments contaminated with metals would be removed from three percolation ponds within the floodplain of the Flathead River; and, 2) a restoration phase in which fill, bank stabilization, and other infrastructure would be removed from the floodplain. The Project site is located on the north bank of the Flathead River, approximately 2 miles northeast of Columbia Falls, in Flathead County, Montana.

Our comments are prepared under the authority of, and in accordance with, the provisions of the Endangered Species Act (ESA; 16 U.S.C. 1531 et. seq.), Migratory Bird Treaty Act (MBTA; 16 U.S.C. 703 et seq.), and Bald and Golden Eagle Protection Act (BGEPA; 16 U.S.C. 668-668d, 54 Stat. 250). We offer the following comments for your consideration.

Threatened and Endangered Species

The current list of candidate, proposed, threatened or endangered species, and designated critical habitat occurring in Flathead County, Montana is as follows:

INTERIOR REGION 5 MISSOURI BASIN

KANSAS, MONTANA*, NEBRASKA, NORTH DAKOTA,
SOUTH DAKOTA

*PARTIAL

INTERIOR REGION 7 UPPER COLORADO RIVER BASIN

COLORADO, NEW MEXICO, UTAH, WYOMING

<i>Scientific Name</i>	<i>Common Name</i>	<i>Status*</i>
<i>Salvelinus confluentus</i>	Bull Trout	LT, CH
<i>Ursus arctos horribilis</i>	Grizzly Bear	LT
<i>Silene spaldingii</i>	Spalding's Campion	LT
<i>Lynx canadensis</i>	Canada Lynx	LT, CH
<i>Coccyzus americanus</i>	Yellow-billed cuckoo (western pop.)	LT
<i>Gulo gulo luscus</i>	Wolverine	P
<i>Lednia tumana</i>	Meltwater Lednian Stonefly	LT
<i>Pinus albicaulis</i>	Whitebark Pine	C

*LE=Listed as Endangered, LT=Listed Threatened, P=Proposed, C=Candidate, CH=Critical Habitat

Additional information may be obtained using the Service's Information for Planning and Consultation (IPaC) project-planning tool, at <https://ecos.fws.gov/ipac/>.

You indicated that (pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act) the Project does not require Federal permits. However, you also indicated that the EPA has required CFAC to consult with relevant Federal agencies and comply with appropriate standards. On April 29, 2020, Jacob Martin, of my staff, discussed the Project with you and separately with Mike Cirian of the EPA. It is our understanding from those conversations that you will be leading consultation with us on behalf of the EPA and CFAC.

Under the ESA, a Federal agency that authorizes, funds, or carries out a proposed action is required to evaluate the action with respect to effects to threatened or endangered species and critical habitat. If the Federal agency, or its delegated agent, determines that the action "may affect" listed species and/or designated critical habitat, the Federal agency is required to enter into section 7 consultation with the Service. It is the responsibility of the Federal agency to ensure that its actions are in compliance with the ESA. Further technical assistance can be provided if you have additional questions regarding project impacts to listed species, or future ESA responsibilities.

Whitebark pine and meltwater lednian stonefly are not expected to occur within the Project area.

The Flathead River is designated critical habitat and an important spawning migration corridor for bull trout and we recommend the following conservation measures (adapted from Service 2020):

- In rivers and streams, foraging, migrating, and overwintering habitat in-channel disturbance should be limited to the period between July 1 and September 30; spawning and rearing habitat in-channel disturbance should be limited to the period between May 1 and August 31.
- All work should be performed in the dry when possible. Any work in rivers and streams should be completed by working from the top of the bank or the work areas should be isolated from flowing or open water using cofferdams, silt curtains, sandbags or other approved means to keep suspended sediment from entering flowing or open water, unless not isolating the area and working in the channel would result in less habitat disturbance.

- Site clearing, staging areas, access routes, and stockpile areas should be conducted and located in a manner that minimizes overall disturbance, minimizes disturbance to riparian vegetation, and precludes erosion into stream channels.
- Sediment barriers should be placed around potentially disturbed sites to prevent sediment from entering a stream directly or indirectly, including by way of roads and ditches.
- A supply of erosion control materials (e.g. silt fence and straw bales) should be kept on hand to respond to sediment emergencies. Sterile straw or certified “weed free” straw should be used to prevent introduction of noxious weeds.
- All equipment fueling, maintenance, and staging areas should be located in non-wetland areas landward of the ordinary high water mark of the waterbody unless no other option is available. When no option is available, these activities should occur at the greatest distance possible perpendicular from any water body to adequately avoid and minimize potential impacts.
- All equipment used for in-channel work should be cleaned of external oil, grease, dirt, mud, plant material or other debris, which may harbor invasive plants or animals; and leaks repaired; prior to arriving at the project site. All equipment should be inspected before unloading at site. Any leaks or accumulations of grease should be corrected before entering streams or areas that drain directly into streams or wetlands.

Spalding's campion has been documented within Flathead County to the south of the Project area near Flathead Lake (Service 2007, page 23). This species occurs with *Festuca sp.* in grassland, sagebrush-steppe, and open pine forest habitats (Service 2007, page 25). From the information provided in your letter it appears that the Project would primarily affect riparian habitats within the Flathead River floodplain, but if any suitable habitat for Spalding's campion would be affected, then we recommend surveys for the species and avoidance (if possible) of occupied areas.

In the western United States, yellow-billed cuckoos breed in large blocks of riparian habitat and dense understory vegetation appears to be an important factor in nest-site selection (66 FR 38611). The species has been observed in Flathead County, near Whitefish. If suitable habitat is present within the Project area, we recommend avoiding impacts to that habitat, if possible. If impacts to suitable habitat cannot be avoided, then we recommend surveys for the species and avoidance of occupied habitat during the breeding season. Additional information is available in the survey protocol for the species:

https://www.fws.gov/southwest/es/Documents/R2ES/YBCU_SurveyProtocol_FINAL_DRAFT_22Apr2015.pdf

Grizzly bears, Canada lynx, and wolverines are wide-ranging species and could occasionally move through the general Project area, but are not expected to occur commonly in the immediate Project vicinity.

The Service recommends implementation of the following (or similar) conservation measures to manage potential bear attractants and reduce the risk of human-grizzly bear conflicts related to this project:

- Promptly clean up any project related spills, litter, garbage, debris, etc.
- Store all food, food related items, petroleum products, antifreeze, garbage, personal hygiene items, and other attractants inside a closed, hard-sided vehicle or commercially manufactured bear resistant container.
- Remove garbage from the project site daily and dispose of it in accordance with all applicable regulations.
- Notify the Project Manager of any animal carcasses found in the area.
- Notify the Project Manager of any bears observed in the vicinity of the project.

Migratory Birds

The MBTA prohibits the purposeful taking, killing, possession, and transportation, (among other actions) of migratory birds, their eggs, parts, and nests, except when specifically permitted. If work is proposed to take place in migratory bird habitats that may result in take of migratory birds, their eggs, or active nests, the Service recommends that the project proponent take all practicable measures to avoid and minimize take, such as maintaining adequate buffers, to protect the birds until the young have fledged. Active nests may not be purposefully removed unless specifically permitted. The Service has developed, and continues to revise and develop, general and industry-specific conservation measures for avoiding and minimizing impacts to birds (<https://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php>). We recommend that the proposed project consider and incorporate these measures into project design, construction, and documentation as appropriate.

Bald and Golden Eagles

Breeding and non-breeding bald and golden eagle activity has been documented in the general project area along the Flathead River. Information held by the Montana Natural Heritage Program indicates that a bald eagle nest was documented in the immediate Project area in 2010 and that a pair of golden eagles were observed during breeding season within 1 mile of the Project area in 2009. We are not aware of the current nesting status of either species within the Project area, and suggest that you follow up with Montana Fish, Wildlife and Parks to determine if nest(s) are still present and active. If there are active eagle nests present within 0.5 mile of the project during planned construction activities, we recommend that the proponent complies with applicable recommended nesting season construction restrictions (February 1–August 15 or until young have fledged) at appropriate nest distance buffers specified in the *2010 Montana Bald Eagle Management Guidelines: An Addendum to Montana Bald Eagle Management Plan (1994)* in order to avoid/minimize the risk for eagle take during construction. The cited Montana guidelines provide a variety of different recommended construction buffers during the nesting season, depending on the type of construction activities proposed and site-specific nest screening (visibility) considerations.

We recognize that observing seasonal avoidance periods for both eagles and bull trout could be very restrictive of the Project work period; we are available to provide further technical assistance as you gather current species information and continue Project planning.

The bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) are protected from a variety of harmful actions via take prohibitions in both the MBTA¹ (16 U.S.C. 703-712) and the BGEPA. The BGEPA, enacted in 1940 and amended several times, prohibits take of bald eagles and golden eagles, including their parts, nests, young or eggs, except where otherwise permitted pursuant to Federal regulations. Incidental take of eagles from actions such as electrocutions from power lines or wind turbine strikes are prohibited unless specifically authorized via an eagle incidental take permit from the Service. BGEPA provides penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The BGEPA defines take to include the following actions: "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The Service expanded this definition by regulation to include the term "destroy" to ensure that "take" also encompasses destruction of eagle nests. Also the Service defined the term disturb which means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

The Service has developed guidance for the public regarding means to avoid take of bald and golden eagles:

- The 2007 National Bald Eagle Management Guidelines serve to advise landowners, land managers, and others who share public and private lands with bald eagles when and under what circumstances the protective provisions of BGEPA may apply. They provide conservation recommendations to help people avoid and/or minimize such impacts to bald eagles, particularly where they may constitute "disturbance," which is prohibited by the BGEPA.

<https://www.fws.gov/northeast/ecologicalservices/pdf/NationalBaldEagleManagementGuidelines.pdf>

¹ On December 22, 2017, the Department of the Interior's (DOI) Office of the Solicitor Memorandum M-37050 titled The Migratory Bird Treaty Act Does Not Prohibit Incidental Take (<https://www.doi.gov/sites/doi.gov/files/uploads/m-37050.pdf>) concludes that the MBTA's prohibitions on pursuing, hunting, taking, capturing, killing, or attempting to do the same apply only to affirmative actions that have as their purpose the taking or killing of migratory birds, their nests, or their eggs. The MBTA list of protected species includes bald and golden eagles, and the law has been an effective tool to pursue incidental take cases involving eagles. However, the primary law protecting eagles is the Bald and Golden Eagle Protection Act (BGEPA) (16 U.S. Code § 668), since the bald eagle was delisted under the Endangered Species Act in 2007. Memorandum-37050 does not affect the ability of the Service to refer entities for prosecution that have violated the take prohibitions for eagles established by the BGEPA.

- The 2013 Eagle Conservation Plan Guidance, Module 1- Land-based Wind Energy, Version 2 is specific to wind energy development and provides in-depth guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities. Development of an Eagle Conservation Plan per these guidelines may serve as the basis for applying for an eagle incidental take permit for wind energy facilities. Applications for such eagle incidental take permits must include an Eagle Conservation Plan.

<https://www.fws.gov/migratorybirds/pdf/management/eagleconservationplanguidance.pdf>

The Service also has promulgated new permit regulations under BGEPA:

- New eagle permit regulations, as allowed under BGEPA, were promulgated by the Service in 2009 (74 FR 46836; Sept. 11, 2009) and revised in 2016 (81 FR 91494; Dec. 16, 2016). The regulations authorize the limited take of bald and golden eagles where the take to be authorized is associated with otherwise lawful activities. These regulations also establish permit provisions for intentional take of eagle nests where necessary to ensure public health and safety, in addition to other limited circumstances. The revisions in 2016 included changes to permit issuance criteria and duration, definitions, compensatory mitigation standards, criteria for eagle nest removal permits, permit application requirements, and fees in order to clarify, improve implementation and increase compliance while still protecting eagles.

<https://www.gpo.gov/fdsys/pkg/FR-2016-12-16/pdf/2016-29908.pdf>

The Service's Office of Law Enforcement carries out its mission to protect eagles through investigations and enforcement, as well as by fostering relationships with individuals, companies, industries and agencies that have taken effective steps to avoid take, including incidental take of these species, and encouraging others to implement measures to avoid take. The Office of Law Enforcement focuses its resources on investigating individuals and entities that take eagles without identifying and implementing all reasonable, prudent and effective measures to avoid that take. Those individuals and entities are encouraged to work closely with Service biologists to identify available protective measures, and to implement those measures during all activities or situations where their action or inaction may result in the take of an eagle(s).

In addition to the above guidance, the 2010 Montana Bald Eagle Management Guidelines: An Addendum to Montana Bald Eagle Management Plan (1994) developed by Montana Fish, Wildlife and Parks (FWP) also provides guidance for avoiding and minimizing the risk for bald eagle take (<http://fwp.mt.gov/fwpDoc.html?id=44181>).

Additional Comments

If wetlands will be affected by the project, the Service recommends keeping wetland disturbances to the minimum extent and duration possible, with as much occurring “in the dry” as possible. This would reduce impacts to aquatic species relative to disturbance and sediment inputs. We also recommend that appropriate erosion and sediment control efforts and measures be implemented during and following construction to avoid introducing sediments or other contaminants to adjacent waters.

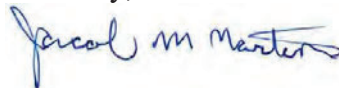
In addition to coordination with the Service, we recommend coordination with FWP and the Montana Natural Heritage Program. These agencies may be able to provide updated, site-specific information regarding fish, wildlife, and sensitive plant resources occurring in the proposed project area. Contact information for these two agencies is below:

Montana Fish, Wildlife and Parks
1420 East Sixth Avenue
P.O. Box 200701
Helena, Montana 59620-0701
Phone: (406) 444-2535

Montana Natural Heritage Program
1515 East 6th Avenue, Box 201800
Helena, Montana 59620-1800
Phone: (406) 444-5354

Thank you for the opportunity to comment on the proposed project. The Service appreciates your efforts to incorporate fish and wildlife resource concerns into your project planning. If you have further questions related to this letter, please contact Jacob Martin at 406-449-5225, extension 215.

Sincerely,

A handwritten signature in blue ink that reads "Jacob Martin".

for Jodi L. Bush
Office Supervisor

Literature Cited:

U.S. Fish and Wildlife Service. 2007. Recovery plan for *Silene spaldingii* (Spalding's catchfly). September 6, 2007. 166 pp. plus appendices.

U.S. Fish and Wildlife Service. 2020. Biological opinion for U. S. Army Corps of Engineers standard local operating procedures for endangered species (SLOPES) for selected nationwide permit activities affecting bull trout and Kootenai River white sturgeon in western Montana and northern Idaho. February 18, 2020. 67 pp. plus appendices.

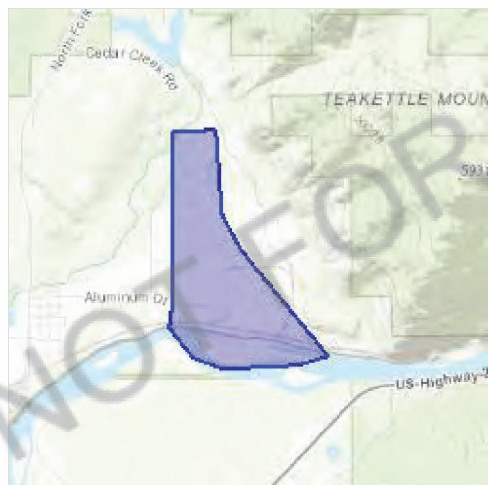
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Flathead County, Montana



Local office

Montana Ecological Services Field Office

☎ (406) 449-5225

📠 (406) 449-5339

585 Shephard Way, Suite 1
Helena, MT 59601-6287

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species¹ and their critical habitats are managed by the [Ecological Services Program](#) of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries²).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact [NOAA Fisheries](#) for [species under their jurisdiction](#).

1. Species listed under the [Endangered Species Act](#) are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the [listing status page](#) for more information.
2. [NOAA Fisheries](#), also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME

STATUS

Canada Lynx *Lynx canadensis*

Threatened

There is **final** critical habitat for this species. Your location is outside the critical habitat.

<https://ecos.fws.gov/ecp/species/3652>

Grizzly Bear *Ursus arctos horribilis*

Threatened

There is **proposed** critical habitat for this species. The location of the critical habitat is not available.

<https://ecos.fws.gov/ecp/species/7642>

North American Wolverine *Gulo gulo luscus*

Proposed Threatened

No critical habitat has been designated for this species.

<https://ecos.fws.gov/ecp/species/5123>

Birds

NAME

STATUS

Yellow-billed Cuckoo *Coccyzus americanus*

Threatened

There is **proposed** critical habitat for this species. Your location is outside the critical habitat.

<https://ecos.fws.gov/ecp/species/3911>

Fishes

NAME

STATUS

Bull Trout *Salvelinus confluentus*

Threatened

There is **final** critical habitat for this species. Your location overlaps the critical habitat.

<https://ecos.fws.gov/ecp/species/8212>

Flowering Plants

NAME

STATUS

Spalding's Catchfly *Silene spaldingii*

Threatened

There is **proposed** critical habitat for this species. The location of the critical habitat is not available.

<https://ecos.fws.gov/ecp/species/3681>

Conifers and Cycads

NAME

STATUS

Whitebark Pine *Pinus albicaulis*

Candidate

No critical habitat has been designated for this species.

<https://ecos.fws.gov/ecp/species/1748>

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Bull Trout <i>Salvelinus confluentus</i> https://ecos.fws.gov/ecp/species/8212#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act¹ and the Bald and Golden Eagle Protection Act².

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described [below](#).

1. The [Migratory Birds Treaty Act](#) of 1918.
2. The [Bald and Golden Eagle Protection Act](#) of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern <http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php>
- Measures for avoiding and minimizing impacts to birds
<http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php>
- Nationwide conservation measures for birds
<http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf>

The birds listed below are birds of particular concern either because they occur on the [USFWS Birds of Conservation Concern](#) (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ [below](#). This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the [E-bird data mapping tool](#) (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found [below](#).

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME

BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)

Bald Eagle *Haliaeetus leucocephalus*

Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

<https://ecos.fws.gov/ecp/species/1626>

Cassin's Finch *Carpodacus cassinii*

Breeds May 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

<https://ecos.fws.gov/ecp/species/9462>

Golden Eagle *Aquila chrysaetos*

Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

<https://ecos.fws.gov/ecp/species/1680>

Rufous Hummingbird *selasphorus rufus*

Breeds Apr 15 to Jul 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

<https://ecos.fws.gov/ecp/species/8002>

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ

"Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is $0.25/0.25 = 1$; at week 20 it is $0.05/0.25 = 0.2$.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

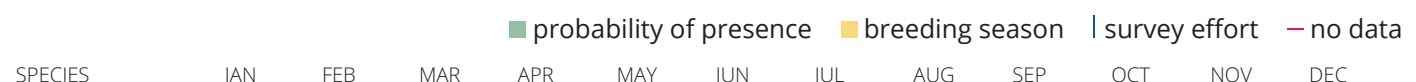
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (—)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

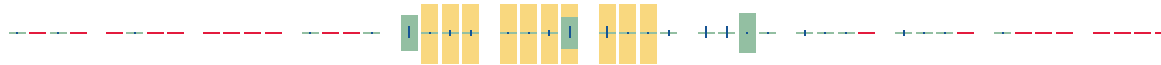
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Bald Eagle
Non-BCC Vulnerable
(This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Cassin's Finch
BCC Rangelwide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Golden Eagle
Non-BCC Vulnerable
(This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



Rufous Hummingbird
BCC Rangelwide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

[Nationwide Conservation Measures](#) describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. [Additional measures](#) and/or [permits](#) may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS [Birds of Conservation Concern \(BCC\)](#) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the [Avian Knowledge Network \(AKN\)](#). The AKN data is based on a growing collection of [survey, banding, and citizen science datasets](#) and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project

intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle ([Eagle Act](#) requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the [AKN Phenology Tool](#).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the [Avian Knowledge Network \(AKN\)](#). This data is derived from a growing collection of [survey, banding, and citizen science datasets](#).

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: [The Cornell Lab of Ornithology All About Birds Bird Guide](#), or (if you are unsuccessful in locating the bird of interest there), the [Cornell Lab of Ornithology Neotropical Birds guide](#). If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are [Birds of Conservation Concern](#) (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the [Eagle Act](#) requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the [Northeast Ocean Data Portal](#). The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the [NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf](#) project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the [Diving Bird Study](#) and the [nanotag studies](#) or contact [Caleb Spiegel](#) or [Pam Loring](#).

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to [obtain a permit](#) to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the [National Wildlife Refuge](#) system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to [NWI wetlands](#) and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local [U.S. Army Corps of Engineers District](#).

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER POND

[Palustrine](#)

RIVERINE

[Riverine](#)

A full description for each wetland code can be found at the [National Wetlands Inventory website](#)

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tubercid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix B

to the

UNILATERAL ADMINISTRATIVE ORDER FOR REMEDIAL DESIGN STATEMENT OF WORK

**Anaconda Aluminum Co. Columbia Falls Reduction Plant Superfund Site
a/k/a Columbia Falls Aluminum Company Site
Columbia Falls, Montana**



Pre-Design Investigation Work Plan

CFAC Facility
2000 Aluminum Drive
Columbia Falls, Montana

June 27, 2025

Prepared for:

Columbia Falls Aluminum Company LLC
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Flathead County
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Table of Contents

Acronym List	iii
1. Introduction	1
2. Site Background	2
3. Pre-Design Investigation Activities	4
3.1 Slurry Wall Geotechnical Pre-Design Study	4
3.2 WSSP Landfill Settlement Study	5
3.3 Groundwater Plume Sampling	5
3.4 Slurry Wall Area Modeling	7
3.5 Asbestos Landfill Cover Evaluation	8
3.6 Soil DU3 Further Delineation	9
3.7 NPP DU4 Sediment Evaluation	12
3.7.1 NPP DU4 Background	12
3.7.2 NPP DU4 Initial Material Preparation and Sampling	13
3.7.3 NPP DU4 Material Handling Field Pilot Test	13
3.8 Cedar Creek Reservoir Overflow Ditch Lining Information	14
3.9 Industrial Landfill Geotechnical Investigation	14
4. References	16

Figures

1. Site Location
2. Site Features
3. Concentrations of Total Cyanide in Groundwater, Upper Hydrogeologic Unit
4. Concentrations of Fluoride in Groundwater, Upper Hydrogeologic Unit
5. Concentrations of Arsenic in Groundwater, Upper Hydrogeologic Unit
6. Generalized Hydrogeologic Cross-Section Transect A-A' Location Map
7. Generalized Hydrogeologic Cross-Section A-A', Upper Hydrogeologic Unit
8. Selected Inorganic Parameter Results, Upper Hydrogeologic Unit
9. Monitoring Well and Staff Gauge Locations
 - 9A. PDI Groundwater Plume Monitoring Network
10. Northern Asbestos Landfills Proposed Test Pit Locations
11. Southern Asbestos Landfills Proposed Test Pit Locations
12. Soil DU3 Areas of Concern
13. Soil Sampling Step-Out Sampling Locations, AOC A
14. Soil Sampling Step-Out Sampling Locations, AOC C
15. Soil Sample Results, AOC D

Table of Contents *(Continued)*

- 16. 16A Soil Sampling Step-Out Sampling Locations, AOC E East
 - 16B Soil Sampling Step-Out Sampling Locations, AOC E East
- 17. Soil Sampling Step-Out Sampling Locations, AOC F
- 18. Soil Sampling Step-Out Sampling Locations, AOC G
- 19. NPP – West Sampling Locations
- 20. NPP – East Sampling Locations

Tables

- 1. Data Quality Objectives
- 2. Water Level Measurement Locations – Screened Intervals and Survey Data
- 3. PDI Plume Monitoring Well Network

Appendices

- A. MRCE Slurry Wall PDI Work Plan
- B. MRCE WSSP Landfill Settlement Study Work Plan
- C. MRCE Industrial Landfill Geotechnical Investigation

Acronym List

Acronym	Definition
AOC	Area of Concern
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFAC	Columbia Falls Aluminum Company LLC
COC	Constituent of Concern
DEQ	Montana Department of Environmental Quality
EPA	United States Environmental Protection Agency, Region 8
EC	Engineering Controls
ERP	Emergency Response Plan
ESD	Explanation of Significant Differences
FSP	Field Sampling Plan
HASP	Health and Safety Plan
IDW	Investigative Derived Waste
IC	Institutional Controls
O&M	Operation and Maintenance
MRCE	Mueser Rutledge Consulting Engineers PLLC
NPL	National Priorities List
NPP	North Percolation Ponds
PAH	Polynuclear Aromatic Hydrocarbon
PDI	Predesign Investigation
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RG	Remedial Goal
RD	Remedial Design
RO	Remedial Objective
ROD	Record of Decision
WSSP	Wet Scrubber Sludge Pond

1. Introduction

This Pre-Design Investigation (PDI) Work Plan has been prepared on behalf of Columbia Falls Aluminum Company LLC (CFAC) to support the design of the remedy selected by the United States Environmental Protection Agency Region 8 (EPA) in the CFAC Record of Decision (ROD) for the cleanup of the Anaconda Aluminum Company, Columbia Falls Reduction Plant, also known as the CFAC Superfund Site (Site), Columbia Falls, Montana. 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) ([Figure 1](#)).

An overview of the Remedial Design is presented in the CFAC Remedial Design Work Plan (RDWP) provided under separate cover (Roux 2025a). The RDWP provides the framework and scope of work for developing design documents for the EPA selected remedy to be conducted under a Consent Decree (CD). In addition to this PDI Work Plan, other documents supporting the RDWP provided under separate cover include the Quality Assurance Project Plan (QAPP), the Investigative-Derived Waste (IDW) Management Plan and the Health and Safety Plan (HASP) (Roux 2025b-d). The schedule for the work is found in the CD, SOW Section 9.

This PDI WP document has the following sections.

- Section 1:** Includes the introduction.
- Section 2:** Describes the Site background.
- Section 3:** Describes the pre-design activities to be conducted.
- Section 4:** Lists the documents referenced herein.

2. Site Background

This section provides a brief overview of site background information. Additional background information can be found in the Remedial Investigation Report (Roux 2020), the Feasibility Study Report (Roux 2021) and the ROD (EPA 2024). [Figure 2](#) depicts site features that are described below.

The Site was operated as a primary aluminum reduction facility (commonly referred to as an aluminum smelter) from 1955 until 2009. Decommissioning of the industrial facilities was completed in the third quarter of 2019. Following decommissioning, the remaining structures include the administration building, the main warehouse, two ancillary warehouses, and the fabrication shop. Three of the buildings are leased for commercial uses. The Bonneville Power Administration owns the former switch yard. Burlington Northern Santa Fe owns the rail line adjacent to the Flathead River.

In February 2025, CFAC sold the majority of the Site to a property developer. CFAC retained ownership of approximately 211.6 acres of land, including all of the landfills and land immediately surrounding them ([Figure 2](#)). CFAC retained access rights for CFAC, EPA, and DEQ to complete all of the remediation activities required by the ROD issued by EPA on January 10, 2025.

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.

The Site study area 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. Cedar Creek is a losing stream flowing from the outlet of the Cedar Creek Reservoir along the western boundary of the Site towards the City of Columbia Falls. The Flathead River is used for recreational activities, including boating, floating, kayaking, hunting, fishing, and bird-watching water activities.

The Cedar Creek Reservoir Overflow Ditch is a losing stream located on the eastern portion of the Site running between the West Landfill and the Sanitary Landfill and alongside the Center Landfill, East Landfill and the Southern Asbestos Landfills on its way to the Flathead River ([Figure 2](#)). The City of Columbia Falls has an easement to operate and maintain the ditch for its management of the Cedar Creek Reservoir.

The elevations at the Site range from approximately 3,020 ft to 3,535 feet (ft) above mean sea level. The general topographic slope is in the south to south-west direction towards the Flathead River. There is a steep slope rising from the area adjacent to the river. From the crest of this slope, the ground is relatively flat into the former Main Plant Area. Beyond the Main Plant area to the north and east toward Teakettle Mountain, the slopes and elevations increase.

The RI defined three stratigraphic units at the Site that consist generally, from land surface down, of the following:

- **Upper Hydrogeologic Unit:** A 50 to 150 ft layer of glaciofluvial outwash 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.).
- **Below Upper Hydrogeologic Unit:** A layer of dense, poorly sorted glacial till with interbedded deposits of glaciolacustrine clays and silts and coarser water-bearing zones. The glacial till has a

higher percentage of fines and is dryer and denser than the overlying outwash and alluvial deposits. The large difference in hydraulic head between the overlying deposits and the Below Upper Hydrogeologic Unit indicate little hydraulic connection between them. The Below Upper Hydrogeologic Unit is at least 200 ft thick across most of the Site.

- **Bedrock:** The bedrock is composed of the metasedimentary rocks of the Precambrian Belt Supergroup and defines the bottom of the hydrogeologic system beneath the Site. The depth to bedrock is estimated to range from depths less than 150 ft near Teakettle Mountain to greater than 300 ft with the bedrock surface in the vicinity of the Site sloping downward in the south – southwest direction towards the Flathead River.

Groundwater typically flows within the Upper Hydrogeologic Unit under unconfined conditions south - southwest 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. Groundwater levels fluctuate seasonally averaging up to 25 ft in the upland areas of the Site due to influx from the spring thaw and snow melt with maximum fluctuations over 50 ft. Groundwater seeps can occur along the banks of the Flathead River.

3. Pre-Design Investigation Activities

The overall objective of the Pre-Design Investigation (PDI) activities described in this section is the collection of additional data necessary to support the design and construction of the remedy selected by EPA in the ROD. This additional data will supplement the extensive dataset and understanding of site conditions developed during the course of the RI. The PDI activities include field work, bench testing, and modeling. Each subsection below describes the information needed and the data to be collected to meet the data quality objectives (DQOs). Certain geotechnical tasks will be conducted by a subcontractor to Roux with the subcontractor's portion of the PDI WP provided in appendices to this Work Plan.

As noted above, the documents supporting the PDI include the QAPP, the IDW Management Plan and the HASP and are provided under separate cover. This Work Plan describes the PDI sampling program including the number and location of samples and the rationale for such sampling. The QAPP provides additional details on DQOs, field sampling methods, laboratory services and data validation. The DQOs are also presented here in Table 1 for reference. The HASP describes practices to prevent or mitigate risks associated with conducting the PDI field work. The IDW Management Plan describes how waste generated during the PDI will be managed on-site and shipped off-site for disposal.

The results of the PDI will be provided in a PDI Report.

3.1 Slurry Wall Geotechnical Pre-Design Study

The installation of a cap on the WSSP Landfill and the installation of a fully-encompassing slurry wall around the West Landfill and WSSP Landfill is required by the ROD. This subsection of the PDI Work Plan describes the activities to be undertaken to support the design of the slurry wall. The Pre-Design Study for the Slurry Wall prepared by a subcontractor to Roux, Mueser Rutledge Consulting Engineers PLLC (MRCE), is provided in [Appendix A](#). Based on MRCE's review of the available geotechnical data, they identified information that would be useful for the design of the slurry wall.

Briefly, the Slurry Wall PDI Study addresses the collection of information to further define the stratigraphy, groundwater levels, and physical and hydraulic soil parameters along the proposed slurry wall alignment. This information will better estimate the depth at which the slurry wall will be keyed into the Glacial till below the Upper Hydrogeologic Unit. This information will also assist with the evaluation of the potential presence of boulders on the slurry wall construction. The additional groundwater level information and physical and hydraulic soil parameters will be important to designing for slurry trench stability during construction. The data will also allow for a seismic evaluation of the slurry wall.

The slurry wall is expected to be a mixture of the existing soils along the alignment and bentonite (and cement-bentonite where needed) to create the low permeability barrier. The need to supplement with imported soils will be evaluated. Bench testing will be conducted to determine the appropriate mixture of alignment soils with bentonite to create a low permeability slurry wall. In addition, compatibility testing and cation exchange testing will be conducted on the selected mix using site groundwater to estimate the potential for contaminated site groundwater to impact the performance of the slurry wall.

A detailed description of the approaches and methods to achieve these objectives is provided in [Appendix A](#).

3.2 WSSP Landfill Settlement Study

The installation of a cap over the Wet Scrubber Sludge Pond (WSSP) Landfill is required by the ROD. This subsection of the PDI Work Plan describes the activities to be undertaken to support the design of the cap. The Pre-Design Study for the cap prepared by MRCE is provided in [Appendix B](#). Based on MRCE's review of the available geotechnical data, they identified information that would be useful for the design of the cap.

The approximately 10.8-acre WSSP Landfill was historically used for the disposal of non-hazardous, calcium fluoride air pollution control wet scrubber sludge. The WSSP Landfill received waste material from the aluminum reduction plant air pollution control wet scrubbers until 1976. An earthen cap was installed over the waste in 1981 and is sparsely vegetated. The surface of the WSSP Landfill currently has a concave shape that is estimated to require a minimum of 43,000 cubic yards of fill to bring the surface to the proper grades for the installation of the required engineered cap. The fill volume to raise grade from the current topography to the hypothetical surface upon which a cap would be constructed was calculated in the Feasibility Study (FS) using AutoCAD Civil 3D (Roux 2020).

Because the geotechnical properties of the wastes within the WSSP Landfill are unknown and fill must be added to allow for proper grades for the cap, the PDI will evaluate the potential for additional settlement, which would then be considered in the design of fill placement and cap for the WSSP Landfill. Also, the strength of the WSSP containment dike will be determined to allow for slope stability evaluation under capped conditions. Bulk samples will be collected for screening level bench scale testing for in-situ stabilization. A seismic evaluation will also be conducted. A topographic survey of the existing WSSP and West Landfills will be conducted with the new survey compared to the 2018 topographic survey to determine if settlement has occurred in the interim period.

If the PDI determines that stabilization measures are needed to support the cap, example measures could include one or more of the following options: surcharge pre-loading, in-situ stabilization or the use of lightweight fill to raise the grades. The PDI will also determine if the expected settlement would be significant enough to preclude the use of a geomembrane and present slope angle assumptions for the proper grade of the engineered cap.

A detailed description of the approaches and methods to achieve these objectives is provided in [Appendix B](#).

3.3 Groundwater Plume Sampling

The ROD requires both short- and long-term groundwater monitoring to characterize groundwater flow directions and to track the expected decline in cyanide, fluoride and arsenic groundwater concentrations in the Upper Hydrogeologic Unit following construction of the fully-encompassing slurry wall around the West Landfill and the WSSP Landfill and construction of the WSSP Landfill cap. This subsection of the PDI Work Plan describes the collection of data needed to prepare the required groundwater monitoring plans.

The short- and long-term groundwater monitoring plans will be developed during the Remedial Design to monitor groundwater downgradient of the West Landfill / WSSP Landfill Slurry Wall Containment Cell to evaluate the performance of the containment system. Groundwater monitoring will primarily focus on the three key contaminants of concern that are total cyanide, fluoride and arsenic. The groundwater remedial goal (RG) for total cyanide is 200 micrograms per liter (ug/L), fluoride is 4,000 ug/L and arsenic (dissolved) is 10 ug/L (ROD, 2025).

As described below, the contaminant concentrations decrease with depth in the Upper Hydrogeologic Unit but this trend needs further definition immediately downgradient of the WSSP Landfill. The PDI will determine if the contaminant plume exists at the base of the Upper Hydrogeologic Unit immediately downgradient of the WSSP Landfill and confirm the vertical trends (e.g., contaminants concentrations decrease with depth) in arsenic, fluoride and total cyanide concentrations in groundwater.

The groundwater plume is well defined, extending from the WSSP Landfill to the Flathead River. The total cyanide, fluoride and arsenic groundwater plumes from the most recent sampling round are shown in [Figures 3, 4, and 5](#). Total cyanide, fluoride and arsenic were detected at the highest concentrations in samples collected from monitoring wells immediately adjacent to the West Landfill and WSSP Landfill. Concentrations generally decrease in the south-southwest downgradient flow direction towards the Flathead River.

[Figure 6](#) shows the location of the cross-section diagram presented in [Figure 7](#). This generalized geologic cross-section is oriented through the approximate center of the total cyanide and fluoride plumes. The vertical profile of the groundwater plume within the Upper Hydrogeologic Unit has been determined in the mid and distal portions of the groundwater plume but is less well defined immediately downgradient of the WSSP Landfill. Total cyanide and fluoride sample results from Upper Hydrogeologic Unit nested wells at locations CFMW-028/028a and CFMW-045/045a that are located approximately down the center of the total cyanide and fluoride plumes, show a decrease in concentration with depth as shown on [Figure 8](#). Monitoring well CFMW-015, which is immediately downgradient of the WSSP landfill, typically has high arsenic, total cyanide and fluoride concentrations, but there is no deeper well at this location within the Upper Hydrogeologic Unit.

It is proposed to install three deeper wells (i.e., CFMW-015a, CFMW-28b, and CFMW-45b) nested with CFMW-015, CFMW-28 and CFMW-45 to evaluate the vertical concentration profile immediately adjacent to the WSSP Landfill ([Figure 9A](#)). Proposed well CFMW-015a is expected to be screened from 3024 to 3014 ft MSL (10-ft screen) with the top of the screen approximately 115 ft below grade and the bottom of the screen at the base of the Upper Hydrogeologic Unit modified as needed based on field conditions (i.e., where the base of the Upper Hydrogeologic Unit is found). Proposed well CFMW-028b is expected to be screened from 2979 to 2969 ft MSL (10-ft screen) with the top of the screen approximately 127 ft below grade and the bottom of the screen at the base of the Upper Hydrogeologic Unit modified as needed based on field conditions (i.e., where the base of the Upper Hydrogeologic Unit is found). Proposed well CFMW-045b is expected to be screened from 2920 to 2910 ft MSL (10-ft screen) with the top of the screen approximately 191 ft below grade and the bottom of the screen at the base of the Upper Hydrogeologic Unit modified as needed based on field conditions (i.e., where the base of the Upper Hydrogeologic Unit is found). During the installation of the proposed wells, soils will be continuously logged following the *Soil Logging Standard Operating Procedure (SOP)* and the well installed following the *Well Installation SOP* found in the FSP/QAPP. A new staff gauge in the Flathead River will also be installed ([Figure 9](#)).

Two rounds of groundwater samples will be collected from each of these three well nests (CFMW-015/15a, CFMW-028/028a/028b, and CFMW-045/045a/045b) along the approximate center line of the groundwater plume. Concurrently, two rounds of groundwater samples will also be collected from selected wells that support defining the extent and current conditions of the plume and support the development of the short- and long-term monitoring plan. The selected wells are listed in Table 3 and are shown on [Figure 9A](#).

The samples will be collected using a positive pressure displacement pump (such as a bladder pump) following low flow sampling methods including monitoring stabilization parameters following the *Low Flow*

Sampling SOP found in the QAPP. New bladders, or similar disposable pump parts will be used for each sample. If decontamination of non-disposable parts of the pump is needed, decontamination will be conducted following the *Equipment Decontamination SOP* found in the QAPP. The decontamination and purge water will be collected and handled following the IDW Management Plan. The *Water Quality Meter SOP* will be followed to collect field geochemical parameter measurements: pH, specific conductance, dissolved oxygen, temperature, turbidity, and ORP using a flow through cell. The total cyanide and fluoride samples will not be field filtered (i.e. no dissolved sample will be collected). Because the RG for arsenic is based on dissolved arsenic, samples collected for arsenic will be field filtered (0.45 um in-line, disposable filter) prior to preservation to provide a dissolved arsenic sample. Samples will be placed into the appropriate containers and preserved as described in *Table 5, Container Size, Preservation and Shipping - Aqueous Samples* of the QAPP.

Groundwater samples will be analyzed in laboratory using the following methods as described *Table 5, Container Size, Preservation and Shipping - Aqueous Samples* of the QAPP.

- Arsenic - SW 846 Method 6020A
- Total Cyanide - EPA Method 335.4
- Fluoride - EPA Method 300

Prior to the collection of each round of groundwater samples, a round of water levels will be collected from the Upper Hydrogeologic Unit monitoring wells and from the Flathead River staff gauge as listed in [Table 2](#) following the *Water Level Measurement SOP* found in the QAPP to provide the data needed to prepare a potentiometric map.

3.4 Slurry Wall Area Modeling

The groundwater modeling results will be used to assist with the development of the groundwater monitoring programs required by the ROD including evaluating monitoring well locations and screen intervals. Groundwater modeling will also be used to assist in the identification of the triggers for beginning groundwater extraction inside of the slurry wall.

Groundwater flow will be modeled in both saturated and unsaturated zones using MODFLOW. Flow can be simulated in the unsaturated zone using the Richards Equation with MODFLOW. *Groundwater Vistas* Version 9 by Environmental Simulations, Inc. will be used as the graphic user interface for data input, model execution, and the post-processing of model results. MODFLOW has the capability to model the slurry wall, groundwater extraction wells and interactions with surface water.

The above goals can be achieved with the model domain limited to the area bounded by the hydrogeologic boundaries of Cedar Creek to the north and west, the Cedar Creek Reservoir Overflow Ditch on the north and east and the Flathead River to the south. The upper recharge boundary of the model domain will be the ground surface and the lower no flow boundary will be the top of the underlying Glacial till. There are no pumping wells that currently exist within the model domain. The model is expected to include a minimum of two layers (unsaturated zone and saturated zone) and may be increased as needed during the development and calibration process. The model will include both steady state and transient conditions. The steady-state model will be manually calibrated to relatively static, quasi-steady conditions using head targets focusing on hydraulic conductivity and streambed/river conductance. Stream/river conductances from the Montana Bureau of Mines and Geology groundwater model for Flathead County will be used as guides for the initial model values (MTBMG 2024). The initial target root mean squared error (RMSE) calibration criterion will be

approximately 5% of the observed head change in the model domain. Given the large fluctuations in the water table, the potential exists that this criterion may not be met throughout the domain. The model report will include a sensitivity analysis to evaluate the relative sensitivity of parameters on the model results. The transient model will be manually calibrated to head targets selected from 1 to 3 years the water level data collected in the RI. Transient head up and down gradient boundary conditions will allow the simulation of the cyclical annual groundwater table fluctuations (i.e., approximately 30 feet of increase during the spring melt followed by significant decline throughout the rest of the year).

Hydraulic conductivities determined from single well tests in the RI as well as in the PDI will be used as the initial hydraulic conductivity values. Storage coefficients from the Montana Bureau of Mines and Geology groundwater model for Flathead County will be used as the initial storage coefficients (MTBMG 2024). Parameter values from literature will also be incorporated into the model for recharge estimates and unsaturated soil characteristics. Stream flow data will be obtained from the City of Columbia Falls for Cedar Creek and Cedar Creek Reservoir Overflow Ditch. Flathead River flow data will be obtained from the United States Geological Survey.

The transient scenarios to be modeled include current conditions without slurry wall construction (the calibrated model), and after slurry wall construction (slurry wall scenario). Groundwater extraction will also be simulated as needed to maintain an inward gradient for the slurry wall scenario. The model report will include written and graphical representations of model assumptions and objectives, the conceptual model, code description, model construction, model calibration and sensitivity analysis, predictive simulations and conclusions.

3.5 Asbestos Landfill Cover Evaluation

The ROD requires that the thickness of the existing covers on the asbestos landfills be verified to be at least 12-inches thick, the elimination of surface depressions and the establishment of a uniform vegetative cover to prevent erosion and minimize erosion. Subsequent to the ROD, the EPA and DEQ recommended that the minimum soil cover should be 18 inches to minimize future maintenance activities and to provide sufficient thickness for a long-term plant growth media (EPA 2025a). This subsection of the PDI describes the data to be collected to assist with the design of a grading and fill plan to meet the ROD requirements.

Asbestos disposal in on-Site landfills reportedly began in the late 1970s early 1980s. The approximate extent of these landfills was estimated from CFAC personnel interviews and aerial photographs. The asbestos landfills are covered with soil but the surface grade is uneven with some small depressions. The area in the vicinity of the Southern Asbestos Landfills, which consists of the Southwest and Southeast Asbestos Landfills, appears as disturbed ground on the 1974 aerial photograph. The two Southern Asbestos Landfills are located within a longitudinal topographic depression with the axis of the depression generally sloping downward from east (approximately 3,171 ft msl) to west (approximately 3,168 ft msl). The Northern Asbestos Landfills, which consists of the Northeast and Northwest Asbestos Landfills, were not clear from aerial photographs, but based on disposal records, they were operated from 1993 to 2009 (Roux 2015). The two North Asbestos Landfills are located at approximately elevation 3,157 ft msl separated from each other by a low hill. The land surface gently but unevenly slopes downward in a southerly direction towards an access road adjacent to which is the West Landfill.

Test pits were excavated in the asbestos landfills in 2016 to approximately 10 ft below grade with the excavated materials visually examined for asbestos by a Montana Licensed Asbestos Inspector prior to

backfilling. Asbestos was generally not observed in the test pits from land surface to a depth of 18 inches except at test pit TP-7 in the Southeast Asbestos Landfill and at test pit TP-15 in the Northwest Asbestos Landfill where asbestos was found six inches below grade (Roux 2020). The soil at and around the asbestos landfills was sampled in 2017 with 56 random samples analyzed for asbestos. Asbestos was not detected in 55 of the 56 cover soil samples. Chrysotile asbestos was detected in a cover soil sample collected from the northeast corner of the Southwest Asbestos Landfill at a concentration less than 0.25% with no asbestos fibers identified in the point count (Roux 2017).

As noted above, previous test pitting (TP-1 to TP-16) indicated that no asbestos was present at the land surface but that there were areas where the cover thickness was less than 12-inches. Additional shallow test pits (TP-17 – TP-158) are proposed to be excavated in a grid-like pattern within the landfills to determine the continuity and thickness of the soil cover. Test pits will be excavated under the supervision of a Montana Licensed Asbestos Inspector using hand tools. A water spray will be used to dampen the soils to prevent airborne asbestos. It is estimated that approximately 142 test pits will be conducted (**Figures 10 and 11**). The test pits will be advanced to a depth of 18-inches and visually inspected for asbestos by a Montana Licensed Asbestos Inspector (Inspector). A soil sample will be collected within the interval of the ground surface to 18" within each test pit at the discretion of the Inspector and analyzed for asbestos using California Air Resources Board (CARB) Method 435. CARB Method 435 utilizes a 400 point count with a method detection limit of 0.25%. One duplicate asbestos sample will be collected for every 20 asbestos samples. A State of Montana certified asbestos inspector will be present for asbestos identification and to provide additional safety oversight for asbestos sampling. The areas will also be inspected for impediments to the anticipating grading operations. The information will be used to design the soil cover improvements operations to minimize disturbance of the existing soil cover while creating properly sloped surfaces to promote run-off and minimizing erosion.

3.6 Soil DU3 Further Delineation

The ROD requires excavation of the impacted soils within the defined areas of concern (AOC) within Soil DU3 (**Figure 12**). The ROD notes that additional delineation of the AOCs will be conducted during the remedial design. This subsection of the PDI Work Plan describes the delineation status of each of the AOCs and presents a step-out sampling program to further delineate AOCs as needed.

The FS determined that the Soil DU3 Exposure Point Concentrations (EPCs)¹ met the human health RGs as long as Incremental Soil Sample (ISS) Grid CFISS-033 (western portion of AOC E) is excavated. The FS also determined that the Soil DU3 EPCs met the RGs for ecological receptors based upon use of the 95% Upper Confidence Limit on the mean (95% UCL) as the EPC for the exposure area. However, due to the potential for small-home range receptors to be adversely impacted by hot spots, the FS utilized individual soil sample results as the EPCs to evaluate compliance with small range receptor PRGs on a point-by-point basis.² This second layer of ecological evaluation in the FS determined that there were eleven individual sample results that exceeded the small range receptor PRGs resulting in the designation of AOCs within the Soil DU3. AOCs A, C, D, E (east portion), F, and G within Soil DU3 were designated in the FS based on exceedances of the copper small range receptor PRG of 1,170 milligrams per kilogram (mg/kg) (AOC A) and

¹ EPCs are based on the 95% Upper Confidence Limit (UCL) for the exposure area.

² The short-tailed shrew PRGs were smaller values than the meadow vole PRGs and accordingly the short-tailed shrew PRGs were used to evaluate the small range ecological receptor.

the HMW PAHs³ small range receptor PRG of 110 mg/kg (AOCs C to G). In addition, the FS identified the former Drum Storage as AOC B based upon the concentrations of cyanide detected in soil within this area.

The delineation status of each of the Soil DU3 AOCs A through G is described below along with a description of the proposed step-out sampling where needed. Where step-out locations are needed to define the extent, discrete grab soil samples will be collected at each step-out location from the 0 to 0.5 ft (surface interval) and the 0.5 to 2 ft depth (shallow soil interval). Step-outs will be located at approximately 15 to 20 ft intervals in the directions away from the sample location where delineation is needed. The step-out process will be repeated as needed to define the extent at each AOC. The step-out interval may vary depending on the step-out results.

The following general step out decision process for each individual AOC step out program will be implemented:

1. The initial set of step out samples will be separated into two groups of four samples each in a way that provides similar geographic and depth coverage for each group. Group 1 will be analyzed and Group 2 samples will be placed on hold at the laboratory pending evaluation of Group 1 results.
2. If there are no exceedances of the small range PRG or RG identified in the Group 1 samples, then:
 - a. The Group 2 samples on hold will not be analyzed, and
 - b. No additional step outs are needed.
3. If in the Group 1 samples, there are no exceedances of the small home range PRG, but one or more exceedances of the applicable RG, then the Group 2 samples will be released for analysis. A 95% UCL will be calculated for the Group 1 and 2 samples for comparison with the applicable RG. If the 95% UCL is at or below the applicable PRG then no more step outs are needed.
4. If analysis of the Group 1 samples indicates one or more exceedances of the small range PRG, then:
 - a. The Group 2 samples will not be analyzed, and
 - b. Step out(s) will be performed away from the locations with exceedances. Each of the initial step outs will consist of one sample location with samples collected for analysis at the same depth(s) at which the exceedance occurred.
5. If there is an exceedance(s) of the small range PRG in the second step out sample(s), the step out process may or may not need to be modified to complete the delineation. If modifications are needed to the step out process and evaluation process, a change request will be submitted to the EPA for review and approval.

AOC A requires remediation based on sample CFSB-002 for the small range ecological copper RG exceedance. Step-outs will be conducted in directions away from CFSB-002 as shown on [Figure 13](#). Each soil sample collected will be analyzed for copper following the general step out decision process.

AOC B requires remediation due to presence of elevated concentrations of cyanide and fluoride within this area (corresponding the Former Drum Storage Area), as compared to other areas throughout Soil DU3 ([Figure 12](#)). Although RG exceedances were not identified at AOC B, the FS slated AOC B for excavation as an additional measure to help reduce the potential for future cyanide and fluoride groundwater contamination. Therefore, no delineation samples are required. Rather, post-excavation samples will be

³ HMW PAHs are a subset of PAHs as follows: benzo(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, benzo (g,h,i) perylene, benzo(k) fluoranthene, chrysene, dibenzo (a,h) anthracene, naphthalene, indeno (1,2,3-cd) pyrene, and pyrene.

collected following excavation of shallow soils to confirm the removal of soil with elevated cyanide and fluoride concentrations.

AOC C requires remediation based on small range ecological RG exceedances for HMW PAHs for samples from ISS Grids CFISS-003 and CFISS-005. Step-outs are not needed to the north, south or east of AOC C⁴ because RI sample results document that the RGs have been met. Similarly, in the west direction, the RI sample results documented that the RGs were met adjacent to ISS Grid CFISS-005 (southern portion of AOC C). However, step-out sampling is needed west of ISS Grid CFISS-003 (northern portion of AOC C). Step-outs will be located along the western border of ISS Grid CFISS-003 as shown on [Figure 14](#). Each soil sample collected will be analyzed for HMW PAHs following the general step out decision process.

AOC D⁵ was designated as an area of concern due to the exceedances found at the ISS grid samples CFISS-012, CFISS-013 and CFISS-020. No exceedances were found in the samples collected from the surrounding ISS grid cells: CFISS-006, CFISS-07, CFISS-08, CFISS-011, CFISS-014, CFISS-018, CFISS-019, CFISS-021, CFISS-024, CFISS-025, and CFISS-025 ([Figure 15](#)). As delineation for AOC D is complete, no step-out sampling is needed.

AOC E is divided into two subsections: AOC E (East) and AOC E (West). AOC E (East) requires remediation based on small range ecological PRG exceedances for HMW PAHs for sample CFISS-034. Step-out samples are not needed to the north, west or east of AOC E (East) because RI sample results document that the RGs have been met. To the south soil samples will be collected from eight step-out locations as shown on [Figure 16A](#). The soil samples collected will be analyzed for HMW PAHs following the general step out decision process.

AOC E (West) requires remediation based on the exceedance of the human health RG for benzo(a)pyrene at ISS Grid sample location CFISS-033⁶. Step-out samples are not needed to the north, west or east of AOC E (West) because RI sample results document that the RGs have been met. In the south direction, soil samples will be collected from eight step-out locations as shown on [Figure 16B](#). The soil samples collected will be analyzed for benzo (a) pyrene following the general step out decision process.

AOC F requires remediation based on small range PRG exceedances for HMW PAHs for samples CFSB-042 and CFSB-044. Step-outs will be conducted in each of the directions away from CFSB-042 and CFSB-044 as shown on ([Figure 17](#)). The soil samples will be analyzed for HMW PAHs following the general step out decision process.

AOC G requires remediation based on small range PRG exceedance for HMW PAHs for sample CFSB-040. Step-outs will be conducted in each of the directions from CFSB-040 as shown on [Figure 18](#)). The soil samples will be analyzed for HMW PAHs following the general step out decision process.

Soil samples will be collected using a hand auger following the *Soil Sample Collection SOP* found in the FSP/QAPP. Decontamination of non-disposable sampling equipment will be conducted following the *Equipment Decontamination SOP* found in the FSP/QAPP. The decontamination and purge water will be collected and handled following the Investigative Derived Waste Management Plan. Samples will be placed

⁴ AOC C has been expanded to include the entirety of grids CFISS-003 and CFISS-005 for simplicity.

⁵ AOC D has been expanded to include the entirety of grid CFISS-20 for simplicity.

⁶ AOC E has been expanded to include the entirety of grid CFISS-033 for simplicity.

into the appropriate containers and preserved as described in *Table 5, Container Size, Preservation and Shipping - Aqueous Samples* of the FSP/QAPP.

Soil samples will be analyzed in the laboratory using the following methods as described *Table 4, Container Size, Preservation and Shipping - Solid Samples* of the FSP/QAPP.

- Copper - SW 846 Method 6020A
- Benzo (a) pyrene – EPA 8270D Low Level
- PAHs – EPA 8270D Low Level
 - HMW PAHs are a subset of PAHs as follows: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo (g,h,i) perylene, benzo(k) fluoranthene, chrysene, dibenzo (a,h) anthracene, naphthalene, indeno (1,2,3-cd) pyrene, and pyrene.

3.7 NPP DU4 Sediment Evaluation

The North Percolation Pond Decision Unit 4 (NPP DU4) includes the North-East Percolation Pond, North-West Percolation Pond, influent ditch, and effluent ditch. The ROD requires the excavation of the sediments from NPP DU4. Based upon the mix and concentrations of COCs in the sediment that would be excavated from NPP DU4 as well as the presence of viscous waste, the FS and the Repository Selection Decision Support Memorandum (Roux 2024) indicated that the WSSP Landfill is the appropriate repository for this excavated material due to the comparability of the wastes. This section of the PDI Work Plan describes the activities to be undertaken to evaluate the handling and consolidation properties of the NPP DU4 sediments to assist with the design of the remedy.

3.7.1 NPP DU4 Background

The North-East Percolation Pond is approximately 2 acres in size, and the topography is depressed below the surrounding area with a maximum depth of approximately 14 ft-bls. The thickness of the waste material in the percolation pond ranges from approximately 0.5 to 2 feet based on visual observations made during drilling (i.e., vertical extent of highly viscous to solid black carbonaceous material). This percolation pond received discharges from various operations within the Main Plant Area until manufacturing ceased in 2009. Groundwater levels in the area of the North-East Percolation Pond range from approximately 30 feet to 73 feet below surrounding grade.

The North-West Percolation Pond is approximately 8 acres in size, and the topography is depressed below the surrounding area with a maximum depth of approximately 22 ft-bls. The thickness of the waste material in the percolation pond ranges from approximately 0.5 to 2 feet based on visual observations made during previously completed drilling. 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. Groundwater levels in the area of the North-West Percolation Pond range from approximately 24 feet to 44 feet below surrounding grade.

The approximate areas and depths of impacted material for each of the pond structures within the North Percolation Pond DU4 are shown in the table below, including reasonable lower and upper estimates of the average depth of the 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 ranges from 0.5 to 2 feet. It is estimated that on average 6 to 12 inches of soil beneath this carbonaceous material

is impacted at levels that contribute to potential human health and ecological risk. The respective volumes for the estimated range of depths were calculated during the FS and are provided below.

Estimated Areas and Range of Volumes for North Percolation Pond DU4 Structures

Pond Structure	Area (acres)	Reasonable Lower Estimate		Reasonable Upper Estimate	
		Avg Depth (ft-bls)	Volume (CY)	Avg Depth (ft-bls)	Volume (CY)
North-East Percolation Pond	2.0	1.5	4,850	4	12,900
North-West Percolation Pond	8.0 ¹	0.5	4,850	2	19,400
Influent Ditch	0.2	0.5	160	3	960
Overflow Ditch	0.4	0.5	320	3	1,920

¹ To calculate the estimated volume for the North-West Percolation Pond, an area of 6.0 acres was used to reflect the observed intermittent nature of the carbonaceous material.

3.7.2 NPP DU4 Initial Material Preparation and Sampling

Based on the Remedial Investigation completed within the NPP DU4, a surficial layer of highly viscous to solid black carbonaceous material exists across the majority of the North-East Percolation Pond, and intermittently across the ditches and North-West Percolation Pond.

Eight test pits will be excavated within the NPP DU4, as shown on [Figures 19 and 20](#) to collect materials for testing. The excavated carbonaceous material will be placed into one pile adjacent to each test pit. Observations will be made regarding the adherence of the carbonaceous material to the bucket at each test pit. Several backhoe buckets of soil from below the carbonaceous material will be placed into a second stockpile. The materials in each stockpile will be field classified following ASTM D2488. The materials also will be field classified for stickiness following Table 3-11 of the United States Department of Agriculture, Soil Survey Manual, Agricultural Handbook No. 18.

Representative samples will be collected from each material stockpile at each test pit, and submitted for laboratory testing, including particle size analysis (ASTM D6913 or ASTM D7928 as applicable), oedometer testing for consolidation (ASTM D2435), and Atterberg Limits (ASTM D4318). These sixteen samples will be collected, packaged and shipped in accordance with the QAPP.

3.7.3 NPP DU4 Material Handling Field Pilot Test

After geotechnical sampling of the stockpiles at each test pit is complete, a field handling pilot test will be performed at each test pit location to determine if stabilization amendments are required to handle and transport the material as well as estimating the potential for consolidation. At the completion of each field pilot test, each test pit will be backfilled by placing the material from the second stockpile into the pit first, followed by the unamended carbonaceous material with the mixed materials placed last into the test pit.

Mixing Test Using Site Soil

Approximately ½ of a 5-gallon bucket (10 quarts) of carbonaceous material will be placed into a mixing tub. Material from the second pile will be gradually added in increments of approximately one quart and mixed

thoroughly in the tub for approximately 5 to 10 minutes with a garden hoe with the stickiness observed after the addition of each increment. The testing can continue until the mixture appears easily handled or 10 quarts have been added (1:1 mixture). A sample of each of these eight final mixtures will be submitted for oedometer testing for consolidation (ASTM D2435).

Mixing Test Using Lime Kiln Dust

Approximately $\frac{1}{2}$ of a 5-gallon bucket (10 quarts) of carbonaceous material will be placed into a mixing tub. Lime kiln dust will be gradually added in increments of approximately $\frac{1}{4}$ quart and mixed in the tub with a garden hoe with the stickiness observed after the addition of each increment. The testing can continue until the mixture appears easily handled or one quart has been added (10% mixture). A sample of each of these eight final mixtures will be submitted for oedometer testing for consolidation (ASTM D2435).

Decontamination and IDW Management

Decontamination of equipment will be conducted following the *Equipment Decontamination SOP* found in the FSP/QAPP and all waste generated as part of the geotechnical evaluation and handling pilot test will be collected and handled following the IDW Management Plan.

3.8 Cedar Creek Reservoir Overflow Ditch Lining Information

The ROD requires lining of the Cedar Creek Reservoir Overflow Ditch to reduce recharge to the Upper Hydrogeologic Unit in the vicinity of the DU1 landfills. Lining of the ditch will have the effect of locally reducing recharge to the Upper Hydrogeologic Unit while increasing surface water flow within the ditch. Portions of the ditch were lined previously. The design documents and as-builts for the original ditch and the lined portions of the ditch will be requested from City of Columbia Falls. The ditch will be walked from the downstream end of the existing liner to a point downstream of all DU1 landfills to assist with identifying potential design and construction challenges. Observations will be recorded including the location, number, construction materials and diameter of pipes conveying ditch water beneath road crossings. The observations will be recorded in a field book and marked on a field map and GPS coordinates obtained with a hand held GPS unit. Photographs will also be taken to record key features. As the Overflow Ditch is owned by the City of Columbia Falls, CFAC will confer with the City regarding ditch lining design to ensure that the design and proposed work is acceptable to the City.

3.9 Industrial Landfill Geotechnical Investigation

The installation of a cap over the Industrial Landfill is required by the ROD. This subsection of the PDI Work Plan describes the activities to be undertaken to support the design of the cap. The Pre-Design Study for the cap prepared by MRCE is provided in [Appendix C](#). Based on MRCE's review of the available geotechnical data, they identified information that would be useful for the design of the cap.

The approximately 12.4-acre Industrial Landfill was historically used for the disposal of non-hazardous waste and debris (scrap metal, wood, MSW). The Industrial Landfill is currently uncovered and has many surface depressions that may promote stormwater infiltration through the landfill's surface. During the South Percolation Ponds Removal Action, the previously existing surface depressions were filled, to an extent, with excavated material from the South Percolation Ponds and a temporary soil cover consisting of onsite borrow material. It is estimated using AutoCAD Civil 3D that the Industrial Landfill would require approximately 56,000 CY of additional grading material to achieve a minimum slope requirement of 3% for a crowned cap design (Roux 2020).

Because the geotechnical properties of the wastes within the Industrial Landfill are unknown and fill must be added to allow for proper grades for the cap, the PDI will evaluate the potential for settlement, which would then be considered in the design of fill placement and cap for the Industrial Landfill. A seismic evaluation will also be conducted. A topographic survey of the existing WSSP and West Landfills will be conducted with the new survey compared to the 2021 topographic survey to determine if settlement has occurred in the interim period.

A detailed description of the approaches and methods to achieve these objectives is provided in [Appendix C](#).

4. References

- Consent Decree 2025, Consent Decree for Remedial Design / Remedial Action, United States Environmental Protection Agency, Region 8, and Columbia Falls Aluminum Company, CERCLA Docket No. YYYYYY, _____, 2025.
- EPA, 2025, Record of Decision for the Anaconda Aluminum Company, Columbia Falls Reduction Plant Site, Flathead County, Montana , United States Environmental Protection Agency, Region 8, January 10, 2025.
- EPA, 2025, Letter from Allie Archer to John Stroiazzo, Comments on Pre-Design Investigation Work Plan, June 18, 2025.
- Roux, 2017, Surface Soil Sampling Results from Asbestos Landfills, Columbia Falls Aluminum Company, Columbia Falls, Montana, October 19, 2017.
- Roux, 2020, Remedial Investigation Report, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, February 21, 2020.
- Roux, 2021, Feasibility Study Report, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, June 16, 2021.
- Roux, 2025a, Remedial Design Work Plan, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, 2025.
- Roux, 2025b, Quality Assurance Project Plan, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, 2025.
- Roux, 2025c, Investigative-Derived Waste Management Plan, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, 2025.
- Roux, 2025d, Health and Safety Plan, CFAC Facility, 2000 Aluminum Drive, Columbia Falls, Montana, prepared on behalf of Columbia Falls Aluminum Company LLC, 2025.

**Pre-Design Investigation Work Plan
2000 Aluminum Drive, Columbia Falls, Montana**

TABLES

1. Data Quality Objectives
2. Water Level Measurement Locations –
Screened Intervals and Survey Data
3. PDI Plume Monitoring Well Network

Table 1. Data Quality Objectives
Columbia Falls Aluminum Company, LLC, 2000 Aluminum Dr., Columbia Falls, MT.

DQO Step	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Task	State the Problem	Identify Goals of the Study	Identify the Information Inputs	Define the Boundaries of the Study	Determine the Analytic Approach	Specific the Performance Criteria or Acceptance Criteria	Decribe the Plan for Obtaining the Data
Slurry Wall Geotechnical Pre-Design Study	The ROD requires the installation of a fully encompassing slurry wall around the West Landfill and WSSP Landfill.	The goals of the study are to further define the stratigraphy, groundwater levels, and physical and hydraulic soil parameters along the proposed alignment. The study will also evaluate the slurry wall mix and compatibility of the slurry wall mix with groundwater.	Information, measurements, and samples will be collected from piezometers, borings and test pits.	The study will be conducted in the area adjacent to the West Landill and WSSP Landfill.	The analytic approach is provided in Table 3 of Appendix A, Slurry Wall PDI Study Work Plan in the PDI Work Plan.	The acceptance criteria are provided in Table 4 of Appendix A, Slurry Wall PDI Study Work Plan in the PDI Work Plan.	Soil borings and test pits will be conducted to collect in-situ field test results and to collect samples for field classification and laboratory analysis. Groundwater samples will also be collected for bench testing.
WSSP Landfill Settlement Study	The addition of fill material is needed to bring the WSSP Landfill to appropriate grades for the installation of an engineered cap and the placement of fill has the potential to cause the waste to consolidate.	The goals of the study are to evaluate the potential for waste consolidation after the additional of fill so that the design can account for such potential settlement of the cap, evaluate cap performance under earthquake conditions, and evaluate the stability of the dike.	Information, measurements, and samples will be collected from piezometers and borings.	The study will be conducted within the WSSP Landfill including the dike.	The analytic approach is provided in Table 3 of Appendix B, WSSP Landfill Settlement Study PDI Study Work Plan in the PDI Work Plan.	The acceptance criteria are provided in Table 4 of Appendix B, WSSP Landfill Settlement Study PDI Study Work Plan in the PDI Work Plan.	Soil borings and cone penetrometer probes will be conducted to collect in-situ test results, and collect samples for field classification and laboratory analysis.
Groundwater Plume Sampling	The lateral extent of the groundwater plume is well defined but additional vertical delineation is needed to confirm vertical concentration trends.	The goals of the study are to verify the arsenic, total cyanide, and fluoride vertical and spatial concentration trends in the groundwater plume.	Groundwater samples will be collected from monitoring wells located throughout the groundwater plume.	The study will be located throughout the groundwater plume from the WSSP Landfill to the most downgradient well near the river bank.	The analytical approach is provided in Section 3.3 of the PDI Wlork Plan.	The acceptance criteria are the attainment of laboratory QA/QC outlined in the QAPP.	Two rounds of groundwater samples will be collected from existing wells plus three new wells to be installed during the PDI.
Slurry Wall Area Modeling	The intallation of a fully encompassing slurry wall will affect groundwater conditions in the vicinity of the West Landfill and the WSSP Landfill.	The goals of the groundwater modeling are to create hypothetical potentiometric maps depicting the changes in groundwater flow, as well as provide insight for the evaluations of triggering groundwater extraction from within the containment cell.	Inputs to the model include monitoring well and river water elevations, aquifer properties (hydraulic conductivity, storage coefficient), and proposed slurry wall properties.	The modelling will be limited to the vicinity of the West Landill and the WSSP Landfil.	No laboratory samples will be collected.	The model will be calibrated to water levels within standard tolerances. The model will not be calibrated to flux targets.	Data will be obtained from the Remedial investigation Report and public sources.
Asbestos Landfill Cover Evaluation	The ROD requires that the cover over the asbestos landfills must be at least 12 inches thick.	The goal of the study is verify that asbestos is covered by at least 18 inches of soil.	Information and samples will be collected from test pits.	The study will be conducted within each of the asbestos landfills.	The analytical approach is provided in Section 3.5 of the PDI Wlork Plan.	The acceptance criteria are the attainment of laboratory QA/QC outlined in the QAPP and no asbestos observed by a certified asbestos inspector.	Shallow test pits will be dug and samples collected for laboratory analysis.
Soil DU3 Further Delineation	The ROD requires that certain exceedances of the small range receptor PRG need additional delineation prior to excavation.	The goal of the study is to further define the limits of soil contamination exceeding the small range receptor PRGs.	Soil samples will be collected to define the extent of small range receptor PRGs.	The study will be conducted at the AOCs within Soil DU3.	The analytical approach is provided in Section 3.6 of the PDI Wlork Plan.	The acceptance criteria are the attainment of laboratory QA/QC outlined in the QAPP.	Hand augers will be used to collect the soil samples. Additional step outs will be collected as dicated by the laboratory results.
NPP DU4 Sediment Evaluation	The potential exists that the NPP sediments may be difficult to handle and may be prone to consolidation.	The goals of the study are to evaluate the handling characteristics, the potential for consolidation and conduct field mix tests to mitigate issues identified.	Information and samples from test pits plus a material handling pilot test, if needed.	The study will be conducted within the NPP DU area.	The analytical approach is provided in Section 3.7 of the PDI Wlork Plan.	The acceptance criteria are the attainment of laboratory QA/QC outlined in the QAPP. Judgment will be used by field personnel to evaluate handling characteristics.	Test pits will be excavated to collect sediment samples and make observations on material handling. Small scale pilot test may be conducted using hand tools with samples submitted to the laboratory for analysis.
Cedar Creek Reservoir Overflow Ditch Lining Information	The flow capacity of the piped portions of the ditch needs to be determined and potential construction issues identified so they can be addressed in the design.	The goal of the study is to determine the dimensions and materials of construction of the piped portions of the ditch as well as identify potential construction issues.	Physical measurements of the piped portions, visual identification of contruction materials and other observations of the ditch and piped portions of the ditch.	The study will extend from the downstream end of the currently lined portion of the ditch a point downstream of the landfill decision units.	No laboratory samples will be collected.	Measurements are accepted in the field by measuring twice.	The ditch will be visually observed in the field, observations record, and measurements collected using a tape measure. The locations of measurements will be recored with a GPS hand-held unit
Industrial Landfill Geotechnical Investigation	The addition of fill material is needed to bring the Industrial Landfill to appropriate grades for the installation of an engineered cap and the placement of fill has the potential, while limited, to cause the waste to consolidate.	The goals of the study are to evaluate the potential for waste consolidation after the additional of fill so that the design can account for such potential settlement of the cap, , and evaluate the stability of the slopes.	Information, measurements, and samples will be collected from borings.	The study will be conducted within the Industrial Landfill.	The analytic approach is provided in Appendix C, Industrial Landfill Geotechnical PDI Study Work Plan in the PDI Work Plan.	The acceptance criteria are provided in Appendix C of the Industrial Landfill Geotechnical Study PDI Study Work Plan in the PDI Work Plan.	Soil borings and cone penetrometer probes will be conducted to collect in-situ test results, and collect samples for field classification and laboratory analysis.

**Table 2. Water Level Measurement Locations - Screened Intervals and Survey Data
Columbia Falls Aluminum Company, LLC, 2000 Aluminum Drive, Columbia Falls, MT**

Monitoring Well/Staff Gauge ID	Top of Casing Elevation (ft-amsl)	Well Pad/ Ground Elevation (ft-amsl)	Well Depth (ft-bls)	Well Screen Top Depth (ft-bls)	Well Screen Top Elevation (ft-amsl)	Well Screen Bottom Depth (ft-bls)	Well Screen Bottom Elevation (ft-amsl)	Northing (Y)	Easting (X)
CFMW-001	3173.78	3170.91	152.5	132.5	3038.41	152.5	3018.41	1549228.859	842170.366
CFMW-002	3145.58	3142.75	80	70	3072.75	80	3062.75	1546021.158	843027.354
CFMW-003	3144.95	3142.32	54	44	3098.32	54	3088.32	1547594.617	841640.301
CFMW-007	3149.20	3147.96	160	91	3056.96	102	3045.96	1546426.597	843029.760
CFMW-008	3192.97	3191.77	38.5	No Screen	No Screen	Open Bottom	Open Bottom	1546564.756	844032.614
CFMW-008a	3196.44	3194.69	98	88	3106.69	98	3096.69	1546575.278	844043.577
CFMW-010	3147.06	3144.69	86	76	3068.69	86	3058.69	1546115.479	842986.314
CFMW-011	3103.41	3100.98	50	40	3060.98	50	3050.98	1545989.982	842462.741
CFMW-012	3142.48	3140.47	90	70	3070.47	85	3055.47	1545999.738	843116.466
CFMW-014	3142.31	3139.97	92	72	3067.97	87	3052.97	1545822.378	842858.322
CFMW-015	3140.65	3138.93	94	72	3066.93	87	3051.93	1545790.290	843070.037
CFMW-015a	proposed well								
CFMW-016	3166.59	3163.84	95	85	3078.84	95	3068.84	1545847.943	843955.534
CFMW-016a	3167.11	3164.29	126	121	3043.29	126	3038.29	1545856.544	843955.402
CFMW-017	3210.57	3207.89	141	137	3070.89	141	3066.89	1545913.137	844140.867
CFMW-018	3212.81	3210.04	122	112	3098.04	122	3088.04	1545750.745	844586.938
CFMW-019	3137.81	3136.23	96	78	3058.23	88	3048.23	1545555.121	843277.960
CFMW-020	3168.74	3166.62	130	113	3053.62	118	3048.62	1545748.365	844071.614
CFMW-021	3138.16	3136.09	90	70	3066.09	85	3051.09	1545558.392	843505.246
CFMW-022	3137.32	3134.39	80	70	3064.39	80	3054.39	1545314.578	843942.176
CFMW-023	3209.98	3208.64	144.5	137.5	3071.14	143.25	3065.39	1545521.210	844694.956
CFMW-025	3103.54	3101.16	24.5	9.5	3091.66	24.5	3076.66	1545240.341	840912.165
CFMW-025b	3103.66	3101.60	60	45	3056.60	60	3041.60	1545233.747	840916.756
CFMW-026	3104.26	3101.58	45	35	3066.58	45	3056.58	1545199.463	841222.779
CFMW-027	3097.11	3094.38	45	35	3059.38	45	3049.38	1545251.431	842166.064
CFMW-028	3108.70	3105.99	60	50	3055.99	60	3045.99	1544970.966	843041.414
CFMW-028a	3108.66	3105.92	120	110	2995.92	120	2985.92	1544970.077	843049.717
CFMW-029	3133.04	3130.52	76	66	3064.52	76	3054.52	1545108.045	843463.411
CFMW-031	3109.49	3107.82	50	35	3072.82	50	3057.82	1544867.601	842797.671
CFMW-032	3116.58	3114.02	55	45	3069.02	55	3059.02	1544745.320	843964.007
CFMW-033	3110.64	3107.97	60	50	3057.97	60	3047.97	1544545.111	842408.017
CFMW-034	3109.99	3107.45	60	50	3057.45	60	3047.45	1544513.493	843342.204
CFMW-035	3109.92	3107.12	70	60	3047.12	70	3037.12	1544499.012	844447.319

**Table 2. Water Level Measurement Locations - Screened Intervals and Survey Data
Columbia Falls Aluminum Company, LLC, 2000 Aluminum Drive, Columbia Falls, MT**

Monitoring Well/Staff Gauge ID	Top of Casing Elevation (ft-amsl)	Well Pad/ Ground Elevation (ft-amsl)	Well Depth (ft-bls)	Well Screen Top Depth (ft-bls)	Well Screen Top Elevation (ft-amsl)	Well Screen Bottom Depth (ft-bls)	Well Screen Bottom Elevation (ft-amsl)	Northing (Y)	Easting (X)
CFMW-037	3113.64	3110.87	100	90	3020.87	100	3010.87	1543140.324	844473.946
CFMW-038	3113.77	3110.88	105	95	3015.88	105	3005.88	1543075.138	843981.359
CFMW-040	3113.72	3111.05	90	80	3031.05	90	3021.05	1543076.822	842863.264
CFMW-042	3110.34	3107.52	60	50	3057.52	60	3047.52	1543285.825	842383.655
CFMW-043	3109.91	3106.97	60	50	3056.97	60	3046.97	1544078.364	842157.850
CFMW-044	3108.09	3105.88	53	No Screen	No Screen	Open Bottom	Open Bottom	1543941.726	841700.388
CFMW-044a	3108.72	3106.11	110	100	3006.11	110	2996.11	1543941.659	841685.038
CFMW-045	3113.75	3111.26	96	86	3025.26	96	3015.26	1542768.892	842543.665
CFMW-045a	3113.93	3111.28	160	150	2961.28	160	2951.28	1542768.562	842554.018
CFMW-047	3117.18	3114.48	120	110	3004.48	120	2994.48	1542470.126	844332.708
CFMW-049	3122.69	3120.17	113	100	3020.17	111	3009.17	1542470.637	844793.481
CFMW-049a	3122.69	3120.49	148.5	138.5	2981.99	148.5	2971.99	1542484.164	844793.737
CFMW-050	3123.12	3120.24	120	110	3010.24	120	3000.24	1542299.178	844928.802
CFMW-053	3111.23	3109.65	77	47	3062.65	77	3032.65	1542974.491	841601.392
CFMW-054	3112.67	3109.92	85	75	3034.92	85	3024.92	1542966.021	841003.141
CFMW-056b	3101.20	3098.60	50	40	3058.60	50	3048.60	1544590.852	839778.849
CFMW-057b	3094.24	3091.97	40	30	3061.97	40	3051.97	1543667.532	837625.006
CFMW-059	3119.42	3117.39	90	80	3037.39	90	3027.39	1542120.760	837611.730
CFMW-065	3106.27	3104.18	37	27	3077.18	37	3067.18	1546255.406	840320.146
CFMW-066	3162.48	3160.26	35	25	3135.26	35	3125.26	1548012.807	842286.828
CFMW-067	3166.94	3164.91	35	25	3139.91	35	3129.91	1548411.563	841767.202
CFMW-068	3120.02	3118.13	85	75	3043.13	85	3033.13	1542803.976	839346.518
CFMW-069	3101.61	3099.62	55	45	3054.62	55	3044.62	1543845.835	839211.632
CFMW-070	3111.40	3109.22	60	50	3059.22	60	3049.22	1544758.390	843606.706
CFMW-071	3123.09	3121.04	105	95	3026.04	105	3016.04	1542961.841	840253.146
Flathead Staff (SG-1)	3014.72	1.60	NA	NA	NA	NA	NA	1541453.873	843980.286

**Table 3. Groundwater Plume Monitoring Network,
Columbia Falls Aluminum Company, LLC, 2000 Aluminum Drive, Columbia Falls, MT**

Well Identification	Feature Monitored
CFMW-002	Source Area
CFMW-010	Source Area
CFMW-012	Source Area
CFMW-014	Source Area
CFMW-015	Source Area
CFMW-015a (proposed)	Source Area

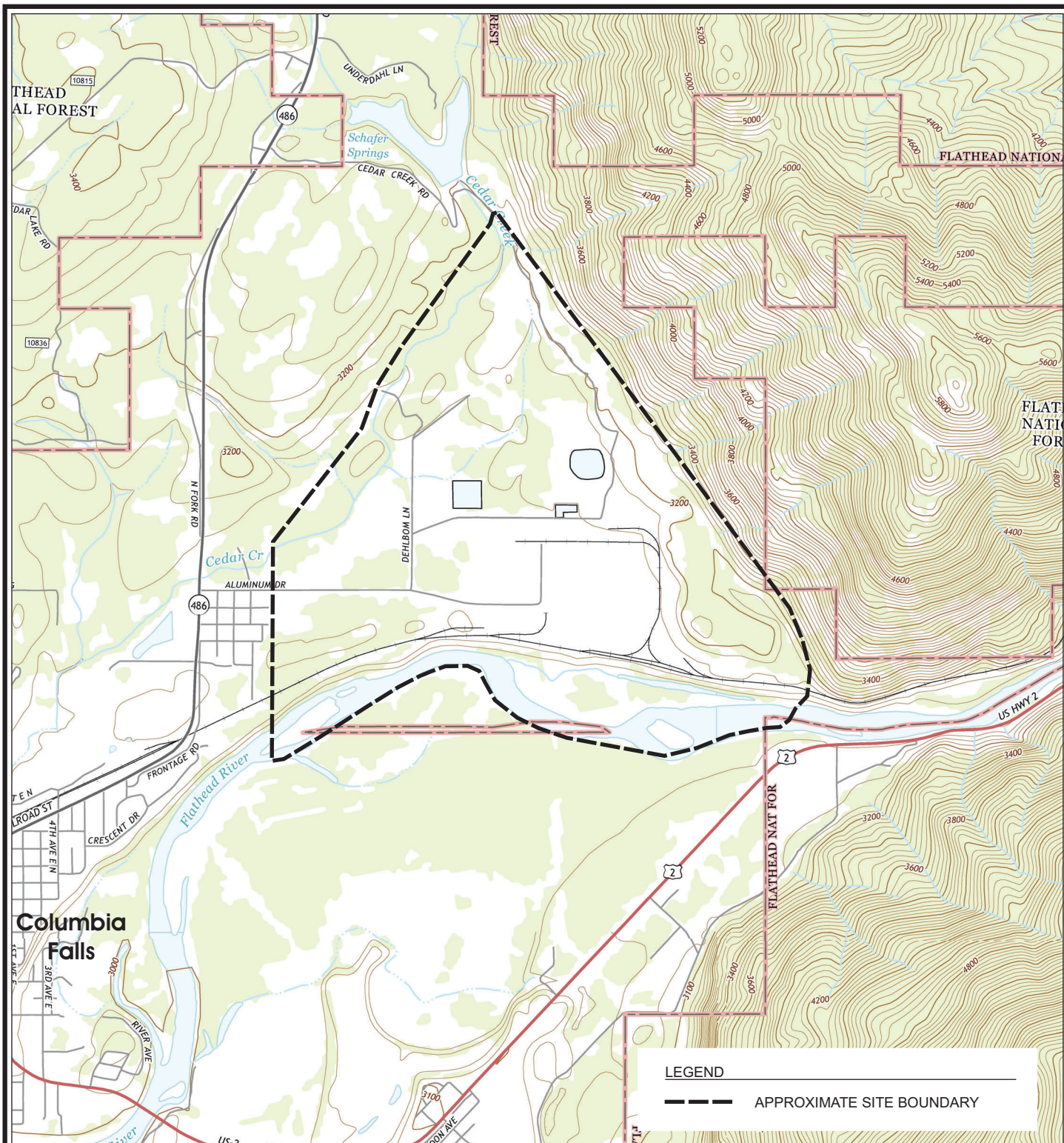
CFMW-028	Center of Plume
CFMW-028a	Center of Plume
CFMW-028b (proposed)	Center of Plume
CFMW-034	Center of Plume
CFMW-038	Center of Plume
CFMW-042	Center of Plume
CFMW-043	Center of Plume
CFMW-045	Center of Plume
CFMW-045a	Center of Plume
CFMW-045b (proposed)	Center of Plume

CFMW-020	Eastern Side of Plume
CFMW-022	Eastern Side of Plume
CFMW-032	Eastern Side of Plume
CFMW-035	Eastern Side of Plume
CFMW-037	Eastern Side of Plume
CFMW-047	Eastern Side of Plume
CFMW-050	Eastern Side of Plume

CFMW-011	Western Side of Plume
CFMW-026	Western Side of Plume
CFMW-027	Western Side of Plume
CFMW-033	Western Side of Plume
CFMW-044	Western Side of Plume
CFMW-44a	Western Side of Plume
CFMW-054	Western Side of Plume
CFMW-071	Western Side of Plume

CFMW-57b	Cross-Gradient Zone
CFMW-059	Cross-Gradient Zone
CFMW-068	Cross-Gradient Zone
CFMW-069	Cross-Gradient Zone

1. Site Location
2. Site Features
3. Concentrations of Total Cyanide in Groundwater, Upper Hydrogeologic Unit
4. Concentrations of Fluoride in Groundwater, Upper Hydrogeologic Unit
5. Concentrations of Arsenic in Groundwater, Upper Hydrogeologic Unit
6. Generalized Hydrogeologic Cross-Section Transect A-A' Location Map
7. Generalized Hydrogeologic Cross-Section A-A', Upper Hydrogeologic Unit
8. Selected Inorganic Parameter Results, Upper Hydrogeologic Unit
9. Monitoring Well and Staff Gauge Locations
 - 9A. PDI Plume Monitoring Well Network
10. Northern Asbestos Landfills Proposed Test Pit Locations
11. Southern Asbestos Landfills Proposed Test Pit Locations
12. Soil DU3 Areas of Concern
13. Soil Sampling Step-Out Sampling Locations, AOC A
14. Soil Sampling Step-Out Sampling Locations, AOC C
15. Soil Sample Results, AOC D
16. 16A Soil Sampling Step-Out Sampling Locations, AOC E East
 - 16B Soil Sampling Step-Out Sampling Locations, AOC E East
17. Soil Sampling Step-Out Sampling Locations, AOC F
18. Soil Sampling Step-Out Sampling Locations, AOC G
19. NPP – West Sampling Locations
20. NPP – East Sampling Locations

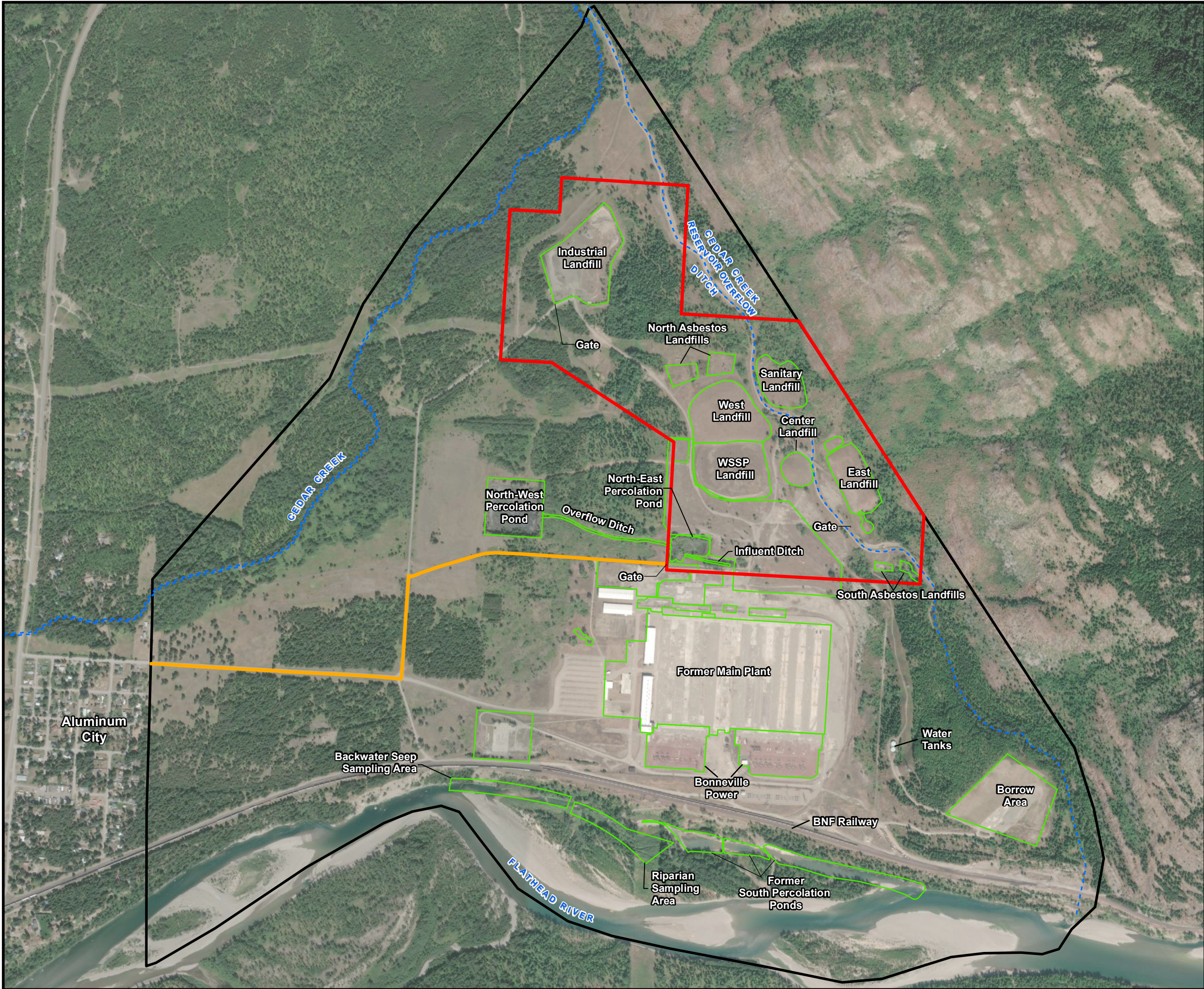


SOURCES:
 USGS; 2013, Columbia Falls No., MT
 USGS; 2013, Columbia Falls So., MT
 USGS; 2013, Doris Mountain, MT
 USGS; 2013, Hungry Horse, MT
 7.5 Minute Topographic Quadrangle

Title:			SITE LOCATION MAP 2000 ALUMINUM DRIVE COLUMBIA FALLS, MONTANA
Prepared for:			
COLUMBIA FALLS ALUMINUM COMPANY, LLC			FIGURE 1
		Compiled by: M.H. Prepared by: B.H.C. Project Mgr: M.H. File: 2476.0001Y316.01.CDR	
		Date: 06FEB24 Scale: AS SHOWN Project: 2476.0001Y016	

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LEGEND

- CREEK FEATURES
- TRAVEL ROUTE
- PROPERTY RETAINED BY CFAC
- SITE FEATURES
- SUPERFUND SITE BOUNDARY

NOTES

1. IN 2025, CFAC SOLD CERTAIN PORTIONS OF THE STUDY AREA. CFAC RETAINED OWNERSHIP OF THE LANDFILL AREAS WITHIN THE STUDY AREA.

Title:

SITE FEATURES

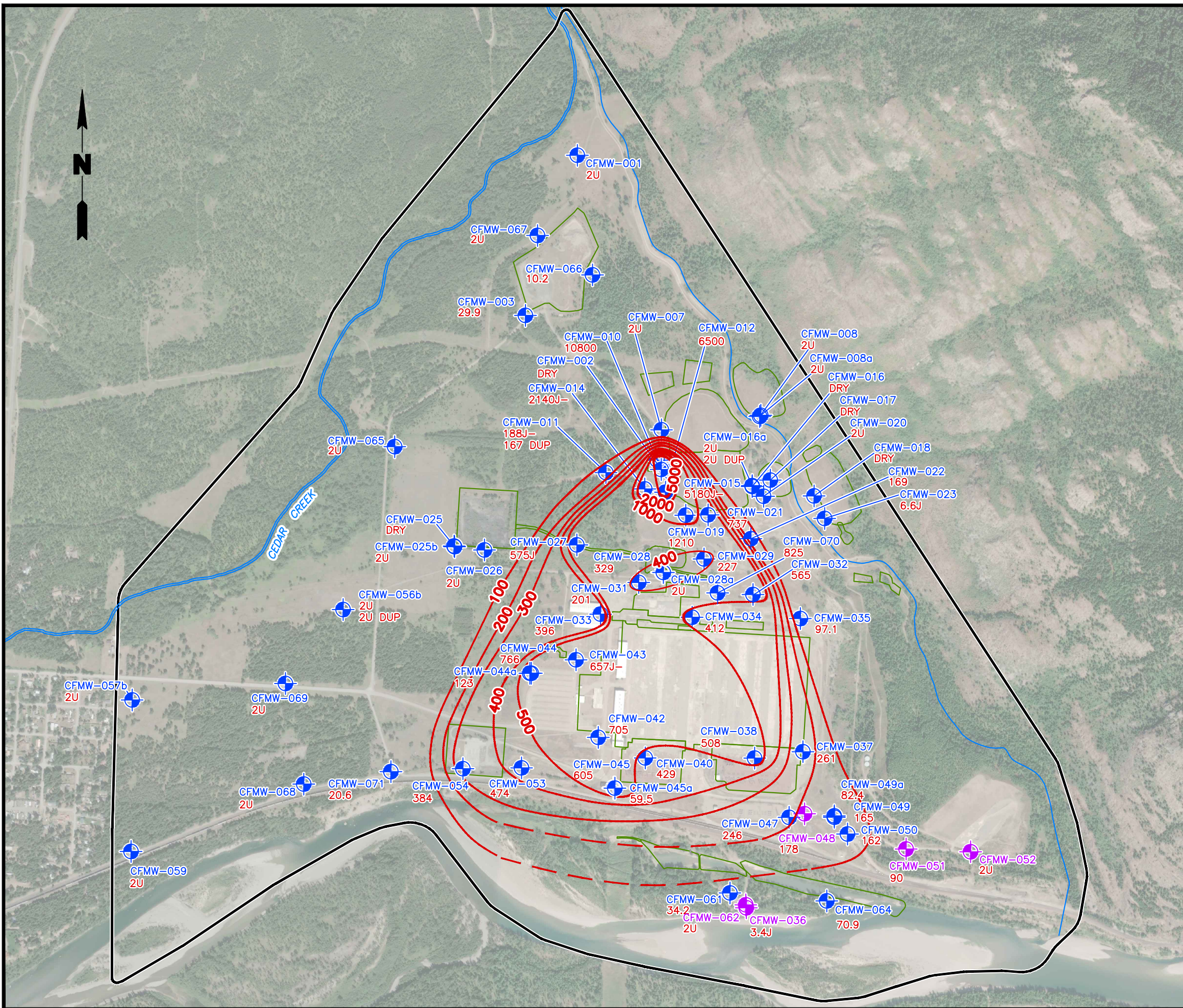
2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

	Compiled by: M.H.	Date: 06/23/25	FIGURE 2
	Prepared by: M.S.R.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y319.02.mxd		

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LEGEND

SITE STUDY AREA

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

405

TOTAL CYANIDE CONCENTRATIONS IN GROUNDWATER (UNITS IN ug/L)

DUP

DUPLICATE SAMPLE

J

ESTIMATED VALUE

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)

- NOTES
1. REMEDIAL GOAL FOR TOTAL CYANIDE = 200 ug/L

2. WELLS CFMW-036, CFMW-061, CFMW-062 AND CFMW-064 WERE ABANDONED IN 2020.

3. PUMPS REMOVED FROM THE FORMER PRODUCTION WELLS IN 2017 TO ALLOW FOR WATER LEVEL MEASUREMENTS AND SAMPLING.

1,00001,000

Title:

C C R
C D R D R
R DR C
C R 1
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

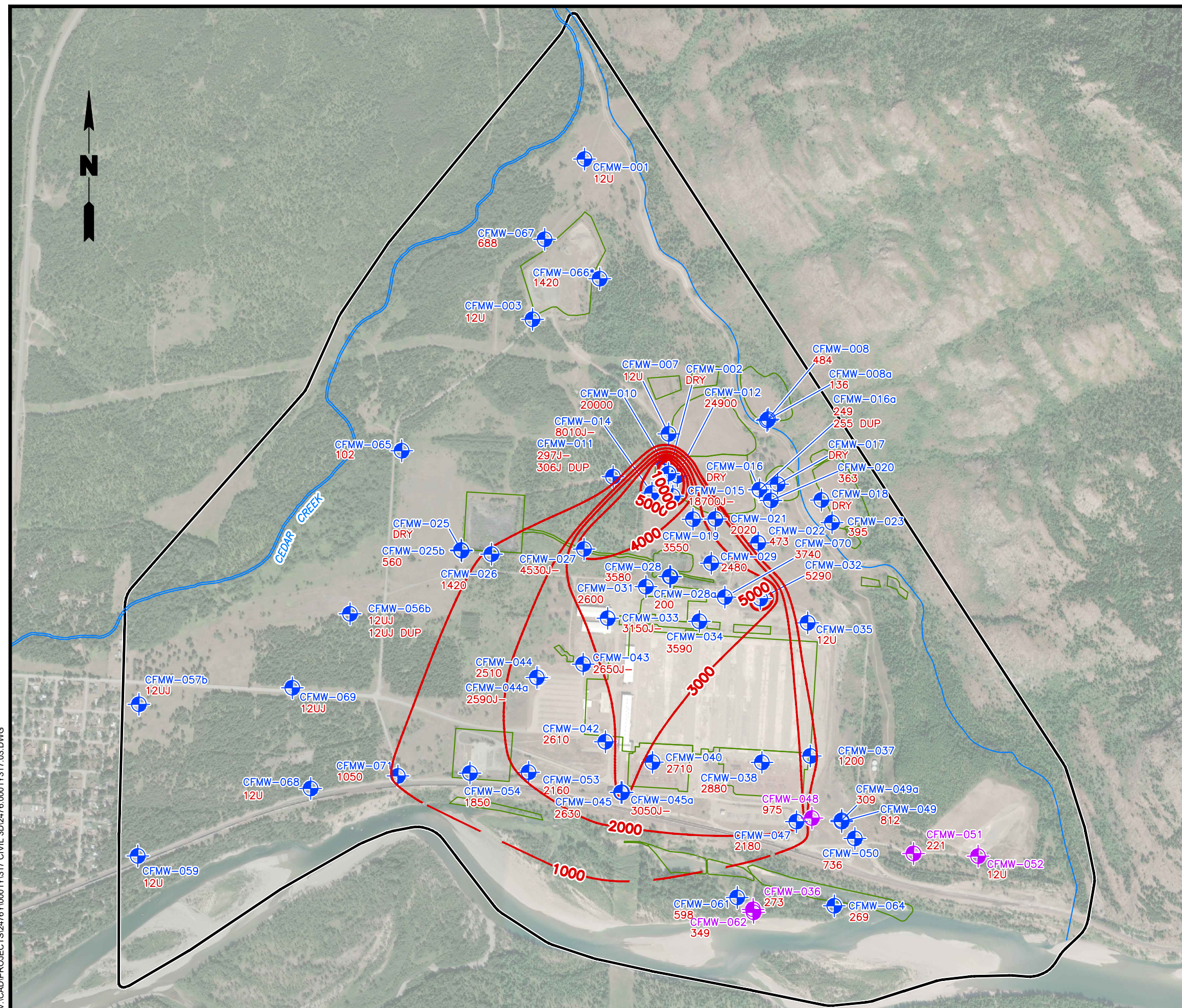
COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: M.H.
Prepared by: G.M.
Project Mgr: M.H.
File: 2476.0001Y317.02.DWG

Date: 21FEB24
Scale: AS SHOWN
Project: 2476.0001Y016

FIGURE

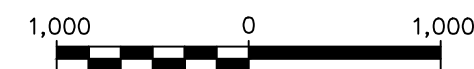


LEGEND

- | | |
|--|--|
|  | SITE STUDY AREA |
|  | 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 |
| 405 | FLUORIDE CONCENTRATIONS IN GROUNDWATER (UNITS IN $\mu\text{g/L}$) |
| DUP | DUPLICATE SAMPLE |
| | ESTIMATED VALUE |
| 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) |

NOTES

1. REMEDIAL GOAL FOR TOTAL FLUORIDE = 4,000 ug/L
2. WELLS CFMW-036, CFMW-061, CFMW-062 AND CFMW-064 WERE ABANDONED IN 2020.
3. PUMPS REMOVED FROM THE FORMER PRODUCTION WELLS IN 2017 TO ALLOW FOR WATER LEVEL MEASUREMENTS AND SAMPLING.



Title: C C R R D R R D R
R DR C
C R 1
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

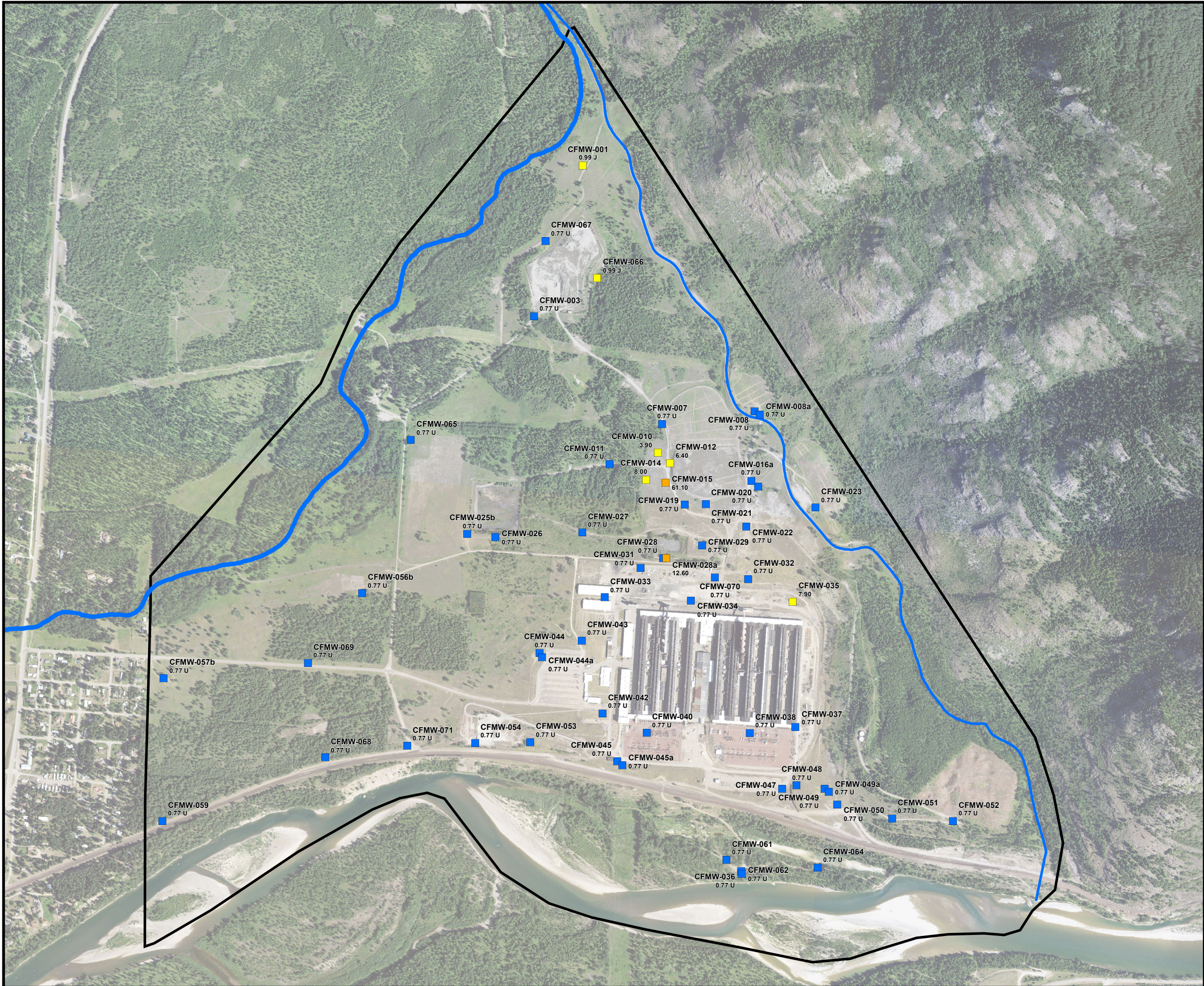
COLUMBIA FALLS ALUMINUM COMPANY



Compiled by: M.H.	Date: 21FEB24
Prepared by: G.M.	Scale: AS SHOWN
Project Mgr: M.H.	Project: 2476.0001Y016
File: 2476.0001Y317.03.DWG	

FIGURE

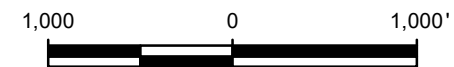
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LEGEND

- ANALYTE NOT DETECTED
- DETECTED AT A CONCENTRATION LESS THAN 10 µg/L
- GREATER THAN 10 µg/L
- SURFACE WATER FEATURE
- SITE STUDY AREA

- NOTES
1. REMEDIAL GOAL FOR ARSENIC DISSOLVED IS 10 µg/L
 2. WELLS CFMW-036, CFMW-061, CFMW-062, AND CFMW-064 WERE ABANDONED IN 2020
 3. PUMPS REMOVED FROM FORMER PRODUCTION WELLS IN 2017 TO ALLOW FOR WATER LEVEL MEASUREMENTS AND SAMPLING



Title:

**CONCENTRATIONS OF ARSENIC IN GROUNDWATER
UPPER HYDROGEOLOGIC UNIT
OCTOBER 2018**

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

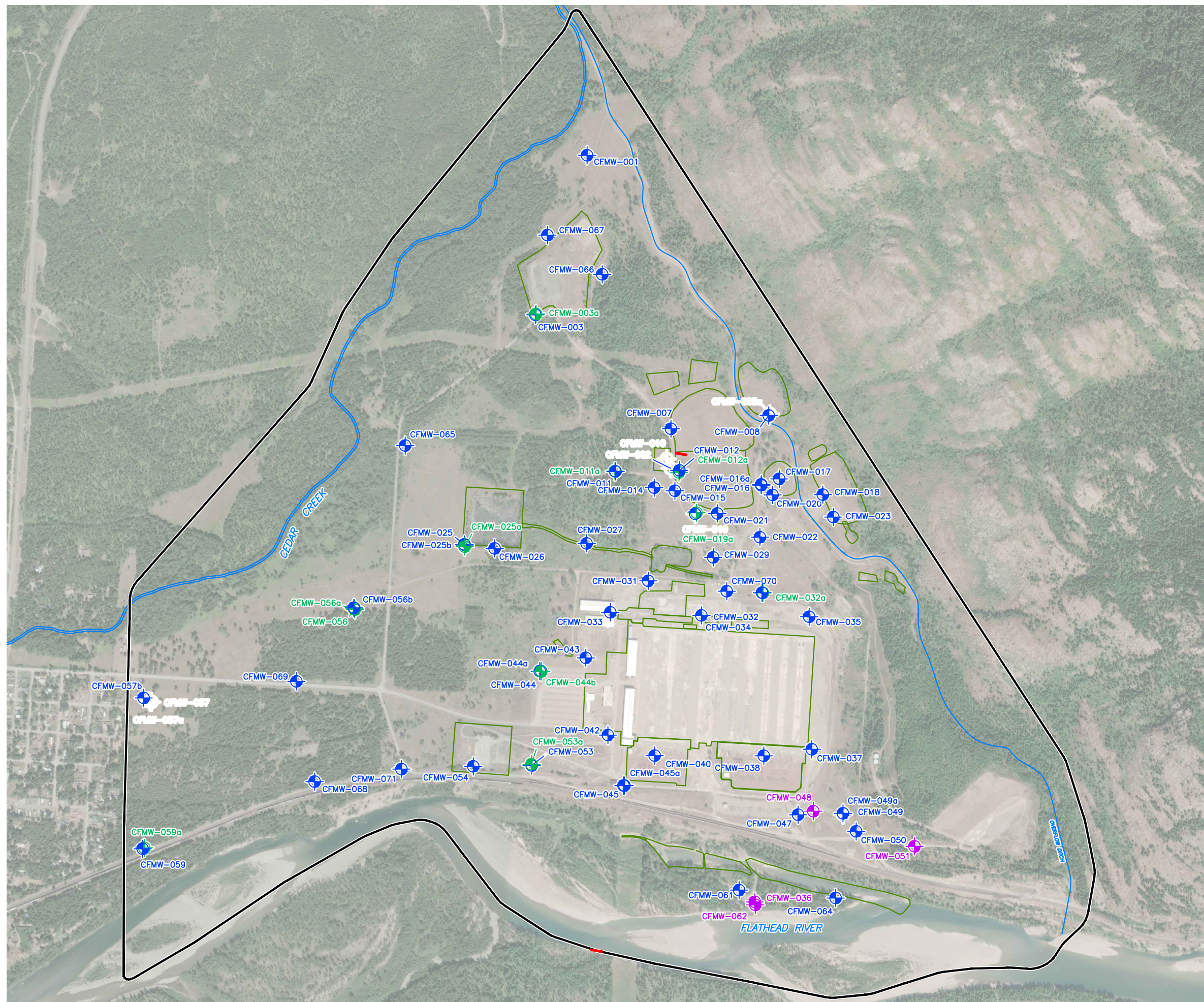
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

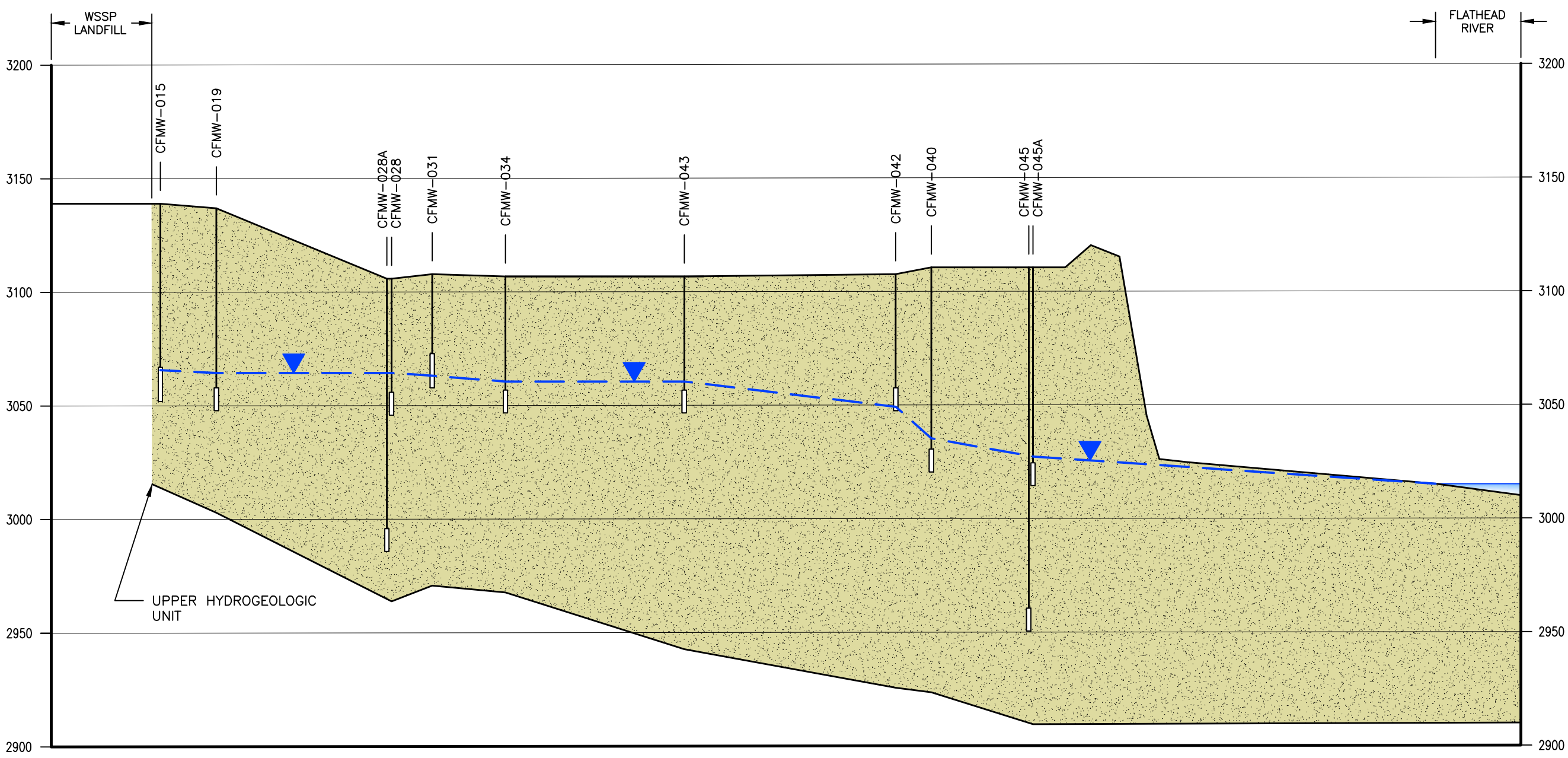
Compiled by: L.J.	Date: 01/06/25
Prepared by: M.S.R.	Scale: AS SHOWN
Project Mgr: M.H.	Project: 2476.0001Y016
File: 2476.0001Y319.5.mxd	

FIGURE

5



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KEY

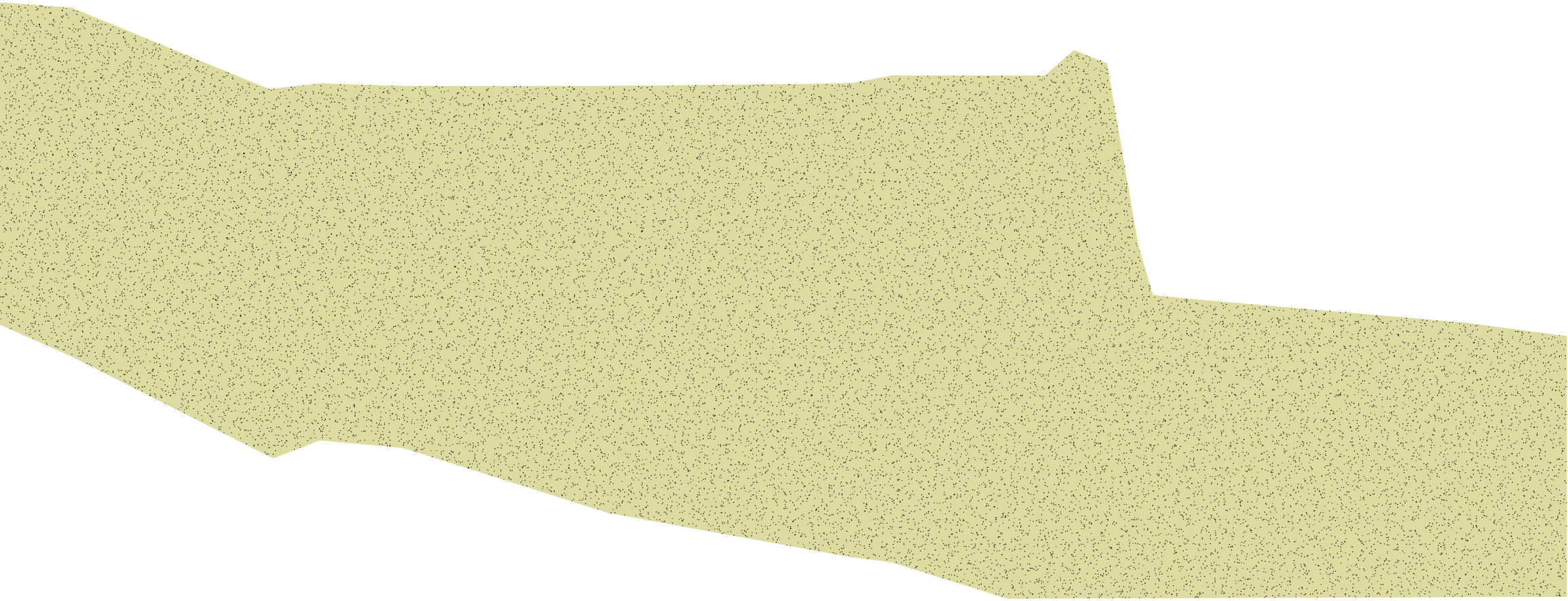
 APPROXIMATE WATER TABLE

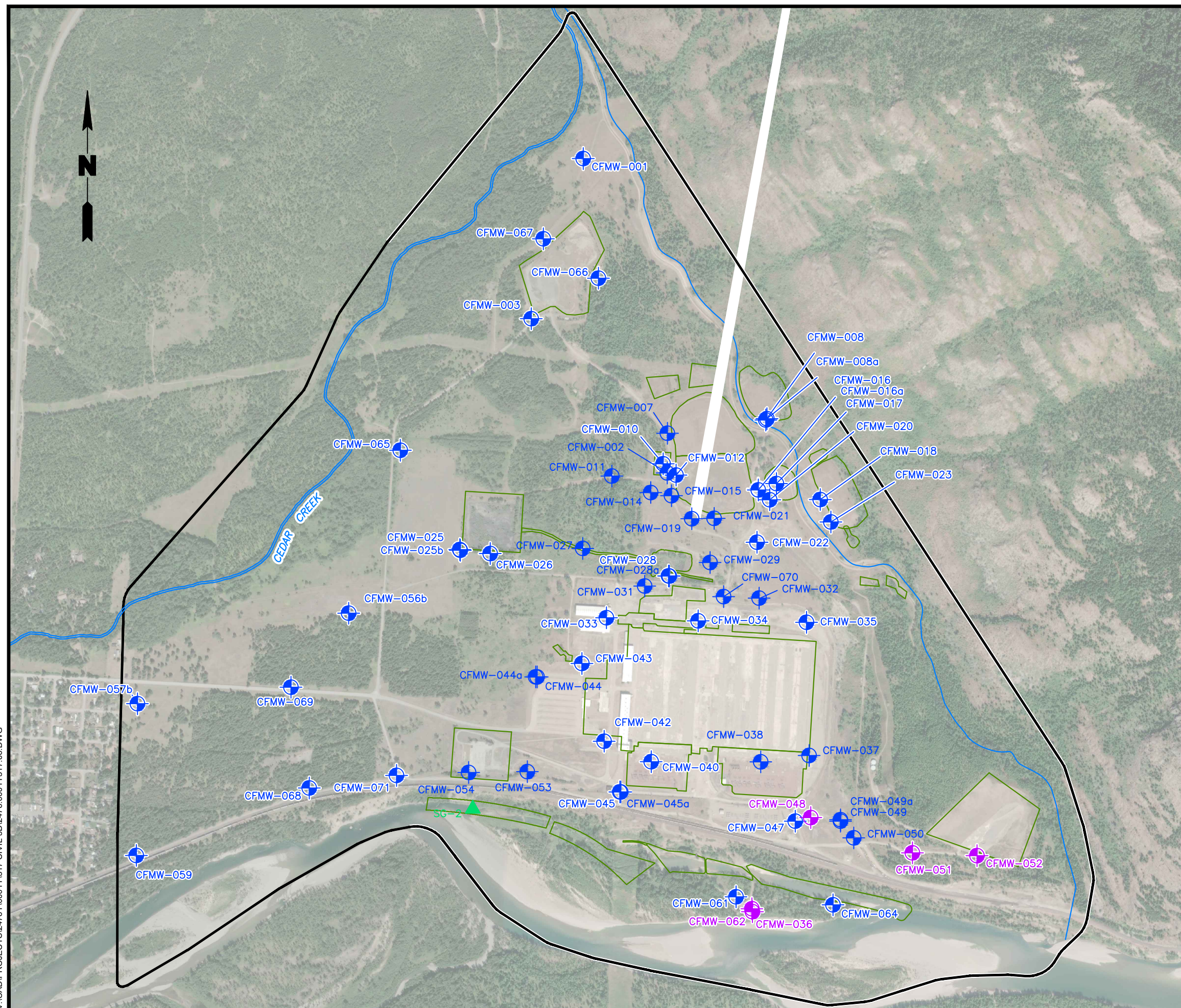
CROSS SECTION A-A'

HORIZONTAL SCALE: 1" = 400'

VERTICAL SCALE: 1" = 50'

Title:			
R D DR C			
CR C - C			
DR DR C			
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA			
Prepared for:			
COLUMBIA FALLS ALUMINUM COMPANY			
	Compiled by: M.H.	Date: 21FEB24	FIGURE
	Prepared by: G.M.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y317.01.DWG		



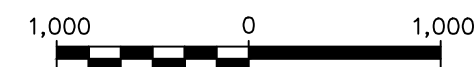


LEGEND

- | | |
|--|--|
|  | SITE STUDY AREA |
|  | 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 |
| SG-2  | PROPOSED LOCATION AND DESIGNATION OF STAFF GAUGE |

NOTES

1. WELLS CFMW-036, CFMW-061, CFMW-062 AND CFMW-064 WERE ABANDONED IN 2020.
2. PUMPS REMOVED FROM THE FORMER PRODUCTION WELLS IN 2017 TO ALLOW FOR WATER LEVEL MEASUREMENTS AND SAMPLING.



Title:

M R C D

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:

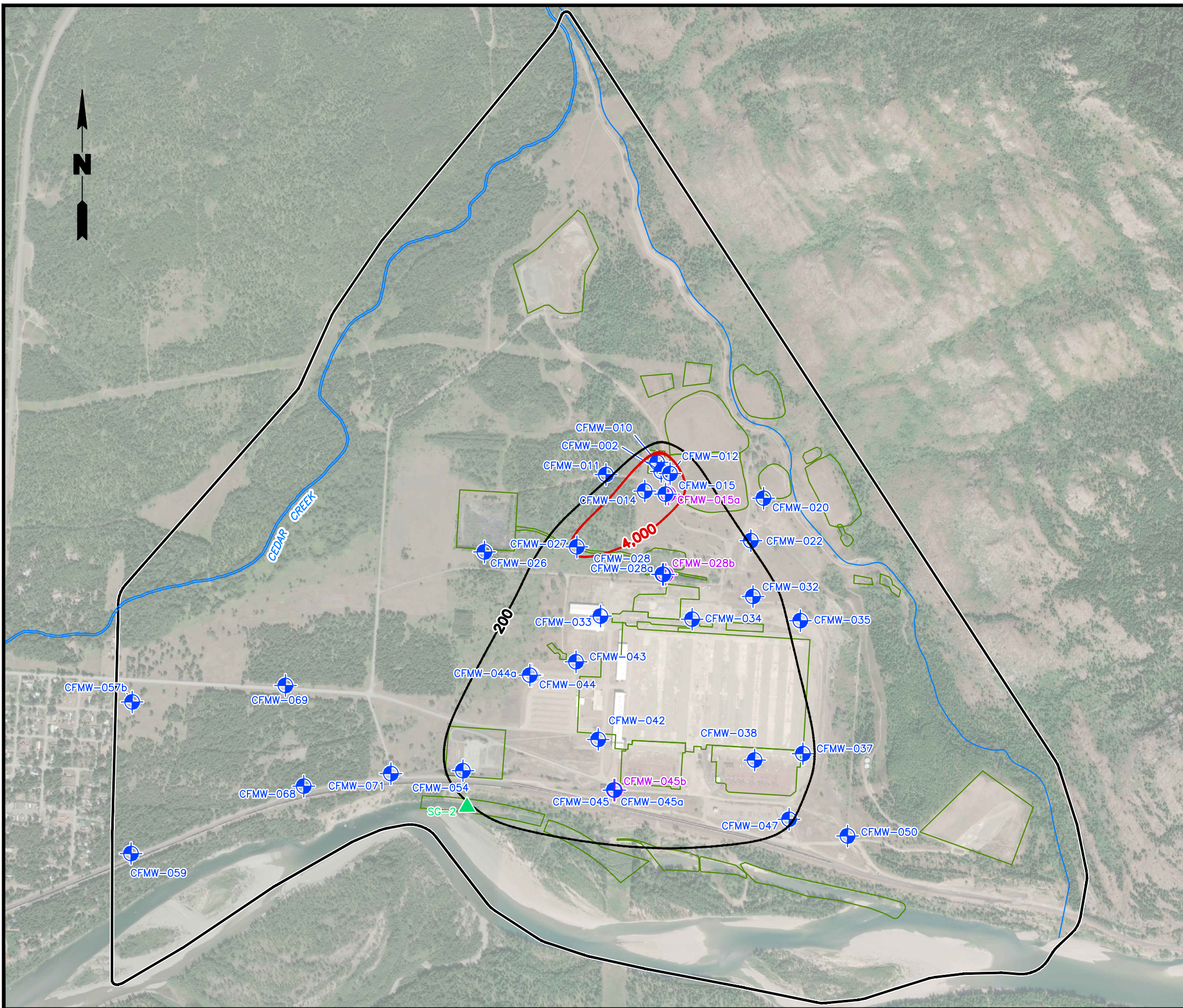
COLUMBIA FALLS ALUMINUM COMPANY



Compiled by: M.H.	Date: 21FEB24
Prepared by: G.M.	Scale: AS SHOWN
Project Mgr: M.H.	Project: 2476.0001Y016
File: 2476.0001Y317.06.DWG	

FIGURE

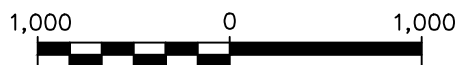
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LEGEND

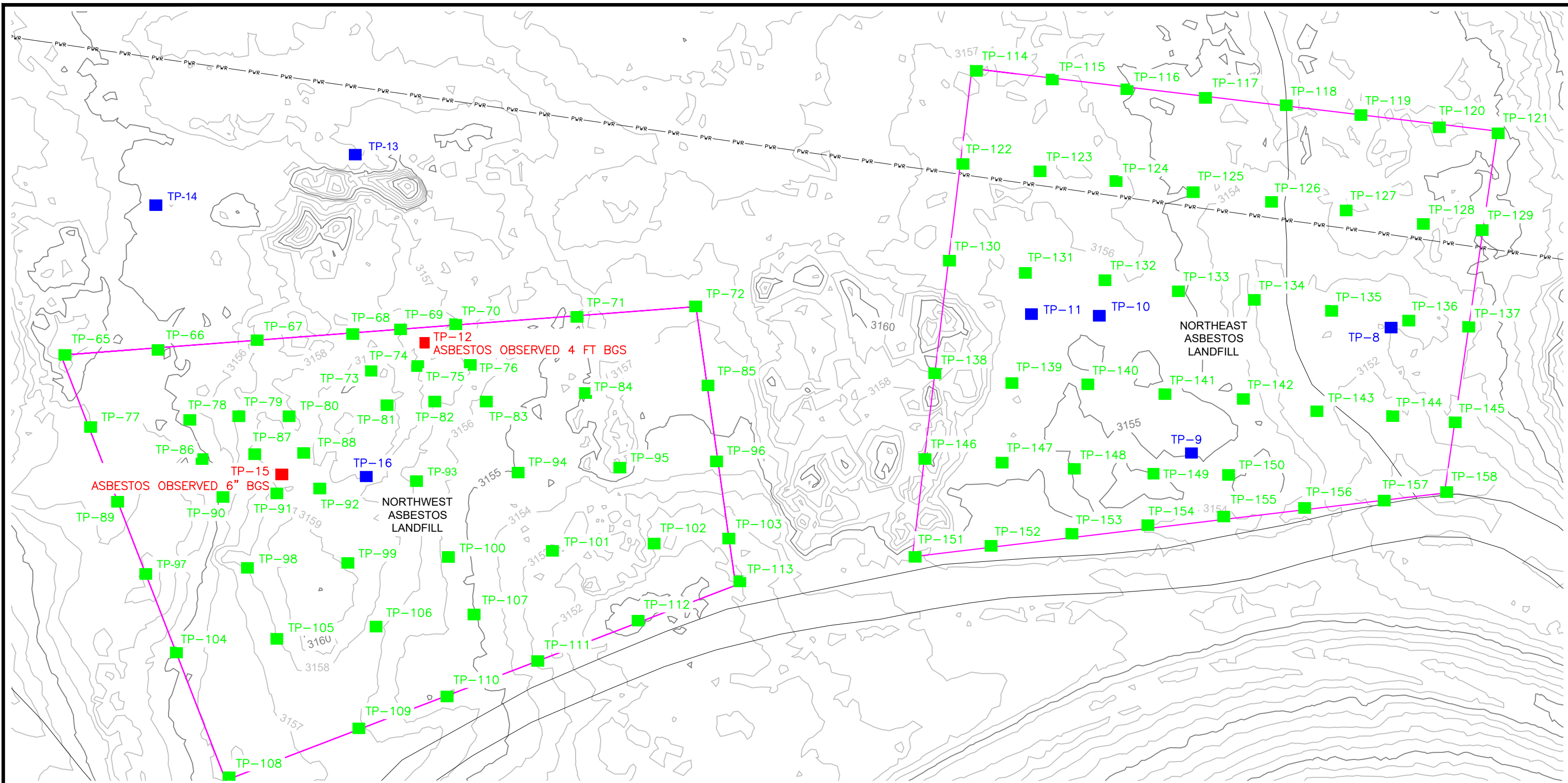
	SITE STUDY AREA
	SURFACE WATER FEATURE
	SITE FEATURE
	LOCATION AND DESIGNATION OF MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
	LOCATION AND DESIGNATION OF PROPOSED MONITORING WELL SCREENED IN UPPER HYDROGEOLOGIC UNIT
	PROPOSED LOCATION AND DESIGNATION OF STAFF GAUGE
	CONTOUR LINE OF TOTAL CYANIDE CONCENTRATION
	CONTOUR LINE OF TOTAL FLUORIDE CONCENTRATION

- NOTES
1. OCTOBER 2018 FLUORIDE AND CYANIDE REMEDIAL OBJECTIVE CONTOURS.
 2. ONLY SELECTED WELLS SHOWN.



Title:			
M R D M C			
2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA			
Prepared for:			
COLUMBIA FALLS ALUMINUM COMPANY			
	Compiled by: M.H.	Date: 24JUN25	FIGURE
	Prepared by: G.M.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y317.07.DWG		

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LEGEND

3170

3171

PWR

TP-16

TP-15

ASBESTOS

OBSERVED 6" BGS

TP-93

EXISTING MINOR CONTOUR LINE

EXISTING MAJOR CONTOUR LINE

EXISTING ASBESTOS LANDFILL EXTENTS

EXISTING POWER LINE

EXISTING ASBESTOS TEST PIT (NEGATIVE RESULT)

EXISTING ASBESTOS TEST PUT (POSITIVE RESULT)

POSITIVE ASBESTOS SAMPLE LOCATION BELOW GROUND SURFACE (BGS)

PROPOSED PRE-DESIGN INVESTIGATION ASBESTOS TEST PIT

Title:

R R D C

2000 ALUMIUM DRIVE
COLUMBIA FALLS, MT

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: MMH

Prepared by: MMH

Project Mgr: MH

File: 2476.0001Y317.05.DWG

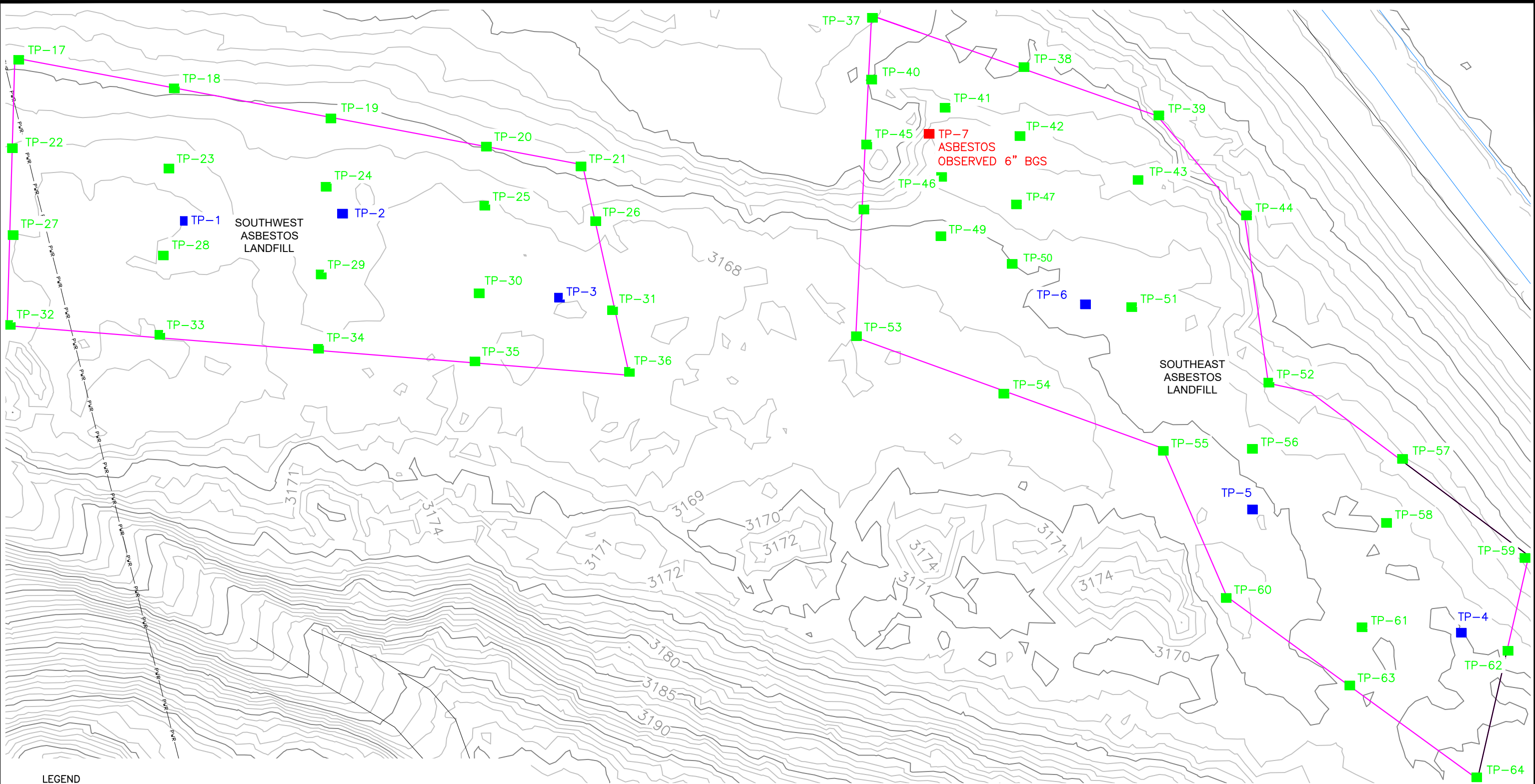
Date: 4/5/2024

Scale: AS SHOWN

Project: 2476.0001Y016

FIGURE
1

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LEGEND

3170

3171

PWR

PWR

PWR

PWR

TP-1

EXISTING MINOR CONTOUR LINE

EXISTING MAJOR CONTOUR LINE

EXISTING ASBESTOS LANDFILL EXTENTS

EXISTING POWER LINE

EXISTING ASBESTOS TEST PIT (NEGATIVE RESULT)

TP-7

ASBESTOS

OBSERVED 6" BGS

TP-17

EXISTING ASBESTOS TEST PUT (POSITIVE RESULT)

POSITIVE ASBESTOS SAMPLE LOCATION BELOW GROUND SURFACE (BGS)

PROPOSED PRE-DESIGN INVESTIGATION ASBESTOS TEST PIT

N

30'

0

30'

Title:

R

R

D

C

D

2000 ALUMIUM DRIVE
COLUMBIA FALLS, MT

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY

ROUX

Compiled by: MMH

Date: 4/5/2024

Prepared by: MMH

Scale: AS SHOWN

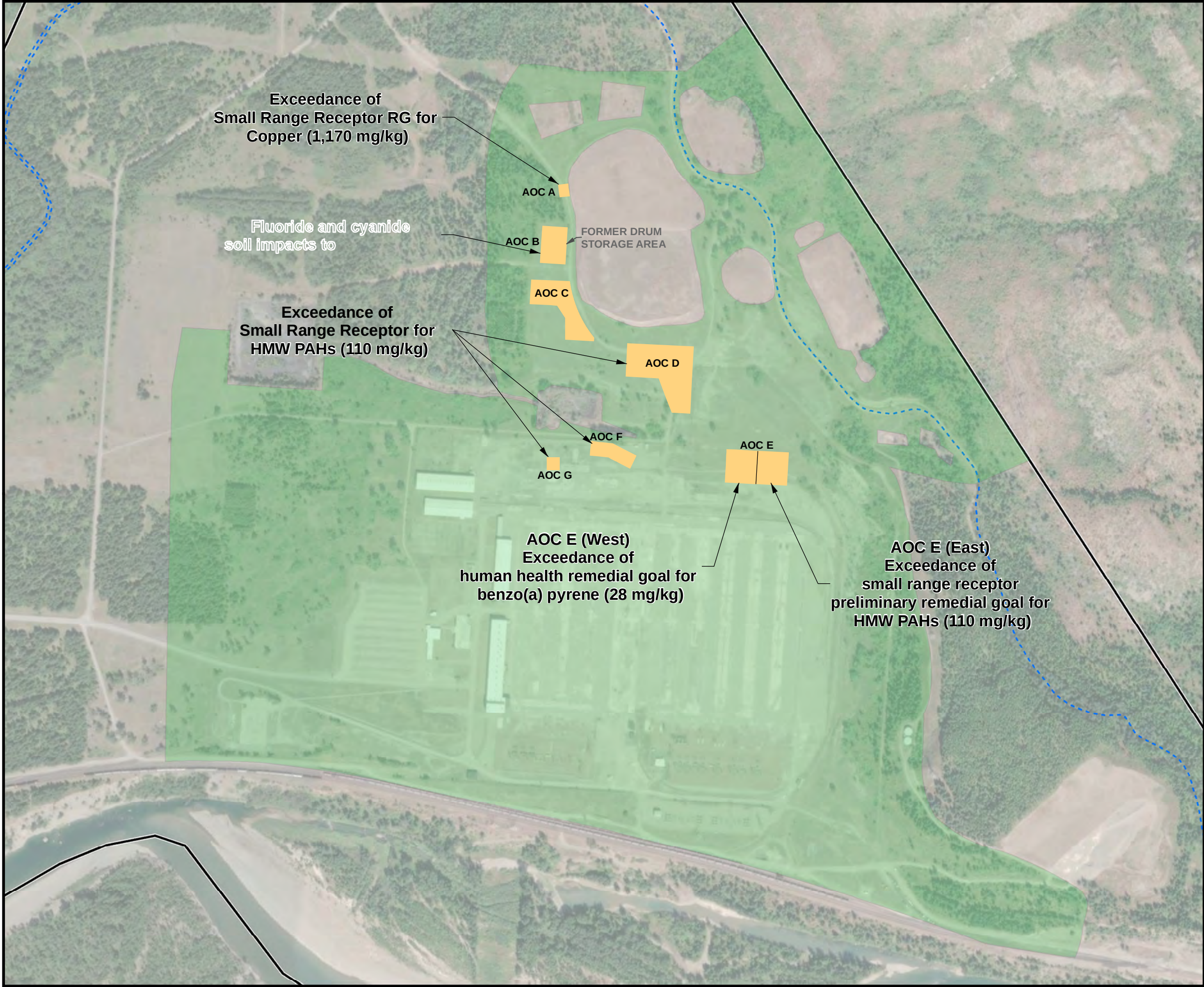
Project Mgr: MH

Project: 2476.0001Y016

File: 2476.0001Y317.05.DWG

FIGURE

11



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LEGEND

- AREAS OF CONCERN
- SOIL DECISION UNIT
- CREEK FEATURES
- SITE BOUNDARY

NOTES

1. DELINEATION TO BE CONDUCTED AT AOCS A TO G EXCEPT FOR B AND D.
2. MG/KG - MILLIGRAMS PER KILOGRAM
3. HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS



Title:

SOIL DU3 AREAS OF CONCERN

2000 ALUMINUM DRIVE
COLUMBIA FALLS, MONTANA

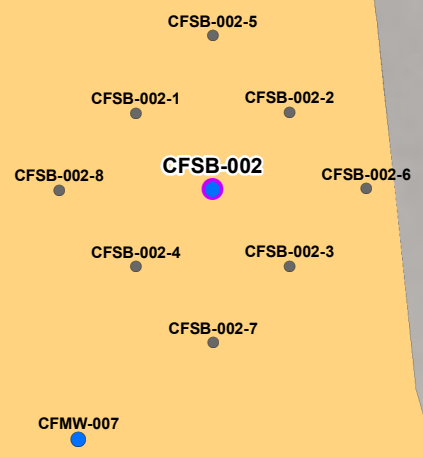
Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX	Compiled by: M.H.	Date: 01/29/25	FIGURE 12
	Prepared by: M.S.R.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y319.12.mxd		



AOC A

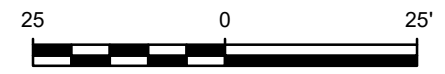


LEGEND

- SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR COPPER (1,170 MG/KG)
- STEP-OUT LOCATION
- SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR COPPER (1,170 MG/KG)
- ISM GRID AREA
- LANDFILL
- AREAS OF CONCERN
- SOIL DECISION UNIT

NOTES

1. MG/KG - MILLIGRAMS PER KILOGRAM
2. GROUP 1 LOCATIONS INCLUDE CFSB-002-1 TO CFSB-002-4
3. GROUP 2 LOCATIONS INCLUDE CFSB-002-5 TO CFSB-002-8



Title:

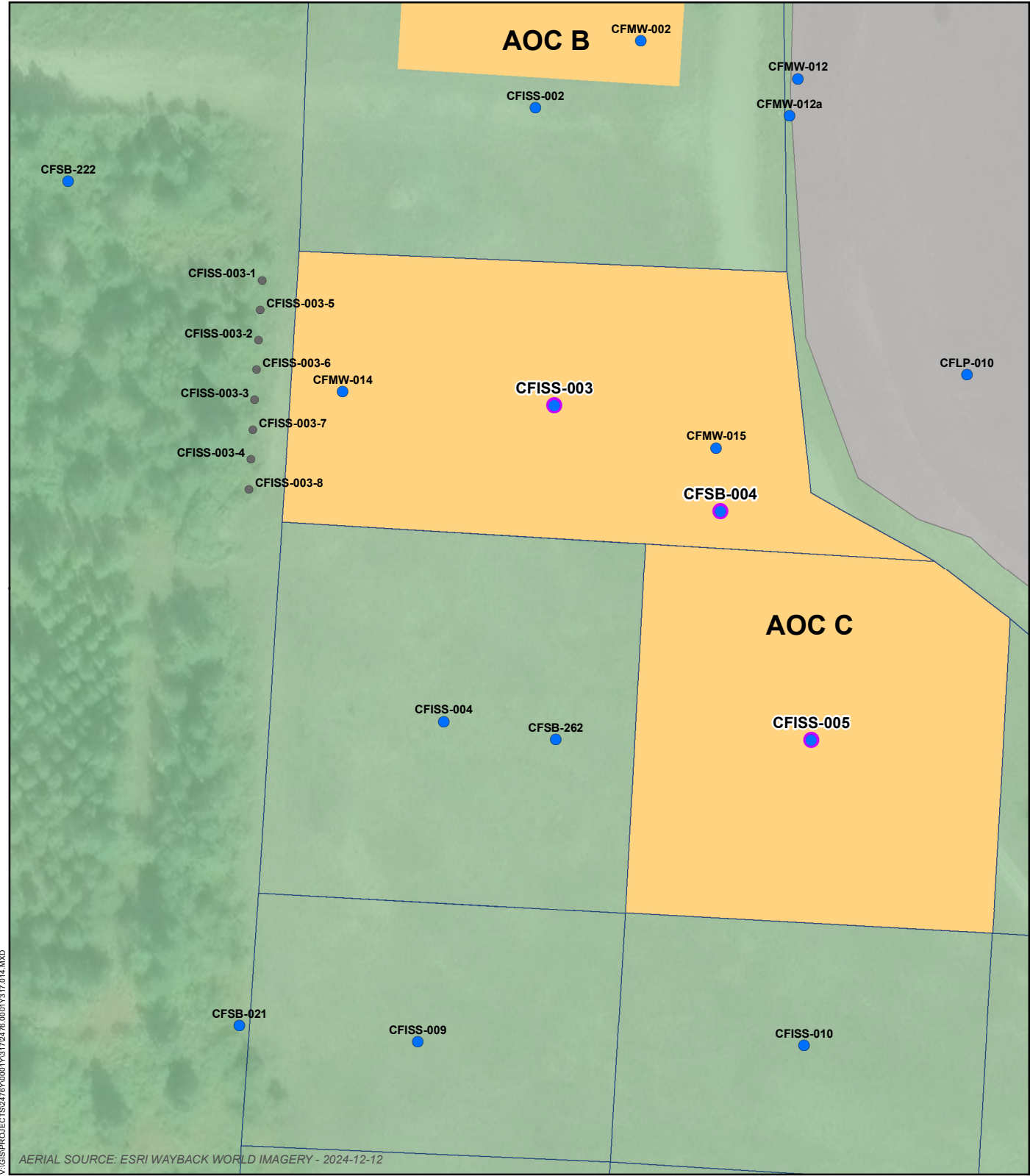
**SOIL SAMPLING
STEP-OUT
LOCATIONS**

AOC A
SOIL DECISION UNIT 3

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

Compiled by: M.H.	Date: 01/27/25	FIGURE 13
Prepared by: M.S.R.	Scale: AS SHOWN	
Project Mgr: M.H.	Project: 2476.0001Y016	
File: 2476.0001Y317.013.mxd		



LEGEND

- SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- STEP-OUT LOCATION
- SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- ISM GRID AREA
- LANDFILL
- AREAS OF CONCERN
- SOIL DECISION UNIT

NOTES

- HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS
- MG/KG - MILLIGRAMS PER KILOGRAM
- GROUP 1 INCLUDES CFISS-003-1 TO CFISS-003-4
- GROUP 2 INCLUDES CFISS-003-5 TO CFISS-003-8



Title:

SOIL SAMPLING
STEP-OUT
LOCATIONS

AOC C
SOIL DECISION UNIT 3

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

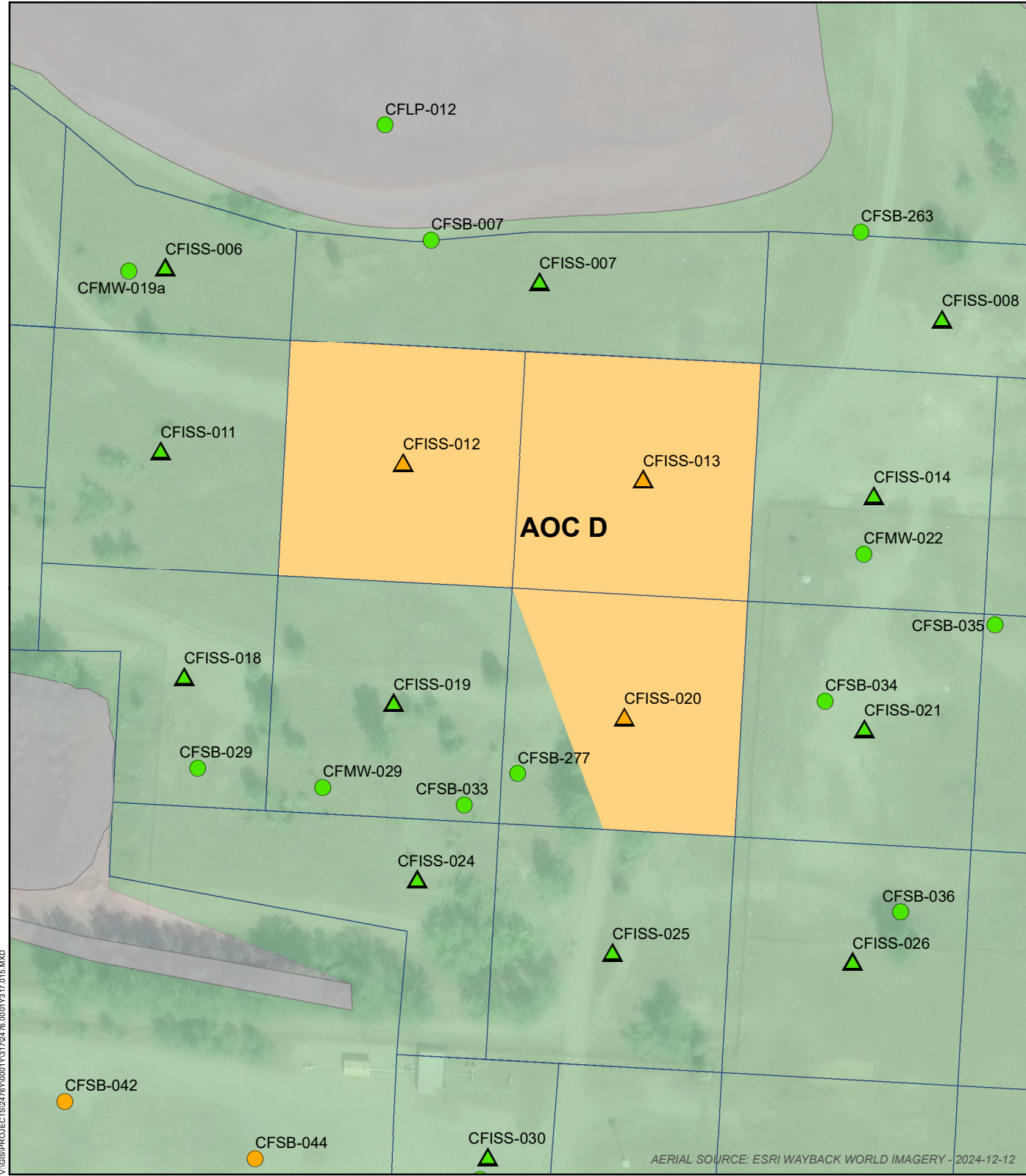
ROUX

Compiled by: M.H.
Prepared by: M.S.R.
Project Mgr: M.H.

Date: 01/24/25
Scale: AS SHOWN
Project: 2476.0001Y016

File: 2476.0001Y317.014.mxd

FIGURE
14



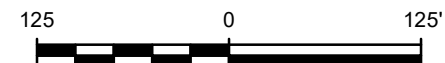
LEGEND

SO - ISM

- SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SAMLL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- ISM GRID AREA
- LANDFILL
- AREAS OF CONCERN
- SOIL DECISION UNIT

NOTES

- ALL CONCENTRATIONS ARE IN MILLIGRAMS PER KILOGRAM (MG/KG)
- HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS
- MG/KG - MILLIGRAMS PER KILOGRAM



Title:

ISM
SOIL SAMPLING
LOCATIONS

AOC D
SOIL DECISION UNIT 3

Prepared for:

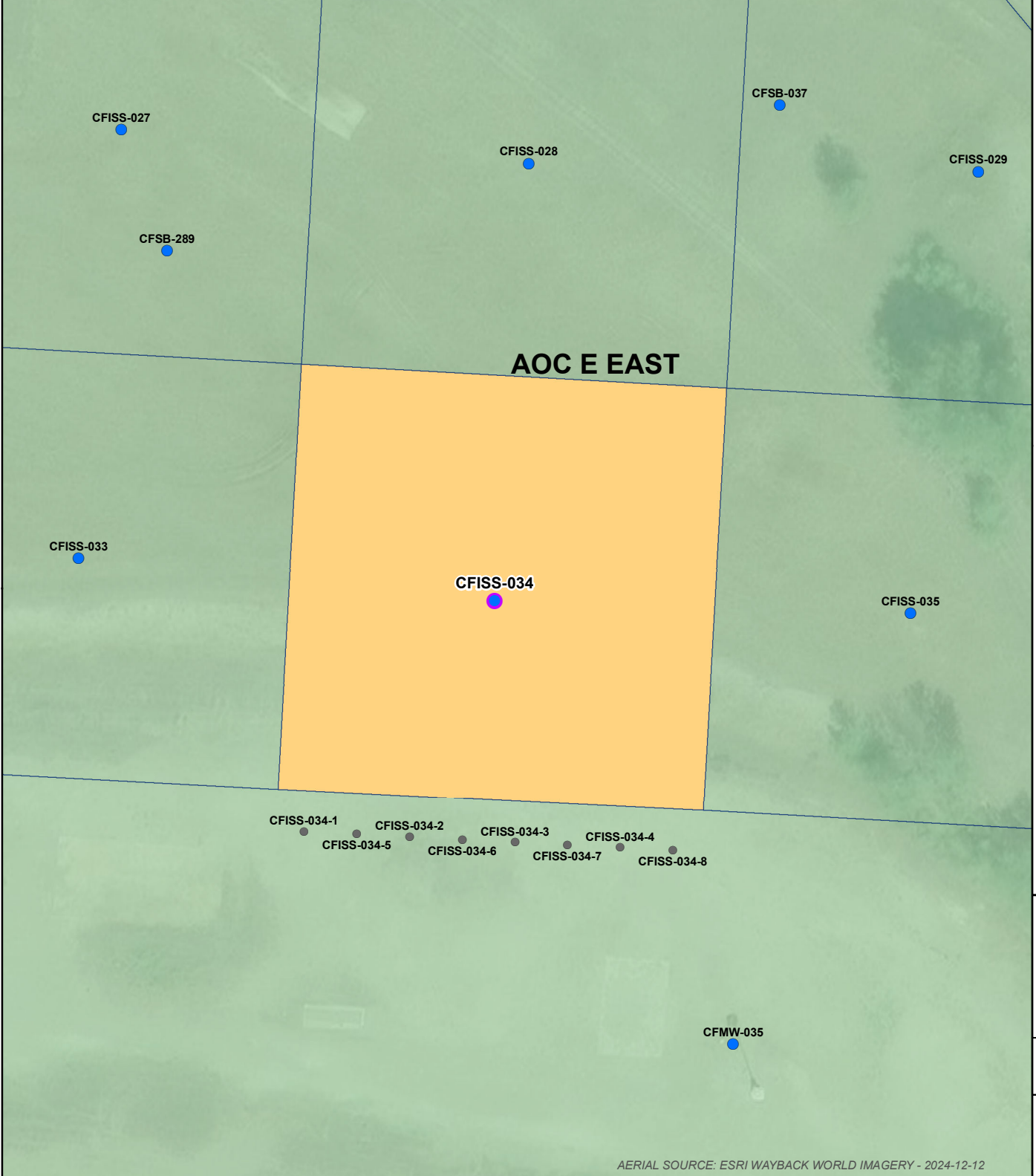
COLUMBIA FALLS ALUMINUM COMPANY, LLC



Compiled by: M.H.	Date: 01/22/25
Prepared by: M.S.R.	Scale: AS SHOWN
Project Mgr: M.H.	Project: 2476.0001Y016
File: 2476.0001Y317.015.mxd	

FIGURE

15



LEGEND

- SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- STEP-OUT LOCATION
- SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
- ISM GRID AREA
- AREAS OF CONCERN
- SOIL DECISION UNIT

NOTES

1. HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS
2. MG/KG - MILLIGRAMS PER KILOGRAM
3. GROUP 1 INCLUDES CFISS-034-1 TO CFISS-034-4
4. GROUP 2 INCLUDES CFISS-034-5 TO CFISS-034-8



Title:

SOIL SAMPLING
STEP-OUT
LOCATIONS

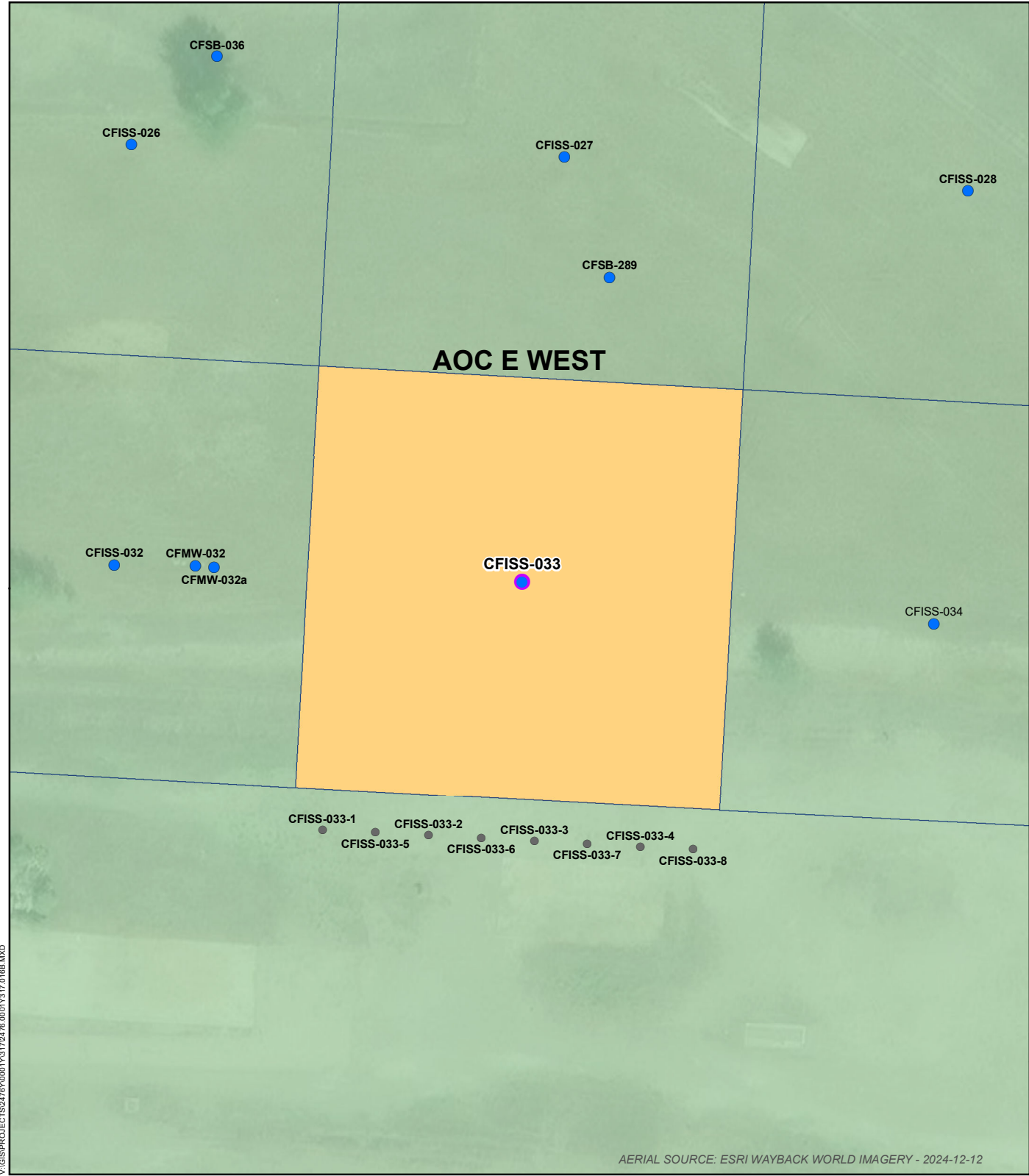
AOC E (EAST)
SOIL DECISION UNIT 3

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

Compiled by: M.H.	Date: 01/24/25	FIGURE 16A
Prepared by: M.S.R.	Scale: AS SHOWN	
Project Mgr: M.H.	Project: 2476.0001Y016	
File: 2476.0001Y317.016A.mxd		

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AERIAL SOURCE: ESRI WAYBACK WORLD IMAGERY - 2024-12-12

LEGEND

- SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE HUMAN HEALTH REMEDIATION GOAL FOR BENZO(A)PYRENE (28 MG/KG)
- STEP-OUT LOCATION
- SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE HUMAN HEALTH REMEDIATION GOAL FOR BENZO(A)PYRENE (28 MG/KG)
- ISM GRID AREA
- AREAS OF CONCERN
- SOIL DECISION UNIT

NOTES

- 1. MG/KG - MILLIGRAMS PER KILOGRAM
- 2. GROUP 1 INCLUDES CFISS-033-1 TO CFISS-033-4
- 3. GROUP 2 INCLUDES CFISS-033-5 TO CFISS-033-8



Title:

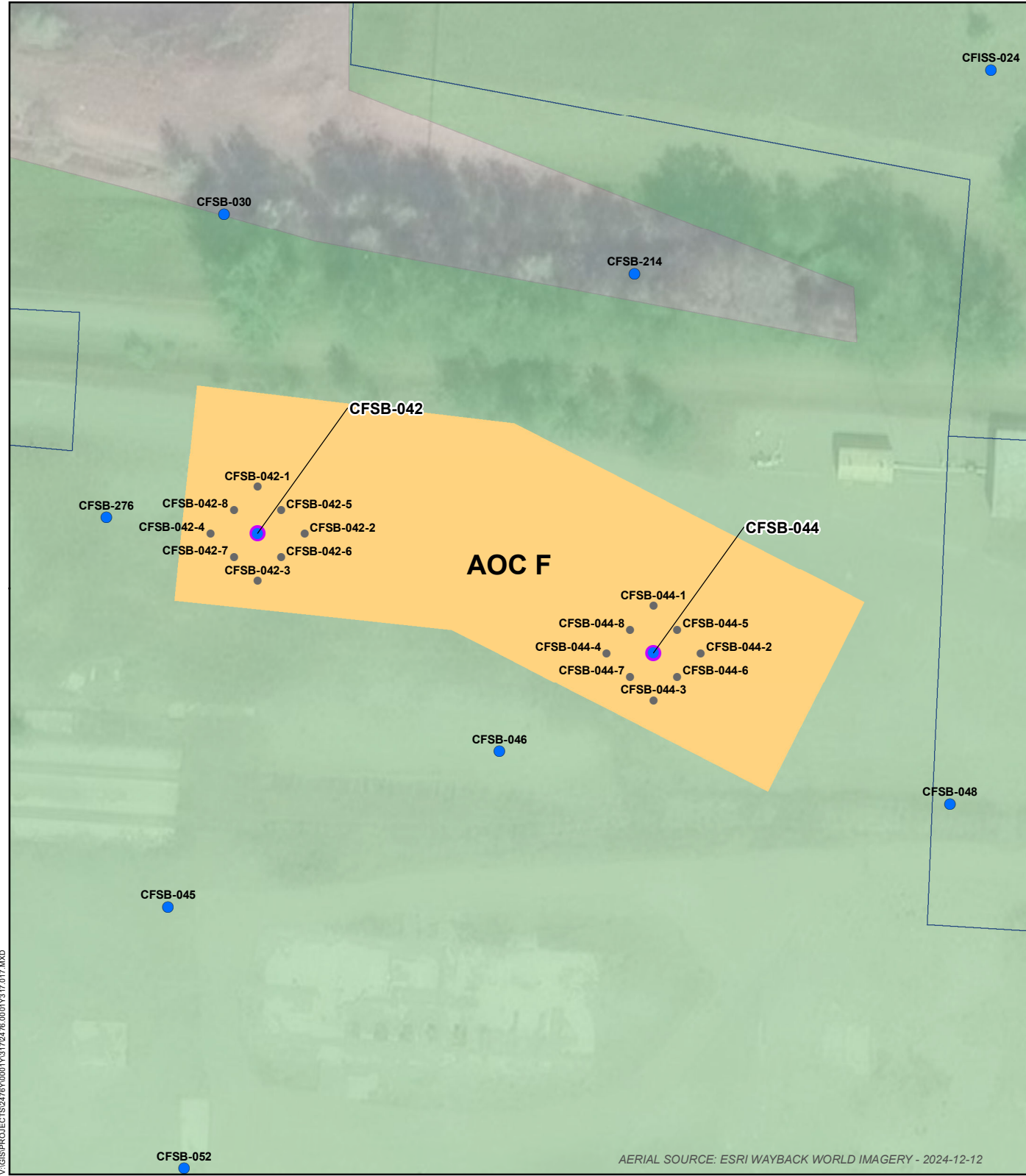
SOIL SAMPLING
STEP-OUT
LOCATIONS

AOC E (WEST)
SOIL DECISION UNIT 3

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

Compiled by: M.H.	Date: 01/27/25	FIGURE 16B
Prepared by: M.S.R.	Scale: AS SHOWN	
Project Mgr: M.H.	Project: 2476.0001Y016	
File: 2476.0001Y317.016B.mxd		



LEGEND

-  SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
-  STEP-OUT LOCATION
-  SOIL SAMPLE LOCATION WITH A RESULT LESS THAN THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)
-  ISM GRID AREA
-  AREAS OF CONCERN
-  SOIL DECISION UNIT
-  SITE BOUNDARY

NOTES

- HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS
- MG/KG - MILLIGRAMS PER KILOGRAM
- GROUP 1 INCLUDES
CFSB-042-1 TO CFSB-042-4
CFSB-044-1 TO CFSB-044-4
- GROUP 2 INCLUDES
CFSB-042-5 TO CFSB-042-8
CFSB-044-5 TO CFSB-044-8



Title:

SOIL SAMPLING
STEP-OUT
LOCATIONS

AOC F
SOIL DECISION UNIT 3

Prepared for:

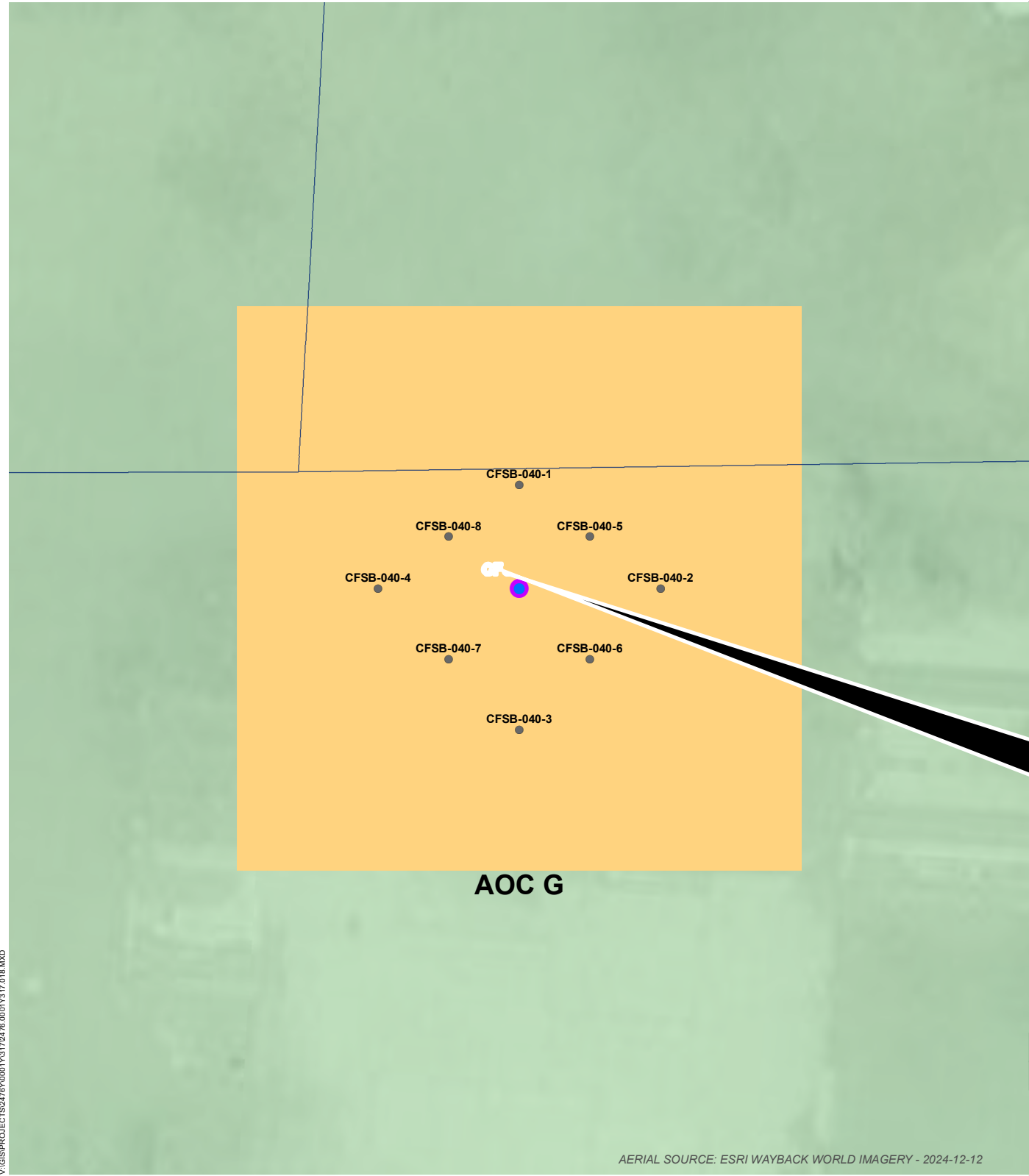
COLUMBIA FALLS ALUMINUM COMPANY, LLC



Compiled by: M.H.	Date: 01/27/25	FIGURE 17
Prepared by: M.S.R.	Scale: AS SHOWN	
Project Mgr: M.H.	Project: 2476.0001Y016	
File: 2476.0001Y317.017.mxd		

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LEGEND

SOIL SAMPLE LOCATION WITH AN EXCEEDANCE OF THE SMALL RANGE RECEPTOR PRELIMINARY REMEDIAL GOAL FOR HMW PAH (110 MG/KG)

STEP-OUT LOCATION

ISM GRID AREA

AREAS OF CONCERN

SOIL DECISION UNIT

- NOTES
1. HMW PAH - HIGH MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS
 2. MG/KG - MILLIGRAMS PER KILOGRAM
 3. GROUP 1 INCLUDES CFSB-040-1 TO CFSB-040-4
 4. GROUP 1 INCLUDES CFSB-040-5 TO CFSB-040-8

20 0 20'

Title:

SOIL SAMPLING
STEP-OUT
LOCATIONS

AOC G
SOIL DECISION UNIT 3

Prepared for:

COLUMBIA FALLS ALUMINUM COMPANY, LLC

Compiled by: M.H.	Date: 01/27/25
Prepared by: M.S.R.	Scale: AS SHOWN
Project Mgr: M.H.	Project: 2476.0001Y016
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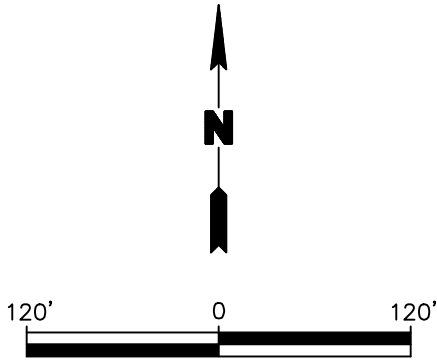
FIGURE

18

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- LEGEND
- NORTH PERCOLATION POND DECISION UNIT
 - SITE FEATURES WITHIN NPP DU
 - AREA OF PROPOSED EXCAVATION
 - NPP-TP1 LOCATION OF PROPOSED NPP DU PRE-DESIGN INVESTIGATION TEST PIT

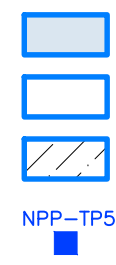
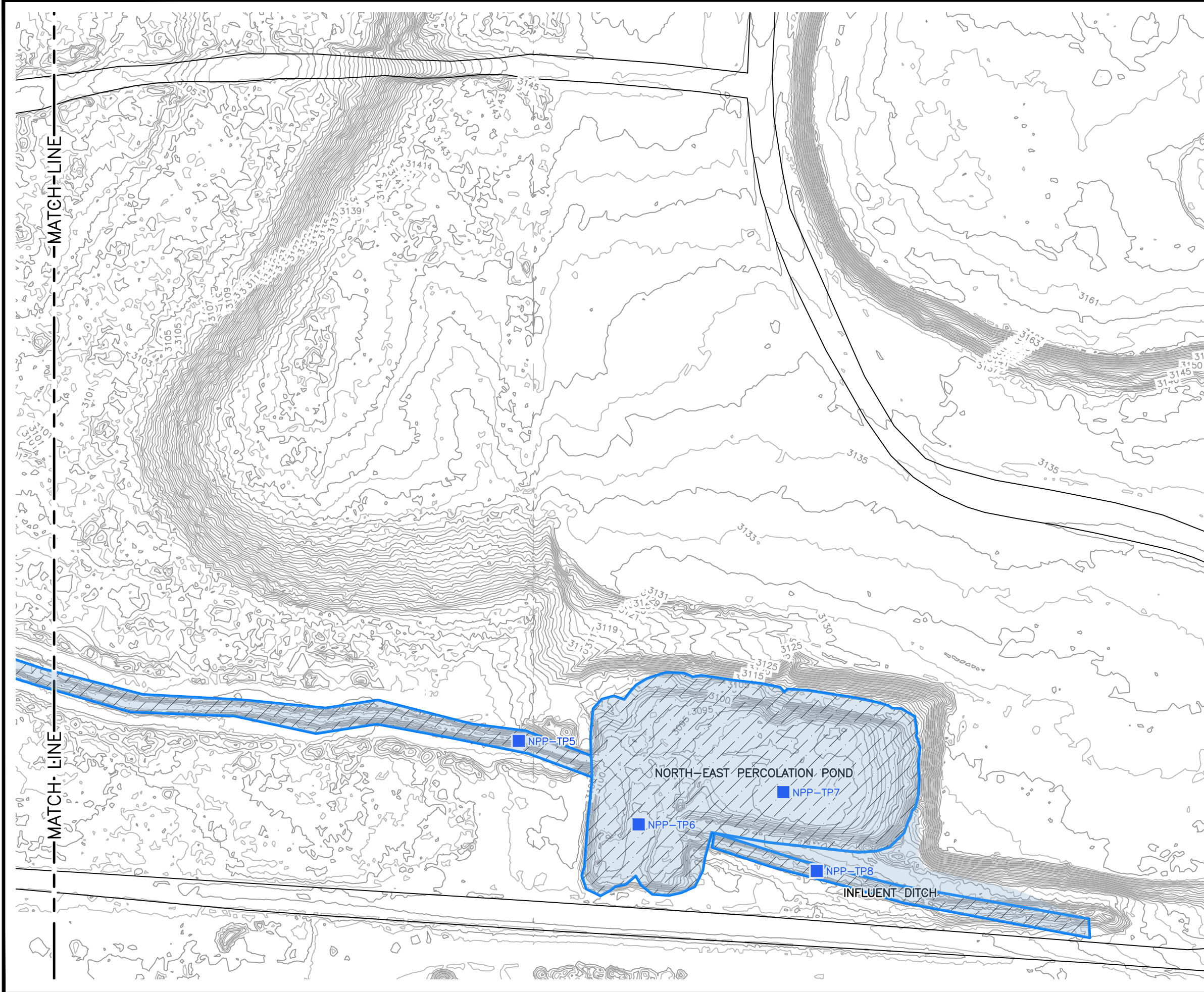


Title: **R RC D**
D C D
M C

2000 ALUMINUM DRIVE, COLUMBIA FALLS, MONTANA

Prepared for:
COLUMBIA FALLS ALUMINUM COMPANY

	Compiled by: M.H.	Date: 03MAR24	FIGURE 1
	Prepared by: G.M.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y317.04.DWG		



Title:			
Prepared for:			
ROUX	Compiled by:	Date:	FIGURE
	Prepared by:	Scale:	
	Project Mgr:	Project:	
	File:		

Pre-Design Investigation Work Plan
2000 Aluminum Drive, Columbia Falls, Montana

APPENDICES

- A. MRCE Slurry Wall PDI Work Plan
- B. MRCE WSSP Landfill Settlement Study Work Plan
- C. MRCE Industrial Landfill Geotechnical Investigation

Pre-Design Investigation Work Plan
2000 Aluminum Drive, Columbia Falls, Montana

APPENDIX A

MRCE Slurry Wall PDI Work Plan

Slurry Wall PDI Study Work Plan
Columbia Falls Aluminum Company
Columbia Falls, Montana

Roux Inc.
1301 W. 22nd Street, Suite 800
Oak Brook, IL 60523

March 21, 2024 (revised June 27, 2025)



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March 21, 2024 (*revised June 27, 2025*)

Roux
1301 W. 22nd Street, Suite 800
Oak Brook, IL 60523

Attn: Mr. Martin Hamper, Director

Re: Pre-Design Investigation Work Plans
Slurry Wall PDI Study Work Plan
Columbia Falls Aluminum Company
Columbia Falls, MT
MRCE File 14780

Dear Mr. Hamper,

In accordance with our December 11, 2023 Proposal, we provide the attached Slurry Wall PDI Study Work Plan. We have updated this Work Plan to incorporate EPA comments dated June 18, 2025. We would be pleased to answer any questions you may have.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS PLLC

Tony D. Canale, PE

TABLE OF CONTENTS

1.	SITE DESCRIPTION AND HISTORY	4
2.	EVALUATION OF EXISTING GEOTECHNICAL DATA	4
2.1	Existing Borings and Monitoring Wells on Slurry Wall Alignment	4
2.2	Hydrogeologic Profile based on Existing Borings	5
2.3	Ground Surface Elevation on Slurry Wall Alignment	5
2.4	Existing Groundwater Level Data	5
2.5	Existing Grain-Size Distribution Data	6
2.6	Available In-Situ Hydraulic Conductivity Data	6
2.7	Advantages and Limitations of Sonic Method used to Drill Existing Borings	6
3.	DATA COLLECTION OBJECTIVES (DATA GAPS)	7
3.1	Proposed Slurry Wall Construction	7
3.2	Additional Data Needed for Barrier Design	8
4.	PROPOSED SLURRY WALL PRE-DESIGN INVESTIGATION	9
4.1	Proposed Investigation Summary and Objectives	9
4.2	Investigation Methods	9
4.2.1	Soil Borings on Barrier Alignment	9
4.2.2	Vibrating Wire Piezometer Installation	11
4.3	Drill Rig Access Requirements	12
4.4	Inspection and Recordkeeping	12
4.5	Decontamination Procedures during Drilling	13
4.6	Sample Packaging, Labeling, and Storage	13
4.7	Sample Handling and Transport	13
4.8	Sample Shipment and Chain-of-Custody (COC)	13
4.9	Laboratory Testing	13
5.	MANAGEMENT OF INVESTIGATION DERIVED WASTE	15
6.	HEALTH AND SAFETY	15
7.	QUALITY ASSURANCE AND CONTROL	15
7.1	QA/QC Procedures	15
7.1.1	Field Work:	15
7.1.2	Laboratory Work:	16
7.1.3	Data Acceptance:	16
8.	SURVEY	17

REFERENCES..... 18

EXHIBITS

Table 1	Summary of Existing Borings and Monitoring Wells within 100 Feet of Slurry Wall
Table 2	Summary of Proposed Slurry Wall PDI Borings
Table 3	Summary of Proposed Slurry Wall PDI Lab Testing
Table 4	Slurry Wall PDI Data Collection Objectives and Quality Standards
Drawing B-1A	Boring Location Plan – Slurry Wall PDI
Drawing GS-R	MRCE Geotechnical Reference Standards
Figure T-1	Test Pit and Reconnaissance Line Location Plan
Appendix A	MRCE Standard Specification for Drilling, Sampling, and Testing (Wash Rotary Borings)
Appendix B	Vibrating Wire Piezometer Technical Information and Installation Procedures
Appendix C	MRCE Sample Boring Log and Field Test Forms
Appendix D	Sample Chain-of-Custody Form

1. SITE DESCRIPTION AND HISTORY

The Columbia Falls Aluminum Company (CFAC) superfund site, formerly known as Anaconda Aluminum Co. Columbia Falls Reduction Plant, is located two miles northeast of Columbia Falls in Flathead County, Montana. It covers approximately 1,340 acres north of the Flathead River.

The site was operated as a primary aluminum smelting facility between 1955 and 2009. Waste products including spent potliner material, wet scrubber sludge, and other wastes were landfilled on site.

The Wet Scrubber Sludge Pond (WSSP) Landfill received sludge generated from the wet scrubber. Review of available descriptions and aerial photographs [1] [2] [3] indicates wet scrubber tailings were transported and placed in the WSSP by hydraulic methods. Hydraulic placement creates an alluvial sorting method that deposits coarse material close to the discharge point and finer-grained sediment at distance from the discharge point. Hydraulic deposition ceased in 1980 when the aluminum facility wet scrubbers were replaced with dry scrubbers. The pond was capped with a soil cap in 1981. The deposition history seen in aerial photographs combined with surface depressions in the current topography suggests the landfill may contain fine, compressible sediments in solid or semi-solid state.

The West Landfill, reported to be unlined, received spent potliner and other solid waste. According to 1994 as-built drawings presented in Appendix G of [3], the West Landfill was capped with a 42-inch-thick cap consisting of a 30 mil PVC liner placed over 18 inches of compacted soil and covered with 24-inches of soil. The combined area of the WSSP and West Landfill is approximately 19 acres.

Remedial investigations performed by Roux Associates Inc. (Roux) identified elevated fluoride and cyanide levels in groundwater local to the West Landfill and WSSP Landfill [3] [4].

The preferred remedial alternative selected by the United States Environmental Protection Agency (USEPA) includes capping the WSSP Landfill with a low-permeability synthetic cap to prevent future percolation of water through the waste, and constructing a fully encompassing perimeter slurry wall around both the WSSP Landfill and West Landfill to contain contaminated ground water [4]. The proposed 3,700 linear foot slurry wall alignment is located approximately 25 to 50 feet outboard of the combined WSSP Landfill and West Landfill, and abuts the toe of the existing embankment at the Cedar Creek Reservoir Overflow Ditch (see Drawing B-1A). The slurry wall will ideally close with the low-permeability fine-grained Glacial Till that typically occurs between 100 and 125 feet below the ground surface near the Landfills [5]. As noted in the Feasibility Study Report [5], there is potential that the barrier may have to close with a coarser grained Glacial Till in areas where the depth to fine-grained Glacial Till is excessive.

This **Slurry Wall PDI Work Plan** provides details of the proposed Pre-Design Investigation (PDI) for the containment remedy at the WSSP Landfill and West Landfill. The objective of this PDI is to collect additional information needed to support analysis of slurry wall constructability and performance, and establishing slurry wall design criteria.

2. EVALUATION OF EXISTING GEOTECHNICAL DATA

2.1 Existing Borings and Monitoring Wells on Slurry Wall Alignment

As part of the Phase I and Phase II remedial investigations [1] [2], Roux made soil borings, collected soil and groundwater samples, and installed monitoring wells across the Site. Of those borings, a total of eleven (11) borings with Monitoring Wells (CFMW series) and fifteen (15) Soil Borings (CFSB series) were made within 100 feet of the proposed slurry wall alignment shown on Drawing B-1A and summarized in Table 1. The CFSB series Soil Borings extended only to depths of 2 feet to 25 feet and are of limited applicability to slurry wall design. CFMW series Monitoring Well borings extended to depths of 80 to 300 feet below grade. As shown in Table 1, three of the eleven CFMW series

borings within 100 feet of the slurry wall alignment extended deep enough to encounter the top of the underlying Glacial Till.

Monitoring Wells installed in the CFMW borings were constructed with a 2-inch diameter PVC slotted well screen and riser pipe set in a granular filter. The Monitoring Wells are used to monitor groundwater quality and groundwater levels. Six of the 11 monitoring wells were installed at two depths at a single location, so that water quality and level are measured at only eight locations. The nested piezometers each consist of a well screened in the upper Outwash/Alluvium and a deeper well screened in the underlying Glacial Till. The deeper well is denoted with the suffix "a."

A summary of existing CFMW borings within 100 feet of the slurry wall alignment is given in Table 1.

2.2 Hydrogeologic Profile based on Existing Borings

The remedial investigation borings [1] defined three stratigraphic units at the Site that consist generally, from land surface down, of:

- **Upper Hydrogeologic Unit:** A 50 to 150 ft thick layer of alluvial coarse-grained deposits and glaciofluvial outwash, varying in vertical extent and grain size depending on vicinity to site features (i.e., Teakettle Mountain, Flathead River, etc.).
- **Below Upper Hydrogeologic Unit:** A layer of compact, poorly sorted Glacial Till with interbedded deposits of glaciolacustrine clays and silts, and coarser water-bearing zones. The Glacial Till has a higher percentage of fines and is more compact than the overlying alluvial and outwash deposits. The large difference in hydraulic head between the Upper Hydrogeologic Unit and the underlying Glacial Till deposits indicate little hydraulic connection between these two units. The Below Upper Hydrogeologic Unit is at least 200 ft thick across most of the Site. This Slurry Wall PDI Work Plan will evaluate the feasibility of closing the slurry wall with the fine-grained (clay/silt) Glacial Till.
- **Bedrock:** The bedrock is composed of the metasedimentary rocks of the Precambrian Belt Supergroup and defines the bottom of the hydrogeologic system beneath the Site. The bedrock surface slopes downward in the south – southwest direction, towards the Flathead River. The depth to bedrock is estimated to range from depths less than 150 ft near Teakettle Mountain to greater than 300 ft at the Flathead River.

According to the geologic sections provided in [1], the top of the Glacial Till is anticipated to vary between El. +3068 to El. +3023 at the West Landfill and is El. +3020 at the WSSP Landfill.

2.3 Ground Surface Elevation on Slurry Wall Alignment

According to the 2018 topographic survey [5], ground surface elevation on the western portion of the slurry wall alignment ranges from El. +3136 to El. +3154, with slopes ranging from 1.5% to 4%. On the eastern portion of the slurry wall alignment, steeper slopes are present as the alignment passes near the Cedar Creek Reservoir Overflow Ditch and the Center Landfill side slopes. On this eastern portion of the alignment the ground surface elevation varies from El. +3138 to El. +3190, with slopes ranging from 5% to 18% (note: it is assumed that the final slurry wall alignment will be adjusted and/or work platform grading will be performed to address short steep slope segments as illustrated on Drawing B-1A). The side slopes of the existing landfills adjacent to the slurry wall alignment are generally 1(V):1.5(H) or flatter.

2.4 Existing Groundwater Level Data

Site-wide groundwater monitoring data [1] [2] indicates significant variation in groundwater levels in the Upper Hydrogeologic Unit. Groundwater levels are influenced both by location with respect to site natural and man-made topographic features and by seasonal changes in rain/snow fall and infiltration.

- At the West Landfill, seasonal high levels ranged from 34 feet to 56 feet below grade, corresponding to El. +3114 to El. +3084.
- At the WSSP Landfill, the average high groundwater level was 56 feet below grade, corresponding to El. +3085. Seasonal variation in groundwater level over the 1-year monitoring period in 2018 was 15 feet to 48 feet.

Significantly deeper groundwater levels ranging from El. +3000 to +3005 were observed in the Glacial Till at Monitoring Well Nos. CFMW-012a and CFMW-019a. Seasonal fluctuation in those wells was muted, with a total range of only 5 feet over a 1-year period.

The data summarized above indicate there is limited hydraulic connectivity between the Upper Hydrogeologic Unit (Outwash/Alluvium) and Below Upper Hydrogeologic Unit (Glacial Till), and that the Glacial Till is a hydraulic confining layer (aquitard) below the site[5].

2.5 Existing Grain-Size Distribution Data

Based on laboratory grain size analyses on samples collected from the CFMW series borings [1],

- Outwash/Alluvium comprises, on average, 15% gravel, 59% sand, and 26% fine material (passing the U.S. No. 200 sieve)
- Glacial Till comprises, on average, 19% gravel, 42% sand, and 39% fine material

2.6 Available In-Situ Hydraulic Conductivity Data

Based on pneumatic slug testing performed in the monitoring wells, Roux [1] reported the following hydraulic conductivity (k) ranges:

- Outwash/Alluvium: 13 ft/day to 1472 ft/day (5×10^{-3} to 5×10^{-1} cm/sec) based on 4 tested wells near the slurry wall alignment.
- Glacial Till: 2.4×10^{-4} ft/day to 123 ft/day (9×10^{-8} to 4×10^{-2} cm/sec) based on testing in the site-wide monitoring wells.

The reported range of hydraulic conductivity of the Outwash/Alluvium is within the typical range for silt, sand, and gravel and likely reflects variability in grain sizes and gradation of this alluvial deposit.

The reported range of hydraulic conductivity of the Glacial Till reflects high geologic variability within that stratum. The high end of the range is biased toward the coarse-grained portions of the Glacial Till in which the monitoring wells were screened.

2.7 Advantages and Limitations of Sonic Method used to Drill Existing Borings

The Phase I and II borings were drilled using Rotasonic methods (hereafter described as “sonic”) techniques. See Section 4.2.1.2 for a description of the drilling method.

Advantages of sonic drilling and sampling include:

- A continuous core sample is obtained, allowing the soil profile to be fully examined including thin features such as seams and lenses.
- A significant volume of soil (i.e. the complete inside volume of the inner core barrel) is typically recovered and available for sampling.
- The drilling equipment can penetrate a wide variety of subsurface materials, including cohesive and cohesionless soil, gravel, boulders, and rock.
- The method does not require continuously circulating drilling fluid, which reduces the quantity

of waste generated.

Limitations of sonic drilling and sampling include:

- Quantitative data on in-situ penetration resistance (needed to estimate soil relative density and shear strength) is not obtained.
- Because a positive head of drilling fluid is not typically maintained in the borehole, there is the potential for blow-in and disturbance of the soil in the sampling zone.
- The recovered soil core samples are disturbed by vibration used to advance the core barrel and are not suitable for geotechnical laboratory testing of soil design parameters such as strength, compressibility, and permeability.
- Split-spoon penetration resistance (N-values) are not typically obtained. N-value is a common test value defining material compactness and stability, and used as an indicator of excavation difficulty for selection of construction tools.

3. DATA COLLECTION OBJECTIVES (DATA GAPS)

3.1 Proposed Slurry Wall Construction

As described in the Feasibility Study Report [6], the slurry wall is anticipated to be 24 to 36 inches wide and extend to close with Glacial Till at depths up to 135 feet below the existing ground surface (bgs). (For pre-design investigation planning, we have conservatively assumed a 10% increase in design depth [150 ft maximum] to accommodate variations in the closure strata surface elevation and to achieve a suitable closure key.)

The Soil-Bentonite (S-B) slurry trench is the best performing and lowest cost hydraulic barrier technology available. The PDI study must determine if S-B trench construction is feasible. This method involves excavating a continuous trench using a combination of long-stick excavator and clamshell equipment (or equivalent). The trench sidewalls are held open with a colloidal bentonite slurry. The slurry is displaced when an engineered low-permeability Soil-Bentonite backfill (blend of excavation spoils and bentonite) is placed in the trench. Important requirements for a S-B slurry wall to be feasible include:

- Relatively long lengths of trench with only minor horizontal deviation in ground surface elevation, or the ability to construct a fill to provide a work platform meeting this need.
- Native soils with sufficient shear strength to facilitate construction of a stable slurry-supported trench, considering the load imposed by construction surcharge and/or existing slopes adjacent to the open trench, and the depth of the trench.
- Groundwater levels suitably below the slurry trench work platform to provide a sufficient head difference between the trench slurry and adjacent soil groundwater level.
- Soil profile in the barrier alignment with suitable physical characteristics to allow preparation of a low-permeability backfill from the excavation spoils and imported borrow soil.

Where these requirements are not met, the barrier may be constructed as a Cement-Bentonite (C-B) barrier. In the C-B method, a slot is excavated in discrete panels using clamshell or hydromill equipment stabilized with C-B slurry; the C-B slurry self-hardens in place to create a low-permeability backfill. The C-B slurry weight and panel system greatly increases excavation stability and can accommodate vertical grade changes in the work surface.

One-pass trenching methods that vertically mix the entire soil profile with cement and bentonite to form a continuous low-permeability Soil-Cement-Bentonite (S-C-B) barrier have potential applicability

but may be limited by boulder presence at this site.

The PDI data collected will allow for evaluation of S-B, C-B, and S-C-B barrier construction options.

3.2 Additional Data Needed for Barrier Design

Following our review of existing geotechnical data summarized in [Section 2](#), additional investigation is needed to refine knowledge of subsurface conditions along the wall alignment to support barrier performance estimates and guide selection of barrier construction methods. The following primary data collection objectives (Data Gaps) have been identified for the Slurry Wall PDI Study:

- **Define a barrier alignment** outboard of the combined WSSP Landfill and West Landfill that avoids excavation into the West Landfill multimedia cap, has moderate cut and fill requirements to create an excavation work platform with minimal grade changes, and has sufficient open space adjacent to the trench for mixing excavation spoils to prepare S-B backfill.
- **Define soil profile and character of Glacial Till along the barrier alignment.** Few available borings encountered the Glacial Till stratum near the wall alignment (see Table 1), leaving significant uncertainty in the soil profile, potential barrier depth, and character of the Glacial Till. Industry guidance (e.g. USEPA 1998, [7]) suggests a boring spacing of 100 to 200 feet is typically acceptable, depending on geologic variability at the site. A 200-foot average boring spacing requires making 18 deep borings extending into the Glacial Till (see [Section 4](#)). Additional borings may be necessary if high geologic variability is revealed along the alignment.
- **Define groundwater elevation along slurry wall alignment.** Definition of shallow and deep groundwater levels in the Outwash/Alluvium, and groundwater level in the Glacial Till along the barrier alignment is needed to evaluate stability of a slurry supported trench and to estimate groundwater flow in the vicinity of the slurry wall.
- **Define physical properties of soils through which the barrier will be excavated.** Physical properties include unit weight, gradation, and strength parameters (compactness and friction angle for coarse-grained soils and undrained shear strength of fine-grained soils). These parameters are needed to evaluate stability of the deep open slurry-supported trench and constructability. Friction angle of granular soils can be obtained from in-situ measurement of penetration resistance (e.g. Standard Penetration Test [SPT] N-value). For cohesive and silt materials, undrained shear strength can be approximated using field pocket penetrometer or Torvane measurements on split spoon samples, but laboratory testing of tube samples recovered from borings will be needed if trench stability is sensitive to shear strength. As discussed in [Section 2.7](#), the existing deep sonic borings do not include measurement of penetration resistance N-value nor collection of samples suitable for geotechnical laboratory testing.
- **Define the prevalence, size, and vertical distribution of oversized particles in the soil profile.** Oversized particles including boulders and cobbles larger than 3 to 4 inches may be excluded from the slurry wall backfill, which will require a segregation and exclusion step in the backfill preparation procedures. The quantity and size of oversized particles is also a consideration for selection of the barrier construction method.
- **Improve definition of the Glacial Till hydraulic conductivity on the alignment.** Additional hydraulic conductivity testing is needed to supplement available data. As discussed in [Section 2.6](#), the existing in-situ hydraulic conductivity test data does not adequately define permeability of the Glacial Till closure layer along the alignment.

- **Collect soil and groundwater samples for slurry wall backfill mix design and performance testing.** Sufficient volumes of representative soil and groundwater from the slurry wall alignment must be obtained to allow for bench-scale laboratory testing of slurry and trial backfill mixes. Laboratory testing will include particle size distribution, water content, and plasticity (Atterberg Limits) on each native soil stratum and gradation and hydraulic conductivity testing on trial blends of the native soil and bentonite, including compatibility with site groundwater. See [Section 4](#) for additional description of the mix design testing.
- **Collect data needed to confirm slurry wall performance in an earthquake.** Performance of the slurry wall in the design earthquake is a function of the site response (ground motion) and ability of the slurry wall materials to accommodate that motion. Seismic velocity data for site response analysis will be collected in the WSSP Landfill Settlement Study PDI (provided under separate cover). Laboratory testing on trial backfill mixes will include test data on backfill stress-strain behavior.

4. PROPOSED SLURRY WALL PRE-DESIGN INVESTIGATION

4.1 Proposed Investigation Summary and Objectives

This Slurry Wall PDI addresses the data gaps identified in [Section 3.2](#). The proposed investigation includes 19 additional borings including eighteen (18) deep (150 feet or more) borings along the slurry wall alignment to define soil stratigraphy and physical properties, and identify the substrata soil for closure, and one (1) shallow (50 foot) boring [MR-19SB] to define the physical properties of the roadway/embankment adjacent to the slurry wall alignment, as summarized in Table 2. Available information was used to plan the investigation depths and sampling. The additional boring schedule incorporates three existing borings (CFMW-12, CFMW-16, and CFMW-19) to define the soil profile along the barrier alignment.

In addition to soil borings, the proposed investigation includes 9 to 12 test pits located on the slurry wall alignment (outside the WSSP Landfill and West Landfill boundaries) and in the existing Borrow Area to improve definition of the prevalence, size, and vertical distribution of oversized particles (boulders and cobbles) in the soil profile. Test pits made by an excavator allow direct visual observation of particles too large to be reliably sampled by relatively small-diameter drilling equipment. To supplement the test pit program, a series of visual “reconnaissance lines” will be performed to view and document the size, prevalence, and vertical distribution of exposed boulders and cobbles on the Flathead River slope below the railroad alignment and in the Flathead River floodplain adjacent to the site. Proposed test pit and reconnaissance line locations are shown on Figure T-1.

4.2 Investigation Methods

4.2.1 Soil Borings on Barrier Alignment

4.2.1.1 Wash Rotary Borings

Nine (9) of the added alignment borings will be drilled by wash rotary methods. The wash rotary drilling method reduces (relative to sonic drilling) disturbance of soil in the sampling zone by maintaining a positive fluid head in the borehole when drilling below groundwater. In this method, water or weighted drilling fluid (typically, a mix of water and bentonite or polymer mud) is continuously recirculated in the borehole during drilling. Bentonite drilling mud will not be allowed in borings used to perform in-situ permeability testing (see [Section 4.2.1.8](#)). Temporary casing may be used if required to stabilize the hole, and for in-situ permeability tests. Rock coring methods will be used if necessary to penetrate obstructions such as boulders that cannot be penetrated with the wash rotary drill tools. The MRCE standard specifications for wash rotary drilling and sampling are provided in Appendix A. Sample log record forms are provided in Appendix B.

4.2.1.2 Sonic Borings

The remaining borings (denoted by “SB” suffix on Drawing B-1A) may be drilled using sonic drilling methods in accordance with ASTM D6914, or may be drilled by wash rotary methods. As discussed in [Section 2.7](#), sonic drilling provides certain advantages by minimizing Investigation Derived Waste (IDW) while providing continuous material recovery for stratigraphy definition and index testing.

In the sonic drilling method, a continuous soil core is obtained by advancing a core barrel into the ground using high-frequency vibration. The core barrel is typically overridden by a larger diameter outer casing that trails the inner core barrel to prevent borehole collapse. The inner core barrel is periodically withdrawn and the recovered soil core is extracted and logged. An inner core diameter of 4” will be used to obtain soil volume for examination and bulk sampling.

4.2.1.3 Boring Depth and Grouting

Each boring will be extended to penetrate 15 feet into the fine-grained (clay/silt) Glacial Till stratum, or to a maximum depth of approximately 200 feet if fine-grained Glacial Till is not encountered. In wash-rotary borings a minimum of 4 split spoon samples will be obtained in the Glacial Till. All completed borings will be closed using cement-bentonite grout placed by the bottom-up tremie method. Borings and grouting, and all instrument installations will be performed under the full-time inspection of an experienced engineer or geologist who will log the boring and describe the soil samples recovered.

4.2.1.4 Split Spoon Sampling with Standard Penetration Test (SPT)

Split spoon sampling with SPT will be performed in all borings in accordance with ASTM D1586. Soil samples will be taken using a 2” O.D. split spoon sampler to measure standard penetration resistance values (N-value) and a 3” O.D. split spoon sampler for recovery of larger particle sizes. Split spoon samples will be collected at 5 feet depth intervals, alternating between 2” and 3” samplers, to measure the N-value at 10 feet intervals. (Note: if sonic drilling is performed, 3” split spoon sampling will be omitted.)

The SPT N-value will be measured by driving the 2” sampler with a 140-pound hammer free-falling 30 inches. The number of blows required to advance the sampler through each of three or four, six-inch drive intervals will be recorded. The N-value, calculated by summing blows from the second and third six-inch drive intervals, is an industry-wide indication of the degree of compactness of the material sampled. The corrected SPT N-value can be used to estimate the friction angle of coarse-grained soils, and to determine susceptibility to liquefaction.

Intact spoon samples of fine-grained soil will be tested using field handheld pocket penetrometer and/or Torvane devices to estimate unconfined compressive strength. Soil samples will be visually classified and logged in accordance with the Unified Soil Classification System (USCS) (ASTM D 2488). Refer to Appendix C for sample boring log forms.

4.2.1.5 Undisturbed (Tube) Samples

If fine-grained soils are encountered in wash rotary borings, thin-walled tube samples will be attempted in accordance with ASTM D1587.

A “Pitcher” type sampling device that includes an outer rotating cutting barrel may be used to advance a tube sampler in the stiff Glacial Till, if needed. Tube samples of the fine-grained Glacial Till, if successfully collected, will be used for laboratory grain size analysis and permeability testing.

4.2.1.6 Bulk Soil Samples for Mix Design Testing

Bulk soil samples for slurry wall backfill mix design will be collected from the sonic borings. Composite

bulk (5-gallon bucket or 50-pound bag) samples will be prepared for each distinct soil layer (10 ft or more thick) observed within the profile. A minimum of four 5-gallon buckets (or equivalent) for each layer will be collected, for an anticipated total of approximately 20 buckets. These samples will be used for bench-scale laboratory testing of trial slurry wall backfill mixes. See [Section 4.9](#) for additional details of laboratory mix design testing.

4.2.1.7 Groundwater Samples for Compatibility Testing

Groundwater samples for interface compatibility testing will be collected from the existing (Roux) standpipe monitoring wells. A minimum of 3 gallons of water will be collected from each of three selected monitoring wells (9 gallons total) distributed over the slurry wall alignment and screened in the Upper Hydrogeologic Unit (Outwash/Alluvium) layer (refer to Table 1). Groundwater samples will be collected using the methods described in the USEPA guidance document titled “Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.” [8] Groundwater samples will be stored in sealed, impact-resistant, chemically inert plastic containers. See [Section 4.9](#) for additional details of laboratory compatibility testing.

4.2.1.8 Borehole Hydraulic Conductivity Tests

Borehole tests will be performed to supplement available test data on the hydraulic conductivity of the Glacial Till at the slurry wall closure depth. Up to 12 in-situ hydraulic conductivity tests will be performed in selected sonic and cased wash rotary borings. In each selected boring, a test will be performed approximately 10 feet below the top of the Glacial Till. Ten feet below the top of the glacial till was selected for In-situ hydraulic conductivity testing to minimize the potential for influence from the more permeable materials present in the Upper Hydrogeologic Unit. Performing the testing at approximately the same depth below the top of the glacial till can provide information on the variability of hydraulic conductivity along the alignment of the proposed slurry wall. Where the measured hydraulic conductivity is higher than anticipated from other tests in the Glacial Till, or where the boundary between the Outwash/Alluvium and Glacial Till layers is not well defined, a second test will be performed at a lower elevation in the boring.

Hydraulic conductivity tests will be performed as variable head tests, described as follows:

In wash rotary borings, the casing will be advanced to the bottom of the borehole after collecting the 1st and 2nd split spoon samples of Glacial Till. The drilling fluid will be changed to water and the casing flushed. The borehole will then be advanced by roller bit and water flush through the next 10 feet (3rd and 4th split spoon samples of Glacial Till), and the test performed over the 10-foot uncased zone below the casing. Similarly, in sonic borings, the outer casing will be advanced approximately 10 feet below the top of Glacial Till and the inner core barrel used to isolate a 10-foot uncased test zone below the outer casing.

Before performing each test, the static (equilibrium) water level in the borehole will be measured. A known head difference (displacement) will then be rapidly imposed by either (a) adding water to increase the water level inside the casing (falling head test) or (b) decreasing the water level in the casing using compressed air or by removal of a solid cylinder (slug) from the water column (rising head test). The subsequent change in water level with time will be recorded using a pressure transducer and data logger (“Level Logger”) device. Readings will be continued until stable (equilibrium) water level is reached, or up to a maximum time of two hours. If water levels return to static or near-static conditions within one hour, another test will be conducted using an increased displacement. A sample variable head test data sheet is provided in Appendix C.

4.2.2 Vibrating Wire Piezometer Installation

A series of fully grouted electric vibrating wire piezometers (VWPs) will be installed in three borings,

(see Table 2 and Drawing B-1A). Each instrumented boring will include three VWP's placed at shallow, intermediate, and deep positions to monitor groundwater pressure. VWP's are installed at selected elevations by sealing in grout by the installation procedures described in Appendix B. Water pressure measured by each VWP will be logged at frequent intervals for 6 to 12 months.

MRCE will provide calibrated piezometers and a read-out device. MRCE Field Engineer will assist the driller with the installation of piezometers and take readings when present on site. Each VWP set can be connected to a remote sensing system consisting of a data logger, solar panels, and cellular modem for real-time monitoring and reporting of groundwater levels. In this way, groundwater level data is automatically logged at regular intervals, typically daily, and reported to a website for viewing by authorized parties.

Refer to Appendix B for technical documentation on the vibrating wire piezometers and sample installation record forms.

4.2.3 Test Pits

Test pits will be made by hydraulic excavator and will extend from the existing ground surface to the practical depth limit of the equipment or for stability of the test pit sidewalls, anticipated to be between 20 and 30 feet. Visual/manual evaluation of the excavated soil at 5-foot depth intervals will be made in accordance with the USCS and will include description of boulder/cobble frequency, size, and shape with depth in each test pit. Bulk samples (1 sample per test pit) of soil material smaller than 3 inches will be collected for laboratory grain size analysis. Test pits will be backfilled with excavated soil compacted in lifts with the excavator bucket.

Test pits will be located outside all mapped contamination areas and outside the boundary of the West Landfill and WSSP Landfill. Test pits will be positioned outside existing roadways to the extent possible. For any test pits in existing roadways, the upper 3 feet of backfill will be compacted in 8-inch lifts by at least 3 passes of a vibrating drum roller or heavy walk-behind compactor and the existing road surface restored in kind.

4.2.4 Boulder/Cobble Reconnaissance Line

The existing Flathead River slope below the railroad alignment will be examined for the presence of oversize particles. A Boulder/Cobble Reconnaissance line will be performed along the existing road traversing the slope shown on Figure T-1. Additional Boulder/Cobble Reconnaissance Lines may be performed at other locations if feasible. At each Boulder/Cobble Reconnaissance Line, the slope will be walked and a visual/manual evaluation made of the materials exposed on the surface. Materials will be examined for prevalence, size, and distribution of boulders and cobbles. Reconnaissance lines will target a 10-foot vertical spacing for observations from the top to the bottom of the slope. Hand excavation into the slope at or just above boulders and cobbles will be performed where needed to measure boulder/cobble size. Where access to the slope or excavation is not practical or is unsafe, high-resolution photography from the adjacent riverbed and/or by drone may be considered.

4.3 Drill Rig Access Requirements

Most proposed borings are located near internal roads and relatively flat areas accessible by a truck rig. Approximately eight (8) borings (MR-4P, MR-9SB to MR-14, and MR-19SB) will require an all-terrain (e.g. track-mounted) drill rig for access. Some clearing may be necessary at MR-4P.

4.4 Inspection and Recordkeeping

The Field Engineer will provide continuous field inspection of the drilling and sampling activities and keep field log records of the drilling activities and samples collected. Sample boring log records are provided in Appendix C.

4.5 Decontamination Procedures during Drilling

Drilling equipment will be decontaminated in general accordance with Roux Standard Operating Procedures (SOP) 9.1 for Field Decontamination of Field Equipment [9]. Soil sampling tools such as split-spoon samplers, spatulas, etc. will be decontaminated using an Alconox rinse between each use.

4.6 Sample Packaging, Labeling, and Storage

Split spoon samples will be stored in heavy-duty air-tight wide mouth plastic screw-top jars or sealed plastic bags after field classification and logging. Bulk samples will be stored in sealed 5-gallon buckets or bags. Thin-walled tube samples will be sealed using wax and ends will be capped and securely taped.

Each sample will be labeled with the project name, sample date, boring number, sample number, sampling depth, and SPT N-value and/or percent recovery for identification prior to transporting them to the designated testing facility.

Soil samples will be stored on-site in a designated secure location protected from weather, freezing, and extreme heat. It is anticipated that the former warehouse building (see Figure 1 of [10]) will serve as the central storage area for soil samples prior to transport.

4.7 Sample Handling and Transport

Soil sample handling and transport will comply with ASTM D 4220 and Roux SOP 3.3 for Sample Handling [9].

Split spoon and bulk soil samples will be preserved and transported in accordance with ASTM D 4220 Group B. Undisturbed tube samples will be preserved and transported in accordance with ASTM D 4220 Group D.

Soil and groundwater samples will be transported by Geotechnical Engineer personnel and / or commercial courier. The Field Engineer will oversee sample packaging, handling, storage, and shipment.

4.8 Sample Shipment and Chain-of-Custody (COC)

Individual sample jars, bags, and tubes will be grouped (typically by boring) for shipment. Additional protective measures for shipping are listed below.

- Individual plastic sample jars and/or plastic bags will be packed into rigid shipping containers (e.g. coolers, specialized shipping containers, or heavy cardboard boxes).
- Undisturbed tube samples will be packed into specialized shipping containers designed for freight transport and meeting the requirements of ASTM D4220, Group D.
- The shipping containers will be securely sealed with heavy-duty packaging tape.
- Shipping containers labeled and shipped in accordance with applicable federal regulations.

The Field Engineer will complete a COC form for each shipping container shipped from the site. The COC will include the details such as sample identification, date of collection, matrix of sample, number of containers, and names of sampler and the person shipping the samples. The COC will accompany samples to the laboratory and a copy of the COC will be retained and placed in the project file. Any visible signs of elevated contamination (e.g. discoloration, odors) observed in specific samples during sampling will be noted on the COC forms. A sample COC form is provided in Appendix D.

4.9 Laboratory Testing

Laboratory testing of samples recovered in the borings will include the following. A summary of tests and governing ASTM standards is provided in Table 3.

days age for cemented backfill) to determine the backfill stress-strain behavior for the purpose of seismic analysis.

5. MANAGEMENT OF INVESTIGATION DERIVED WASTE

The following types of investigation-derived waste (IDW) will be generated during the Slurry Wall PDI Study:

- Soil cuttings
- Liquid waste including excess drilling mud or wash water, water pumped from piezometers during purging, and waste water from equipment and personnel decontamination
- Used personal protective equipment (PPE) (e.g. gloves) or other disposable items that contact soil, drilling mud, or water

Management of IDW will be in accordance with the Project IDW Management Plan prepared by Roux.

6. HEALTH AND SAFETY

Health and Safety measures will be implemented in accordance with the project Health and Safety Plan (HASP) prepared by Roux [11]. Each entity performing work on the site (including engineering firms and drilling contractors) will be required to prepare and adhere to their own site-specific HASP that references and conforms to the overall project HASP.

7. QUALITY ASSURANCE AND CONTROL

Quality assurance (QA) and control (QC) procedures will be implemented to ensure the data collected from the Slurry Wall PDI Study satisfies the investigation objectives and meets applicable quality standards. Table 4 lists data collection objectives, quality standards, and acceptance criteria.

7.1 QA/QC Procedures

In general, the investigation will be conducted in accordance with the project Quality Assurance Plan prepared by Roux. Specific to the Slurry Wall PDI Study, the following procedures will be followed:

7.1.1 Field Work:

- Field drilling, sampling, testing, and instrumentation installation will be performed in general conformance with reference standards including those published by the American Society for Testing and Materials (ASTM) where applicable (see Table 4).
- The Field Engineer will provide full-time responsible oversight of the drilling, sampling, in-situ testing, test pit excavation and backfilling, boulder/cobble reconnaissance lines, and instrument installation activities. If multiple drilling rigs are utilized, each Field Engineer will oversee no more than two drilling rigs.
- Each piece of field equipment used for data collection (e.g. tape measures, levels, pocket penetrometers, Torvanes, electronic piezometers and readout devices) will be furnished by the Geotechnical Engineer. The Field Engineer will check functionality of each piece of field equipment daily before use. Any field equipment visibly damaged, impaired, or which produces suspect results will be removed from service.
- Current calibration records for specialized field equipment (e.g. pressure gauges, inclinometer probes, downhole testing equipment, etc.) will be maintained by the Geotechnical Engineer and provided on request.
- All instrumentation installed (e.g. vibrating wire piezometers) will be furnished with

manufacturer calibration records. The Field Engineer will review calibration records and perform field pre-installation acceptance testing, quality control during installation, and post-installation testing as described in Appendix B.

- Standard log forms will be used to document all data collected and instruments installed. Sample log forms are provided in Appendix C.
- Each Field Engineer will prepare a Daily Field Report (DFR) documenting drilling, test pits, boulder/cobble reconnaissance, and data collection activities. The reports are to be filed at the end of each day, via email to the Project Manager and project file. The Project Manager will review DFRs and direct any necessary modifications to the field work based on reported progress. The DFR is used to document the hours of work, contractor presence, and progress of work performed each day and inspector presence (time of day) and inspector time expended to complete reports/logs/test documentation. The DFR is used to document events which are not recorded in other test data forms, construction logs, or record contract documents. The reports define any open items which require resolution, and a future report must close all open items – giving resolution decision. A sample DFR form is provided in Appendix C.
- The Project Manager will visit the site periodically (QA visits) during the PDI activities to assure the field QC procedures described above are being followed. The Project Manager will document each QA visit on a DFR and describe any corrective actions made.

7.1.2 Laboratory Work:

- Each laboratory that performs geotechnical testing for the project will maintain and implement a quality system in accordance with ASTM E 329, ASTM D 3740 and AASHTO R18 (as applicable) and confirmed by proficiency sampling and regular audits, as documented by accreditation through the American Association of State Highway and Transportation Officials (AASHTO) accreditation program (AAP) or equivalent.
- Each laboratory test will be conducted in accordance with the applicable reference standard (see Table 4). Test data will be collected and its useability evaluated in accordance with the test standard. Data and results will be documented on standard data forms meeting the requirements of the standard.

7.1.3 Data Acceptance:

- All field and laboratory data will be evaluated against the Data collection objectives and quality standards listed in Table 4. Any data not meeting one or more criteria will be further evaluated by the Project Manager to determine if the data may still be acceptable for project use (potentially with some degree of qualification) or must be rejected.
- Field data forms will be reviewed by an engineer having equal or greater experience as the Field Engineer (e.g. the Project Manager or a designee). Corrections will be documented as redline markup of the original data sheets and final checked data reports documented by initialing.
- Each soil sample will be reviewed by an independent geotechnical engineer or geologist and field descriptions revised as necessary, incorporating laboratory test results where applicable, before finalizing the boring log soil descriptions. Revisions to the field boring logs will be documented as redline markup and the final checked boring logs documented by initialing.

8. SURVEY

A topographic survey will be performed prior to the start of field work to provide current topographic elevations. The survey will cover the existing WSSP and West Landfill and extend a minimum of 50 feet beyond the proposed Adjusted Slurry Wall Alignment.

Survey of the as-drilled location and elevation of each boring, test pit location, and instrument well head installed will be provided by a licensed surveyor under subcontract to Roux Associates, Inc.

All surveys performed will be tied to Montana State Plane (NAD83) coordinate grid and reference NAVD88 datum.

EXHIBITS

Table 1 – Summary of Existing Borings and Monitoring Wells within 100 feet of Slurry Wall Alignment

Well Number	Ground Surface Elev. (ft)	Boring Depth (ft)	Well Screen Top Depth (ft) ¹	Well Screened Stratum	Groundwater Elevation (ft) ^{2,3}			Remarks
					Low-water Season	High-water Season	Seasonal Variation	
CFMW-002	3143	80	70	Outwash/Alluvium	3063.1	3084.6	21.5	
CFMW-007	3148	160	91	Outwash/Alluvium	3065.2	3113.7	48.5	
CFMW-010	3145	86	76	Outwash/Alluvium	3063.2	3086.9	23.7	
CFMW-012	3140	90	70	Outwash/Alluvium	3063.6	3083.9	20.3	
CFMW-012a	3140	255	200	Outwash/Alluvium below Glacial Till	2999.5	3004.9	5.4	Clay Till at 128 ft - 199 ft bgs, Sand and Gravel
CFMW-015	3139	94	72	Outwash/Alluvium	3063	3081.5	18.5	
CFMW-016	3164	95	85	Outwash/Alluvium	Dry	3109.4	-	
CFMW-016a	3164	300	121	Outwash/Alluvium and Sand Till	3064	3109.2	45.2	Sand Till at ~125 ft below ground surface (bgs)
CFMW-019	3136	96	78	Outwash/Alluvium	3062.3	3077.8	15.5	
CFMW-019a	3137	300	210	Sand Till	2999.6	3005	5.4	Silt and Clay Till at 134 ft to 197 ft bgs, Sand Till encountered below
CFMW-021	3136	90	70	Outwash/Alluvium	3062.5	3078	15.5	

Notes:

1. All well screens are 10 feet long.
2. Based on the year 2018 monitoring data.
3. High- and low- water seasons are reported as around June and October, respectively.

Table 2 – Summary of Proposed Slurry Wall PDI Borings

Boring No.^{1,2,3}	Anticipated Depth (ft)	Existing Ground Elev. (ft)	Location	Sampling and Instrumentation	Data Collection Objectives⁴
MR-1SBP	180	3137	Toe of WSSP Landfill	Sonic core w/ SPT; 3 VWP series	a, b, c, d, e
MR-2	150	3140	Toe of WSSP Landfill	Split spoon w/ SPT	a, c, d
MR-3SB	150	3143	Toe of WSSP Landfill	Sonic core w/ SPT	a, c, d, e
MR-4P	150	3147	Toe of West Landfill	Split spoon w/ SPT; 3 VWP series	a, b, c, d
MR-5SB	150	3153	Toe of West Landfill	Sonic core w/ SPT	a, c, d, e
MR-6	150	3151	Toe of West Landfill	Split spoon w/ SPT	a, c, d
MR-7SB	150	3153	Toe of West Landfill	Sonic core w/ SPT	a, c, d, e
MR-8P	150	3153	Toe of West Landfill	Split spoon w/ SPT; 3 VWP series	a, b, c, d
MR-9SB	150	3156	Toe of West Landfill	Sonic core w/ SPT	a, c, d, e
MR-10	150	3170	Toe of West Landfill	Split spoon w/ SPT	a, c, d
MR-11SB	150	3173	Toe of West Landfill	Sonic core w/ SPT	a, c, d, e
MR-12P	150	3175	Toe of West Landfill	Split spoon w/ SPT; 3 VWP series	a, b, c, d
MR-13SB	150	3170	Toe of WSSP Landfill	Sonic core w/ SPT	a, c, d, e
MR-14	150	3167	Toe of WSSP Landfill	Split spoon w/ SPT	a, c, d
MR-15SB	150	3160	Toe of WSSP Landfill	Sonic core w/ SPT	a, c, d, e
MR-16	180	3140	Toe of WSSP Landfill	Split spoon w/ SPT	a, c, d
MR-17SB	180	3138	Toe of WSSP Landfill	Sonic core w/ SPT	a, c, d, e
MR-18	180	3137	Toe of WSSP Landfill	Split spoon w/ SPT	a, c, d
MR-19SB	50	3194	Sanitary Landfill roadway	Sonic core w/ SPT	c

Notes:

1. "SB" suffix indicates boring may be drilled by sonic method or by wash rotary methods.
2. Borings without "SB" suffix will be drilled by wash rotary methods.
3. "P" indicates vibrating wire piezometer series installed in boring.
4. Data Collection Objectives:
 - a. Define stratigraphy and top elevation of closure layer along slurry wall alignment
 - b. Define groundwater elevation profile along slurry wall alignment
 - c. Define physical properties of soils through which the slurry trench will be excavated, and soils adjacent to the trench
 - d. Improve definition of hydraulic conductivity of slurry wall closure layer
 - e. Collect soil samples for S-B backfill mix design and performance testing

Table 3 – Summary of Proposed Slurry Wall PDI Laboratory Testing

Type	Test Method	ASTM/EPA Standard	Estimated No. of Tests	Notes
Tests on Soils	Sieve Analysis of Coarse-grained Soils	D6913	60	Tests on 3" O.D split spoon or sonic samples of granular soils. Two to three tests per boring. 9 to 12 tests on bulk samples of Outwash/Alluvium from test pits.
	Hydrometer Analysis of Fine-grained Soils	D7928	12 to 15	Tests on selected fine-grained Outwash/Alluvium and Glacial Till samples
	Water Content	D2216	100 to 250	All fine-grained samples
	Atterberg Limits	D4318	15 to 20	Test one Till sample from each boring and fine-grained Outwash/Alluvium samples, if encountered
	Triaxial Test - Unconsolidated Undrained Shear Strength	D2850	6	Test fine-grained samples from Outwash/Alluvium stratum, if encountered, at a confining pressure of 80% of effective vertical stress
	Permeability - Clay/Silt Glacial Till	D5084	4	Select confining pressure based on in-situ effective stress and to provide sample saturation in accordance with test standard
	Cation Exchange Capacity in Soils	EPA SW-846 9081	1 per bulk sample	Test for cation exchange capacity on native subsurface soils
Tests on Slurry Wall Backfill Mix	Sieve Analysis of Soil Blend	D6913	1 per trial mix ¹	Perform gradation analysis of each soil blend
	Hydraulic Conductivity	D5084	2 per trial mix ¹	Test for hydraulic conductivity at a confining pressure of 10 psi. Test at hydraulic gradient representative of service conditions with safety factor
	Compressive Strength (cemented mixes only)	C39 / D1633	2 each at 3, 7, 28, and 90 days (8 tests) per mix	Define compressive strength gain with time
	Compatibility with site groundwater	D7100	2 for selected mix	Same test parameters as hydraulic conductivity testing. Saturate test specimens with site groundwater (S-B mixes) or fresh water (C-B or S-C-B mixes). Permeate with site groundwater. Run tests at 28 days for cemented mixes. Conduct tests until hydraulic and chemical equilibrium are achieved.
	Triaxial stress-strain behavior	D4767	1 per trial mix ¹	Confirm backfill stress-strain behavior for the purpose of seismic analysis

Notes:

1. At least two trial mixes will be prepared and tested.

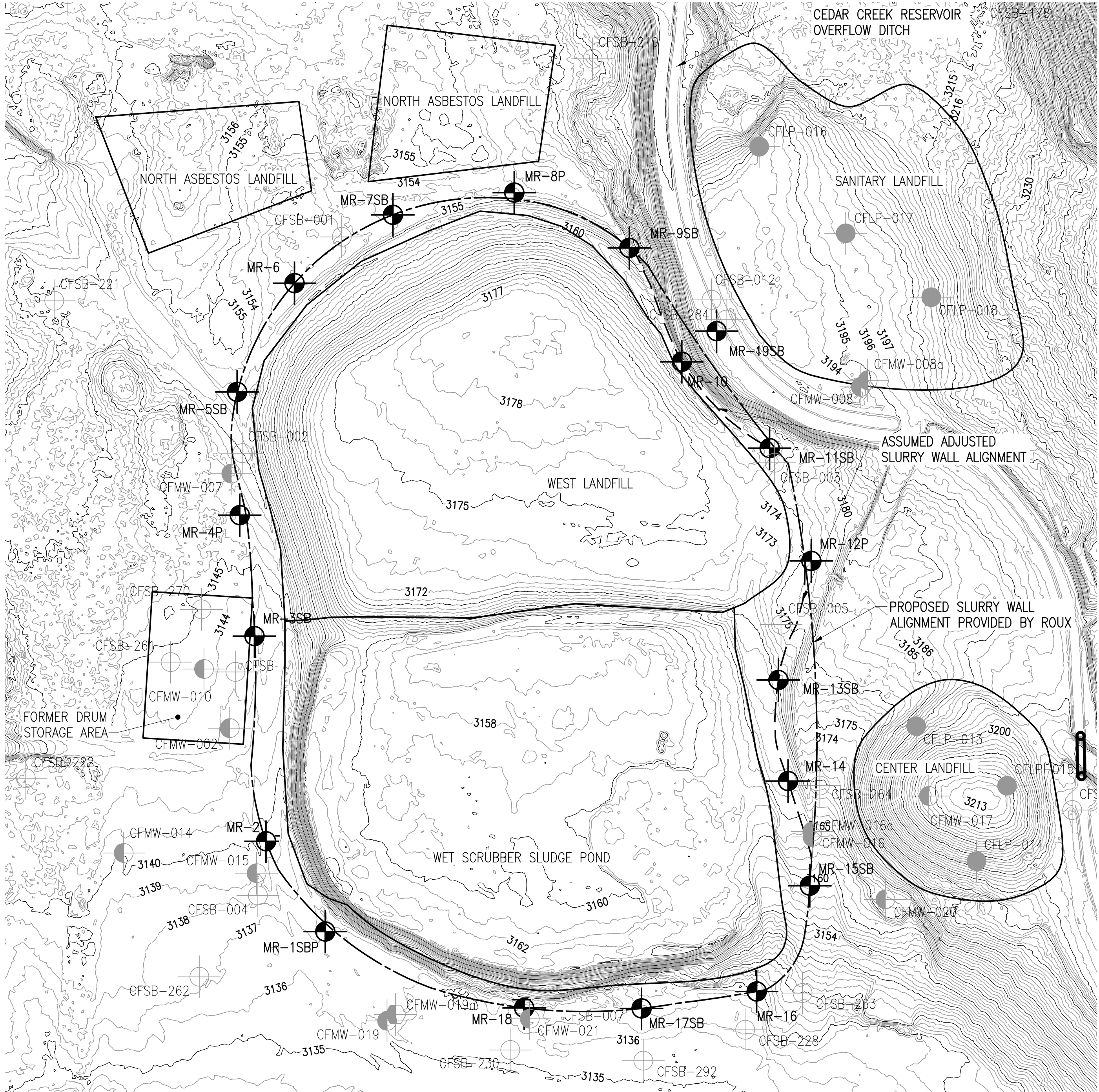
Table 4 - Slurry Wall PDI Data Collection Objectives and Quality Standards

Data Collection Objective	Investigation or Test	Method or Reference Standard	No. of Borings / Tests	Data Acceptance Criteria
Define barrier alignment	Add deep borings to provide 200-ft average boring spacing	Sonic drilling (ASTM D6914)	10	Boring reaches 15 ft (min) penetration into fine-grained (Clay/Silt) Glacial Till stratum, or 200 foot depth, whichever is deeper
Define soil profile and character of Glacial Till along the barrier alignment	Topographic Survey of WSSP and West Landfill	Wash rotary drilling	9	Boring reaches 15 ft (min) penetration into fine-grained (Clay/Silt) Glacial Till stratum, or 200 foot depth, whichever is deeper
Define current groundsurface elevation along the proposed Slurry Wall Alignment	Describe soil strata encountered in borings	n/a	n/a	Survey performed by licensed surveyor referencing Montana State Plane (NAD83) coordinate grid and reference NAVD88 datum
	Make additional borings where necessary	ASTM D 2488	each sample	Visual/manual soil discription of each sample in accordance with the Unified Soil Classification System (USCS) is made and recorded on boring log
		n/a	TBD	Borings will be added at any location where high geologic variability is revealed by the PDI borings
Define groundwater elevation along slurry wall alignment	Install vibrating wire piezometers (VWP) set in grout in selected borings	VWP installation guidelines (see Appendix B)	series of 3 VWPs installed in 4 borings (12 total)	VWPs are calibrated, satisfy pre-installation acceptance testing, are installed successfully, and meet post-installation acceptance criteria (see Appendix B). Remote automated data collection system operational.
Define physical properties of soils through which the barrier will be excavated	Standard Penetration Tests	ASTM D1586	1 test per 10 feet depth per boring	SPT N-value is obtained and recorded on boring log
	Field pocket penetrometer	n/a	each cohesive sample recovered	Pocket penetrometer unconfined compressive strength is obtained and recorded on boring log
	Field torvane	n/a	each cohesive sample recovered	Torvane undrained shear strength is obtained and recorded on boring log
	Collect undisturbed tubes	ASTM D1587	Where fine-grained soil encountered in wash rotary boring	Minimum 18" recovery per tube is obtained and sample does not appear disturbed
	Laboratory grain size (sieve) analysis	ASTM D6913	2 to 3 per boring	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory hydrometer analysis	ASTM D7928	selected fine-grained samples	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory water content test	ASTM D2216	each fine-grained sample	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory Atterberg Limits test	ASTM D4318	2 to 3 per boring	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory unconsolidated undrained triaxial test	ASTM D4850	4 to 8	Laboratory test procedure and data report meets requirements of ASTM standard
Define the prevalence, size, and vertical distribution of oversized particles in the soil profile	Visual/manual description of soil, cobbles, and boulders exposed in test pits and reconnaissance lines	ASTM D 2488	5-ft vertical spacing in test pits and 10-ft vertical spacing on recon. lines	Visual/manual soil discription and description of number, size, and shape of oversized particles (boulders and cobbles larger than 3 inches) is made and recorded
Improve definition of Glacial Till hydraulic conductivity on the alignment	In-situ hydraulic conductivity tests in Glacial Till	Variable head test procedure (see Report text)	Up to 12	Steady trend in head drop over time is recorded, or equilibrium water level reached
	Lab hydraulic conductivity on fine-grained Glacial Till samples	ASTM D5084	Up to 4	Laboratory test procedure and data report meets requirements of ASTM standard
	Estimate hydraulic conductivity from grain size analysis data	Hazen correlation	selected Glacial Till samples	Estimated hydraulic conductivity consistent with that measured from in-situ and lab tests
Define soil characteristics for slurry wall backfill mix design	Grain size (sieve) analysis on native source soil	ASTM D6913	1 per bulk sample	Laboratory test procedure and data report meets requirements of ASTM standard
	Cation Exchange Capacity (CEC) on native soils	EPA SW-846 9081	1 per bulk sample	Laboratory test procedure and data report meets requirements of ASTM standard
	Grain size (sieve) analysis on trial mix soil blends	ASTM D6913	1 per trial mix	Laboratory test procedure and data report meets requirements of ASTM standard
Performance testing of slurry wall backfill mix	Laboratory hydraulic conductivity test	ASTM D5084	2 per trial mix	Laboratory test procedure and data report meets requirements of ASTM standard; Hydraulic conductivity of trial backfill meets design goal
	Mix compatibility testing	ASTM D7100	2 on selected mix	Laboratory test procedure and data report meets requirements of ASTM standard; Hydraulic conductivity remains within design range after permeating with site water
	Compressive strength (cemented backfill only)	ASTM C39 / D1633	6 per trial mix	Laboratory test procedure and data report meets requirements of ASTM standard; Compressive strength behavior with time defined and consistent with design
	Triaxial stress-strain behavior	ASTM D4767	1 per trial mix	Laboratory test procedure and data report meets requirements of ASTM standard and define stress-strain curve for backfill material

Notes:

1. ASTM = American Society for Testing and Materials
2. See Drawing B-1 and Table 1 for proposed boring and piezometer locations and anticipated boring depths
3. See Table 3 for summary of proposed laboratory tests

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BORING LOCATION PLAN



PROGRESS PRINT
03-04-2024

WARNING: IT IS A VIOLATION OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER ANY ITEM ON THESE PLANS IN ANY WAY. IF ALTERATIONS TO THESE PLANS ARE MADE, THE ALTERATIONS SHALL BE MADE IN ACCORDANCE WITH ARTICLE 145 - SECTION 7209.2 OF THE NEW YORK STATE EDUCATION LAW.

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- NOTES:
1. SITE FEATURES MAP AND TOPOGRAPHIC SURVEY PROVIDED BY ROUX.
 2. COORDINATES AND SURVEY ELEVATIONS PROVIDED IN NAD83 (HORIZONTAL) AND NAVD88 (VERTICAL) WITHIN MONTANA STATE PLANE COORDINATE SYSTEM (FIPS2500).
 3. ALL BORING LOCATIONS ARE APPROXIMATE.
 4. BORINGS NOT DESIGNATED AS SONIC DRILL WILL BE DRILLED BY WASH ROTARY METHODS. BORINGS DESIGNATED AS SONIC DRILL MAY BE DRILLED BY SONIC DRILL OR WASH ROTARY METHODS.

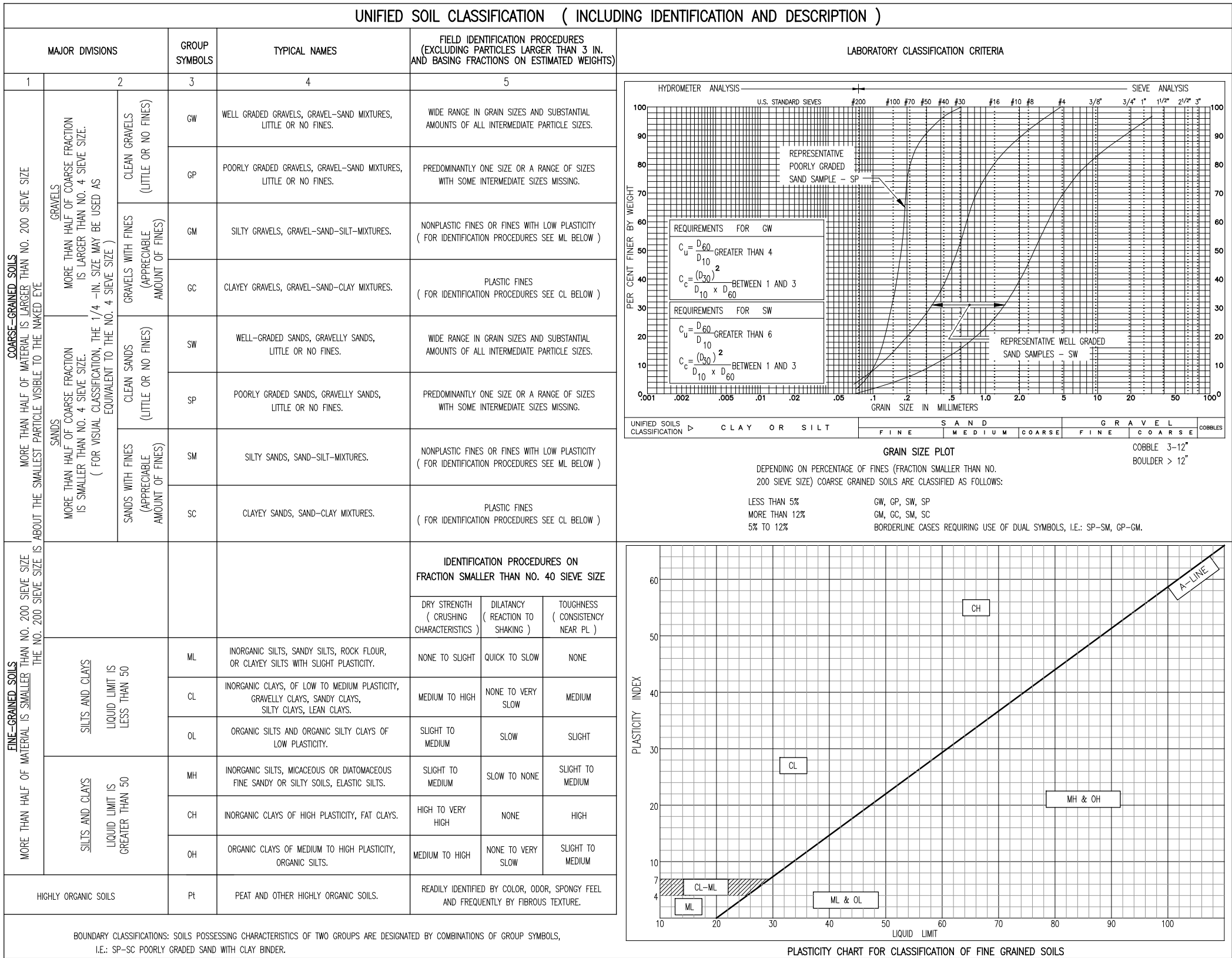
PROPOSED BORING LEGEND:

- MR-1SBP
- PROPOSED SOIL BORING
 - 'SB' INDICATES SONIC DRILL BORINGS
 - 'P' INDICATES VIBRATING WIRE PIEZOMETER SERIES INSTALLED IN BORING

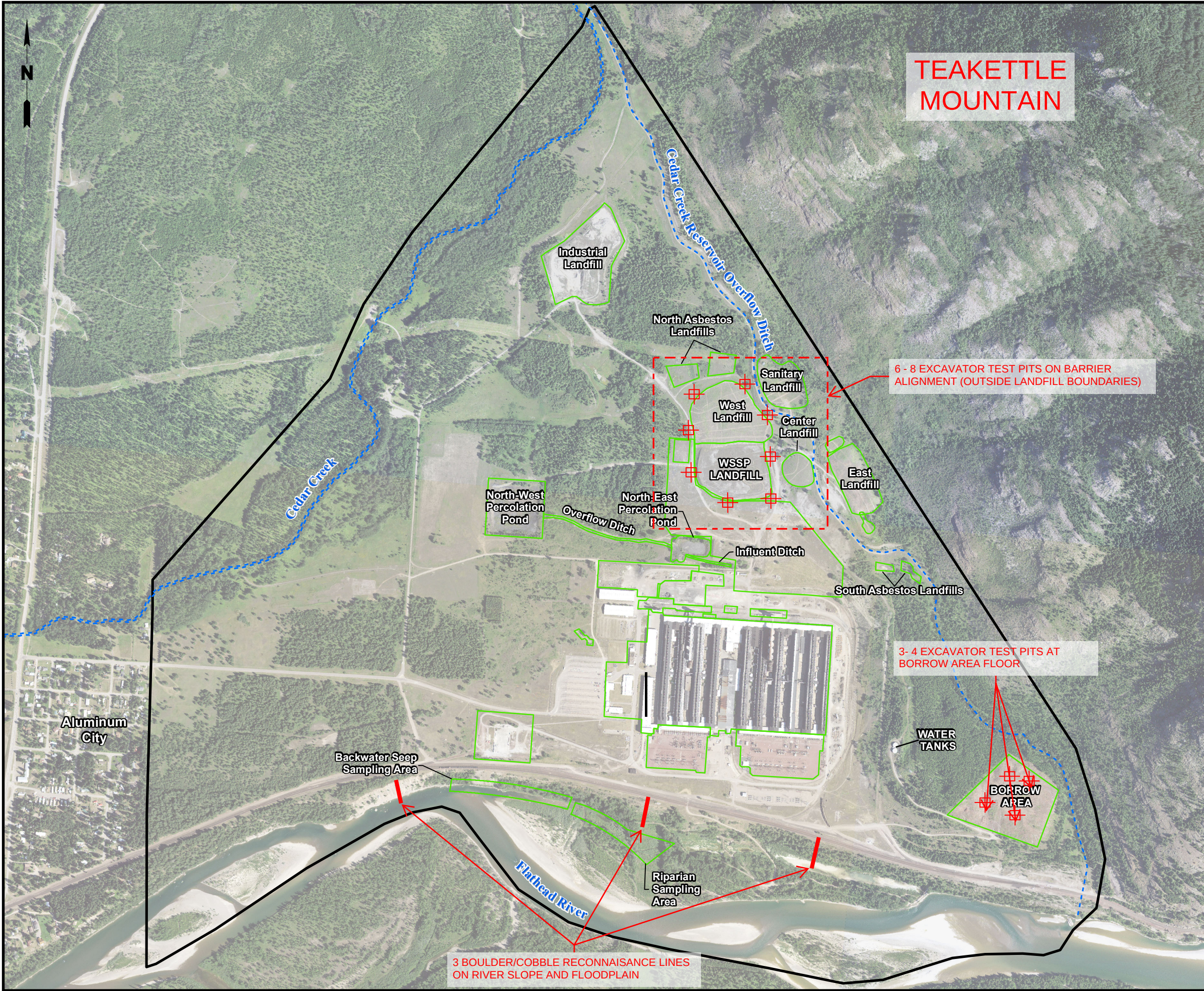
EXISTING (ROUX) BORING LEGEND

- CFMW-019a
- MONITORING WELL LOCATIONS SCREENED BELOW UPPER HYDROGEOLOGIC UNIT
- CFMW-010
- MONITORING WELL LOCATIONS SCREENED IN UPPER HYDROGEOLOGIC UNIT
- CFSB-271
- SOIL BORING LOCATIONS

REV.	DATE	BY	DESCRIPTION	
COLUMBIA FALLS ALUMINUM COMPANY PRE—DESIGN INVESTIGATION				
COLUMBIA FALLS			MONTANA	
ROUX				
OAK BROOK			ILLINOIS	
MUESER RUTLEDGE CONSULTING ENGINEERS PLLC 14 PENN PLAZA – 225 WEST 34TH STREET, NEW YORK, NY 10122				
SCALE	MADE BY: J.P.		DATE: 02—14—2024	FILE NUMBER
AS NOTED	CH'KD BY: C.G.		DATE: 03—14—2024	14780
BORING LOCATION PLAN SLURRY WALL PDI				DRAWING NUMBER B—1A



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NOTES
1. PROPOSED TEST PIT AND RECONNAISSANCE LINE LOCATIONS SHOWN ARE APPROXIMATE AND WILL BE ADJUSTED BASED ON FIELD CONDITIONS, ACCESSIBILITY, AND PRESENCE OF COBBLES/BOULDERS INDICATED BY BORINGS.

LEGEND

- SITE FEATURES
- CREEK FEATURES
- STUDY AREA
- PROPOSED EXCAVATOR TEST PIT
- PROPOSED BOULDER/COBBLE RECONNAISSANCE LINE

** ANNOTATIONS IN RED COLOR WERE ADDED BY MRCE TO BASE FIGURE PREPARED BY ROUX.



Title: **Test Pit and Reconnaissance Line Location Plan**

Prepared for: COLUMBIA FALLS ALUMINUM COMPANY, LLC

ROUX	Compiled by: M.H.	Date: 03/06/24	FIGURE T-1
	Prepared by: M.S.R.	Scale: AS SHOWN	
	Project Mgr: M.H.	Project: 2476.0001Y016	
	File: 2476.0001Y319.02.mxd		

APPENDIX A
MRCE Standard Specifications for
Drilling, Sampling, and Testing
(Wash Rotary Borings)

SECTION S

MRCE STANDARD SPECIFICATION FOR DRILLING, SAMPLING, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

1. This Section presents the standard equipment, materials, mixtures, and procedures required for advancement of geotechnical borings for soil and rock sampling, and completion of work enumerated under Section A in the Scope of Work. Requirements for other in-situ testing, if requested, are provided under separate cover.

1.02 RELATED SECTIONS

1. All terms, definitions, requirements, plans, schedules, and drawings noted hereunder are incorporated within this specification. Where conflicts arise, Section A shall supersede this Section. The Related Sections are:
 - a. Section A – Information to Bidders.

1.03 DEFINITIONS

1. Administration – the preparation of submittals, acquisition of permits and approvals, and procurement and delivery of materials to/from the site and between boring and test locations.
2. Mobilization – the maintenance of equipment, and transport of equipment to/from the site and between boring and test locations.
3. Observation Well – an instrument for measuring head elevation in an aquifer and sampling groundwater installed in a completed borehole which captures the phreatic surface within the screened interval where the screened interval does not include a bentonite seal.
4. Obstruction – an object within a borehole which cannot be broken up or bypassed readily by a soil drilling bit as mutually determined by the Contractor and Engineer.
5. One-Call Notification System (One-Call) – a system operated by an organization that has, as one of its purposes, the duty to receive notification from excavators of intended excavation in a specified area to disseminate such notification to underground facility operators that are members of the system so that such operators can locate and mark their facilities prior to excavation.
6. Piezometer – an instrument for measuring head pressure and field testing permeability of an aquifer installed in a completed borehole which is screened and sealed below the phreatic surface. Types consist of either: (a) Open-Standpipe or (b) Grouted-in-Place.
7. Scope of Work – the number and types of borings and schedule of sampling and testing as enumerated in Section A.
8. Tremie – method for the placement of a fluid by insertion of an injection pipe or hose from the bottom of a borehole and extracting such that injection point remains a minimum of 2 feet within the injected fluid at all times.
9. The Work – all items to be furnished and performed by the Contractor and necessary to complete the Contract.
10. Written Notice – delivery in person to the individual or to a member of the firm for whom it is intended, or if delivered at or sent by registered or electronic mail to the last business address known to those who give the notice.

1.04 REFERENCES

1. Referenced Standards

- a. For all referenced standards, use the most recent approved version of the standard.
- b. American Society for Testing and Materials (ASTM):
 - (1.) ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils;
 - (2.) ASTM D1587 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes;
 - (3.) ASTM D2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation;
 - (4.) ASTM D4220 Standard Practices for Preserving and Transporting Soil Samples;
 - (5.) ASTM D4633 Standard Test Method for Energy Measurement for Dynamic Penetrometers;
 - (6.) ASTM D5079 Standard Practices for Preserving and Transporting Rock Core Samples;
 - (7.) ASTM D5088 Standard Practice for Decontamination of Field Equipment Used at Waste Sites;
 - (8.) ASTM D5092 Standard Practice for Design and Installation of Groundwater Monitoring Wells;
 - (9.) ASTM D5299 Standard Practice for Decommissioning of Groundwater Wells and Boreholes;
 - (10.) ASTM D5783 Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices;
 - (11.) ASTM D6151 Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling;
 - (12.) ASTM D6519 Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler;

1.05 SUBMITTALS

1. See Section A.

PART 2 PRODUCTS

2.01 EQUIPMENT

1. General:
 - a. Supply all equipment to be used for the successful completion of the Work.
 - b. Maintain all equipment in sufficient readily available supply for the continuous expeditious execution of the Work.
 - c. Maintain all equipment in good working condition and repair equipment to a good working condition as rapidly as is practicable.
 - d. Visually inspect all equipment prior to each use, if any item is found to be damaged; clean, repair, or replace that item prior to being put into further use.
 - e. Make all equipment available for visual inspection by the Engineer. Clean, repair, or replace any piece of equipment deemed to be in an unsatisfactory condition as necessary for the satisfactory completion of the Work.
 - f. Sufficiently repair all equipment leaks to prevent spillage. Handle spillage in accordance with the Contractor's Health and Safety Plan.

2. Casing:
 - a. Provide drill casing in quantities and sizes adequate for expeditious performance of the Work.
 - b. Provide casing with a minimum 2 ½ inch inner diameter (I.D.) casing for split barrel sample borings and not less than 3 ½ inch I.D. for undisturbed sample borings.
3. Drill Tools:
 - a. Provide rotary drill bits and downhole tooling appropriate for the resistance encountered and maintained in good condition at all times.
 - b. Provide drill bits which deflect wash water flow toward the sides of the borehole and prevent jetting of the borehole.
 - c. Inspect tooling for damage and operability upon removal from borehole. Clean, repair, or replace all equipment found to be damaged prior to use.
 - d. Hollow Stem Auger Plug – provide a solid steel plug attachment with an outside diameter not less than 95% of the inside diameter of the casing.
4. Split Barrel Sampling Tools and Jars:
 - a. Provide Split Barrel Samplers and equipment necessary to perform the Standard Penetration Test in general conformance with ASTM D1586. The following hammer types may be used:
 - (1.) Donut Hammer;
 - (2.) Safety Hammer; and
 - (3.) Automatic Hammer,
 - b. Provide storage jars with:
 - (1.) Removable screw lid with water tight gasket to preserve moisture content of the soil sample;
 - (2.) Minimum dimensions of 3 ½ inches high, by 1 ¾ inch I.D. at the mouth with inside diameter of the jar no more than ¼ inch larger than the mouth.
5. Tube Sampling Tools and Sample Tubes:
 - a. Provide Stationary Piston and Shelby Tube sampler and sample tubes in general conformance with ASTM D1587 and D6519. Provide sample tubes made of one of the following: brass, hardened aluminum, stainless steel, galvanized steel, or steel coated with lacquer and free from rust.
 - b. Clean the undisturbed sampler to the satisfaction of the Engineer prior to each use.
6. Coring Tools and Boxes:
 - a. Provide core barrels of double tube construction and of the size and type indicated in Section A and in general accordance with ASTM D2113.
 - b. Provide core boxes a minimum of 5 feet long on the interior and able to fit core of the same type and size as the core obtained and in general conformance with ASTM D5079.

2.02 MATERIALS

1. General:
 - a. Supply all materials to be used for the successful completion of the Work unless otherwise specified in Section A.
2. Water, Hoses, Tanks and Pumps:
 - a. Provide water and equipment which are free from impurities which will affect the work.
 - b. Water may not be readily available at the site. Secure all permits and permission to access water supplies unless otherwise stated in Section A or prior arrangements have been made with the Engineer or Owner.
 - c. Provide hoses of sufficient length, tanks of sufficient volume and pumps of sufficient capacity for the expeditious completion of the work.

3. Drilling Fluids:
 - a. Bentonite or non-biodegradable drilling fluid additives may be used in the drilling mud to stabilize the borehole walls in borings that do not receive a groundwater monitoring instrument as enumerated in Section A.
 - b. Biodegradable drilling fluid additives or water only may be used in the drilling mud to stabilize the borehole walls in borings that will receive a groundwater monitoring instrument as enumerated in Section A.
4. Open-Standpipe Piezometers and Observation Wells
 - a. Riser – Schedule 40 polyvinyl chloride (PVC) with threaded gasket joints of the diameter indicated on the Contract Drawings. Where non-uniform lengths of standpipe are joined, use couplers as approved by the Engineer and tape both ends of the coupler.
 - b. Screen – Schedule 40 PVC with a minimum of No. 10 slots spaced at 40 to 50 slots per foot of the diameter indicated on the Contract Drawings.
 - c. End Cap – Schedule 40 PVC with threaded gasket joint.
 - d. Cap – screw top with a gasket.
 - e. Seal – bentonite pellets.
 - f. Filter Pack – No. 2 Morie Sand or approved equal.
 - g. Flush Mounted Well Cover – rated for traffic with gasket seal and a minimum of two bolts.
 - h. Standpipe – steel pipe with a locking steel lid of the diameter indicated on the Contract Drawings.

PART 3 EXECUTION

3.01 INSPECTION OF WORK

1. Provide the Engineer with access for inspection of the Work at all times. Including drilling borings, sampling, sample handling and storage, testing, instrument installation, closeout, and cleanup.

3.02 MOBILIZATION

1. Do not begin Mobilization until given written notice by the Engineer. Upon receipt of notice to proceed, provide the Engineer with estimated time of arrival, list of proposed crews, contact information, and proceed with Mobilization.
2. Examination of Site:
 - a. Prior to mobilization to the site, become familiar with the nature of the Work and the local site conditions. For pre-bid site meetings, see Section A.
 - b. Perform One-Call notification for the site jurisdiction. Confirm that site has been marked by the public utilities. Refer to the Project Drawings for callouts of utility locations known to the Engineer.
3. Permits and Licenses: Obtain all permits, give all notices and comply with all laws, ordinances, rules, and regulations bearing on the conduct of the Work as drawn and specified.

3.03 PROTECTION

1. Continuously protect the Work from damage, protect the site and adjacent property, and maintain lights and other safety devices as provided by law and as local conditions require, or as specified in Section A. Promptly repair all damage caused by Contractor's operations under this Contract.
2. Clearly cordon off work areas such that inadvertent entry by the public is prevented.
3. Continuously employ the accepted Health and Safety Plan throughout the project and appoint a site representative for Emergency Response.

4. The Owner and Engineer have attempted to identify boring locations which are clear of underground utilities and structures and to permit work to be done at locations favorable to the Contractor's operations. It is the Contractor's responsibility to ensure that each boring is advanced past the utility depth without damaging utilities. If damage to a utility occurs, repair utility to the satisfaction of the utility owner at no additional cost to the Owner.

3.04 ADVANCEMENT OF BORINGS

1. Locations:
 - a. Locate proposed boring locations by survey accurate to within 6 inches. Observe utility markout, vicinity of the boring location and refer to available information to verify boring location prior to advancement. Relocate borings as necessary to prevent subsurface interferences.
2. Casing:
 - a. Case all borings in the upper 10 feet and to greater depths as necessary to provide a stable borehole and meet field conditions.
 - b. The Engineer may require casing for the full depth of borings if, in their opinion, successful boring operations cannot be carried out without casing, or if casing is required to obtain groundwater observations at particular depths or for extended periods.
3. Mud Rotary Drilling:
 - a. Perform mud rotary drilling in general conformance with ASTM D5783.
 - b. Advance the boring in an open hole stabilized with weighted drilling mud or water. Where casing is necessary to maintain an open hole, advance boring a minimum of five (5) feet ahead of the casing, unless otherwise agreed upon by the Engineer. Advancing boring by washing through split-barrel sampler is not permitted.
 - c. Use casing and/or drilling mud when advancing borings through granular soils.
 - d. Lift drill bit off the bottom of the hole and flush thoroughly to remove all soil cuttings upon reaching the sampling interval.
 - e. Maintain a water or mud level at or near the top of the casing when removing tooling from borehole.
4. Hollow Stem Auger
 - a. Perform hollow stem auger drilling in general conformance with ASTM D6151.
 - b. Use a Hollow Stem Auger Plug at all times while advancing augers.
 - c. Maintain a water or mud level at or near the top of the casing when removing tooling from borehole.
5. Jetting:
 - a. Advancing the borehole by jetting with air or water is not permitted.

3.05 SOIL SAMPLING

1. General:
 - a. Obtain soil samples at the depths, intervals, and of the type indicated in Section A.
 - b. Clearly mark all samples obtained with the following information:
 - (1.) MRCE project number, boring number, sample number, depth interval, recovery, penetration resistance, and field test values obtained;
2. Split Spoon Sampling and Standard Penetration Test (SPT):
 - a. Lower sampler and tooling into the hole until the sampler comes to rest on the bottom. Compare sampler depth to drill depth, if cuttings greater than six (6) inches in thickness have settled above the sample depth, remove sampler and tooling from the borehole and cleanout the borehole with drill bit as normal and re-attempt sample.

- b. Perform the SPT in general accordance with ASTM D1586 using a 2 inch outer diameter and 1 3/8 inch inner diameter split barrel sampler. Continue application of blows until one of the following occurs:
 - (1.) Sampler refusal is obtained. Sampler refusal is defined as either:
 - i. A total of 50 blows have been applied over any 2 inch increment;
 - ii. A total of 100 blows have been applied over any 6 inch increment;
 - (2.) A total of 2 feet of penetration has been obtained;
 - c. Open split barrel sampler prior to advancing borehole. If sample consists of wash material or is of less than six inches measured recovery, make a second attempt with a 2 inch O.D. split barrel sampler. If second attempt is unsuccessful, make a final attempt with a 3 inch O.D. split barrel sampler.
3. Tube Sampling
- a. Perform Stationary Piston Sampling in general conformance with ASTM D6519.
 - b. Perform Shelby Tube Sampling in general conformance with ASTM D1587.
 - c. Test tube sampling device above ground to demonstrate it is in good working order.
 - d. Fully jack rig off of springs and make stationary.
 - e. Push sampling device no more than 24 inches and leave in place for ten or more minutes after advance. Prior to sampler removal, rotate drill string two full rotations.
 - f. Place tube samples having less than six inches recovery and samples within damaged tubes in glass jars.
 - g. Provide sample to Engineer for classification. Seal tube after classification is complete as follows:
 - (1.) Cover soil in sample on bottom with a minimum of ½ inch of liquid paraffin wax and allow to cool. Pack any remaining space with sand or a stiff material which repels water. Place plastic cap over sample end and tape in place. Repeat for top of sample. Dip each end in liquid paraffin wax a minimum of 1 inch beyond tape.
 - h. Mark sample with: MRCE job number, boring number, sample number, sampling interval, length of push, length of recovery, date sample was taken, location of top of soil, and location of bottom of soil.
 - i. Samples that are disturbed, damaged or have low recovery at the fault of the Contractor will not be accepted and no payment will be made for such samples.

3.06 ROCK CORING

- 1. General:
 - a. Obtain core samples of the type and in the quantity indicated in Section A.
 - b. Clearly mark all core samples obtained with the following information:
 - (1.) MRCE project number, boring number, sample number, depth interval, recovery, and rock quality designation (RQD);
- 2. Perform coring in general accordance with ASTM D2113 in runs no greater than five feet in length. Core run length may be reduced at the direction of the Engineer.
- 3. Commence coring at the depth of driven sampler refusal accompanied by a minimum of 6 inches of continuous smooth drilling with significant down pressure applied. Drilling beyond 6 inches will not be permitted. Obtain core in run lengths no greater than 5 feet. At boreholes with rock coring, do not terminate the borehole in bedrock with less than 35% recovery unless directed otherwise by the Engineer.
- 4. Tape measure borehole depth to verify quantity of core recovered upon retrieval of core barrel. Make a second attempt to recover portions of core not captured by the first attempt.

5. Preserve and transport core in accordance with ASTM D5079. Secure core samples inside core boxes to prevent movement during transport.

3.07 OBSTRUCTIONS

1. Advance the boring through obstructions in general accordance with ASTM D2113 in core lengths no greater than 5 feet. Resume soil sampling and drilling techniques immediately upon bypassing the obstruction.
2. Borings may be offset and drilled without sampling to the deepest depth obtained prior to encountering an obstruction. No payment will be made for offsetting the boring and drilling without sampling to the prior depth.

3.08 STORAGE, HANDLING, AND SHIPMENT

1. Arrange for storage of equipment and materials unless such space is made available by the Owner.
2. Storage and Handling of Soil and Core Samples:
 - a. Sample Storage Location: Confer with the Engineer prior to the start of work and determine an acceptable storage location for samples. Select a cool, dry, level location out of direct sunlight with controlled access.
 - b. Jar Samples: Handle in general accordance with ASTM D4220. Samples which have been lost or those thrown or dropped from a height may be rejected and will need to be replaced. No payment will be made for replacement of samples which are directly caused by the Contractor.
 - c. Tube Samples: Handle in general accordance with ASTM D1587. Do not expose samples to extreme heat, freezing temperature, undue vibrations. Do not shock or jar samples.
 - d. Core Samples: Handle in general accordance with ASTM D5079. Lay core samples flat. Do not allow core samples to soak in water.
3. Ship samples to the address and at the frequency specified in Section A.

3.09 GROUNDWATER OBSERVATIONS

1. Provide the Engineer with access to make observations of groundwater levels at the beginning and end of each shift and at the terminated depth of the boring. Report any and all unusual water conditions and gain or loss of drilling fluid to the Engineer. When required by the Engineer, bail borings for observations of groundwater conditions.

3.10 OBSERVATION WELL AND OPEN-STANDPIPE PIEZOMETER INSTALLATION

1. Install observation wells and open-standpipe piezometers in general accordance with ASTM D5092 in borings as enumerated in the Scope of Work. Dimensions and depths of screen, riser, filter pack, and seals will be determined by the Engineer in the field in accordance with Drawing P-1.
2. Backfill boreholes deeper than planned piezometer installations with grout and allow to set overnight or backfill with sand and/or bentonite pellets to the required depth.
3. Place materials by tremie pipe or other means which prevents bridging of annulus or which permits removal of drill casing without disturbing observation well or open-standpipe piezometer installation. Verify depth of material by tape measure continuously during placement.
4. Flush by tremie method until return is clear or as otherwise directed by the Engineer.
5. Perform a variable head permeability test on all observation wells and open-standpipe piezometers with recordings by the Engineer. The Engineer will measure the initial water level in the casing and then request either of the following methods:
 - a. Fill the casing with fresh water, reduce flow while adding water to minimize turbulence of water surface and confirm that the casing is full, then allow water in casing to re-stabilize; or
 - b. Evacuate casing with a pump and allow water in casing to re-stabilize.

- iv. *If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and verify piezometer function or replace with alternate sensor.*

8. Mix and place CB grout.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

9. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.7, Step 7.3.

10. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred. Obtain reading at each visit to piezometer to obtain curing trends where practical.

Temperatures are likely to spike in the short term, and pressure should stabilize to that of the surrounding groundwater following initial grout set. Obtain readings at each visit.

11. Top off grout and install borehole surface protection.

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

12. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

13. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings throughout the monitoring period. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

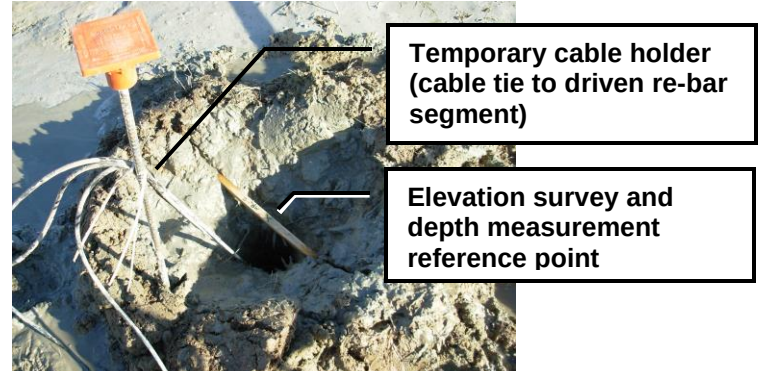


Figure C-2. Example temporary cable holder and survey reference point

14. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the relative permeability between the bentonite-grout and adjacent soil formation. Reliable baseline readings may be obtained after readings have stabilized. Plot data and provide to Project Manager.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster/string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

Vibration Wire Piezometer (VWP) Installation Procedure
Type 2 – Fully Grouted
Method B (Supported on Tremie Pipe or Instrument Casing)

A. SUMMARY

Procedure to install one or more vibrating wire piezometers in a grouted borehole by supporting on the tremie pipe, or on any vertical, full-depth instrument casing installed in the borehole (e.g. that of an ABS inclinometer casing, PVC extensometer casing or along the grouted and solid pipe section of a PVC open standpipe piezometer casing).

Note: This method is required if instruments must be supported from the bottom of the borehole, as during removal of temporary casing (if used) and grouting. If it is practical to suspend instruments from the top, use Method A.

Commentary: Method B may be required if temporary casing is needed for borehole support, as it may prove impractical to suspend piezometer cables from the top while removing the casing. Other options may be possible in some cases (see Method A and consult driller). If feasible, Method A is more desirable than Method B because it is less costly (does not require abandonment of tremie pipe in borehole) and reduces the number of potential paths for hydraulic communication between piezometers in the borehole.

B. REFERENCED DOCUMENTS

1. ASTM D4380-84 (2006), Standard Test Method for Density of Bentonitic Slurries.
2. Mikkelsen and Green, 2003, "Piezometers in Fully-Grouted Boreholes." International Symposium on Geomechanics, Oslo, Norway. September 2003.

C. MATERIALS

1. Vibrating wire (VW) piezometers shall be Model 4500-series as manufactured by Geokon, Inc., Model 52611024, manufactured by Durham Geo Slope Indicator (DGSI), or approved equal. Pressure ranges shall be selected such that piezometers will be within standard operating range under expected groundwater conditions, and will not exceed two (2) times rated maximum pressure (over-stress) for highest possible grout level during CB grout placement.
2. Cement-bentonite (CB) grout shall consist of 94 lbs Portland cement (1 sack US) with 35 gallons of water, blended with approximately 25 lbs dry bentonite.
3. Cement grout shall consist of 94 pounds cement (1 sack US) to 6.5 gallons water.
4. Tremie pipe shall be $\frac{3}{4}$ " or 1" Schedule 40 PVC with threaded or coupled joints. Coupled joints, if used, shall be sealed with PVC cement. Tremie pipe shall have side discharge.

D. EQUIPMENT

- Survey tape for cable measurement, sufficiently long to reach deepest borehole depth.
- Optional: Second survey tape for permanent installation in borehole (tape length $\geq$ borehole depth)
- Mud balance for slurry density measurement (ASTM D4380)
- Hand-held vibrating wire read-out compatible with piezometer
- Water level indicator for slurry/mud depth measurement during borehole advancement

E. PREPARATION

1. Complete Pre-Installation Acceptance Test (Appendix D-1) to verify piezometer function and linear gage factor.

Confirm that sensor serial number is correctly labeled at the free end of the cable; this label will be the only way to identify the sensor once buried. It's always a good idea to add additional serial number labels to the cable, or prepare extra stick-on labels for use in the field if the cable is to be cut or spliced (see Note below). It is also helpful to mark the cable with its total length after preparation (see Paragraph E.3 below).

Note: cutting or splicing piezometer cables in the field should be avoided whenever possible (see Paragraph F.15 below).

2. Prepare piezometer for installation (Fig. D-6).
3. Saturate filter tips by soaking in de-aired water for at least 2 hours.

Because air is compressible, trapped air in the filter tip will increase sensor response time and may result in errant pressure measurement. Submerge filter tips in de-aired, or as hot as possible, water overnight before installation

4. Option: Affix a survey tape to the bottom of the tremie pipe. Confirm the “zero” mark on tape coincides with the bottom end of the tremie pipe.

Piezometer depth is critical to data interpretation. The optional survey tape provides a running measure of sensor position with depth in the borehole. Affix firmly using tape and/or zip ties. Else, carefully log length of pipe sections installed, generally 10 ft sections, and carefully measure offset distance to each affixed piezometer diaphragm intake relative to PVC pipe joints, typically up from previous flush mount joint. Confirm measurements prior to lowering into slurry or grout, and assure relative depths (to the nearest inch or tenth of a foot) are documented on logs.

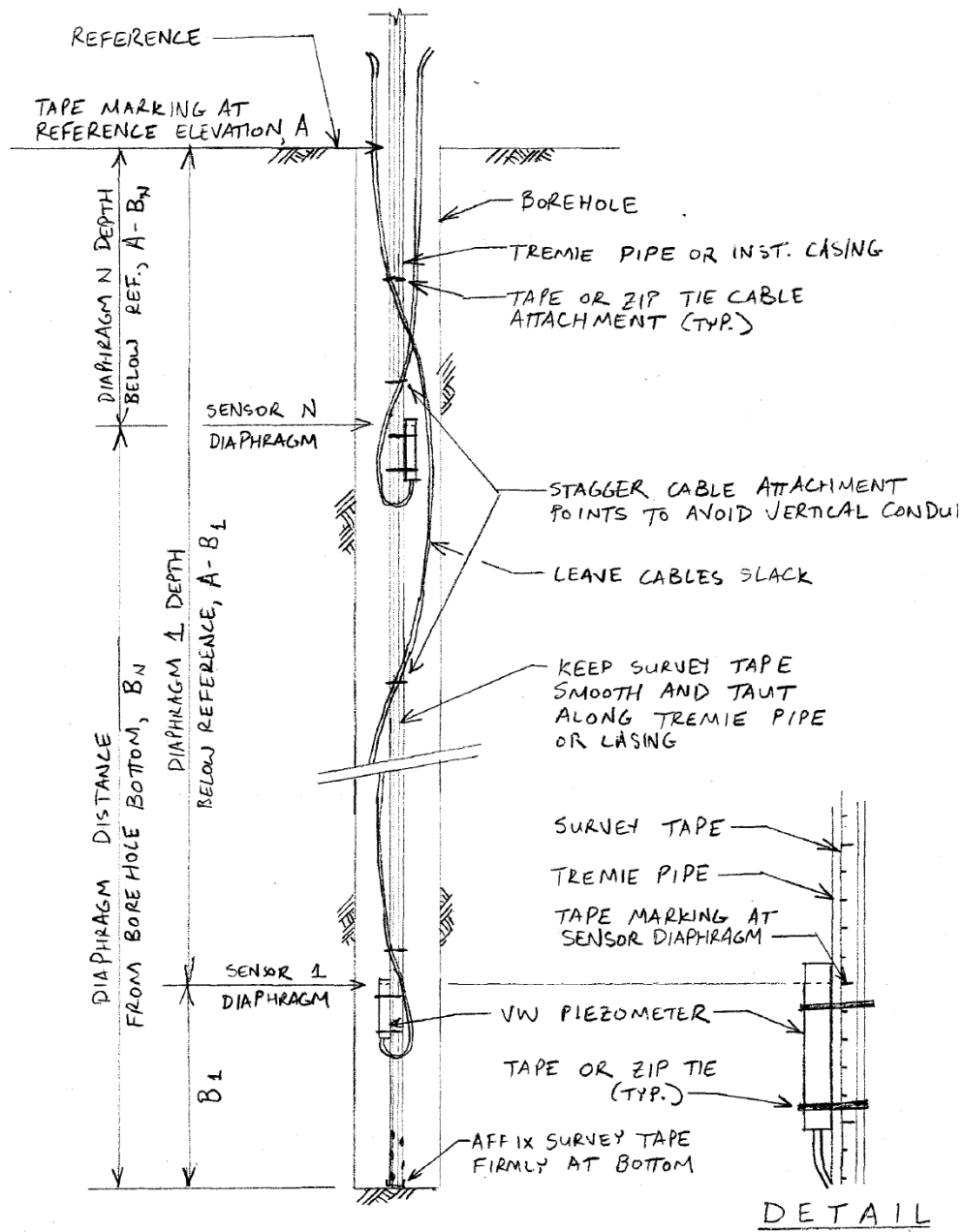
F. INSTALLATION

1. Drill and log borehole as specified.
2. Confirm desired diaphragm depths with MRCE Project Manager based on soil profile from boring. Select piezometer cable lengths and pressure ranges based on desired depths.

Verify adequate piezometer pressure range per paragraph C.1. Assume a unit weight of 80 pcf for CB grout during placement.

3. Confirm piezometers to be installed in borehole are functional.

Record VW piezometer output (digital reading, R and temperature, T) in air. Confirm the reading is consistent with reading taken during Pre-Installation Acceptance Test (Lab R₀). See Sample VW Piezometer Installation Record.



4. Flush borehole to 1

FIGURE D-6

with fresh drilling mud.

5. For each piezometer to be installed in the borehole, submerge sensor in clean water and place saturated filter tip over end. Keep sensor tip pointing upwards so that the tip remains saturated.

The space between the sensor diaphragm and filter tip should be completely full of water.

6. For each piezometer to be installed in the borehole, record VW piezometer reading at site barometric pressure and borehole fluid temperature (field zero). See Sample VW Piezometer Installation Record.

Sealed VW sensors are calibrated to report zero at a certain pressure (usually 1 atm), and temperature determined during manufacture. The field zero reading is used to adjust the zero reading to the barometric pressure and borehole temperature at the site at the time of installation. Perform the following steps:

- a. Lower piezometer to depth representative of the typical fluid temperature in the borehole (typically 10-20 feet).
 - b. Attach and power-up hand-held VW read-out.
 - c. Wait until temperature reading stabilizes (typically 5-10 minutes).
 - d. Remove piezometer from borehole. Keep filter tip pointed upward to maintain saturation.
 - e. Record piezometer output (digital reading, R_0 and temperature, T_0).
7. Assemble tremie pipe or instrument casing and begin lowering into borehole. Where optional survey tape is permanently affixed to casing, confirm survey tape runs smooth and taut along the tremie pipe or casing; affix tape to pipe/casing at regular intervals.

Where used, the survey tape provides an accurate running depth reference. Affix to tremie pipe or instrument casing with tape or zip ties at approximately 10-foot intervals.

8. While lowering tremie pipe or instrument casing, install VW piezometers in accordance with manufacturer's instructions, typically as follows:
 - 8.1. Attach piezometer to tremie pipe or instrument casing with diaphragm at Distance A from borehole bottom for deepest piezometer. Record tape marking at sensor diaphragm.

Secure piezometer body to tremie pipe using tape and/or cable ties. It is advisable to take a photograph of the attached piezometer with serial number and tape marking both visible, for future reference.

- 8.2. Continue assembling and lowering tremie pipe or instrument casing as specified until Distance A for next piezometer is reached. Secure sensor cable(s) to pipe at regular intervals using tape and/or cable ties, leaving slack so that cables are not in direct contact with pipe. Stagger cable attachment points so that multiple cables are not attached to the pipe at the same point.

Leaving cables slack and staggering attachment points reduces the possibility that a vertical path for hydraulic communication can develop along the cables and pipe or casing.

8.3. Repeat Steps 6.1 and 6.2 until all piezometers have been attached.

It may be useful to attach the hand-held VW read-out to free cable ends periodically while lowering to verify that piezometers sense the pressure increase due to drilling mud submergence. If possible, record VW piezometer output at several depths.

9. Record tape marking at reference elevation (e.g. ground surface) with the tremie pipe resting on the bottom of the borehole, B.

Subtract distance A from distance B to determine the depth of each piezometer diaphragm below the reference.

10. Confirm all sensors in borehole are functional under drilling mud.

Table 1. Typical Fluid Weights

Fluid	Unit Weight (pcf)*
Fresh Water	62.4
Drilling Mud	64 - 72
CB Grout	68 - 80

*ranges approximate.

- a. Record VW piezometer output (digital reading, R and temperature, T).
- b. Compute equivalent water column height, H_E , from output:
- i. Compute measured fluid pressure, P using the piezometer's linear gage factor, G , and thermal factor, K , from the Pre-Installation Acceptance Test, relative to the field R_0 and T_0 :

$$\text{Pressure, } P = G (R_0 - R) + K (T - T_0)$$

- ii. Convert the measured fluid pressure, P to an equivalent water column:

$$\text{Equiv. Water Column, } H_E [\text{ft}] = \text{Pressure, } P [\text{psi}] \times 144 / 62.4$$

- c. Measure depth from reference to borehole fluid level. Determine actual fluid column height above sensor diaphragm, H_A .
- d. Compute average fluid unit weight, γ_F , by comparing equivalent water column height, H_E with actual fluid column height, H_A :

$$\text{Calculated Fluid Weight, } \gamma_F [\text{pcf}] = H_E / H_A \times 62.4$$

- e. Compare computed fluid weight, γ_F to reasonable ranges (Table 1).
- f. If computed fluid weight is not reasonable:
- i. Verify that the diaphragm depth is correctly computed; revise if necessary.
- ii. Verify that mud weight does not differ greatly from that assumed.
- iii. Verify field zero reading (Step 6).
- iv. If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and replace with alternate sensor.

11. Mix and place CB grout. Remove any temporary casing from borehole.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

Take care not to disturb piezometers during any casing withdrawal.

12. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.10.

13. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred.

14. Top off grout and install borehole surface protection (Fig. D-2).

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

15. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

16. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings over the life of the piezometer. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

17. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the soil formation's in-situ permeability. Reliable baseline readings may be obtained after readings have stabilized.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster or string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

APPENDIX B.2
Vibrating Wire Piezometer Installation
Record Forms

MUESER RUTLEDGE CONSULTING ENGINEERS

14 Penn Plaza - 225 West 34th Street, NY, NY 10122

PIEZOMETER PRE-INSTALLATION ACCEPTANCE TEST RECORD

Project Name: _____
Project Location: _____
Client: _____
Contract No.: _____
MRCE File: _____
Date: _____

Instrument Type: Vibrating Wire Piezometer
Manufacturer: _____
Model No: _____
Serial No: _____
Purchase Date: _____
Inspector: _____

Examine factory calibration curve
and/or tabulated data to
verify completeness.

☐ Yes ☐ No

Calibration Date: _____

Check tag numbers on instrument
and cable.

☐ Yes ☐ No ☐ NA

Comment: _____

Check cable length.

☐ Yes ☐ No ☐ NA

Comment: _____

Length: _____

Check that model, dimensions, and
materials are correct.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify connection integrity.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify all components fit together
correctly.

☐ Yes ☐ No ☐ NA

Comment: _____

Check all components for damage.

☐ Yes ☐ No ☐ NA

Comment: _____

Update inventory.

☐ Yes ☐ No

Comment: _____

Resistance testing:

☐ Yes ☐ No

Applied
voltage: _____

Resistance: _____

Ω

Factory Zero Reading _____ dg

Factory Temp _____ °C

Ambient Reading _____ dg (in air)

Temperature: _____ °C (in air)

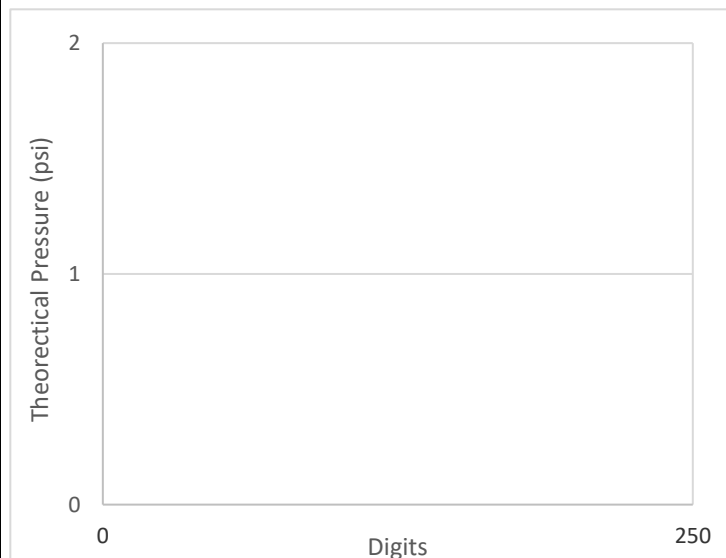
Linear Gage Factor: _____ psi/dg

Thermal Factor: _____ psi/°C

Range: Minimum: _____ 0 _____ psi

Maximum: _____ psi

Water Column Test



Depth (ft) Digit (dg) Temp (°C)

Theoretical Pressure (psi)	Calculated Pressure (psi)

Theoretical Unit Weight Water (pcf): _____

Verified gage factor (psi/dg): _____

Percent difference: _____

APPENDIX C
MRCE Sample Boring Log and Field
Test Forms



BORING LOG

BORING NO. _____

SHEET _____ OF _____

FILE NO. _____

SURFACE ELEV. _____

RES. ENGR. _____

PROJECT: _____

LOCATION:

[illegible]



SONIC BORING LOG

BORING NO.

SHEET 1 OF _____

FILE NO. _____

SURFACE ELEV. _____

RES. ENGR. _____

PROJECT:

LOCATION: _____

[illegible]

BORING NO.



BORING NO. _____
SHEET _____ **OF** _____
FILE NO. _____
SURFACE ELEV. _____
DATUM _____

PROJECT _____
LOCATION _____
BORING LOCATION _____

SONIC BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

		TYPE OF FEED			
TYPE OF BORING RIG	DURING CORING	CASING USED	☐ YES	☐ NO	
TRUCK	MECHANICAL	DIA., IN.	DEPTH, FT. FROM	TO	
SKID	HYDRAULIC	DIA., IN.	DEPTH, FT. FROM	TO	
BARGE	OTHER	DIA., IN.	DEPTH, FT. FROM	TO	
OTHER					

TYPE AND SIZE OF:	DRILLING MUD USED	☐ YES	☐ NO
D-SAMPLER	DIAMETER OF ROTARY BIT, IN.		
U-SAMPLER	TYPE OF DRILLING MUD		
S-SAMPLER			
CORE BARREL	AUGER USED	☐ YES	☐ NO
CORE BIT	TYPE AND DIAMETER, IN.		
DRILL RODS			
	CASING HAMMER, LBS.		AVERAGE FALL, IN.
	SAMPLER HAMMER, LBS.		AVERAGE FALL, IN.

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION

PIEZOMETER INSTALLED ☐ YES ☐ NO **SKETCH SHOWN ON** _____

STANDPIPE:	TYPE	ID, IN.	LENGTH, FT.	TOP ELEV.
INTAKE ELEMENT:	TYPE	OD, IN.	LENGTH, FT.	TIP ELEV.
FILTER:	MATERIAL	OD, IN.	LENGTH, FT.	BOT. ELEV.

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	NO. OF 3" SHELBY TUBE SAMPLES
3.5" DIA. U-SAMPLE BORING	LIN. FT.	NO. OF 3" UNDISTURBED SAMPLES
CORE DRILLING IN ROCK	LIN. FT.	OTHER:

BORING CONTRACTOR _____
DRILLER _____ **HELPERS** _____
REMARKS _____
RESIDENT ENGINEER _____ **DATE** _____
CLASSIFICATION CHECK: _____ **TYPING CHECK:** _____



PERCOLATION TEST DATA RECORD

In a Boring

PROJECT _____
 LOCATION _____
 CONTRACTOR _____
 RESIDENT ENGINEER _____

BOREHOLE NO. _____
 TEST NO. _____
 SHEET NO. _____ OF _____
 FILE NO. _____
 DATUM _____
 SURFACE ELEV. _____

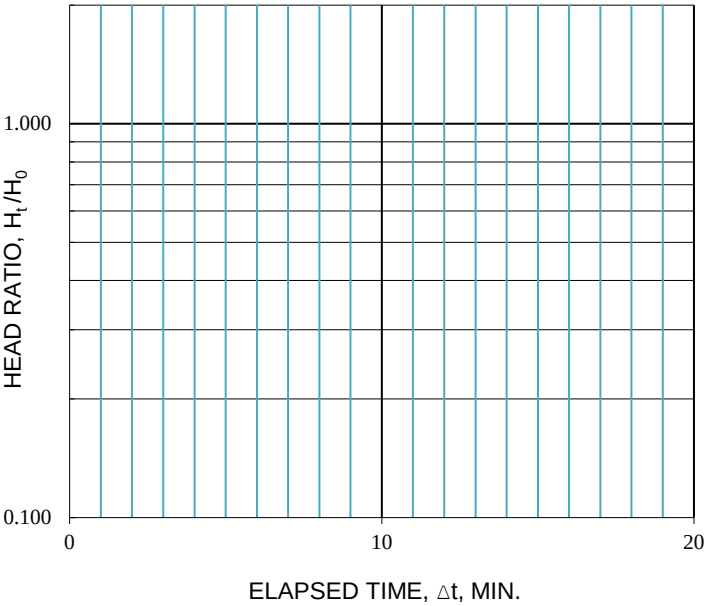
DRILLING

START DATE _____ START TIME _____ WEATHER _____
 DATE COMPLETED _____ END TIME _____
 DRILL RIG TYPE _____ DRILLING METHOD _____ DEPTH OF PERCOLATION TEST _____ FT
 BIT TYPE & SIZE _____ CASING I.D. _____ IN
 REMARKS _____

PERCOLATION TEST MEASUREMENTS AND DATA

SOIL DESCRIPTION _____
 SATURATION PERIOD: START DATE _____ END DATE _____ Water temperature (°C), T= _____
 START TIME _____ END TIME _____ R_t= _____
 START OF TESTING PERIOD: DATE _____ TIME _____ HEIGHT CASING FILLED TO _____ IN
 REMARKS _____

FIELD READINGS		CALCULATED DATA			
TIME (min)	DEPTH (in)	HEIGHT (in)	H _t /H ₀	t ₂ -t ₁ (hr)	K (in/hr)
0.5					
1					
2					
3					
4					
5					
10					
15					



K = _____ in/hr K = _____ cm/s

PERMEABILITY COEFFICIENT, $K_m = \pi \cdot R_t \cdot \frac{D \cdot \ln\left(\frac{H_1}{H_2}\right)}{11(t_2 - t_1)}$

$R_t = 2.2902(0.9842^T)/T^{0.1702}$ and T is temperature in °C

UNDISTURBED SAMPLE LOG

SUBCODE _____

Project_____

Material ☐ Brass ☐ Steel ☐ Stainless Steel

Depth _____ to _____ rec = _____ in.
push = _____ in.

DEPTH FT.	top	SOIL DESCRIPTION & REMARKS	PERFORMED BY	TARE DATE	ω No.	TEST %	TEST TYPE	TEST VALUE
--------------	-----	----------------------------	-----------------	--------------	----------	-----------	--------------	---------------

Tube Scale: 1 div = 1 inch

bottom of tube

$\omega, \%$

Length

Average Water Content = _____ %

Boring No._____

Sample No. _____

APPENDIX D
Sample Chain-of-Custody Form

Pre-Design Investigation Work Plan
2000 Aluminum Drive, Columbia Falls, Montana

APPENDIX B

MRCE WSSP Landfill Settlement Study Work Plan

Wet Scrubber Sludge Pond Landfill Settlement Study PDI Work Plan

**Columbia Falls Aluminum Company
Columbia Falls, Montana**

**Roux Inc.
1301 W. 22nd Street, Suite 800
Oak Brook, IL 60523**

March 21, 2024 (revised June 27, 2025)



NEW YORK CITY | PHILADELPHIA | VIRGINIA / DC | BOSTON

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Attn: Mr. Martin Hamper, Director

Re: Pre-Design Investigation Work Plans
Wet Scrubber Sludge Pond (WSSP) Landfill Settlement Study
Columbia Falls Aluminum Company
Columbia Falls, MT
MRCE File 14780

Dear Mr. Hamper,

In accordance with our December 11, 2023 Proposal, we provide the attached Wet Scrubber Sludge Pond (WSSP) Landfill Settlement PDI Study Work Plan. We have updated this Work Plan to incorporate EPA comments dated June 18, 2025. We would be pleased to answer any questions you may have.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS PLLC

Tony D. Canale, PE

TABLE OF CONTENTS

TABLE OF CONTENTS.....	2
1. SITE DESCRIPTION AND HISTORY.....	4
2. EVALUATION OF EXISTING GEOTECHNICAL DATA.....	4
2.1 WSSP Landfill Topography	4
2.2 Existing Borings and Monitoring Wells	5
2.3 Hydrogeologic Profile based on Existing Borings	5
2.4 Existing Groundwater Level Data.....	5
3. DATA COLLECTION OBJECTIVES (DATA GAPS).....	5
3.1 Proposed Remediation Plan	5
3.2 Additional Data Needed for WSSP Landfill Cap Design	6
4. PROPOSED WSSP LANDFILL SETTLEMENT STUDY PRE-DESIGN INVESTIGATION.....	7
4.1 Proposed Investigation Summary and Objectives	7
4.2 Investigation Methods.....	7
4.2.1 Cone Penetration Test (CPT)	7
4.2.2 Soil Borings	8
4.2.3 Vibrating Wire Piezometer Installation.....	9
4.3 Drill Rig Access Requirements	10
4.4 Inspection and Recordkeeping	10
4.5 Decontamination Procedures during Drilling	10
4.6 Sample Packaging, Labeling, and Storage	10
4.7 Sample Handling and Transport.....	10
4.8 Sample Shipment and Chain-of-Custody (COC)	11
4.9 Laboratory Testing.....	11
5. MANAGEMENT OF INVESTIGATION DERIVED WASTE	12
6. HEALTH AND SAFETY	12
7. QUALITY ASSURANCE AND CONTROL.....	12
7.1 QA/QC Organization.....	12
7.2 QA/QC Procedures.....	12
7.2.1 Field Work:	12
7.2.2 Laboratory Work:.....	13
7.2.3 Data Acceptance:.....	13
8. SURVEY.....	14
REFERENCES.....	14

EXHIBITS

Table 1A	Summary of Existing WSSP Landfill Cap Hand Auger Borings
Table 1B	Summary of Existing Borings and Monitoring Wells within 100 feet of WSSP Landfill
Table 2	Summary of Proposed WSSP Landfill Settlement Study PDI
Table 3	Summary of Proposed WSSP Landfill Settlement Study PDI Lab Testing
Table 4	WSSP Landfill Settlement PDI Data Collection Objectives and Quality Standards

Drawing B-1B Boring Location Plan – WSSP Landfill Settlement Study PDI
Drawing GS-R MRCE Geotechnical Reference Standards

Appendix A	MRCE Standard Drilling and Sampling Specifications (Wash Rotary Borings)
Appendix B	Vibrating Wire Piezometer Technical Information
Appendix C	MRCE Sample Boring Log and Field Test Forms
Appendix D	Sample Chain-of-Custody Form

1. SITE DESCRIPTION AND HISTORY

The Columbia Falls Aluminum Company (CFAC) superfund site, formerly known as Anaconda Aluminum Co. Columbia Falls Reduction Plant, is located two miles northeast of Columbia Falls in Flathead County, Montana. It covers approximately 1,340 acres north of the Flathead River.

The site was operated as a primary aluminum smelting facility between 1955 and 2009. Waste products including spent potliner material, wet scrubber sludge, and other wastes were landfilled on site.

The approximately 10.8-acre Wet Scrubber Sludge Pond (WSSP) Landfill received sludge generated from the wet scrubber. Review of available descriptions and aerial photographs [1] [2] [3] indicates wet scrubber tailings were transported and placed in the WSSP Landfill by hydraulic methods. Hydraulic placement creates an alluvial sorting method that deposits coarse material close to the discharge point and finer-grained sediment at distance from the discharge point. Review of aerial photographs from 1963 and 1974 suggest deposition points were in the north-central, west and southwest areas of the pond.

By 1974, the perimeter embankment had been formed and the pond appeared to contain a combination of liquid and solid spoils. Changes in the appearance of the perimeter dike in aerial photographs between 1974 and 1980 suggest the dike was being raised incrementally, typical of tailings pond construction. Hydraulic deposition ceased in 1980 when the aluminum facility wet scrubbers were replaced with dry scrubbers. The WSSP Landfill was capped with a soil cap in 1981. The deposition history seen in aerial photographs combined with surface depressions in the current topography suggests the landfill may contain fine, compressible sediments that have undergone consolidation settlement.

Remedial investigations performed by Roux Associates Inc. (Roux) identified elevated fluoride and cyanide levels in groundwater, local to the West Landfill and WSSP Landfill [1] [2].

The preferred remedial alternative selected by the United States Environmental Protection Agency (USEPA) includes capping the WSSP Landfill with a low-permeability synthetic cap to prevent future percolation of water through the waste, and constructing a fully encompassing perimeter slurry wall around both the WSSP Landfill and West Landfill to contain contaminated ground water [2]. To achieve a crowned cap shape requires placing an estimated 43,000 cubic yards (cy) of fill over the WSSP Landfill [3] to support the cap.

This **WSSP Landfill Settlement Study PDI Work Plan** provides details of the proposed Pre-Design Investigation (PDI). The objective of the PDI is to collect additional information needed to define the thickness, extent, and geotechnical properties of the WSSP Landfill sediment and provide parameters for analysis of the existing WSSP Landfill sediment and side slopes to support the proposed cap and maintain acceptable surface slope. The collected data will also facilitate an evaluation of options to stabilize the existing WSSP Landfill materials to support cap construction, if determined necessary.

2. EVALUATION OF EXISTING GEOTECHNICAL DATA

2.1 WSSP Landfill Topography

As shown on Drawing B-1B, the top surface of the WSSP Landfill ranges from a high El. +3165 at the east edge to a low El. +3157 in the north-central area. The north, south, and west edges are at El. +3160 to +3163. The WSSP Landfill surface has a dished (concave) shape.

A 15- to 20-foot-high dike with 1.5H:1V to 2H:1V side slopes defines the south and west perimeter of the WSSP Landfill. Surrounding grades are from El. +3137 to +3142. The dike contains wet scrubber sludge materials which are estimated to be 30 feet thick [3].

2.2 Existing Borings and Monitoring Wells

Phase I and II remedial investigations performed by Roux [4] [5] included six (6) shallow hand-auger borings (CFLP series) in the WSSP Landfill at the locations shown on Drawing B-1B. These borings were made to a depth of 2 feet using a 4-inch diameter hand auger to recover grab samples of the earthen cap material. The recovered soils had an average composition of 34% gravel, 39% sand, and 27% fines content (percent passing the U.S. No. 200 sieve). A summary of the CFLP borings is provided in Table 1A. No other borings were made within the WSSP Landfill.

Several borings were made, and monitoring wells installed, outside the footprint of the WSSP Landfill as shown on Drawing B-1B [4] [5]. Refer to the **Slurry Wall PDI Study Workplan** for a summary of those borings and wells.

2.3 Hydrogeologic Profile based on Existing Borings

The remedial investigation [4] defined three stratigraphic units at the Site that consist generally, from land surface down, of:

- **Upper Hydrogeologic Unit:** A 50 to 150 ft thick layer of alluvial coarse-grained deposits and glaciofluvial outwash, varying in vertical extent and grain size depending on vicinity to site features (i.e., Teakettle Mountain, Flathead River, etc.).
- **Below Upper Hydrogeologic Unit:** A layer of compact, poorly sorted Glacial Till with interbedded deposits of glaciolacustrine clays and silts, and coarser water-bearing zones. The Glacial Till has a higher percentage of fines and is more compact than the overlying alluvial and outwash deposits. The large difference in hydraulic head between the Upper Hydrogeologic Unit and the underlying Glacial Till deposits indicate little hydraulic connection between these two units. The Below Upper Hydrogeologic Unit is at least 200 ft thick across most of the Site.
- **Bedrock:** The bedrock is composed of the metasedimentary rocks of the Precambrian Belt Supergroup and defines the bottom of the hydrogeologic system beneath the Site. The bedrock surface slopes downward in the south – southwest direction, towards the Flathead River. The depth to bedrock is estimated to range from depths less than 150 ft near Teakettle Mountain to greater than 300 ft at the Flathead River.

According to the geologic sections provided in [4], the top of Glacial Till at the WSSP Landfill is at approximate El. +3020.

No data is available on the geotechnical properties of the WSSP Landfill sediments.

2.4 Existing Groundwater Level Data

Site-wide groundwater monitoring data [4] [5] indicates significant seasonal variation in groundwater level in the Upper Hydrogeologic Unit. Near the WSSP Landfill, groundwater level fluctuation of 15 to 48 feet was measured over a 1-year monitoring period in 2018, with the seasonal high groundwater level at approximate El. +3085.

A significantly lower groundwater level, ranging from El. +3000 to +3005, was observed in the Glacial Till at Monitoring Well Nos. CFMW-012a and CFMW-019a. Seasonal fluctuation in those wells was muted, with a total range of only 5 feet over a 1-year period.

3. DATA COLLECTION OBJECTIVES (DATA GAPS)

3.1 Proposed Remediation Plan

The surface of the WSSP Landfill currently has a concave shape that will require the addition of at

least 43,000 cubic yards of shaping fill to bring the surface to the positive grades for installation of the required engineered cap [3]. The potential for consolidation of the WSSP Landfill sediments under the added weight of shaping fill must be considered in the cap grading design to provide positive slopes for runoff and infiltration drainage long-term. The proposed cap is expected to meet requirements for an MDEQ Class II landfill cap, which include a low-permeability membrane, a drainage layer (composed of sand and/or geosynthetic materials), an 18-inch barrier soil layer, and a 6-inch topsoil layer with surface vegetation [3].

3.2 Additional Data Needed for WSSP Landfill Cap Design

As summarized in [Section 2](#), there is no existing geotechnical data on the extent, depth, nor geotechnical properties of the WSSP Landfill sediments and perimeter dike. Additional investigation is required to define these parameters for design of the proposed cap. The following primary data collection objectives (Data Gaps) have been identified:

- **Define thickness, material variation, and physical characteristics of the WSSP Landfill sediments.** Cone Penetration Test (CPT) probes placed on a primary (125-foot) grid pattern will define the distribution of sediment compressibility and thickness. The CPT probes will be supplemented by soil borings at selected locations to include split spoon sampling with standard penetration testing (SPT), and collection of thin-walled tube samples of fine-grained materials. Laboratory testing on recovered samples will define a profile of geotechnical index properties including water content, unit weight, grain size distribution, and plasticity at each boring. The spatial distribution of fill materials with those properties can be estimated by comparison with the CPT data set.
- **Define strength of WSSP Landfill sediments to support the cap and earthwork construction loads.** Soil strength parameters including drained and undrained shear strength for fine-grained soils and friction angle for coarse-grained soils are required to evaluate the load-bearing capacity of the WSSP Landfill sediment. Drained shear strength of fine-grained soils will be measured by laboratory testing on thin-walled tube samples recovered from the borings. Friction angle and undrained shear strength will be estimated from SPT blow count data and CPT tip resistance. Strength measured in laboratory tests will be related to water content, SPT, and CPT data to evaluate the variation in strength over the WSSP area and depth.
- **Estimate the potential for WSSP Landfill materials to undergo consolidation settlement and design the cap shaping fill grades** to provide positive slopes for runoff and infiltration drainage long-term, after settlement. One-dimensional consolidation (oedometer) tests on thin-walled tube samples of fine-grained pond sediments will provide consolidation parameters needed to estimate settlement of the fill and cap over time. Consolidation parameters from the laboratory tests will be related to water content, SPT, and CPT data to evaluate the variation of compressibility over the pond area and depth.
- **Define groundwater pressure profile within the WSSP Landfill sediments.** There is no available data regarding the groundwater table within the WSSP Landfill. An elevated perched water table could result from fine-grained pond bottom sediments acting as a low-permeability layer holding precipitation infiltration in the pond. Definition of perched and static groundwater tables is needed for cap stability, settlement, and seismic analyses. Installation of a vertical series of fully grouted vibrating wire piezometers (VWP) in one boring will define these water tables and their seasonal variation. Optionally, these VWPs can be left in place below the final cap to observe the effectiveness of the cap in eliminating perched groundwater and groundwater level fluctuation in response to precipitation. Data from the VWPs will be supplemented by pore pressure data from the CPT probes and other piezometers at the site,

including existing monitoring wells and piezometers to be installed in the Slurry Wall PDI (work plan provided under separate cover).

- **Define cross-section geometry and strength of the perimeter dike.** Additional investigation is required to evaluate slope stability of the WSSP perimeter dike to support the proposed cap. At least two closely spaced transects of CPT probes perpendicular to the slope aligned with proposed borings and piezometers (including those proposed for the Slurry Wall PDI Study) will allow the construction of geologic sections through the dike and assignment of shear strength parameters needed to evaluate slope stability. Additional CPT probe transects may be necessary if significant variability in cross-section geometry and/or shear strength parameters is revealed by the first two transects.
- **Collect data needed to confirm cap performance in an earthquake.** Performance of the cap in the design earthquake is a function of the site response (ground motion) and strength of the WSSP Landfill and perimeter dike soils to resist the earthquake-induced stresses. Seismic velocity data for site response analysis will be measured in approximately 15% (5) of the proposed CPT probes and will also be estimated from SPT blow counts from the borings. CPT tip resistance and SPT blow count data will be used to evaluate the potential for seismic liquefaction of the WSSP Landfill sediments, estimate the magnitude of earthquake-induced settlement, and assign post-liquefaction shear strength if liquefaction is determined likely. Field vane shear testing will be performed in selected soil borings within the WSSP Landfill sediment to provide additional data on the remolded (residual) shear strength of the sediment.
- **Evaluate potential stabilization measures.** Geotechnical data collected from the CPT probes and borings will support evaluation of potential stabilization measures if it is determined necessary to support the proposed cap and restricting settlement is necessary for long-term cap performance. Stabilization options could include surcharge pre-loading, in-situ stabilization of soft sediments, or use of lightweight fill to raise grades.

4. PROPOSED WSSP LANDFILL SETTLEMENT STUDY PRE-DESIGN INVESTIGATION

4.1 Proposed Investigation Summary and Objectives

This WSSP Landfill Settlement Study PDI addresses the data gaps identified in [Section 3.2](#). The proposed investigation consists of 29 CPT probes spaced on an approximately 125-foot primary grid pattern over the WSSP Landfill footprint, five (5) wash rotary soil borings to define soil stratigraphy and physical properties and collect samples for laboratory testing, two arrays of closely spaced CPT probes perpendicular to the perimeter dike, in-situ vane shear testing of the fine-grained Landfill sediment in two of the borings, and in-situ seismic velocity testing and pore pressure dissipation testing in approximately 15% (5) of the CPT probes. The primary CPT probe pattern may be supplemented by additional probes at reduced spacing at locations where the primary probes reveal high variability in Landfill sediment thickness and/or properties. The proposed investigation is summarized in Table 2 and shown on Drawing B-1B.

4.2 Investigation Methods

4.2.1 Cone Penetration Test (CPT)

CPT (ASTM D5778) is performed by pushing an instrumented 1.4" or 1.7" diameter (10 cm² or 15 cm² base area) steel probe through the soil at a constant rate to obtain a continuous record of soil behavior. This method does not produce large open holes, samples, or drill cuttings. The CPT probe is equipped with sensors to measure tip resistance, side (sleeve) friction resistance, pore water pressure, inclination, and seismic wave arrival.

All CPT probes will be advanced to the depth where the probe response suggests the native soils below the bottom of the WSSP Landfill has been reached, anticipated to be signaled by a marked increase in tip resistance and changes in side friction and pore pressure behavior. CPT probes may be terminated above this depth if they encounter practical refusal, i.e. the depth beyond which the probe cannot be advanced by the rig weight or probe inclination becomes excessive.

CPT probe records will be used to evaluate the pond sediment material distribution. Robertson 2010 soil behavior type correlations will be used to estimate material grain size and compressibility from CPT probe response.

Shear wave velocity will be measured in five (5) of the CPT probes. At these locations, probe advance will be periodically paused (typically at 1-meter depth intervals) and a seismic shear wave will be generated at the ground surface. The measured time from wave generation to arrival is used to generate a profile of seismic velocity with depth. These CPT probes will be advanced to practical refusal.

Pore pressure dissipation testing will be performed within fine-grained WSSP sediments at five (5) of the CPT locations. To perform this test, the CPT probe penetration is stopped, the push rod is unloaded, and porewater pressure is recorded as a function of time until an equilibrium condition is reached. The dissipation data will be used in published correlations to augment time rate of consolidation calculations using laboratory consolidation test data.

CPT probe holes will be backfilled with hydrated bentonite gel or cement bentonite grout.

4.2.2 Soil Borings

4.2.2.1 Wash Rotary Soil Borings

Wash rotary borings will be made at five (5) locations chosen to capture the range in WSSP Landfill thickness and characteristics, including at the high and low points of the fill surface, the approximate center of the WSSP Landfill, and at the perimeter dike. Borings will be located close to CPT probes to allow correlation between boring and CPT data. Soil borings will generally be performed after the CPT probes, so that some boring locations may be adjusted in the field to confirm CPT probe findings of incompressible coarse aggregates or obstructions.

The wash rotary drilling method limits disturbance of soil in the sampling zone by maintaining a positive fluid head in the borehole when drilling below groundwater. In this method, water or weighted drilling fluid (typically, a mix of water and bentonite or polymer mud) is continuously recirculated in the borehole during drilling. Temporary casing may be used if required to stabilize the hole.

The MRCE standard specifications for wash rotary drilling and sampling are provided in Appendix A. Sample log record forms are provided in Appendix B.

4.2.2.2 Boring Depth and Grouting

Each boring will be extended to penetrate approximately 10 feet below the WSSP Landfill sediments, or to an anticipated depth of 40 feet. The boring near the center of the WSSP Landfill will be extended to sufficient depth to set the lowest VWP below the zone of seasonal groundwater level fluctuation, an anticipated depth of 110 feet.

All completed borings will be closed using cement-bentonite grout placed by the bottom-up tremie method. Borings, grouting, and instrument installations will be performed under the full time inspection of an experienced engineer or geologist who will log the boring and describe the soil samples recovered.

4.2.2.3 Split Spoon Sampling with Standard Penetration Test (SPT)

Split spoon sampling with SPT will be performed in all soil borings in accordance with ASTM D1586. Soil samples will be taken using a 2" O.D. split spoon sampler to measure standard penetration resistance values (N-value). Continuous split spoon samples will be collected through the WSSP sediment thickness (up to 30 foot anticipated depth) and at 5 feet depth intervals thereafter. Each 2" O.D. split spoon sample within the WSSP sediment will be followed by a 3" O.D. split spoon sampler to collect bulk samples for in-situ stabilization feasibility testing. At least one bulk sample per distinct stratum within the WSSP sediments will be collected.

The SPT N-value will be measured by driving the 2" sampler with a 140-pound hammer free-falling 30 inches. The number of blows required to advance the sampler through each of three or four, six-inch drive intervals will be recorded. The N-value, calculated by summing blows from the second and third six-inch drive intervals, is an indication of the degree of compactness of the material sampled. The corrected SPT N-value can be used to calculate the friction angle of coarse-grained soils, and to determine susceptibility to liquefaction. The applied energy of each SPT hammer used on the project will be measured in accordance with ASTM D4633 to allow correction of SPT blow counts to a standard energy ratio.

Intact spoon samples of fine-grained soil will be tested using field handheld pocket penetrometer and/or Torvane devices to estimate unconfined compressive strength. Split spoon soil samples will be visually classified and logged in accordance with the Unified Soil Classification System (USCS) (ASTM D 2488). Refer to Appendix C for sample boring log forms.

4.2.2.4 Undisturbed (Tube) Samples

Collection of thin-walled tube samples of the fine-grained WSSP Landfill sediment will be attempted in the wash rotary soil borings in accordance with ASTM D1587. These samples will be used for laboratory index properties, strength, and compressibility testing. A maximum of 12 undisturbed (tube) samples is anticipated.

If stiff or cemented fine-grained sediments prevent hydraulic advancement of the sampling tube, a "Pitcher" device that includes an outer rotating cutting barrel may be used to aid tube sample recovery.

4.2.2.5 Field Vane Shear Test

Field Vane Shear Testing (FVST) in accordance with ASTM D2573 will be performed in the fine-grained WSSP Landfill sediments in two soil borings (6 total tests anticipated) to measure the in-situ peak and remolded (residual) undrained shear strength.

The FVST is performed by inserting a four-bladed vane into the intact soil at the bottom of the borehole at the test depth and rotating the vane to induce shear failure on a cylindrical surface while measuring torque. After the maximum torque (peak undrained shear strength) is reached, the vane is rotated rapidly through several complete revolutions and torque measured to determine the remolded undrained shear strength.

4.2.3 Vibrating Wire Piezometer Installation

A series of fully grouted electric vibrating wire piezometers (VWPs) will be installed in the deepest soil boring. The boring will include three piezometers placed at shallow (within WSSP sediment), intermediate (within the zone of seasonal groundwater fluctuation in the Upper Hydrogeologic Unit), and deep (below the zone of seasonal fluctuation in the Upper Hydrogeologic Unit) to monitor groundwater pressures. Water pressures will be measured monthly for 6 to 12 months using a manual readout device. Alternatively, battery- or solar-powered data logging equipment can be installed to enable more frequent readings.

MRCE will provide calibrated piezometers and a read-out device. The Field Engineer will assist the drilling contractor with installation of piezometers and take readings when present on site.

Refer to Appendix B for technical documentation on the vibrating wire piezometers and sample installation record forms.

4.3 Drill Rig Access Requirements

It is anticipated that all CPTs on the WSSP Landfill will require an all-terrain low ground pressure (track mounted) rig due to the unknown characteristics of the underlying fine-grained compressible pond sediments. CPTs on the dike slope, where feasible, will require a rig equipped with outriggers and levelling jacks.

Borings on the WSSP Landfill are also anticipated to require all-terrain drilling rigs for access. Depending on the stability of the underlying pond sediments, a temporary reinforced working platform consisting of a heavy biaxial or triaxial geogrid followed by one to two feet of compacted granular soil may be necessary to access the boring locations.

Access requirements will be reviewed and confirmed in a site visit prior to finalizing PDI contract documents.

4.4 Inspection and Recordkeeping

The Field Engineer will provide continuous field inspection of the drilling, CPT probing, sampling, and in-situ testing activities and keep field log records of the drilling activities and samples collected. Sample boring log records are provided in Appendix C.

4.5 Decontamination Procedures during Drilling

Drilling equipment will be decontaminated in general accordance with Roux Standard Operating Procedures (SOP) 9.1 for Field Decontamination of Field Equipment [6]. Soil sampling tools such as split-spoon samplers, spatulas, etc. will be decontaminated using an Alconox rinse between each use.

The CPT probe and rods will be decontaminated by wiping and rinsing with an Alconox/water solution after each probe.

4.6 Sample Packaging, Labeling, and Storage

Split spoon samples will be stored in heavy-duty air-tight wide mouth plastic screw-top jars or sealed plastic bags after field classification and logging. Thin-walled tube samples will be sealed using wax and ends will be capped and securely taped.

Each sample will be labeled with the project name, sample date, boring number, sample number, sampling depth, and SPT N-value and/or percent recovery for identification prior to transporting them to the designated testing facility.

Soil samples will be stored on-site in a designated secure location protected from weather, freezing, and extreme heat. It is anticipated that the former warehouse building (see Figure 1 of [7]) will serve as the central storage area for soil samples prior to transport.

4.7 Sample Handling and Transport

Soil sample handling and transport will comply with ASTM D 4220 and Roux SOP 3.3 for Sample Handling [6].

Split spoon and bulk soil samples will be preserved and transported in accordance with ASTM D 4220 Group B. Undisturbed tube samples will be preserved and transported in accordance with ASTM D 4220 Group D.

Soil samples will be transported by Geotechnical Engineer personnel and / or commercial courier. The Field Engineer will oversee sample packaging, handling, storage, and shipment.

4.8 Sample Shipment and Chain-of-Custody (COC)

Individual sample jars, bags, and tubes will be grouped (typically by boring) for shipment. Additional protective measures for shipping are listed below.

- Individual plastic sample jars and/or plastic bags will be packed into rigid shipping containers (e.g. coolers, specialized shipping containers, or heavy cardboard boxes).
- Undisturbed tube samples will be packed into specialized shipping containers designed for freight transport and meeting the requirements of ASTM D4220, Group D.
- The shipping containers will be securely sealed with heavy-duty packaging tape.
- Shipping containers labeled and shipped in accordance with applicable federal regulations.

The Field Engineer will complete a COC form for each shipping container shipped from the site. The COC will include the details such as sample identification, date of collection, matrix of sample, number of containers, and names of sampler and the person shipping the samples. The COC will accompany samples to the laboratory and a copy of the COC will be retained and placed in the project file. Any visible signs of elevated contamination (e.g. discoloration, odors) observed in specific samples during sampling will be noted on the COC forms. A sample COC form is provided in Appendix D.

4.9 Laboratory Testing

Laboratory testing of samples recovered in the borings will include the following. A summary of tests and governing ASTM standards is provided in Table 3.

- **Physical (index) properties of soils.** Soil index testing of split spoon and tube samples recovered in the borings will include water content (ASTM D2216), particle size distribution of coarse-grained soils (ASTM D6913), hydrometer analysis of fine-grained soils (ASTM D7928), Atterberg limits of fine-grained soils (ASTM D4318), and specific gravity of soils (ASTM D854).
- **Compressibility of sludge sediments.** One-dimensional consolidation (oedometer) tests (ASTM D2435) will be performed on thin-walled tube samples of the fine-grained WSSP sediments to define the compressibility and load relationships with moisture content variation.
- **Shear strength of sludge sediments.** Thin-walled tube samples of fine-grained WSSP sediments will be tested for drained shear strength using Consolidated Drained (CD) triaxial testing (ASTM D7181) and for undrained shear strength using Consolidated Undrained (CU) triaxial testing (ASTM D4767). The consolidated triaxial tests are proposed to mask test specimen disturbance anticipated from handling and shipping of low plasticity silt samples. In addition to triaxial testing, peak and residual drained shear strength will be measured by Direct Shear (DS) testing (ASTM D3080) on thin-walled tube samples of fine-grained WSSP sediments. Each type of test (CD, CU, and DS) will be performed at 3 different effective confining pressures to allow construction of Mohr-Coulomb shear strength envelopes.
- **In-situ Stabilization Feasibility.** Specimens of soil-cement using a blend of WSSP Landfill sediment and Portland cement will be prepared at three cement contents. Molded specimens will be prepared and tested for unconfined compressive strength (ASTM C39) at 7 and 28 days to evaluate the feasibility of in-situ stabilization of sediment as a potential stabilization measure.

5. MANAGEMENT OF INVESTIGATION DERIVED WASTE

The following types of investigation-derived waste (IDW) will be generated during the WSSP Landfill Settlement PDI Study:

- Soil cuttings
- Liquid waste including excess drilling mud or wash water, water pumped from piezometers during purging, and waste water from equipment and personnel decontamination
- Used personal protective equipment (PPE) (e.g. gloves) or other disposable items that contact soil, drilling mud, or water

Management of IDW will be in accordance with the Project IDW Management Plan prepared by Roux.

6. HEALTH AND SAFETY

Health and Safety measures will be implemented in accordance with the project Health and Safety Plan (HASP) prepared by Roux [8]. Each entity performing work on the site (including engineering firms and drilling contractors) will be required to prepare and adhere to their own site-specific Health and Safety Plan that references and conforms to the overall project HASP.

7. QUALITY ASSURANCE AND CONTROL

7.1 QA/QC Organization

Quality assurance (QA) and control (QC) procedures will be implemented to ensure the data collected from the Slurry Wall PDI Study satisfies the investigation objectives and meets applicable quality standards. Table 4 lists data collection objectives, quality standards, and acceptance criteria.

7.2 QA/QC Procedures

The Geotechnical engineer will implement a QA/QC process to ensure the reliability and usability of geotechnical data collected in the PDI. The following procedures, as a minimum, will be followed.

7.2.1 Field Work:

- Field drilling, sampling, testing, and instrumentation installation will be performed in general conformance with reference standards including those published by the American Society for Testing and Materials (ASTM) where applicable (see Table 4).
- The Field Engineer will provide full-time responsible oversight of the drilling, sampling, in-situ testing, and instrument installation activities. If multiple drilling rigs are utilized, each Field Engineer will oversee no more than two drilling rigs.
- Each piece of field equipment used for data collection (e.g. tape measures, levels, pocket penetrometers, Torvanes, electronic piezometers and readout devices) will be furnished by the Geotechnical Engineer. The Field Engineer will check functionality of each piece of field equipment daily before use. Any field equipment visibly damaged, impaired, or which produces suspect results will be removed from service.
- Proof of calibration of all CPT equipment used on the project meeting the requirements of ASTM D5778 will be provided prior to start of work.
- Measured energy ratio of each SPT hammer used on the project in accordance with ASTM D4633 will be provided prior to start of work.
- Current calibration records for in-situ field vane testing equipment in accordance with ASTM D2573 will be provided prior to start of work.

- All instrumentation installed (e.g. vibrating wire piezometers) will be furnished with manufacturer calibration records. The Field Engineer will review calibration records and perform field pre-installation acceptance testing, quality control during installation, and post-installation testing as described in Appendix B.
- Standard log forms will be used to document all data collected and instruments installed. Sample log forms are provided in Appendix C.
- Each Field Engineer will prepare a Daily Field Report (DFR) documenting drilling and data collection activities. The reports are to be filed at the end of each day, via email to the Project Manager and project file. The Project Manager will review DFRs and direct any necessary modifications to the field work based on reported progress. The DFR is used to document the hours of work, contractor presence, and progress of work performed each day and inspector presence (time of day) and inspector time expended to complete reports/logs/test documentation. The DFR is used to document events which are not recorded in other test data forms, construction logs, or record contract documents. The reports define any open items which require resolution, and a future report must close all open items – giving resolution decision. A sample DFR form is provided in Appendix C.
- The Project Manager will visit the site periodically (QA visits) during the PDI activities to assure the field QC procedures described above are being followed. The Project Manager will document each QA visit on a DFR and describe any corrective actions made.

7.2.2 Laboratory Work:

- Each laboratory that performs geotechnical testing for the project will maintain and implement a quality system in accordance with ASTM E 329, ASTM D 3740 and AASHTO R18 (as applicable), and confirmed by proficiency sampling and regular audits, as documented by accreditation through the American Association of State Highway and Transportation Officials (AASHTO) accreditation program (AAP) or equivalent.
- Each laboratory test will be conducted in accordance with the applicable reference standard (see Table 4). Test data will be collected and its useability evaluated in accordance with the test standard. Data and results will be documented on standard data forms meeting the requirements of the standard.

7.2.3 Data Acceptance:

- All field and laboratory data will be evaluated against the Data collection objectives and quality standards listed in Table 4. Any data not meeting one or more criteria will be further evaluated by the Project Manager to determine if the data may still be acceptable for project use (potentially with some degree of qualification) or must be rejected.
- Field data forms will be reviewed by an engineer having equal or greater experience as the Field Engineer (e.g. the Project Manager or a designee). Corrections will be documented as redline markup of the original data sheets and final checked data reports documented by initialing.
- Each soil sample will be reviewed by an independent geotechnical engineer or geologist and field descriptions revised as necessary, incorporating laboratory test results where applicable, before finalizing the boring log soil descriptions. Revisions to the field boring logs will be documented as redline markup and the final checked boring logs documented by initialing.

8. SURVEY

A topographic survey will be performed prior to the start of field work to provide current topographic elevations. The survey will cover the existing WSSP and West Landfill and extend a minimum of 50 feet beyond the proposed Adjusted Slurry Wall Alignment. The survey will define ground surface elevation over the WSSP landfill and provide data on ground surface settlement since the 2018 survey.

Survey of the as-drilled location and elevation of each boring, CPT location, and instrument well head installed will be provided by a licensed surveyor under subcontract to Roux Associates, Inc.

All surveys performed will be tied to Montana State Plane (NAD83) coordinate grid and reference NAVD88 datum.

REFERENCES

- [1] "Remedial Investigation Report - CFAC Facility, Columbia Falls, Montana," Roux Environmental Engineering and Geology, D.P.C, February 21, 2020.
- [2] "Proposed Plan for Cleanup - Columbia Falls Aluminum Company Superfund Site," EPA, June 2023.
- [3] "Feasibility Study Report - CFAC Facility," Roux Environmental Engineering and Geology, D.P.C, June 16, 2021.
- [4] "Phase II Site Characterization Data Summary Report - Columbia Falls Aluminum Company Superfund Site, Vol I of II," Roux Environmental Engineering and Geology, D.P.C, July 29, 2019.
- [5] "Phase II Site Characterization Data Summary Report - Columbia Falls Aluminum Company Superfund Site, Volume II of II," Roux Environmental Engineering and Geology, D.P.C, July 29, 2019.
- [6] "Phase II Site Characterization Sampling and Analysis Plan - Columbia Falls Aluminum Company," Roux Associates, Inc., May 3, 2018.
- [7] "Investigation-derived Waste Management Plan - Columbia Falls Aluminum Company," Roux Associates, Inc, May 9, 2016.
- [8] "Health and Safety Plan - Columbia Falls Aluminum Company," Roux Associates, Inc, April 26, 2018.
- [9] "Evaluation of Subsurface Engineered Barriers at Waste Sites, EPA-542-R-98-005," United States Environmental Protection Agency, 1998.
- [10] *Topographic Map of the Site (Prepared for Columbia Falls Aluminum Company, LLC)*, Roux, July 11, 2018.

CFLP-007	3160	2	Dry	4" dia. hand auger
CFLP-008	3158	2	Dry	4" dia. hand auger
CFLP-009	3159	2	Dry	4" dia. hand auger
CFLP-010	3159	2	Dry	4" dia. hand auger
CFLP-011	3157	2	Dry	4" dia. hand auger
CFLP-012	3159	2	Dry	4" dia. hand auger

CFMW-002	3143	80	70	Outwash/Alluvium	3063.1	3084.6	21.5	
CFMW-010	3145	86	76	Outwash/Alluvium	3063.2	3086.9	23.7	
CFMW-012	3140	90	70	Outwash/Alluvium	3063.6	3083.9	20.3	
CFMW-012a	3140	255	200	Outwash/Alluvium below Glacial Till	2999.5	3004.9	5.4	Clay Till at 128 ft - 199 ft bgs, Sand and Gravel Outwash/Alluvium encountered below
CFMW-015	3139	94	72	Outwash/Alluvium	3063	3081.5	18.5	
CFMW-016	3164	95	85	Outwash/Alluvium	Dry	3109.4	-	
CFMW-016a	3164	300	121	Outwash/Alluvium and Sand Till	3064	3109.2	45.2	Sand Till at ~125 ft below ground surface (bgs)
CFMW-019	3136	96	78	Outwash/Alluvium	3062.3	3077.8	15.5	
CFMW-019a	3137	300	210	Sand Till	2999.6	3005	5.4	Silt and Clay Till at 134 ft to 197 ft bgs, Sand Till encountered below
CFMW-021	3136	90	70	Outwash/Alluvium	3062.5	3078	15.5	

Notes:

1. All well screens are 10 feet long.
2. Based on the year 2018 monitoring data.
3. High- and low- water seasons are reported as around June and October, respectively.

Table 2 – Summary of Proposed WSSP Landfill Settlement Study PDI

CPT or Boring No. ^{1,2}	Anticipated Depth (ft)	Existing Ground Elev. (ft)	Sampling and Instrumentation	Data Collection Objectives ⁵
CPT-1 through CPT-29	Note 3	varies**	CPT	a, b, c, e
CPT-4SD	Note 3	3140	CPT	a, b, e
CPT-16SD	Note 4	3143	CPT	a, b, e
CPT-18SD	Note 4	3147	CPT	a, b, e
CPT-19SD	Note 4	3153	CPT	a, b, c, e
CPT-27SD	Note 4	3151	CPT	a, b, c, e
CPT-19a	Note 3	3142	CPT	a, c
CPT-19b	Note 3	3142	CPT	a, c
CPT-27a	Note 3	3156	CPT	a, c
CPT-27b	Note 3	3143	CPT	a, c
MR-20	40	3163	Wash rotary w/ SPT	a, c, d
MR-21	40	3162	Wash rotary w/ SPT	a, c, d
MR-22P	110	3159	Wash rotary w/ SPT; 3 VWP series	a, b, d, e
MR-23	40	3157	Wash rotary w/ SPT	a, d
MR-24	40	3157	Wash rotary w/ SPT	a, d

Notes:

1. "SD" suffix indicates seismic shear wave velocity and pore pressure dissipation tests performed in CPT.
2. "P" indicates vibrating wire piezometer series installed in boring.
3. CPT probes will be advanced into native soil below WSSP Landfill sediments or to practical refusal depth, whichever is shallower
4. CPT probes will be advanced to nearby soil boring depth or to practical refusal depth, whichever is shallower.
5. Data Collection Objectives:
 - a. Define thickness, material variation, and physical characteristics of WSSP Landfill sediment
 - b. Define groundwater pressure profile within WSSP Landfill sediments
 - c. Define cross section geometry and strength of the perimeter dike
 - d. Collect thin-walled tube samples for laboratory strength and compressibility testing
 - e. Collect data needed to confirm cap performance in an earthquake

Table 3 – Summary of Proposed WSSP Landfill PDI Laboratory Testing

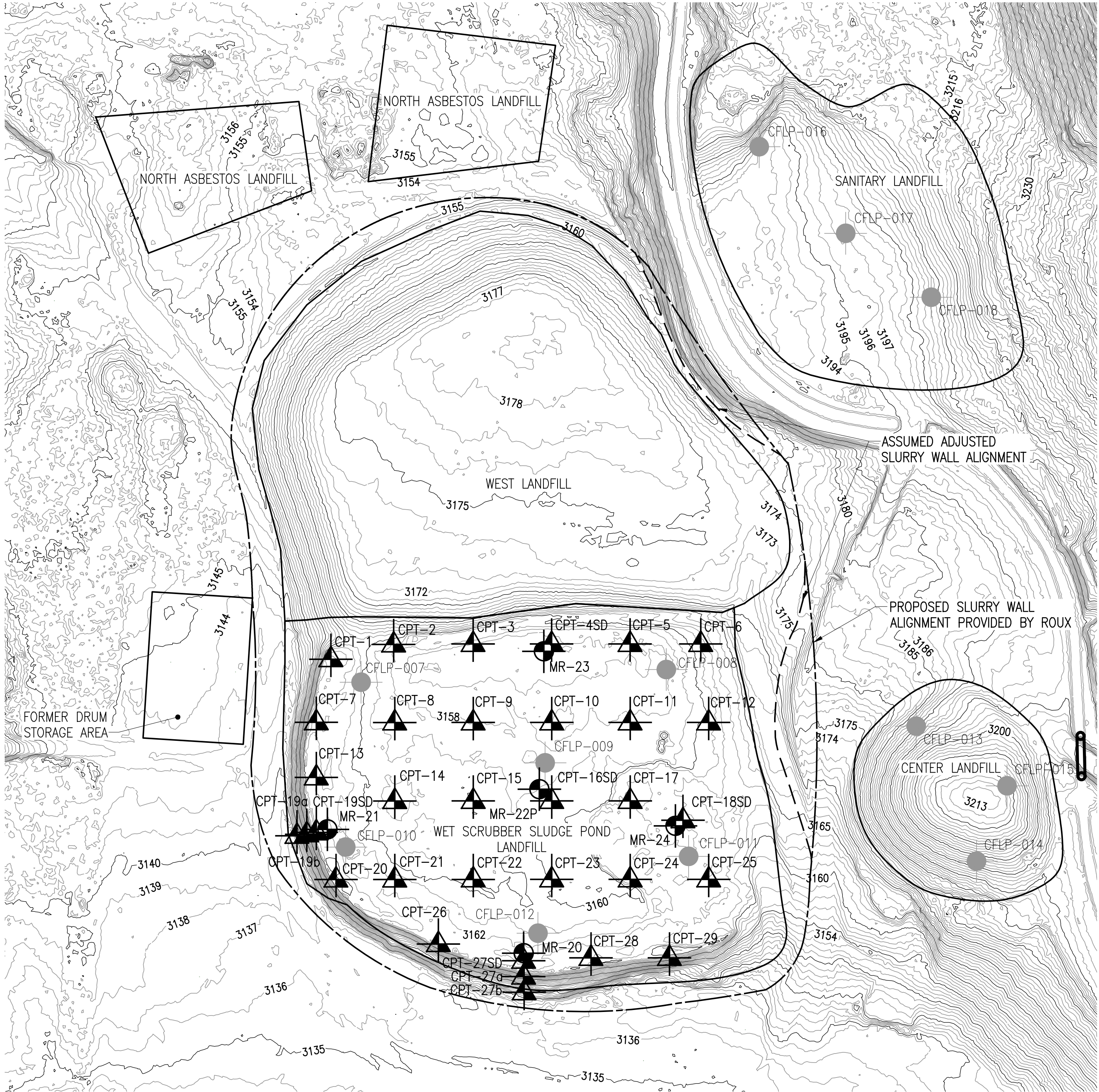
Lab Test	ASTM	# of Tests	Notes
Water Content	D2216	30 to 40	Test all fine-grained samples to correlate with compressibility and strength
Sieve Analysis of Coarse-grained Soils	D6913	12	Test representative coarse- and fine-grained soil samples
Hydrometer Analysis of Fine-grained Soils	D7928	6	Test representative fine-grained sludge samples
Atterberg Limits	D4318	6	Test representative fine-grained sludge samples
Specific Gravity	D854	12	Test representative coarse- and fine-grained soil samples
1D Consolidation (Oedometer)	D2435	5	Evaluate compressibility of fine-grained sludge sediments
Triaxial Test - Consolidated Drained	D7181	3	Evaluate drained shear strength of fine-grained sludge sediments for bearing capacity analysis
Triaxial Test - Consolidated Undrained	D4767	5	Evaluate undrained shear strength of fine-grained sludge sediments for slope stability analysis
Direct Shear Test	D3080	3	Evaluate peak and residual shear strength of fine-grained sludge sediments for slope stability analysis

Table 4 - WSSP Landfill PDI Data Collection Objectives and Quality Standards

Data Collection Objective	Investigation or Test Method	Test Method or Reference Standard	No. of Borings / Tests	Data Acceptance Criteria
Define WSSP Landfill surface topography	Topographic Survey of WSSP and West Landfill	n/a	n/a	Survey performed by licensed surveyor referencing Montana State Plane (NAD83) coordinate grid and reference NAVD88 datum
Define thickness, material variation, and physical characteristics of the WSSP Landfill sediments Evaluate potential stabilization measures	CPT probes placed on primary (125-ft) grid pattern	ASTM D5778	27	CPT probe advances to bottom of WSSP Landfill sediment or practical refusal; CPT tip resistance, sleeve friction, and pore pressure data allow assignment of Soil Behavior Type. CPT probes will be added at reduced spacing where high variability is revealed by the primary probes.
	Soil borings in WSSP Landfill	Wash rotary drilling	4	Boring reaches 10-ft (min) into native soil below WSSP Landfill sediments; SPT data is collected; profile of split spoon samples are collected for testing
	Deep soil boring in WSSP Landfill	Wash rotary drilling	1	Boring reaches sufficient depth to set VWP below seasonal low groundwater table; SPT data is collected; profile of split spoon samples are collected for testing
	Describe soil strata encountered in soil borings	ASTM D 2488	Each sample	Visual/manual soil discription of each sample in accordance with the Unified Soil Classification System (USCS) is made and recorded on boring logs
	Collect undisturbed tubes	ASTM D1587	12	Minimum 18" recovery per tube is obtained and sample does not appear disturbed
	Laboratory water content test	ASTM D2216	Each fine-grained sample	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory grain size (sieve) analysis	ASTM D6913	12	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory hydrometer analysis	ASTM D7928	6	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory Atterberg Limits test	ASTM D4318	6	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory specific gravity test	ASTM D854	12	Laboratory test procedure and data report meets requirements of ASTM standard; allows calculation of unit weight
	Unconfined Compressive Strength test	ASTM C39	12	Laboratory test procedure and data report meets requirements of ASTM standard; performed for 3 cement contents at 7 and 28 days
Define strength of WSSP Landfill sediments to support the cap and earthwork construction loads	Laboratory consolidated drained triaxial test	ASTM D7181	3	Laboratory test procedure and data report meets requirements of ASTM standard; Test results define drained shear strength envelope for WSSP Landfill sediments
	CPT probes placed on primary (125-ft) grid pattern	ASTM D5778	Readings at penetration intervals less than 2 inches	CPT tip resistance data allow estimation of soil friction angle and undrained shear strength
	Standard Penetration Test (SPT)	ASTM D1586	1 test / 2 ft depth in WSSP Landfill sediment at 5 boring locations	SPT blow count data allow estimation of soil friction angle and undrained shear strength
Estimate the potential for WSSP Landfill materials to undergo consolidation settlement and design the cap shaping fill	One-dimensional consolidation (oedometer) test	ASTM D2435	5	Laboratory test procedure and report meet requirements of ASTM standard; load-deformation and time-deformation parameters are obtained and related to water content
	CPT with pore pressure dissipation measurement	ASTM D5778	perform in fine-grained WSSP Landfill sediment in 5 CPTs	Pore pressure measurement is recorded
Define groundwater pressure profile within the WSSP Landfill sediments	Vibrating wire piezometers (VWP) series set in grout in WSSP Landfill boring	VWP installation guidelines (see Appendix B)	Series of 3 VWPs installed in one boring (1 near bottom of WSSP Landfill sediment, 2 in soils below)	VWPs are calibrated, satisfy pre-installation acceptance testing, are installed successfully, and meet post-installation acceptance criteria (see Appendix B)
	CPT pore pressure measurement	ASTM D5778	each CPT probe location	CPT pore pressure data define elevation of water table (projected zero pore pressure elevation)
	Use data from other piezometers at the site	see Slurry Wall PDI Study Wok Plan		
Define cross-section geometry and strength of the perimeter dike	closely spaced transects of CPTs perpendicular to dike	ASTM D5778	3 CPT probes per transect	CPT probes allow interpretation of dike cross-section; CPT tip resistance, sleeve friction, and pore pressure data allow assignment of Soil Behavior Type and shear strength
	Laboratory consolidated undrained triaxial test	ASTM D4767	5 tests on fine-grained WSSP Landfill sediment	Laboratory test procedure and data report meets requirements of ASTM standard; test results define range in undrained shear strength for WSSP Landfill sediment
Collect data needed to confirm cap performance in an earthquake	CPT with seismic shear wave velocity measurement	ASTM D5778 / D7400	perform at 1-meter depth intervals in 5 CPT probes	Seismic velocity data defines shear wave velocity profile through WSSP Landfill, and is related to SPT blow count data from nearby soil borings
	CPT tip resistance	ASTM D5778	33	CPT data is usable to evaluate liquefaction potential
	SPT blow count with hammer energy correction	ASTM D1586 / D4633	1 test / 2 ft depth in WSSP Landfill sediment at 5 boring locations	Corrected SPT blow count data is useable to evaluate liquefaction potential
	In-situ Field Vane Shear Test in soil borings	ASTM D2573	3 depths in 2 borings (6 total)	In-situ test procedure meets requirements of ASTM standard; peak and remolded (residual) undrained shear strength of WSSP Landfill sediments are measured
	Laboratory direct shear test	ASTM D3080	3	Laboratory test procedure and data report meet requirements of ASTM standard; peak and residual shear strength are measured

- Notes:
1. ASTM = American Society for Testing and Materials
 2. CPT = Cone Penetration Test
 3. SPT = Standard Penetration Test
 4. See Drawing B-1B and Table 2 for proposed investigation borings
 5. See Table 3 for summary of proposed laboratory tests

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BORING LOCATION PLAN



- NOTES:
1. SITE FEATURES MAP AND TOPOGRAPHIC SURVEY PROVIDED BY ROUX.
 2. COORDINATES AND SURVEY ELEVATIONS PROVIDED IN NAD83 (HORIZONTAL) AND NAVD88 (VERTICAL) WITHIN MONTANA STATE PLANE COORDINATE SYSTEM (FIPS2500).
 3. ALL BORING AND CPT LOCATIONS ARE APPROXIMATE.
 4. TWO BORING LOCATIONS WITHIN WSSP LANDFILL WILL BE ADJUSTED, IF NEEDED, TO CONFIRM CPT PROBE FINDINGS OF INCOMPRESSIBLE COARSE AGGREGATES OR OBSTRUCTIONS.
 5. LOCATIONS OF CPTS WITH SEISMIC VELOCITY AND PORE PRESSURE DISSIPATION TESTS WILL BE ADJUSTED BASED ON FIELD CONDITIONS.

PROPOSED INVESTIGATION LEGEND:

- MR-22P PROPOSED WASH ROTARY SOIL BORING
- 'P' INDICATES VIBRATING WIRE PIEZOMETER SERIES INSTALLED IN BORING
- CPT-4SD PROPOSED CPT LOCATIONS
- 'SD' INDICATES SEISMIC SHEAR WAVE VELOCITY AND PORE PRESSURE DISSIPATION TESTS PERFORMED IN CPT

EXISTING (ROUX) BORING LEGEND

- CFLP-010 LANDFILL CAP SOIL SAMPLE LOCATIONS

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OAK BROOK			ILLINOIS	
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BORING LOCATION PLAN				DRAWING NUMBER
WSSP LANDFILL SETTLEMENT STUDY				
PDI				
				B-1B

APPENDIX A
MRCE Standard Specifications for
Drilling, Sampling, and Testing
(Wash Rotary Borings)

SECTION S

MRCE STANDARD SPECIFICATION FOR DRILLING, SAMPLING, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

1. This Section presents the standard equipment, materials, mixtures, and procedures required for advancement of geotechnical borings for soil and rock sampling, and completion of work enumerated under Section A in the Scope of Work. Requirements for other in-situ testing, if requested, are provided under separate cover.

1.02 RELATED SECTIONS

1. All terms, definitions, requirements, plans, schedules, and drawings noted hereunder are incorporated within this specification. Where conflicts arise, Section A shall supersede this Section. The Related Sections are:
 - a. Section A – Information to Bidders.

1.03 DEFINITIONS

1. Administration – the preparation of submittals, acquisition of permits and approvals, and procurement and delivery of materials to/from the site and between boring and test locations.
2. Mobilization – the maintenance of equipment, and transport of equipment to/from the site and between boring and test locations.
3. Observation Well – an instrument for measuring head elevation in an aquifer and sampling groundwater installed in a completed borehole which captures the phreatic surface within the screened interval where the screened interval does not include a bentonite seal.
4. Obstruction – an object within a borehole which cannot be broken up or bypassed readily by a soil drilling bit as mutually determined by the Contractor and Engineer.
5. One-Call Notification System (One-Call) – a system operated by an organization that has, as one of its purposes, the duty to receive notification from excavators of intended excavation in a specified area to disseminate such notification to underground facility operators that are members of the system so that such operators can locate and mark their facilities prior to excavation.
6. Piezometer – an instrument for measuring head pressure and field testing permeability of an aquifer installed in a completed borehole which is screened and sealed below the phreatic surface. Types consist of either: (a) Open-Standpipe or (b) Grouted-in-Place.
7. Scope of Work – the number and types of borings and schedule of sampling and testing as enumerated in Section A.
8. Tremie – method for the placement of a fluid by insertion of an injection pipe or hose from the bottom of a borehole and extracting such that injection point remains a minimum of 2 feet within the injected fluid at all times.
9. The Work – all items to be furnished and performed by the Contractor and necessary to complete the Contract.
10. Written Notice – delivery in person to the individual or to a member of the firm for whom it is intended, or if delivered at or sent by registered or electronic mail to the last business address known to those who give the notice.

1.04 REFERENCES

1. Referenced Standards

- a. For all referenced standards, use the most recent approved version of the standard.
- b. American Society for Testing and Materials (ASTM):
 - (1.) ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils;
 - (2.) ASTM D1587 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes;
 - (3.) ASTM D2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation;
 - (4.) ASTM D4220 Standard Practices for Preserving and Transporting Soil Samples;
 - (5.) ASTM D4633 Standard Test Method for Energy Measurement for Dynamic Penetrometers;
 - (6.) ASTM D5079 Standard Practices for Preserving and Transporting Rock Core Samples;
 - (7.) ASTM D5088 Standard Practice for Decontamination of Field Equipment Used at Waste Sites;
 - (8.) ASTM D5092 Standard Practice for Design and Installation of Groundwater Monitoring Wells;
 - (9.) ASTM D5299 Standard Practice for Decommissioning of Groundwater Wells and Boreholes;
 - (10.) ASTM D5783 Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices;
 - (11.) ASTM D6151 Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling;
 - (12.) ASTM D6519 Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler;

1.05 SUBMITTALS

1. See Section A.

PART 2 PRODUCTS

2.01 EQUIPMENT

1. General:
 - a. Supply all equipment to be used for the successful completion of the Work.
 - b. Maintain all equipment in sufficient readily available supply for the continuous expeditious execution of the Work.
 - c. Maintain all equipment in good working condition and repair equipment to a good working condition as rapidly as is practicable.
 - d. Visually inspect all equipment prior to each use, if any item is found to be damaged; clean, repair, or replace that item prior to being put into further use.
 - e. Make all equipment available for visual inspection by the Engineer. Clean, repair, or replace any piece of equipment deemed to be in an unsatisfactory condition as necessary for the satisfactory completion of the Work.
 - f. Sufficiently repair all equipment leaks to prevent spillage. Handle spillage in accordance with the Contractor's Health and Safety Plan.

2. Casing:
 - a. Provide drill casing in quantities and sizes adequate for expeditious performance of the Work.
 - b. Provide casing with a minimum 2 ½ inch inner diameter (I.D.) casing for split barrel sample borings and not less than 3 ½ inch I.D. for undisturbed sample borings.
3. Drill Tools:
 - a. Provide rotary drill bits and downhole tooling appropriate for the resistance encountered and maintained in good condition at all times.
 - b. Provide drill bits which deflect wash water flow toward the sides of the borehole and prevent jetting of the borehole.
 - c. Inspect tooling for damage and operability upon removal from borehole. Clean, repair, or replace all equipment found to be damaged prior to use.
 - d. Hollow Stem Auger Plug – provide a solid steel plug attachment with an outside diameter not less than 95% of the inside diameter of the casing.
4. Split Barrel Sampling Tools and Jars:
 - a. Provide Split Barrel Samplers and equipment necessary to perform the Standard Penetration Test in general conformance with ASTM D1586. The following hammer types may be used:
 - (1.) Donut Hammer;
 - (2.) Safety Hammer; and
 - (3.) Automatic Hammer,
 - b. Provide storage jars with:
 - (1.) Removable screw lid with water tight gasket to preserve moisture content of the soil sample;
 - (2.) Minimum dimensions of 3 ½ inches high, by 1 ¾ inch I.D. at the mouth with inside diameter of the jar no more than ¼ inch larger than the mouth.
5. Tube Sampling Tools and Sample Tubes:
 - a. Provide Stationary Piston and Shelby Tube sampler and sample tubes in general conformance with ASTM D1587 and D6519. Provide sample tubes made of one of the following: brass, hardened aluminum, stainless steel, galvanized steel, or steel coated with lacquer and free from rust.
 - b. Clean the undisturbed sampler to the satisfaction of the Engineer prior to each use.
6. Coring Tools and Boxes:
 - a. Provide core barrels of double tube construction and of the size and type indicated in Section A and in general accordance with ASTM D2113.
 - b. Provide core boxes a minimum of 5 feet long on the interior and able to fit core of the same type and size as the core obtained and in general conformance with ASTM D5079.

2.02 MATERIALS

1. General:
 - a. Supply all materials to be used for the successful completion of the Work unless otherwise specified in Section A.
2. Water, Hoses, Tanks and Pumps:
 - a. Provide water and equipment which are free from impurities which will affect the work.
 - b. Water may not be readily available at the site. Secure all permits and permission to access water supplies unless otherwise stated in Section A or prior arrangements have been made with the Engineer or Owner.
 - c. Provide hoses of sufficient length, tanks of sufficient volume and pumps of sufficient capacity for the expeditious completion of the work.

3. Drilling Fluids:
 - a. Bentonite or non-biodegradable drilling fluid additives may be used in the drilling mud to stabilize the borehole walls in borings that do not receive a groundwater monitoring instrument as enumerated in Section A.
 - b. Biodegradable drilling fluid additives or water only may be used in the drilling mud to stabilize the borehole walls in borings that will receive a groundwater monitoring instrument as enumerated in Section A.
4. Open-Standpipe Piezometers and Observation Wells
 - a. Riser – Schedule 40 polyvinyl chloride (PVC) with threaded gasket joints of the diameter indicated on the Contract Drawings. Where non-uniform lengths of standpipe are joined, use couplers as approved by the Engineer and tape both ends of the coupler.
 - b. Screen – Schedule 40 PVC with a minimum of No. 10 slots spaced at 40 to 50 slots per foot of the diameter indicated on the Contract Drawings.
 - c. End Cap – Schedule 40 PVC with threaded gasket joint.
 - d. Cap – screw top with a gasket.
 - e. Seal – bentonite pellets.
 - f. Filter Pack – No. 2 Morie Sand or approved equal.
 - g. Flush Mounted Well Cover – rated for traffic with gasket seal and a minimum of two bolts.
 - h. Standpipe – steel pipe with a locking steel lid of the diameter indicated on the Contract Drawings.

PART 3 EXECUTION

3.01 INSPECTION OF WORK

1. Provide the Engineer with access for inspection of the Work at all times. Including drilling borings, sampling, sample handling and storage, testing, instrument installation, closeout, and cleanup.

3.02 MOBILIZATION

1. Do not begin Mobilization until given written notice by the Engineer. Upon receipt of notice to proceed, provide the Engineer with estimated time of arrival, list of proposed crews, contact information, and proceed with Mobilization.
2. Examination of Site:
 - a. Prior to mobilization to the site, become familiar with the nature of the Work and the local site conditions. For pre-bid site meetings, see Section A.
 - b. Perform One-Call notification for the site jurisdiction. Confirm that site has been marked by the public utilities. Refer to the Project Drawings for callouts of utility locations known to the Engineer.
3. Permits and Licenses: Obtain all permits, give all notices and comply with all laws, ordinances, rules, and regulations bearing on the conduct of the Work as drawn and specified.

3.03 PROTECTION

1. Continuously protect the Work from damage, protect the site and adjacent property, and maintain lights and other safety devices as provided by law and as local conditions require, or as specified in Section A. Promptly repair all damage caused by Contractor's operations under this Contract.
2. Clearly cordon off work areas such that inadvertent entry by the public is prevented.
3. Continuously employ the accepted Health and Safety Plan throughout the project and appoint a site representative for Emergency Response.

4. The Owner and Engineer have attempted to identify boring locations which are clear of underground utilities and structures and to permit work to be done at locations favorable to the Contractor's operations. It is the Contractor's responsibility to ensure that each boring is advanced past the utility depth without damaging utilities. If damage to a utility occurs, repair utility to the satisfaction of the utility owner at no additional cost to the Owner.

3.04 ADVANCEMENT OF BORINGS

1. Locations:
 - a. Locate proposed boring locations by survey accurate to within 6 inches. Observe utility markout, vicinity of the boring location and refer to available information to verify boring location prior to advancement. Relocate borings as necessary to prevent subsurface interferences.
2. Casing:
 - a. Case all borings in the upper 10 feet and to greater depths as necessary to provide a stable borehole and meet field conditions.
 - b. The Engineer may require casing for the full depth of borings if, in their opinion, successful boring operations cannot be carried out without casing, or if casing is required to obtain groundwater observations at particular depths or for extended periods.
3. Mud Rotary Drilling:
 - a. Perform mud rotary drilling in general conformance with ASTM D5783.
 - b. Advance the boring in an open hole stabilized with weighted drilling mud or water. Where casing is necessary to maintain an open hole, advance boring a minimum of five (5) feet ahead of the casing, unless otherwise agreed upon by the Engineer. Advancing boring by washing through split-barrel sampler is not permitted.
 - c. Use casing and/or drilling mud when advancing borings through granular soils.
 - d. Lift drill bit off the bottom of the hole and flush thoroughly to remove all soil cuttings upon reaching the sampling interval.
 - e. Maintain a water or mud level at or near the top of the casing when removing tooling from borehole.
4. Hollow Stem Auger
 - a. Perform hollow stem auger drilling in general conformance with ASTM D6151.
 - b. Use a Hollow Stem Auger Plug at all times while advancing augers.
 - c. Maintain a water or mud level at or near the top of the casing when removing tooling from borehole.
5. Jetting:
 - a. Advancing the borehole by jetting with air or water is not permitted.

3.05 SOIL SAMPLING

1. General:
 - a. Obtain soil samples at the depths, intervals, and of the type indicated in Section A.
 - b. Clearly mark all samples obtained with the following information:
 - (1.) MRCE project number, boring number, sample number, depth interval, recovery, penetration resistance, and field test values obtained;
2. Split Spoon Sampling and Standard Penetration Test (SPT):
 - a. Lower sampler and tooling into the hole until the sampler comes to rest on the bottom. Compare sampler depth to drill depth, if cuttings greater than six (6) inches in thickness have settled above the sample depth, remove sampler and tooling from the borehole and cleanout the borehole with drill bit as normal and re-attempt sample.

- b. Perform the SPT in general accordance with ASTM D1586 using a 2 inch outer diameter and 1 3/8 inch inner diameter split barrel sampler. Continue application of blows until one of the following occurs:
 - (1.) Sampler refusal is obtained. Sampler refusal is defined as either:
 - i. A total of 50 blows have been applied over any 2 inch increment;
 - ii. A total of 100 blows have been applied over any 6 inch increment;
 - (2.) A total of 2 feet of penetration has been obtained;
 - c. Open split barrel sampler prior to advancing borehole. If sample consists of wash material or is of less than six inches measured recovery, make a second attempt with a 2 inch O.D. split barrel sampler. If second attempt is unsuccessful, make a final attempt with a 3 inch O.D. split barrel sampler.
3. Tube Sampling
- a. Perform Stationary Piston Sampling in general conformance with ASTM D6519.
 - b. Perform Shelby Tube Sampling in general conformance with ASTM D1587.
 - c. Test tube sampling device above ground to demonstrate it is in good working order.
 - d. Fully jack rig off of springs and make stationary.
 - e. Push sampling device no more than 24 inches and leave in place for ten or more minutes after advance. Prior to sampler removal, rotate drill string two full rotations.
 - f. Place tube samples having less than six inches recovery and samples within damaged tubes in glass jars.
 - g. Provide sample to Engineer for classification. Seal tube after classification is complete as follows:
 - (1.) Cover soil in sample on bottom with a minimum of ½ inch of liquid paraffin wax and allow to cool. Pack any remaining space with sand or a stiff material which repels water. Place plastic cap over sample end and tape in place. Repeat for top of sample. Dip each end in liquid paraffin wax a minimum of 1 inch beyond tape.
 - h. Mark sample with: MRCE job number, boring number, sample number, sampling interval, length of push, length of recovery, date sample was taken, location of top of soil, and location of bottom of soil.
 - i. Samples that are disturbed, damaged or have low recovery at the fault of the Contractor will not be accepted and no payment will be made for such samples.

3.06 ROCK CORING

- 1. General:
 - a. Obtain core samples of the type and in the quantity indicated in Section A.
 - b. Clearly mark all core samples obtained with the following information:
 - (1.) MRCE project number, boring number, sample number, depth interval, recovery, and rock quality designation (RQD);
- 2. Perform coring in general accordance with ASTM D2113 in runs no greater than five feet in length. Core run length may be reduced at the direction of the Engineer.
- 3. Commence coring at the depth of driven sampler refusal accompanied by a minimum of 6 inches of continuous smooth drilling with significant down pressure applied. Drilling beyond 6 inches will not be permitted. Obtain core in run lengths no greater than 5 feet. At boreholes with rock coring, do not terminate the borehole in bedrock with less than 35% recovery unless directed otherwise by the Engineer.
- 4. Tape measure borehole depth to verify quantity of core recovered upon retrieval of core barrel. Make a second attempt to recover portions of core not captured by the first attempt.

5. Preserve and transport core in accordance with ASTM D5079. Secure core samples inside core boxes to prevent movement during transport.

3.07 OBSTRUCTIONS

1. Advance the boring through obstructions in general accordance with ASTM D2113 in core lengths no greater than 5 feet. Resume soil sampling and drilling techniques immediately upon bypassing the obstruction.
2. Borings may be offset and drilled without sampling to the deepest depth obtained prior to encountering an obstruction. No payment will be made for offsetting the boring and drilling without sampling to the prior depth.

3.08 STORAGE, HANDLING, AND SHIPMENT

1. Arrange for storage of equipment and materials unless such space is made available by the Owner.
2. Storage and Handling of Soil and Core Samples:
 - a. Sample Storage Location: Confer with the Engineer prior to the start of work and determine an acceptable storage location for samples. Select a cool, dry, level location out of direct sunlight with controlled access.
 - b. Jar Samples: Handle in general accordance with ASTM D4220. Samples which have been lost or those thrown or dropped from a height may be rejected and will need to be replaced. No payment will be made for replacement of samples which are directly caused by the Contractor.
 - c. Tube Samples: Handle in general accordance with ASTM D1587. Do not expose samples to extreme heat, freezing temperature, undue vibrations. Do not shock or jar samples.
 - d. Core Samples: Handle in general accordance with ASTM D5079. Lay core samples flat. Do not allow core samples to soak in water.
3. Ship samples to the address and at the frequency specified in Section A.

3.09 GROUNDWATER OBSERVATIONS

1. Provide the Engineer with access to make observations of groundwater levels at the beginning and end of each shift and at the terminated depth of the boring. Report any and all unusual water conditions and gain or loss of drilling fluid to the Engineer. When required by the Engineer, bail borings for observations of groundwater conditions.

3.10 OBSERVATION WELL AND OPEN-STANDPIPE PIEZOMETER INSTALLATION

1. Install observation wells and open-standpipe piezometers in general accordance with ASTM D5092 in borings as enumerated in the Scope of Work. Dimensions and depths of screen, riser, filter pack, and seals will be determined by the Engineer in the field in accordance with Drawing P-1.
2. Backfill boreholes deeper than planned piezometer installations with grout and allow to set overnight or backfill with sand and/or bentonite pellets to the required depth.
3. Place materials by tremie pipe or other means which prevents bridging of annulus or which permits removal of drill casing without disturbing observation well or open-standpipe piezometer installation. Verify depth of material by tape measure continuously during placement.
4. Flush by tremie method until return is clear or as otherwise directed by the Engineer.
5. Perform a variable head permeability test on all observation wells and open-standpipe piezometers with recordings by the Engineer. The Engineer will measure the initial water level in the casing and then request either of the following methods:
 - a. Fill the casing with fresh water, reduce flow while adding water to minimize turbulence of water surface and confirm that the casing is full, then allow water in casing to re-stabilize; or
 - b. Evacuate casing with a pump and allow water in casing to re-stabilize.

- iv. *If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and verify piezometer function or replace with alternate sensor.*

8. Mix and place CB grout.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

9. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.7, Step 7.3.

10. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred. Obtain reading at each visit to piezometer to obtain curing trends where practical.

Temperatures are likely to spike in the short term, and pressure should stabilize to that of the surrounding groundwater following initial grout set. Obtain readings at each visit.

11. Top off grout and install borehole surface protection.

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

12. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

13. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings throughout the monitoring period. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

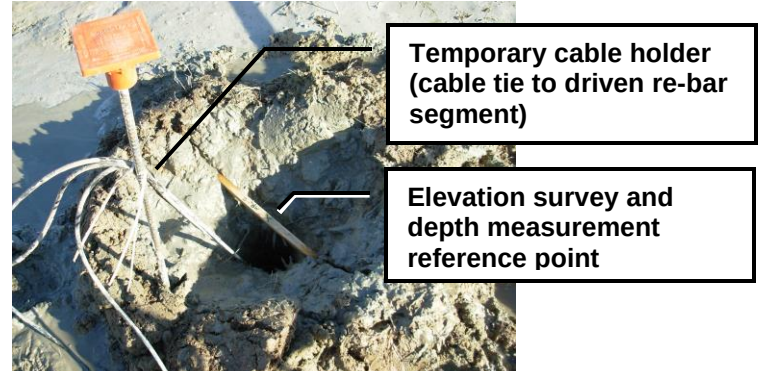


Figure C-2. Example temporary cable holder and survey reference point

14. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the relative permeability between the bentonite-grout and adjacent soil formation. Reliable baseline readings may be obtained after readings have stabilized. Plot data and provide to Project Manager.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster/string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

Vibration Wire Piezometer (VWP) Installation Procedure
Type 2 – Fully Grouted
Method B (Supported on Tremie Pipe or Instrument Casing)

A. SUMMARY

Procedure to install one or more vibrating wire piezometers in a grouted borehole by supporting on the tremie pipe, or on any vertical, full-depth instrument casing installed in the borehole (e.g. that of an ABS inclinometer casing, PVC extensometer casing or along the grouted and solid pipe section of a PVC open standpipe piezometer casing).

Note: This method is required if instruments must be supported from the bottom of the borehole, as during removal of temporary casing (if used) and grouting. If it is practical to suspend instruments from the top, use Method A.

Commentary: Method B may be required if temporary casing is needed for borehole support, as it may prove impractical to suspend piezometer cables from the top while removing the casing. Other options may be possible in some cases (see Method A and consult driller). If feasible, Method A is more desirable than Method B because it is less costly (does not require abandonment of tremie pipe in borehole) and reduces the number of potential paths for hydraulic communication between piezometers in the borehole.

B. REFERENCED DOCUMENTS

1. ASTM D4380-84 (2006), Standard Test Method for Density of Bentonitic Slurries.
2. Mikkelsen and Green, 2003, "Piezometers in Fully-Grouted Boreholes." International Symposium on Geomechanics, Oslo, Norway. September 2003.

C. MATERIALS

1. Vibrating wire (VW) piezometers shall be Model 4500-series as manufactured by Geokon, Inc., Model 52611024, manufactured by Durham Geo Slope Indicator (DGSI), or approved equal. Pressure ranges shall be selected such that piezometers will be within standard operating range under expected groundwater conditions, and will not exceed two (2) times rated maximum pressure (over-stress) for highest possible grout level during CB grout placement.
2. Cement-bentonite (CB) grout shall consist of 94 lbs Portland cement (1 sack US) with 35 gallons of water, blended with approximately 25 lbs dry bentonite.
3. Cement grout shall consist of 94 pounds cement (1 sack US) to 6.5 gallons water.
4. Tremie pipe shall be $\frac{3}{4}$ " or 1" Schedule 40 PVC with threaded or coupled joints. Coupled joints, if used, shall be sealed with PVC cement. Tremie pipe shall have side discharge.

D. EQUIPMENT

- Survey tape for cable measurement, sufficiently long to reach deepest borehole depth.
- Optional: Second survey tape for permanent installation in borehole (tape length $\geq$ borehole depth)
- Mud balance for slurry density measurement (ASTM D4380)
- Hand-held vibrating wire read-out compatible with piezometer
- Water level indicator for slurry/mud depth measurement during borehole advancement

E. PREPARATION

1. Complete Pre-Installation Acceptance Test (Appendix D-1) to verify piezometer function and linear gage factor.

Confirm that sensor serial number is correctly labeled at the free end of the cable; this label will be the only way to identify the sensor once buried. It's always a good idea to add additional serial number labels to the cable, or prepare extra stick-on labels for use in the field if the cable is to be cut or spliced (see Note below). It is also helpful to mark the cable with its total length after preparation (see Paragraph E.3 below).

Note: cutting or splicing piezometer cables in the field should be avoided whenever possible (see Paragraph F.15 below).

2. Prepare piezometer for installation (Fig. D-6).
3. Saturate filter tips by soaking in de-aired water for at least 2 hours.

Because air is compressible, trapped air in the filter tip will increase sensor response time and may result in errant pressure measurement. Submerge filter tips in de-aired, or as hot as possible, water overnight before installation

4. Option: Affix a survey tape to the bottom of the tremie pipe. Confirm the “zero” mark on tape coincides with the bottom end of the tremie pipe.

Piezometer depth is critical to data interpretation. The optional survey tape provides a running measure of sensor position with depth in the borehole. Affix firmly using tape and/or zip ties. Else, carefully log length of pipe sections installed, generally 10 ft sections, and carefully measure offset distance to each affixed piezometer diaphragm intake relative to PVC pipe joints, typically up from previous flush mount joint. Confirm measurements prior to lowering into slurry or grout, and assure relative depths (to the nearest inch or tenth of a foot) are documented on logs.

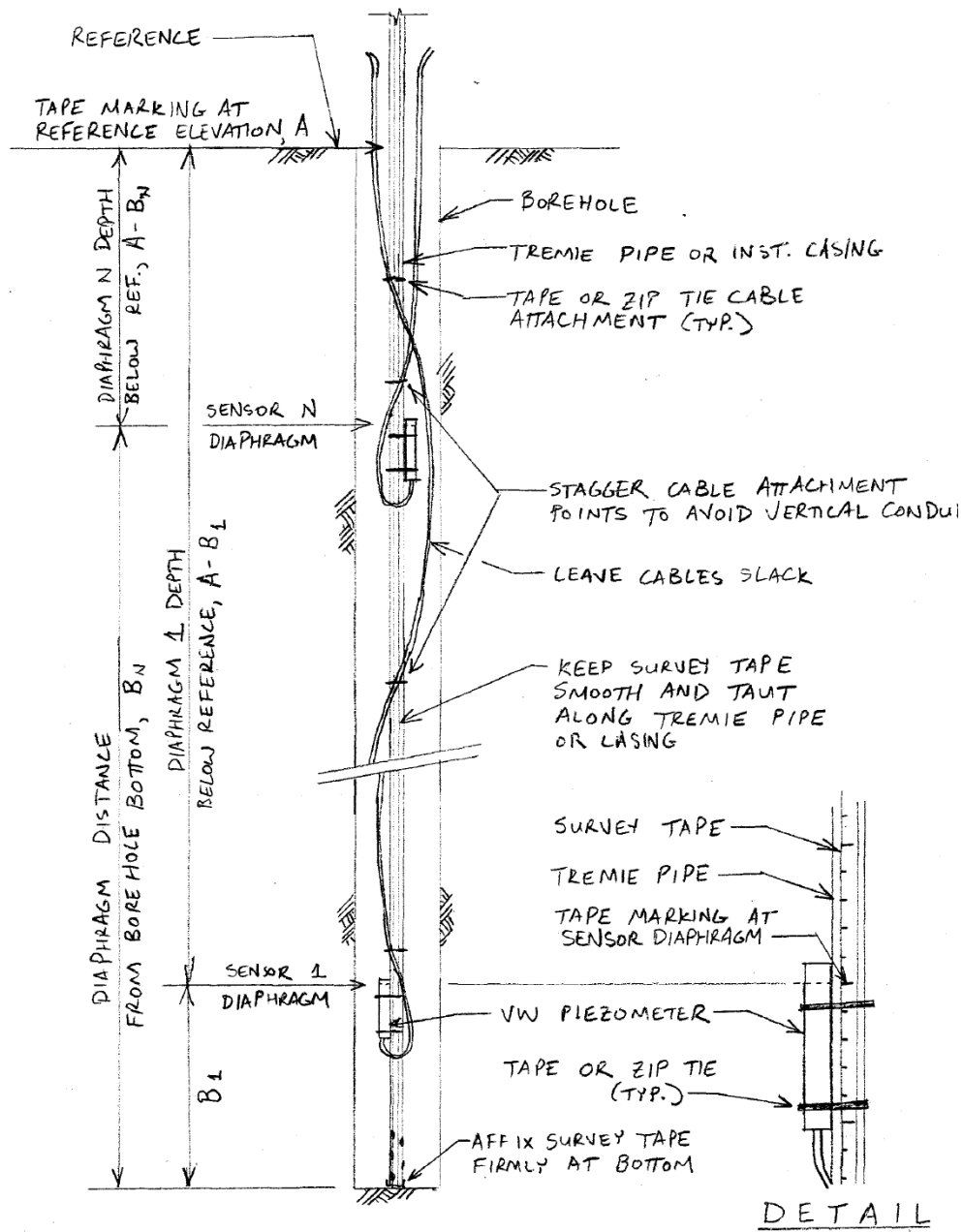
F. INSTALLATION

1. Drill and log borehole as specified.
2. Confirm desired diaphragm depths with MRCE Project Manager based on soil profile from boring. Select piezometer cable lengths and pressure ranges based on desired depths.

Verify adequate piezometer pressure range per paragraph C.1. Assume a unit weight of 80 pcf for CB grout during placement.

3. Confirm piezometers to be installed in borehole are functional.

Record VW piezometer output (digital reading, R and temperature, T) in air. Confirm the reading is consistent with reading taken during Pre-Installation Acceptance Test (Lab R₀). See Sample VW Piezometer Installation Record.



4. Flush borehole to

FIGURE D-6

fresh drilling mud.

5. For each piezometer to be installed in the borehole, submerge sensor in clean water and place saturated filter tip over end. Keep sensor tip pointing upwards so that the tip remains saturated.

The space between the sensor diaphragm and filter tip should be completely full of water.

6. For each piezometer to be installed in the borehole, record VW piezometer reading at site barometric pressure and borehole fluid temperature (field zero). See Sample VW Piezometer Installation Record.

Sealed VW sensors are calibrated to report zero at a certain pressure (usually 1 atm), and temperature determined during manufacture. The field zero reading is used to adjust the zero reading to the barometric pressure and borehole temperature at the site at the time of installation. Perform the following steps:

- a. Lower piezometer to depth representative of the typical fluid temperature in the borehole (typically 10-20 feet).
 - b. Attach and power-up hand-held VW read-out.
 - c. Wait until temperature reading stabilizes (typically 5-10 minutes).
 - d. Remove piezometer from borehole. Keep filter tip pointed upward to maintain saturation.
 - e. Record piezometer output (digital reading, R_0 and temperature, T_0).
7. Assemble tremie pipe or instrument casing and begin lowering into borehole. Where optional survey tape is permanently affixed to casing, confirm survey tape runs smooth and taut along the tremie pipe or casing; affix tape to pipe/casing at regular intervals.

Where used, the survey tape provides an accurate running depth reference. Affix to tremie pipe or instrument casing with tape or zip ties at approximately 10-foot intervals.

8. While lowering tremie pipe or instrument casing, install VW piezometers in accordance with manufacturer's instructions, typically as follows:
 - 8.1. Attach piezometer to tremie pipe or instrument casing with diaphragm at Distance A from borehole bottom for deepest piezometer. Record tape marking at sensor diaphragm.

Secure piezometer body to tremie pipe using tape and/or cable ties. It is advisable to take a photograph of the attached piezometer with serial number and tape marking both visible, for future reference.

- 8.2. Continue assembling and lowering tremie pipe or instrument casing as specified until Distance A for next piezometer is reached. Secure sensor cable(s) to pipe at regular intervals using tape and/or cable ties, leaving slack so that cables are not in direct contact with pipe. Stagger cable attachment points so that multiple cables are not attached to the pipe at the same point.

Leaving cables slack and staggering attachment points reduces the possibility that a vertical path for hydraulic communication can develop along the cables and pipe or casing.

8.3. Repeat Steps 6.1 and 6.2 until all piezometers have been attached.

It may be useful to attach the hand-held VW read-out to free cable ends periodically while lowering to verify that piezometers sense the pressure increase due to drilling mud submergence. If possible, record VW piezometer output at several depths.

9. Record tape marking at reference elevation (e.g. ground surface) with the tremie pipe resting on the bottom of the borehole, B.

Subtract distance A from distance B to determine the depth of each piezometer diaphragm below the reference.

10. Confirm all sensors in borehole are functional under drilling mud.

Table 1. Typical Fluid Weights

Fluid	Unit Weight (pcf)*
Fresh Water	62.4
Drilling Mud	64 - 72
CB Grout	68 - 80

*ranges approximate.

- a. Record VW piezometer output (digital reading, R and temperature, T).
- b. Compute equivalent water column height, H_E , from output:
- i. Compute measured fluid pressure, P using the piezometer's linear gage factor, G , and thermal factor, K , from the Pre-Installation Acceptance Test, relative to the field R_0 and T_0 :

$$\text{Pressure, } P = G (R_0 - R) + K (T - T_0)$$

- ii. Convert the measured fluid pressure, P to an equivalent water column:

$$\text{Equiv. Water Column, } H_E [\text{ft}] = \text{Pressure, } P [\text{psi}] \times 144 / 62.4$$

- c. Measure depth from reference to borehole fluid level. Determine actual fluid column height above sensor diaphragm, H_A .
- d. Compute average fluid unit weight, γ_F , by comparing equivalent water column height, H_E with actual fluid column height, H_A :

$$\text{Calculated Fluid Weight, } \gamma_F [\text{pcf}] = H_E / H_A \times 62.4$$

- e. Compare computed fluid weight, γ_F to reasonable ranges (Table 1).
- f. If computed fluid weight is not reasonable:
- i. Verify that the diaphragm depth is correctly computed; revise if necessary.
- ii. Verify that mud weight does not differ greatly from that assumed.
- iii. Verify field zero reading (Step 6).
- iv. If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and replace with alternate sensor.

11. Mix and place CB grout. Remove any temporary casing from borehole.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

Take care not to disturb piezometers during any casing withdrawal.

12. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.10.

13. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred.

14. Top off grout and install borehole surface protection (Fig. D-2).

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

15. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

16. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings over the life of the piezometer. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

17. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the soil formation's in-situ permeability. Reliable baseline readings may be obtained after readings have stabilized.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster or string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

MUESER RUTLEDGE CONSULTING ENGINEERS

14 Penn Plaza - 225 West 34th Street, NY, NY 10122

PIEZOMETER PRE-INSTALLATION ACCEPTANCE TEST RECORD

Project Name: _____
Project Location: _____
Client: _____
Contract No.: _____
MRCE File: _____
Date: _____

Instrument Type: Vibrating Wire Piezometer
Manufacturer: _____
Model No: _____
Serial No: _____
Purchase Date: _____
Inspector: _____

Examine factory calibration curve
and/or tabulated data to
verify completeness.

☐ Yes ☐ No

Calibration Date: _____

Check tag numbers on instrument
and cable.

☐ Yes ☐ No ☐ NA

Comment: _____

Check cable length.

☐ Yes ☐ No ☐ NA

Comment: _____

Length: _____

Check that model, dimensions, and
materials are correct.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify connection integrity.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify all components fit together
correctly.

☐ Yes ☐ No ☐ NA

Comment: _____

Check all components for damage.

☐ Yes ☐ No ☐ NA

Comment: _____

Update inventory.

☐ Yes ☐ No

Comment: _____

Resistance testing:

☐ Yes ☐ No

Applied
voltage: _____

Resistance: _____

Ω

Factory Zero Reading _____ dg

Factory Temp _____ °C

Ambient Reading _____ dg (in air)

Temperature: _____ °C (in air)

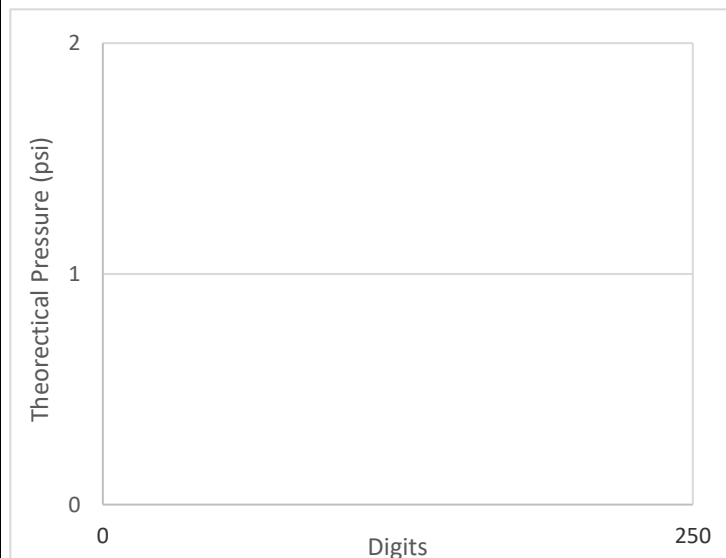
Linear Gage Factor: _____ psi/dg

Thermal Factor: _____ psi/°C

Range: Minimum: _____ 0 _____ psi

Maximum: _____ psi

Water Column Test



Depth (ft) Digit (dg) Temp (°C)

Theoretical
Pressure (psi)

Calculated
Pressure (psi)

Theoretical Unit Weight Water (pcf): _____

Verified gage factor (psi/dg): _____

Percent difference: _____



PROJECT _____
LOCATION _____
BORING LOCATION _____

BORING NO. _____
SHEET _____ **OF** _____
FILE NO. _____
SURFACE ELEV. _____
DATUM _____ NAVD 88

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG	TYPE OF FEED	CASING USED	☐ YES	☐ NO
MAKE AND MODEL:	DURING CORING:			
TRUCK _____	MECHANICAL _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____
SKID _____	HYDRAULIC _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____
BARGE _____	OTHER _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____
OTHER _____				

TYPE AND SIZE OF:	DRILLING MUD USED	☐ YES	☐ NO
D-SAMPLER _____	DIAMETER OF ROTARY BIT, IN. _____		
U-SAMPLER _____	TYPE OF DRILLING MUD _____		
S-SAMPLER _____			
CORE BARREL _____	AUGER USED	☐ YES	☐ NO
CORE BIT _____	TYPE AND DIAMETER, IN. _____		
DRILL RODS _____			
	CASING HAMMER, LBS. _____	AVERAGE FALL, IN. _____	
	SAMPLER HAMMER, LBS. _____	AVERAGE FALL, IN. _____	
	TYPE OF HAMMER _____		
	HAMMER RATE, BPM _____		

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION

PIEZOMETER INSTALLED ☐ YES ☐ NO **SKETCH SHOWN ON** _____

STANDPIPE:	TYPE	_____	ID, IN.	_____	LENGTH, FT.	_____	TOP ELEV.	_____
INTAKE ELEMENT:	TYPE	_____	OD, IN.	_____	LENGTH, FT.	_____	TIP ELEV.	_____
FILTER:	MATERIAL	_____	OD, IN.	_____	LENGTH, FT.	_____	BOT. ELEV.	_____

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	_____	NO. OF 3" SHELBY TUBE SAMPLES	_____
3.5" DIA. U-SAMPLE BORING	LIN. FT.	_____	NO. OF 3" UNDISTURBED SAMPLES	_____
CORE DRILLING IN ROCK	LIN. FT.	_____	OTHER:	_____

BORING CONTRACTOR _____

DRILLER _____ **HELPERS** _____

REMARKS _____

RESIDENT ENGINEER _____ **DATE** _____

BORING NO. _____



BORING NO. _____
SHEET _____ **OF** _____
FILE NO. _____
SURFACE ELEV. _____
DATUM _____

PROJECT _____
LOCATION _____
BORING LOCATION _____

SONIC BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

		TYPE OF FEED			
TYPE OF BORING RIG	DURING CORING	CASING USED	☐ YES	☐ NO	
TRUCK _____	MECHANICAL _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
SKID _____	HYDRAULIC _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
BARGE _____	OTHER _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
OTHER _____					

TYPE AND SIZE OF:	DRILLING MUD USED	☐ YES	☐ NO
D-SAMPLER _____	DIAMETER OF ROTARY BIT, IN. _____		
U-SAMPLER _____	TYPE OF DRILLING MUD _____		
S-SAMPLER _____			
CORE BARREL _____	AUGER USED	☐ YES	☐ NO
CORE BIT _____	TYPE AND DIAMETER, IN. _____		
DRILL RODS _____			
	CASING HAMMER, LBS. _____	AVERAGE FALL, IN. _____	
	SAMPLER HAMMER, LBS. _____	AVERAGE FALL, IN. _____	

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION

PIEZOMETER INSTALLED ☐ YES ☐ NO **SKETCH SHOWN ON** _____

STANDPIPE:	TYPE	_____	ID, IN.	_____	LENGTH, FT.	_____	TOP ELEV.	_____
INTAKE ELEMENT:	TYPE	_____	OD, IN.	_____	LENGTH, FT.	_____	TIP ELEV.	_____
FILTER:	MATERIAL	_____	OD, IN.	_____	LENGTH, FT.	_____	BOT. ELEV.	_____

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	_____	NO. OF 3" SHELBY TUBE SAMPLES	_____
3.5" DIA. U-SAMPLE BORING	LIN. FT.	_____	NO. OF 3" UNDISTURBED SAMPLES	_____
CORE DRILLING IN ROCK	LIN. FT.	_____	OTHER:	_____

BORING CONTRACTOR _____
DRILLER _____ **HELPERS** _____
REMARKS _____

RESIDENT ENGINEER _____ **DATE** _____
CLASSIFICATION CHECK: _____ **TYPING CHECK:** _____



SHEET NO. OF

PIEZOMETER LOCATION:



Diameter, in = ft = = 2R

STANDPIPE/RISER

Diameter, in = ft = = 2r

BOREHOLE

Diameter, in = ft = = 2R

Depth to which standpipe/casing
was bailed or filled to, ft = = Z_0

NOTES

PIEZOMETER NO.

UNDISTURBED SAMPLE LOG

SHEET OF

FILE NO. _____

SUBCODE _____

Project_____

TUBE O.D. = _____ in. Thickness = _____ in.

Material ☐ Brass ☐ Steel ☐ Stainless Steel

Boring No._____ **Sample No.**_____

Depth _____ to _____ rec = _____ in.
push = _____ in.

DEPTH FT.	top	SOIL DESCRIPTION & REMARKS	PERFORMED BY	TARE DATE	ω No.	TEST %	TEST TYPE	TEST VALUE
--------------	-----	----------------------------	-----------------	--------------	----------	-----------	--------------	---------------

Tube Scale: 1 div = 1 inch

bottom of tube

 $\omega, \%$

Length

Average Water Content = _____%

Boring No. _____

Sample No._____

APPENDIX D
Sample Chain-of-Custody Form

Pre-Design Investigation Work Plan
2000 Aluminum Drive, Columbia Falls, Montana

APPENDIX C

MRCE Industrial Landfill Geotechnical Investigation

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K74L *Topographic Map of the Site (Prepared for Columbia Falls Aluminum Company, LLC)*, #63 #
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EXHIBITS

Table 1A – Summary of Existing Industrial Landfill Hand Auger Borings

Sample Number	Ground Surface Elev. (ft)	Sample Depth (ft)	Moisture Content	Sampling Method
CFLP-001	3176	2	Dry	4" dia. hand auger
CFLP-002	3164	2	Dry	4" dia. hand auger
CFLP-003	3154	2	Dry	4" dia. hand auger
CFLP-004	3169	2	Dry	4" dia. hand auger
CFLP-005	3186	2	Dry	4" dia. hand auger
CFLP-006	3183	2	Dry	4" dia. hand auger

Table 1B – Summary of Existing Borings and Monitoring Wells within 100 feet of the Industrial Landfill

Well Number	Ground Surface Elev. (ft)	Boring Depth (ft)	Well Screen Top Depth (ft) ¹	Well Screened Stratum	Groundwater Elevation (ft) ^{2,3}			Remarks
					Low-water Season	High-water Season	Seasonal Variation	
CFSB-191	3172	2	-	-	-	-	-	4" dia. hand auger
CFSB-192	3147	2	-	-	-	-	-	4" dia. hand auger
CFSB-193	3169	2	-	-	-	-	-	4" dia. hand auger
CFSB-194	3172	2	-	-	-	-	-	4" dia. hand auger
CFSB-195	3167	2	-	-	-	-	-	4" dia. hand auger
CFSB-250	3184	12	-	-	-	-	-	2" Macro-Core
CFSB-252	3165	12	-	-	-	-	-	2" Macro-Core
CFSB-253	3176	12	-	-	-	-	-	2" Macro-Core
CFMW-003	3143	55	45	Outwash/Alluvium	3121.6	3125.6	4	
CFMW-003a	3143	245	190	Sand Till	2996.9	3000.6	3.7	
CFMW-066	3150	35	25	Outwash/Alluvium	3132.8	3139.2	6.4	
CFMW-067	3165	45	25	Outwash/Alluvium	3136.3	3140.1	3.8	

Notes:

1. All well screens are 10 feet long.
2. Based on the year 2018 monitoring data.
3. High- and low- water seasons are reported as around June and October, respectively.

Table 2 – Summary of Proposed Industrial Landfill Geotechnical Investigation

CPT or Boring No.^{1,2}	Anticipated Depth (ft)	Existing Ground Elev. (ft)	Sampling and Instrumentation	Data Collection Objectives⁵
CPT-100 through CPT-143	Note 3	varies**	CPT	a, b, d
CPT-100SD	Note 4	3179	CPT	a, b, c, d, e
CPT-104SD	Note 3	3187	CPT	a, b, c, d, e
CPT-112SD	Note 3	3180	CPT	a, b, c, d, e
CPT-114SD	Note 3	3186	CPT	a, b, c, d, e
CPT-117	Note 4	3180	CPT	a, b, d
CPT-121SD	Note 3	3184	CPT	a, b, c, d, e
CPT-125SD	Note 3	3185	CPT	a, b, c, d, e
CPT-126	Note 4	3185	CPT	a, b, d
CPT-130	Note 4	3172	CPT	a, b, d
CPT-136SD	Note 3	3170	CPT	a, b, c, d, e
CPT-143SD	Note 3	3166	CPT	a, b, c, d, e
MR-100P	165	3179	Wash rotary w/ SPT; 3 VWP series	a, b, d, e
MR-101P	165	3180	Wash rotary w/ SPT; 3 VWP series	a, b, d, e
MR-102P	170	3185	Wash rotary w/ SPT; 3 VWP series	a, b, d, e
MR-103P	165	3172	Wash rotary w/ SPT; 3 VWP series	a, b, d, e

Notes:

1. "SD" suffix indicates seismic shear wave velocity and pore pressure dissipation tests performed in CPT.
2. "P" indicates vibrating wire piezometer series installed in boring.
3. CPT probes will be advanced into native soil below Industrial Landfill sediments or to practical refusal depth, whichever is shallower.
4. CPT probes will be advanced to nearby soil boring depth or to practical refusal depth, whichever is shallower.
5. Data Collection Objectives:
 - a. Define thickness, material variation, and physical characteristics of the Industrial Landfill sediments
 - b. Define strength of Industrial Landfill sediments to support the cap and slope stability
 - c. Estimate the potential for Industrial Landfill materials to undergo consolidation settlement and design the cap shaping fill
 - d. Define groundwater elevation within the Industrial Landfill
 - e. Collect data needed to confirm cap performance in an earthquake

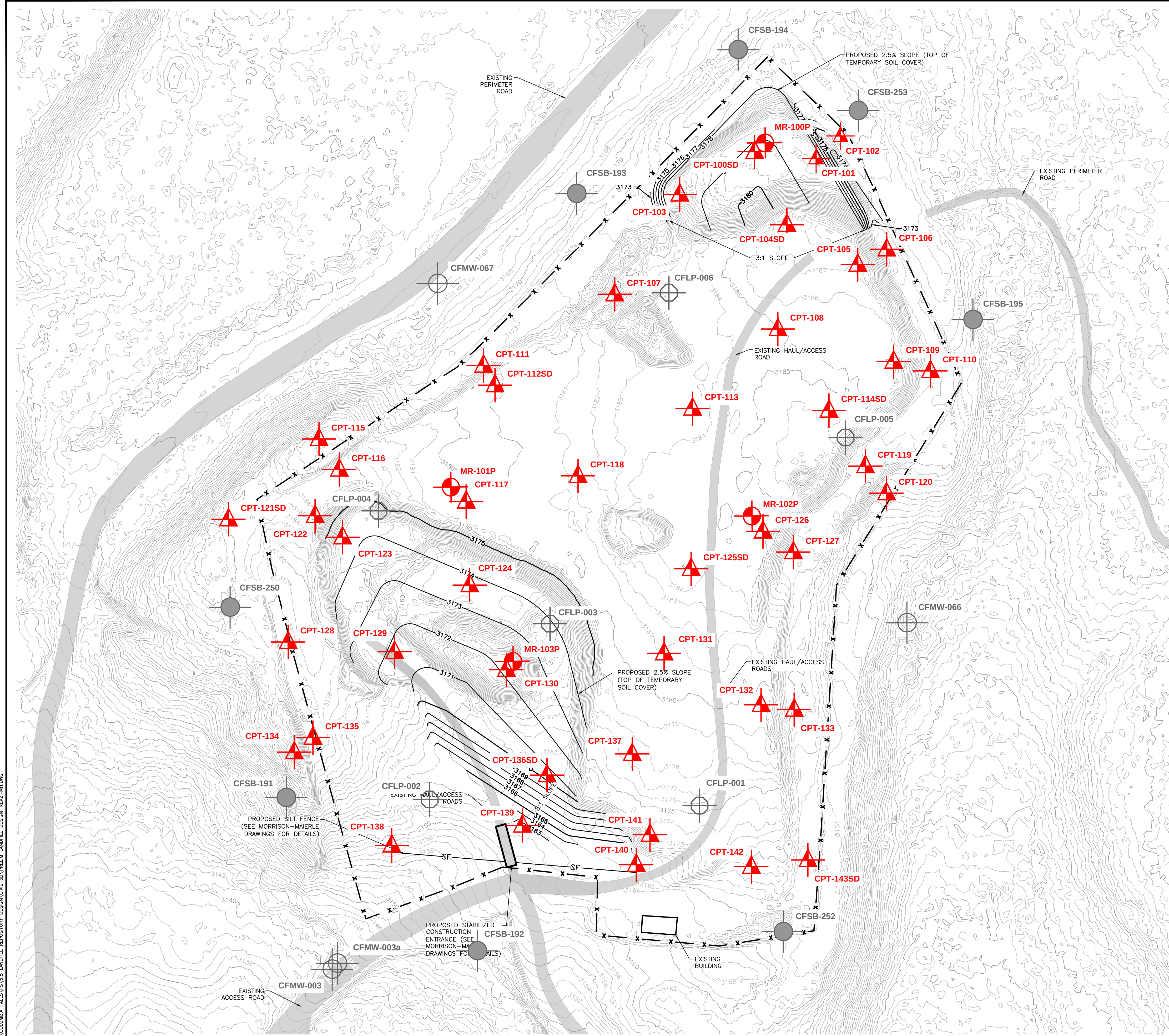
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Table 4 - Industrial Landfill Geotechnical Investigation Data Collection Objectives and Quality Standards

Data Collection Objective	Investigation or Test Method	Test Method or Reference Standard	No. of Borings / Tests	Data Acceptance Criteria
Define thickness, material variation, and physical characteristics of the Industrial Landfill sediments	CPT probes	ASTM D5778	44	CPT probe advances to bottom of Industrial Landfill sediment or practical refusal; CPT tip resistance, sleeve friction, and pore pressure data allow assignment of Soil Behavior Type. CPT probes will be added at reduced spacing where high variability is revealed by the primary probes.
	Soil boring in Industrial Landfill	Wash rotary drilling	4	Boring reaches sufficient depth to set VWP below seasonal low groundwater table; SPT data is collected; profile of split spoon samples are collected for testing
	Describe soil strata encountered in soil borings	ASTM D 2488	Each sample	Visual/manual soil discription of each sample in accordance with the Unified Soil Classification System (USCS) is made and recorded on boring logs
	Collect undisturbed tubes	ASTM D1587	12	Minimum 18" recovery per tube is obtained and sample does not appear disturbed
	Laboratory water content test	ASTM D2216	Each fine-grained sample	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory grain size (sieve) analysis	ASTM D6913	16	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory hydrometer analysis	ASTM D7928	6	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory Atterberg Limits test	ASTM D4318	10	Laboratory test procedure and data report meets requirements of ASTM standard
	Laboratory specific gravity test	ASTM D854	16	Laboratory test procedure and data report meets requirements of ASTM standard; allows calculation of unit weight
Define strength of Industrial Landfill sediments to support the cap and slope stability	Laboratory consolidated drained triaxial test	ASTM D7181	6	Laboratory test procedure and data report meets requirements of ASTM standard; Test results define drained shear strength envelope for WSSP Landfill sediments
	Laboratory consolidated undrained triaxial test	ASTM D4767	6	Laboratory test procedure and data report meets requirements of ASTM standard; Test results define undrained shear strength envelope for WSSP Landfill sediments
	CPT probes	ASTM D5778	Readings at penetration intervals less than 2 inches	CPT tip resistance data allow estimation of soil friction angle and undrained shear strength
	Standard Penetration Test (SPT)	ASTM D1586	1 test / 2 ft depth in Industrial Landfill sediment at 4 boring locations	SPT blow count data allow estimation of soil friction angle and undrained shear strength
Estimate the potential for Indsutrial Landfill materials to undergo consolidation settlement and design the cap shaping fill	One-dimensional consolidation (oedometer) test	ASTM D2435	4	Laboratory test procedure and report meet requirements of ASTM standard; load-deformation and time-deformation parameters are obtained and related to water content
	CPT with pore pressure dissipation measurement	ASTM D5778	perform in fine-grained Indsutrial Landfill sediment in 7 CPTs	Pore pressure measurement is recorded
Define groundwater elevation within the Industrial Landfill	Vibrating wire piezometers (VWP) series set in grout in Industrial Landfill boring	VWP installation guidelines (see Appendix B)	Series of 3 VWPs installed in four borings (1 near bottom of Industrial Landfill sediment, 2 in soils below)	VWPs are calibrated, satisfy pre-installation acceptance testing, are installed successfully, and meet post-installation acceptance criteria (see Appendix B)
	CPT pore pressure measurement	ASTM D5778	each CPT probe location	CPT pore pressure data define elevation of water table (projected zero pore pressure elevation)
Collect data needed to confirm cap performance in an earthquake	CPT with seismic shear wave velocity measurement	ASTM D5778 / D7400	perform at 1-meter depth intervals in 5 CPT probes	Seismic velocity data defines shear wave velocity profile through Industrial Landfill, and is related to SPT blow count data from nearby soil borings
	CPT tip resistance	ASTM D5778	44	CPT data is usable to evaluate liquefaction potential
	SPT blow count with hammer energy correction	ASTM D1586 / D4633	1 test / 2 ft depth in Industrial Landfill sediment at 5 boring locations	Corrected SPT blow count data is useable to evaluate liquefaction potential
	In-situ Field Vane Shear Test in soil borings	ASTM D2573	3 depths in 2 borings (6 total)	In-situ test procedure meets requirements of ASTM standard; peak and remolded (residual) undrained shear strength of WSSP Landfill sediments are measured
	Laboratory direct shear test	ASTM D3080	4	Laboratory test procedure and data report meet requirements of ASTM standard; peak and residual shear strength are measured

Notes:

- 1. ASTM = American Society for Testing and Materials
- 2. CPT = Cone Penetration Test
- 3. SPT = Standard Penetration Test
- 4. See Drawing B-1B and Table 2 for proposed investigation borings
- 5. See Table 3 for summary of proposed laboratory tests



LEGEND	
	EXISTING MAJOR CONTOUR LINE
	EXISTING MINOR CONTOUR LINE
	PROPOSED MAJOR CONTOUR LINE
	PROPOSED MINOR CONTOUR LINE
	EXISTING FENCE LINE (LANDFILL BOUNDARY)
	PROPOSED SILT FENCE
	EXISTING ROADS

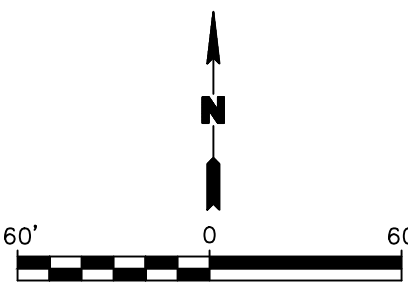
- NOTES:
- EXISTING CONDITIONS ARE BASED OFF OF A DRONE SURVEY CONDUCTED BY SAND SURVEYING INC. ON MAY 22, 2018. DATA GAPS DUE TO THE PRESENCE OF WATER AND EXCESSIVE VEGETATION MAY EXIST IN THE SURVEY DATA. COORDINATES ARE BASED ON NORTH AMERICAN DATUM 1983 (NAD83) AND NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88), MONTANA STATE PLANE COORDINATE SYSTEM (FPS2500). EXISTING CONTOURS ARE SHOWN ON 1-FOOT INTERVALS.
 - PROPOSED GRADES ON THIS PLAN ARE PROVIDED FOR ROUGH GRADING PURPOSES ONLY, AND REPRESENT APPROXIMATE ELEVATIONS TO ALLOW PLACEMENT OF AN ESTIMATED 30,000 CUBIC YARDS OF SOUTH PERCOLATION POND DREDGED SEDIMENT.
 - THE SOUTH AREA DEPRESSION SHALL BE GIVEN PRIORITY TO BE FILLED AND GRADED AS SPECIFIED WITH THE SOUTH PERCOLATION POND DREDGED SEDIMENT. ANY REMAINING SEDIMENT SHALL BE USED TO FILL AND GRADE THE NORTH AREA DEPRESSION AS SPECIFIED.
 - A SECOND STABILIZED CONSTRUCTION ENTRANCE WILL BE NECESSARY IF EXCESS FILL IS TO BE PUT IN THE NORTH AREA DEPRESSION.
 - ALL STAGING OF EQUIPMENT AND MATERIALS SHALL BE WITHIN THE EXISTING LANDFILL FENCE AREA.
 - TEMPORARY ACCESS ROADS AND/OR RAMPS TO BE EXTENDED AND/OR IMPROVED BY CONTRACTOR AS NECESSARY TO PERFORM THE WORK.
 - A SILT FENCE WILL BE INSTALLED AS SHOWN TO PREVENT EROSION FROM LEAVING THE WORK AREA. AN ADDITIONAL SILT FENCE MAY BE NECESSARY ALONG THE NORTH AREA DEPRESSION IF USED FOR LANDFILLING.

PROPOSED INVESTIGATION LEGEND:

- MR-100P
PROPOSED WASH ROTARY SOIL BORING
- 'P' INDICATES VIBRATING WIRE PIEZOMETER SERIES INSTALLED IN BORING
- CPT-100SD
PROPOSED CPT LOCATIONS
- 'SD' INDICATES SEISMIC SHEAR WAVE VELOCITY AND PORE PRESSURE DISSIPATION TESTS PERFORMED IN CPT

EXISTING (ROUX) BORING LEGEND

- CFSB-191
ROUX SOIL BORING LOCATION
- CFMW-066
ROUX MONITORING WELL LOCATION
- CFLP-001
LANDFILL SOIL SAMPLE LOCATIONS



Notes:
1. Baseplan adapted from Daring C-1 "OVERALL SITE PLAN" prepared by Roux, dated 8/14/2020.

NO.	DATE	REVISION DESCRIPTION	INT.

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DRAWING FILE: PRELIM LANDFILL DESIGN_REV2-MH.DWG	

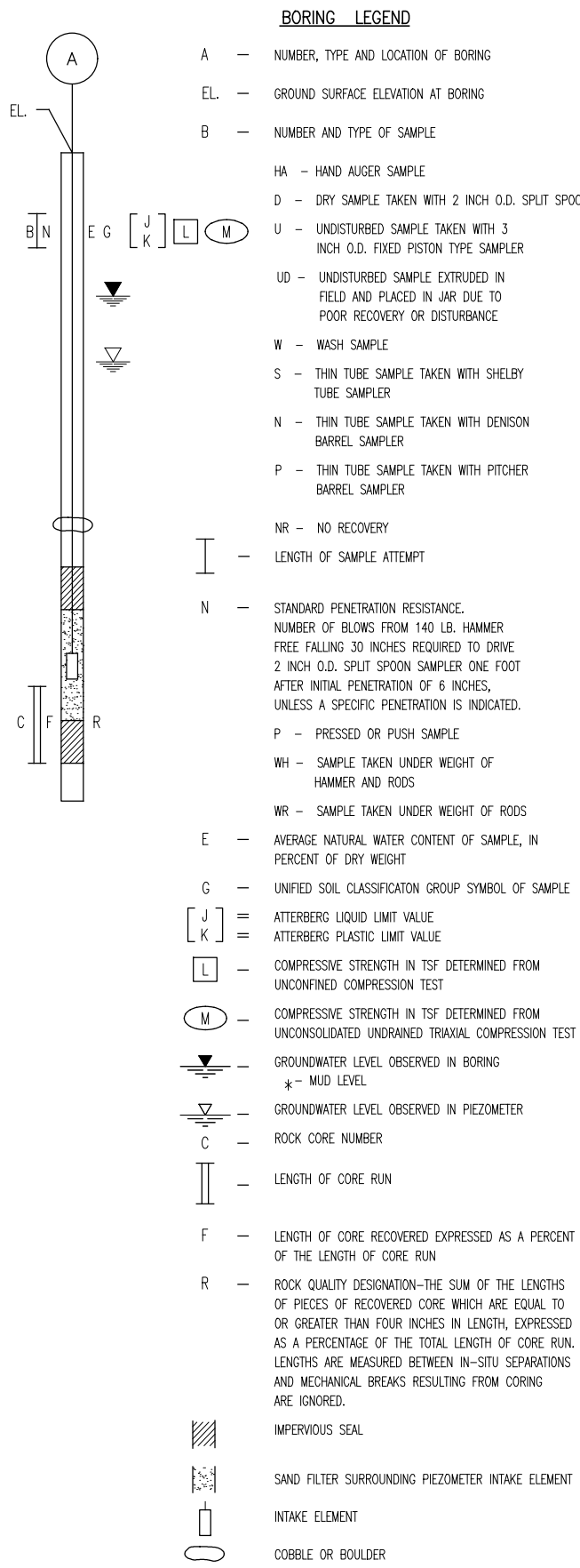
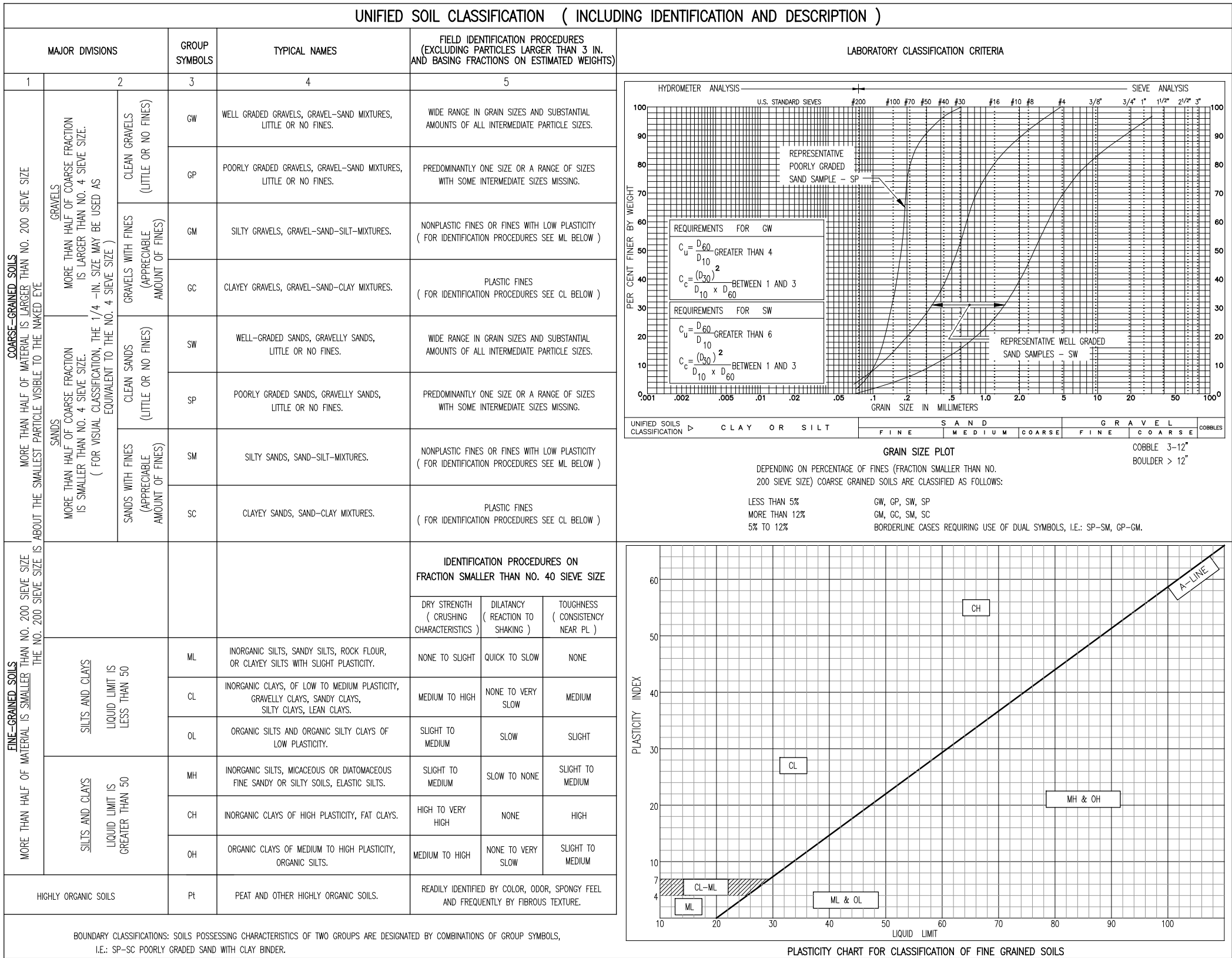


Roux Environmental
Engineering and Geology, D.P.C.
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(631) 232-2600

PROJECT NAME:
INDUSTRIAL LANDFILL WASTE MANAGEMENT
GRADING PLAN

PROJECT FOR:
COLUMBIA FALLS ALUMINUM COMPANY

DRAWING B-2
BORING LOCATION PLAN



REVISED 5-12-2020

- b. Perform the SPT in general accordance with ASTM D1586 using a 2 inch outer diameter and 1 3/8 inch inner diameter split barrel sampler. Continue application of blows until one of the following occurs:
 - (1.) Sampler refusal is obtained. Sampler refusal is defined as either:
 - i. A total of 50 blows have been applied over any 2 inch increment;
 - ii. A total of 100 blows have been applied over any 6 inch increment;
 - (2.) A total of 2 feet of penetration has been obtained;
 - c. Open split barrel sampler prior to advancing borehole. If sample consists of wash material or is of less than six inches measured recovery, make a second attempt with a 2 inch O.D. split barrel sampler. If second attempt is unsuccessful, make a final attempt with a 3 inch O.D. split barrel sampler.
3. Tube Sampling
- a. Perform Stationary Piston Sampling in general conformance with ASTM D6519.
 - b. Perform Shelby Tube Sampling in general conformance with ASTM D1587.
 - c. Test tube sampling device above ground to demonstrate it is in good working order.
 - d. Fully jack rig off of springs and make stationary.
 - e. Push sampling device no more than 24 inches and leave in place for ten or more minutes after advance. Prior to sampler removal, rotate drill string two full rotations.
 - f. Place tube samples having less than six inches recovery and samples within damaged tubes in glass jars.
 - g. Provide sample to Engineer for classification. Seal tube after classification is complete as follows:
 - (1.) Cover soil in sample on bottom with a minimum of ½ inch of liquid paraffin wax and allow to cool. Pack any remaining space with sand or a stiff material which repels water. Place plastic cap over sample end and tape in place. Repeat for top of sample. Dip each end in liquid paraffin wax a minimum of 1 inch beyond tape.
 - h. Mark sample with: MRCE job number, boring number, sample number, sampling interval, length of push, length of recovery, date sample was taken, location of top of soil, and location of bottom of soil.
 - i. Samples that are disturbed, damaged or have low recovery at the fault of the Contractor will not be accepted and no payment will be made for such samples.

3.06 ROCK CORING

- 1. General:
 - a. Obtain core samples of the type and in the quantity indicated in Section A.
 - b. Clearly mark all core samples obtained with the following information:
 - (1.) MRCE project number, boring number, sample number, depth interval, recovery, and rock quality designation (RQD);
- 2. Perform coring in general accordance with ASTM D2113 in runs no greater than five feet in length. Core run length may be reduced at the direction of the Engineer.
- 3. Commence coring at the depth of driven sampler refusal accompanied by a minimum of 6 inches of continuous smooth drilling with significant down pressure applied. Drilling beyond 6 inches will not be permitted. Obtain core in run lengths no greater than 5 feet. At boreholes with rock coring, do not terminate the borehole in bedrock with less than 35% recovery unless directed otherwise by the Engineer.
- 4. Tape measure borehole depth to verify quantity of core recovered upon retrieval of core barrel. Make a second attempt to recover portions of core not captured by the first attempt.

5. Preserve and transport core in accordance with ASTM D5079. Secure core samples inside core boxes to prevent movement during transport.

3.07 OBSTRUCTIONS

1. Advance the boring through obstructions in general accordance with ASTM D2113 in core lengths no greater than 5 feet. Resume soil sampling and drilling techniques immediately upon bypassing the obstruction.
2. Borings may be offset and drilled without sampling to the deepest depth obtained prior to encountering an obstruction. No payment will be made for offsetting the boring and drilling without sampling to the prior depth.

3.08 STORAGE, HANDLING, AND SHIPMENT

1. Arrange for storage of equipment and materials unless such space is made available by the Owner.
2. Storage and Handling of Soil and Core Samples:
 - a. Sample Storage Location: Confer with the Engineer prior to the start of work and determine an acceptable storage location for samples. Select a cool, dry, level location out of direct sunlight with controlled access.
 - b. Jar Samples: Handle in general accordance with ASTM D4220. Samples which have been lost or those thrown or dropped from a height may be rejected and will need to be replaced. No payment will be made for replacement of samples which are directly caused by the Contractor.
 - c. Tube Samples: Handle in general accordance with ASTM D1587. Do not expose samples to extreme heat, freezing temperature, undue vibrations. Do not shock or jar samples.
 - d. Core Samples: Handle in general accordance with ASTM D5079. Lay core samples flat. Do not allow core samples to soak in water.
3. Ship samples to the address and at the frequency specified in Section A.

3.09 GROUNDWATER OBSERVATIONS

1. Provide the Engineer with access to make observations of groundwater levels at the beginning and end of each shift and at the terminated depth of the boring. Report any and all unusual water conditions and gain or loss of drilling fluid to the Engineer. When required by the Engineer, bail borings for observations of groundwater conditions.

3.10 OBSERVATION WELL AND OPEN-STANDPIPE PIEZOMETER INSTALLATION

1. Install observation wells and open-standpipe piezometers in general accordance with ASTM D5092 in borings as enumerated in the Scope of Work. Dimensions and depths of screen, riser, filter pack, and seals will be determined by the Engineer in the field in accordance with Drawing P-1.
2. Backfill boreholes deeper than planned piezometer installations with grout and allow to set overnight or backfill with sand and/or bentonite pellets to the required depth.
3. Place materials by tremie pipe or other means which prevents bridging of annulus or which permits removal of drill casing without disturbing observation well or open-standpipe piezometer installation. Verify depth of material by tape measure continuously during placement.
4. Flush by tremie method until return is clear or as otherwise directed by the Engineer.
5. Perform a variable head permeability test on all observation wells and open-standpipe piezometers with recordings by the Engineer. The Engineer will measure the initial water level in the casing and then request either of the following methods:
 - a. Fill the casing with fresh water, reduce flow while adding water to minimize turbulence of water surface and confirm that the casing is full, then allow water in casing to re-stabilize; or
 - b. Evacuate casing with a pump and allow water in casing to re-stabilize.

- iv. *If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and verify piezometer function or replace with alternate sensor.*

8. Mix and place CB grout.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

9. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.7, Step 7.3.

10. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred. Obtain reading at each visit to piezometer to obtain curing trends where practical.

Temperatures are likely to spike in the short term, and pressure should stabilize to that of the surrounding groundwater following initial grout set. Obtain readings at each visit.

11. Top off grout and install borehole surface protection.

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

12. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

13. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings throughout the monitoring period. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

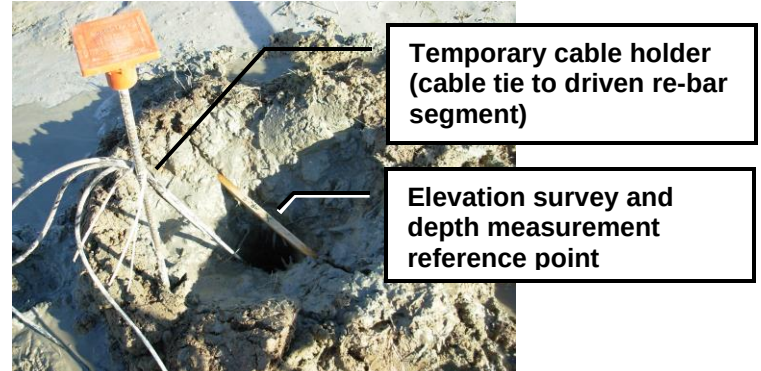


Figure C-2. Example temporary cable holder and survey reference point

14. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the relative permeability between the bentonite-grout and adjacent soil formation. Reliable baseline readings may be obtained after readings have stabilized. Plot data and provide to Project Manager.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster/string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

Vibration Wire Piezometer (VWP) Installation Procedure
Type 2 – Fully Grouted
Method B (Supported on Tremie Pipe or Instrument Casing)

A. SUMMARY

Procedure to install one or more vibrating wire piezometers in a grouted borehole by supporting on the tremie pipe, or on any vertical, full-depth instrument casing installed in the borehole (e.g. that of an ABS inclinometer casing, PVC extensometer casing or along the grouted and solid pipe section of a PVC open standpipe piezometer casing).

Note: This method is required if instruments must be supported from the bottom of the borehole, as during removal of temporary casing (if used) and grouting. If it is practical to suspend instruments from the top, use Method A.

Commentary: Method B may be required if temporary casing is needed for borehole support, as it may prove impractical to suspend piezometer cables from the top while removing the casing. Other options may be possible in some cases (see Method A and consult driller). If feasible, Method A is more desirable than Method B because it is less costly (does not require abandonment of tremie pipe in borehole) and reduces the number of potential paths for hydraulic communication between piezometers in the borehole.

B. REFERENCED DOCUMENTS

1. ASTM D4380-84 (2006), Standard Test Method for Density of Bentonitic Slurries.
2. Mikkelsen and Green, 2003, "Piezometers in Fully-Grouted Boreholes." International Symposium on Geomechanics, Oslo, Norway. September 2003.

C. MATERIALS

1. Vibrating wire (VW) piezometers shall be Model 4500-series as manufactured by Geokon, Inc., Model 52611024, manufactured by Durham Geo Slope Indicator (DGSI), or approved equal. Pressure ranges shall be selected such that piezometers will be within standard operating range under expected groundwater conditions, and will not exceed two (2) times rated maximum pressure (over-stress) for highest possible grout level during CB grout placement.
2. Cement-bentonite (CB) grout shall consist of 94 lbs Portland cement (1 sack US) with 35 gallons of water, blended with approximately 25 lbs dry bentonite.
3. Cement grout shall consist of 94 pounds cement (1 sack US) to 6.5 gallons water.
4. Tremie pipe shall be $\frac{3}{4}$ " or 1" Schedule 40 PVC with threaded or coupled joints. Coupled joints, if used, shall be sealed with PVC cement. Tremie pipe shall have side discharge.

D. EQUIPMENT

- Survey tape for cable measurement, sufficiently long to reach deepest borehole depth.
- Optional: Second survey tape for permanent installation in borehole (tape length $\geq$ borehole depth)
- Mud balance for slurry density measurement (ASTM D4380)
- Hand-held vibrating wire read-out compatible with piezometer
- Water level indicator for slurry/mud depth measurement during borehole advancement

E. PREPARATION

1. Complete Pre-Installation Acceptance Test (Appendix D-1) to verify piezometer function and linear gage factor.

Confirm that sensor serial number is correctly labeled at the free end of the cable; this label will be the only way to identify the sensor once buried. It's always a good idea to add additional serial number labels to the cable, or prepare extra stick-on labels for use in the field if the cable is to be cut or spliced (see Note below). It is also helpful to mark the cable with its total length after preparation (see Paragraph E.3 below).

Note: cutting or splicing piezometer cables in the field should be avoided whenever possible (see Paragraph F.15 below).

2. Prepare piezometer for installation (Fig. D-6).
3. Saturate filter tips by soaking in de-aired water for at least 2 hours.

Because air is compressible, trapped air in the filter tip will increase sensor response time and may result in errant pressure measurement. Submerge filter tips in de-aired, or as hot as possible, water overnight before installation

4. Option: Affix a survey tape to the bottom of the tremie pipe. Confirm the “zero” mark on tape coincides with the bottom end of the tremie pipe.

Piezometer depth is critical to data interpretation. The optional survey tape provides a running measure of sensor position with depth in the borehole. Affix firmly using tape and/or zip ties. Else, carefully log length of pipe sections installed, generally 10 ft sections, and carefully measure offset distance to each affixed piezometer diaphragm intake relative to PVC pipe joints, typically up from previous flush mount joint. Confirm measurements prior to lowering into slurry or grout, and assure relative depths (to the nearest inch or tenth of a foot) are documented on logs.

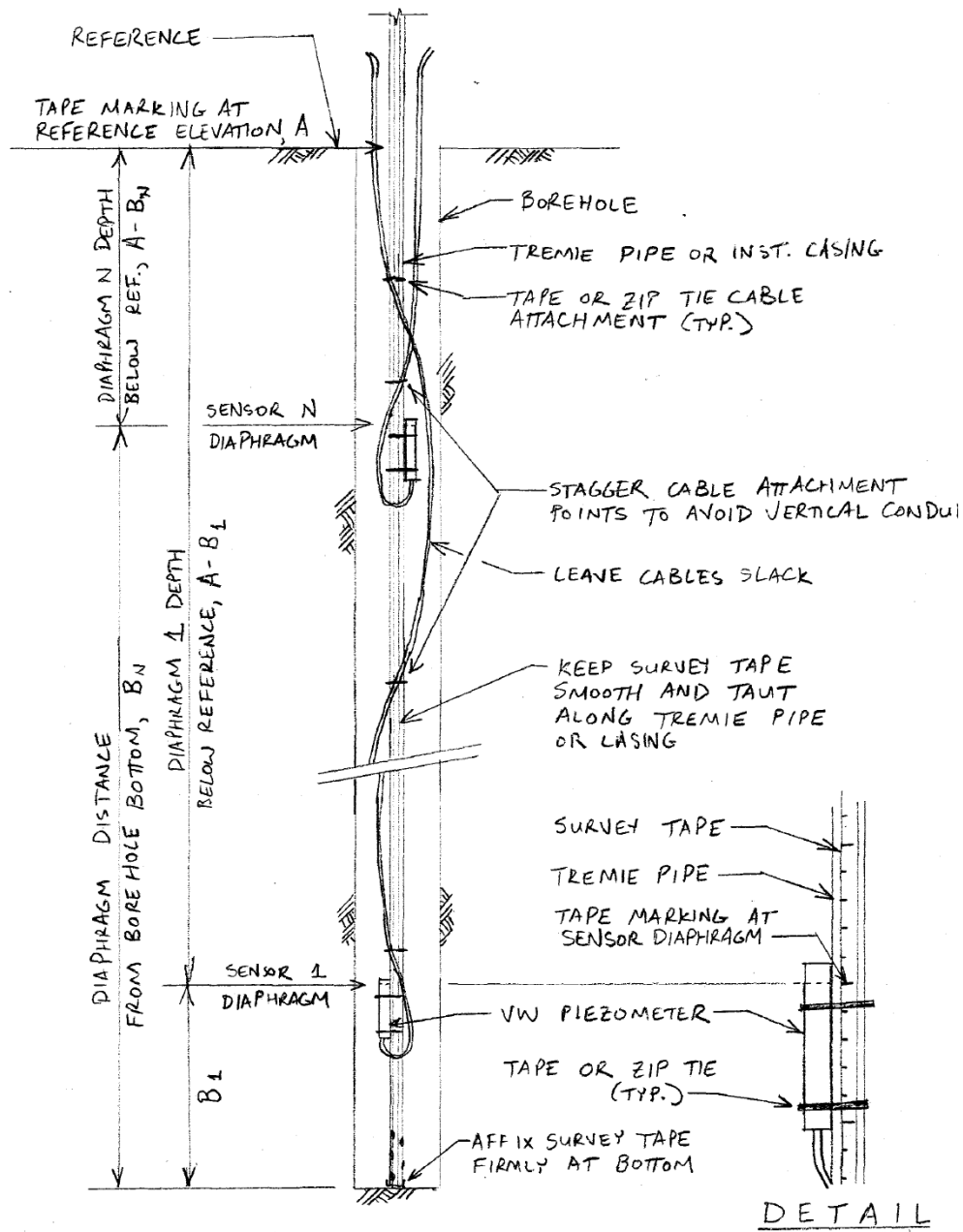
F. INSTALLATION

1. Drill and log borehole as specified.
2. Confirm desired diaphragm depths with MRCE Project Manager based on soil profile from boring. Select piezometer cable lengths and pressure ranges based on desired depths.

Verify adequate piezometer pressure range per paragraph C.1. Assume a unit weight of 80 pcf for CB grout during placement.

3. Confirm piezometers to be installed in borehole are functional.

Record VW piezometer output (digital reading, R and temperature, T) in air. Confirm the reading is consistent with reading taken during Pre-Installation Acceptance Test (Lab R₀). See Sample VW Piezometer Installation Record.



4. Flush borehole to 1

FIGURE D-6

fresh drilling mud.

5. For each piezometer to be installed in the borehole, submerge sensor in clean water and place saturated filter tip over end. Keep sensor tip pointing upwards so that the tip remains saturated.

The space between the sensor diaphragm and filter tip should be completely full of water.

6. For each piezometer to be installed in the borehole, record VW piezometer reading at site barometric pressure and borehole fluid temperature (field zero). See Sample VW Piezometer Installation Record.

Sealed VW sensors are calibrated to report zero at a certain pressure (usually 1 atm), and temperature determined during manufacture. The field zero reading is used to adjust the zero reading to the barometric pressure and borehole temperature at the site at the time of installation. Perform the following steps:

- a. Lower piezometer to depth representative of the typical fluid temperature in the borehole (typically 10-20 feet).
 - b. Attach and power-up hand-held VW read-out.
 - c. Wait until temperature reading stabilizes (typically 5-10 minutes).
 - d. Remove piezometer from borehole. Keep filter tip pointed upward to maintain saturation.
 - e. Record piezometer output (digital reading, R_0 and temperature, T_0).
7. Assemble tremie pipe or instrument casing and begin lowering into borehole. Where optional survey tape is permanently affixed to casing, confirm survey tape runs smooth and taut along the tremie pipe or casing; affix tape to pipe/casing at regular intervals.

Where used, the survey tape provides an accurate running depth reference. Affix to tremie pipe or instrument casing with tape or zip ties at approximately 10-foot intervals.

8. While lowering tremie pipe or instrument casing, install VW piezometers in accordance with manufacturer's instructions, typically as follows:
 - 8.1. Attach piezometer to tremie pipe or instrument casing with diaphragm at Distance A from borehole bottom for deepest piezometer. Record tape marking at sensor diaphragm.

Secure piezometer body to tremie pipe using tape and/or cable ties. It is advisable to take a photograph of the attached piezometer with serial number and tape marking both visible, for future reference.

- 8.2. Continue assembling and lowering tremie pipe or instrument casing as specified until Distance A for next piezometer is reached. Secure sensor cable(s) to pipe at regular intervals using tape and/or cable ties, leaving slack so that cables are not in direct contact with pipe. Stagger cable attachment points so that multiple cables are not attached to the pipe at the same point.

Leaving cables slack and staggering attachment points reduces the possibility that a vertical path for hydraulic communication can develop along the cables and pipe or casing.

8.3. Repeat Steps 6.1 and 6.2 until all piezometers have been attached.

It may be useful to attach the hand-held VW read-out to free cable ends periodically while lowering to verify that piezometers sense the pressure increase due to drilling mud submergence. If possible, record VW piezometer output at several depths.

9. Record tape marking at reference elevation (e.g. ground surface) with the tremie pipe resting on the bottom of the borehole, B.

Subtract distance A from distance B to determine the depth of each piezometer diaphragm below the reference.

10. Confirm all sensors in borehole are functional under drilling mud.

Table 1. Typical Fluid Weights

Fluid	Unit Weight (pcf)*
Fresh Water	62.4
Drilling Mud	64 - 72
CB Grout	68 - 80

*ranges approximate.

- a. Record VW piezometer output (digital reading, R and temperature, T).
- b. Compute equivalent water column height, H_E , from output:
- i. Compute measured fluid pressure, P using the piezometer's linear gage factor, G , and thermal factor, K , from the Pre-Installation Acceptance Test, relative to the field R_0 and T_0 :

$$\text{Pressure, } P = G (R_0 - R) + K (T - T_0)$$

- ii. Convert the measured fluid pressure, P to an equivalent water column:

$$\text{Equiv. Water Column, } H_E [\text{ft}] = \text{Pressure, } P [\text{psi}] \times 144 / 62.4$$

- c. Measure depth from reference to borehole fluid level. Determine actual fluid column height above sensor diaphragm, H_A .
- d. Compute average fluid unit weight, γ_F , by comparing equivalent water column height, H_E with actual fluid column height, H_A :

$$\text{Calculated Fluid Weight, } \gamma_F [\text{pcf}] = H_E / H_A \times 62.4$$

- e. Compare computed fluid weight, γ_F to reasonable ranges (Table 1).
- f. If computed fluid weight is not reasonable:
- i. Verify that the diaphragm depth is correctly computed; revise if necessary.
- ii. Verify that mud weight does not differ greatly from that assumed.
- iii. Verify field zero reading (Step 6).
- iv. If the above steps do not resolve discrepancy, remove piezometer from well, rinse with fresh water, and replace with alternate sensor.

11. Mix and place CB grout. Remove any temporary casing from borehole.

CB grout should be thoroughly mixed using a screw (e.g. Moyno), colloidal, or centrifugal mixer, or pumping equivalent. Circulate grout rapidly to increase mixing shear. Mix the cement and water first, then add the bentonite. Add bentonite slowly to prevent clumping. Adjust the amount of bentonite to produce a grout with the consistency of a heavy cream. If the grout is too thin, it will bleed into the surrounding soil; if too thick, it will be difficult to pump.

Using tremie pipe, place grout from the bottom up to displace drilling fluid. Keep the tremie pipe full of grout from start to finish, with the discharge end of the pipe completely submerged below grout. Place CB grout continuously until fresh grout flows out of the borehole at the ground surface without evidence of drill cuttings, drilling fluid, or water. Record date and time of grouting completion on boring log.

Take care not to disturb piezometers during any casing withdrawal.

12. Confirm all sensors in borehole are functional under fluid CB grout.

Follow procedure in Paragraph F.10.

13. From 12 to 24 hours after grout placement, check borehole for grout settlement. Re-compute sensor depths if piezometer settlement has occurred.

14. Top off grout and install borehole surface protection (Fig. D-2).

Ensure cable ends are clearly marked and protected against moisture intrusion and disturbance by site activities. It may be useful to coil free ends of cables, place in plastic sealable bags, and stow inside well casing or hang on stake.

15. Install cover or other surface protection as specified.

Secure piezometer cables against damage. Cut cable only if needed (see Note). Be conservative and leave a little more than necessary. Add new label to cable before cutting extra wire.

Note: Changing cable length may alter sensor calibration for some manufacturers; avoid if possible. Confirm with MRCE Project Manager prior to modifying cable length. If it is necessary to perform a field splice, use only approved splicing kits and procedures.

16. Survey and record reference elevation.

The reference elevation will be used to compute groundwater elevations from sensor readings over the life of the piezometer. Survey the same reference point used to determine diaphragm depth (e.g. ground surface or base of temporary cable holder).

17. Perform regular piezometer readings until readings have stabilized.

Borehole drilling and backfilling temporarily alter the soil's natural pore-water pressure. Recovery of the natural pore-water pressure may take a few hours to a few weeks, depending on the soil formation's in-situ permeability. Reliable baseline readings may be obtained after readings have stabilized.

G. DOCUMENTATION

1. Boring Log and Backsheet – 1 per boring
2. Pre-Installation Acceptance Test Record(s) – 1 per piezometer
3. VW Piezometer Installation Record(s) – 1 per piezometer or piezometer cluster or string
4. VW Piezometer Factory Calibration Sheet(s) – 1 per piezometer

MUESER RUTLEDGE CONSULTING ENGINEERS

14 Penn Plaza - 225 West 34th Street, NY, NY 10122

PIEZOMETER PRE-INSTALLATION ACCEPTANCE TEST RECORD

Project Name: _____
Project Location: _____
Client: _____
Contract No.: _____
MRCE File: _____
Date: _____

Instrument Type: Vibrating Wire Piezometer
Manufacturer: _____
Model No: _____
Serial No: _____
Purchase Date: _____
Inspector: _____

Examine factory calibration curve
and/or tabulated data to
verify completeness.

☐ Yes ☐ No

Calibration Date: _____

Check tag numbers on instrument
and cable.

☐ Yes ☐ No ☐ NA

Comment: _____

Check cable length.

☐ Yes ☐ No ☐ NA

Comment: _____

Length: _____

Check that model, dimensions, and
materials are correct.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify connection integrity.

☐ Yes ☐ No ☐ NA

Comment: _____

Verify all components fit together
correctly.

☐ Yes ☐ No ☐ NA

Comment: _____

Check all components for damage.

☐ Yes ☐ No ☐ NA

Comment: _____

Update inventory.

☐ Yes ☐ No

Comment: _____

Resistance testing:

☐ Yes ☐ No

Applied
voltage: _____

Resistance: _____

Ω

Factory Zero Reading _____ dg

Factory Temp _____ °C

Ambient Reading _____ dg (in air)

Temperature: _____ °C (in air)

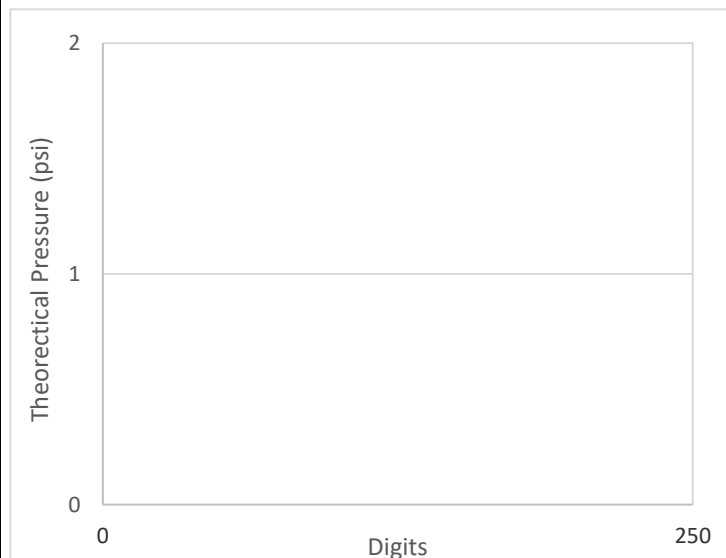
Linear Gage Factor: _____ psi/dg

Thermal Factor: _____ psi/°C

Range: Minimum: _____ 0 _____ psi

Maximum: _____ psi

Water Column Test



Depth (ft) Digit (dg) Temp (°C)

Theoretical Pressure (psi)	Calculated Pressure (psi)

Theoretical Unit Weight Water (pcf): _____

Verified gage factor (psi/dg): _____

Percent difference: _____



PROJECT _____
LOCATION _____
BORING LOCATION _____

BORING NO. _____
SHEET _____ OF _____
FILE NO. _____
SURFACE ELEV. _____
DATUM _____ NAVD 88

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG _____ TYPE OF FEED _____
MAKE AND MODEL: _____ DURING CORING: _____ CASING USED ☐ YES ☐ NO
TRUCK _____ MECHANICAL _____ DIA., IN. _____ DEPTH, FT. FROM _____ TO _____
SKID _____ HYDRAULIC _____ DIA., IN. _____ DEPTH, FT. FROM _____ TO _____
BARGE _____ OTHER _____ DIA., IN. _____ DEPTH, FT. FROM _____ TO _____
OTHER _____

TYPE AND SIZE OF: _____ DRILLING MUD USED ☐ YES ☐ NO
D-SAMPLER _____ DIAMETER OF ROTARY BIT, IN. _____
U-SAMPLER _____ TYPE OF DRILLING MUD _____
S-SAMPLER _____
CORE BARREL _____
CORE BIT _____
DRILL RODS _____
AUGER USED ☐ YES ☐ NO
TYPE AND DIAMETER, IN. _____
CASING HAMMER, LBS. _____ AVERAGE FALL, IN. _____
SAMPLER HAMMER, LBS. _____ AVERAGE FALL, IN. _____
TYPE OF HAMMER _____
HAMMER RATE, BPM _____

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION

PIEZOMETER INSTALLED ☐ YES ☐ NO SKETCH SHOWN ON _____
STANDPIPE: TYPE _____ ID, IN. _____ LENGTH, FT. _____ TOP ELEV. _____
INTAKE ELEMENT: TYPE _____ OD, IN. _____ LENGTH, FT. _____ TIP ELEV. _____
FILTER: MATERIAL _____ OD, IN. _____ LENGTH, FT. _____ BOT. ELEV. _____

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING LIN. FT. _____ NO. OF 3" SHELBY TUBE SAMPLES _____
3.5" DIA. U-SAMPLE BORING LIN. FT. _____ NO. OF 3" UNDISTURBED SAMPLES _____
CORE DRILLING IN ROCK LIN. FT. _____ OTHER: _____

BORING CONTRACTOR _____
DRILLER _____ HELPERS _____
REMARKS _____
RESIDENT ENGINEER _____ DATE _____
BORING NO. _____



SONIC BORING LOG

BORING NO.

SHEET 1 OF _____

FILE NO. _____

SURFACE ELEV. _____

RES. ENGR. _____

PROJECT:

LOCATION: _____

[illegible]

BORING NO.



BORING NO. _____
SHEET _____ **OF** _____
FILE NO. _____
SURFACE ELEV. _____
DATUM _____

PROJECT _____
LOCATION _____
BORING LOCATION _____

SONIC BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

	TYPE OF FEED				
TYPE OF BORING RIG	DURING CORING	CASING USED	☐ YES	☐ NO	
TRUCK _____	MECHANICAL _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
SKID _____	HYDRAULIC _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
BARGE _____	OTHER _____	DIA., IN. _____	DEPTH, FT. FROM _____	TO _____	
OTHER _____					

TYPE AND SIZE OF:	DRILLING MUD USED	☐ YES	☐ NO
D-SAMPLER _____	DIAMETER OF ROTARY BIT, IN. _____		
U-SAMPLER _____	TYPE OF DRILLING MUD _____		
S-SAMPLER _____			
CORE BARREL _____	AUGER USED	☐ YES	☐ NO
CORE BIT _____	TYPE AND DIAMETER, IN. _____		
DRILL RODS _____			
	CASING HAMMER, LBS. _____	AVERAGE FALL, IN. _____	
	SAMPLER HAMMER, LBS. _____	AVERAGE FALL, IN. _____	

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION

PIEZOMETER INSTALLED ☐ YES ☐ NO **SKETCH SHOWN ON** _____

STANDPIPE:	TYPE	_____	ID, IN.	_____	LENGTH, FT.	_____	TOP ELEV.	_____
INTAKE ELEMENT:	TYPE	_____	OD, IN.	_____	LENGTH, FT.	_____	TIP ELEV.	_____
FILTER:	MATERIAL	_____	OD, IN.	_____	LENGTH, FT.	_____	BOT. ELEV.	_____

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	_____	NO. OF 3" SHELBY TUBE SAMPLES	_____
3.5" DIA. U-SAMPLE BORING	LIN. FT.	_____	NO. OF 3" UNDISTURBED SAMPLES	_____
CORE DRILLING IN ROCK	LIN. FT.	_____	OTHER:	_____

BORING CONTRACTOR _____
DRILLER _____ **HELPERS** _____
REMARKS _____
RESIDENT ENGINEER _____ **DATE** _____
CLASSIFICATION CHECK: _____ **TYPING CHECK:** _____



SHEET NO. OF

PIEZOMETER LOCATION:



Diameter, in = ft = = 2R

STANDPIPE/RISER

Diameter, in = ft = = 2r

BOREHOLE

Diameter, in = ft = = 2R

Depth to which standpipe/casing
was bailed or filled to, ft = = Z_0

NOTES

PIEZOMETER NO.



PERCOLATION TEST DATA RECORD

In a Boring

PROJECT _____
 LOCATION _____
 CONTRACTOR _____
 RESIDENT ENGINEER _____

BOREHOLE NO. _____
 TEST NO. _____
 SHEET NO. _____ OF _____
 FILE NO. _____
 DATUM _____
 SURFACE ELEV. _____

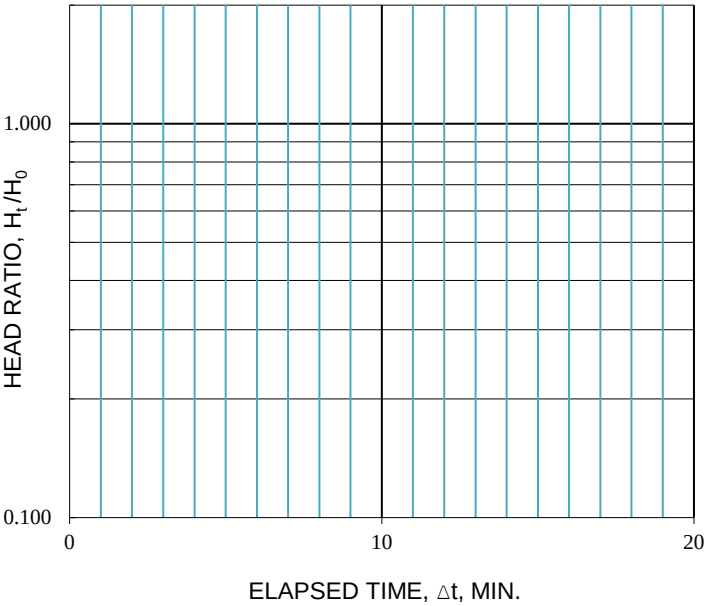
DRILLING

START DATE _____ START TIME _____ WEATHER _____
 DATE COMPLETED _____ END TIME _____
 DRILL RIG TYPE _____ DRILLING METHOD _____ DEPTH OF PERCOLATION TEST _____ FT
 BIT TYPE & SIZE _____ CASING I.D. _____ IN
 REMARKS _____

PERCOLATION TEST MEASUREMENTS AND DATA

SOIL DESCRIPTION _____
 SATURATION PERIOD: START DATE _____ END DATE _____ Water temperature (°C), T= _____
 START TIME _____ END TIME _____ R_t= _____
 START OF TESTING PERIOD: DATE _____ TIME _____ HEIGHT CASING FILLED TO _____ IN
 REMARKS _____

FIELD READINGS		CALCULATED DATA			
TIME (min)	DEPTH (in)	HEIGHT (in)	H _t /H ₀	t ₂ -t ₁ (hr)	K (in/hr)
0.5					
1					
2					
3					
4					
5					
10					
15					



K = _____ in/hr K = _____ cm/s

$$\text{PERMEABILITY COEFFICIENT, } K_m = \pi \cdot R_t \cdot \frac{D \cdot \ln\left(\frac{H_1}{H_2}\right)}{11(t_2 - t_1)}$$

$$R_t = 2.2902(0.9842^T)/T^{0.1702} \text{ and } T \text{ is temperature in } ^\circ\text{C}$$

MUESER RUTLEDGE CONSULTING ENGINEERS

UNDISTURBED SAMPLE LOG

SHEET _____ OF _____

FILE No. _____

Project _____

SUBCODE _____

TUBE O.D. = _____ in. Thickness = _____ in.

Material ☐ Brass ☐ Steel ☐ Stainless Steel

Boring No. _____ Sample No. _____

Depth _____ to _____ rec = _____ in.
push = _____ in.

DEPTH FT. top	SOIL DESCRIPTION & REMARKS	PERFORMED BY	TARE DATE	No.	ω %	TEST TYPE	TEST VALUE
------------------	----------------------------	-----------------	--------------	-----	---------------	--------------	---------------

Tube Scale: 1 div = 1 inch

bottom of tube

ω , %

Length

Average Water Content = _____ %

Boring No. _____

Sample No. _____

APPENDIX D
Sample Chain-of-Custody Form



CHAIN OF CUSTODY RECORD

NO:

CLIENT:	PROJECT NO.	PROJECT MGR:		ANALYSES REQUIRED												Send results to: Mueser Rutledge Consulting Engineers 225 West 34th Street, 6th Floor New York, NY 10122 Telephone: (917) 339-9300 Fax: (917) 339-9400 Submitted to:				
PROJECT NAME:	NOTES - (Reference QAPP and/or analytical protocols to be used):																			
SAMPLERS:																				
DESCRIPTION	..	DATE	HORIZON															REMARKS		
Relinquished by: (Signature)	Date:	Time:	Shipped via:	Airbill #:		Received by:(Signature)								Date:	Time:	Cooler Temp: °C Samples Intact: ___Yes ___No				
Relinquished by: (Signature)	Date:	Time:	Shipped via:	Airbill #:		Received by:(Signature)								Date:	Time:	Cooler Temp: °C Samples Intact: ___Yes ___No				
Relinquished by: (Signature)	Date:	Time:	Shipped via:	Airbill #:		Received by:(Signature)								Date:	Time:	Cooler Temp: °C Samples Intact: ___Yes ___No				

- TYPE CODES:

SD- Sediment

SS- Surface Soil

SB- Subsurface Soil

MW- Monitoring Well Boring
- TP- Test Pit/Tank Pit

DR- Drum Waste

WA- Solid Waste

OS- Other Solid
- WATER

MW- Monitoring Well

LC- Leachate

SW- Surface Water

DW- Drill Water
- FD- Fuel Dispenser

MH- Manhole

OW- Oil Water Separator

PR- Piping Run
- ST- Storm Water

WW- Waste Water

OL- Other Liquid (eg. Drum liquid)
- MATRIX

W - Water

S - Soil
- QUALITY CONTROL

FB- Field Blank (with date)

TB- Trip Blank (with date)

WB- Wash Blank (with date)

Appendix B
Map of the Site

