

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION VIII

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U.S. EPA REGION 8
HEARING CLERK

IN THE MATTER OF:

CERCLA Docket No. CERCLA-08-2026-0003

Barker Hughesville Mining District Site
Cascade and Judith Basin Counties, Montana

Mt. Emmons Mining Company,

Respondent.

Proceeding Under Sections 104, 106(a), 107 and
122 of the Comprehensive Environmental
Response, Compensation, and Liability Act

**ADMINISTRATIVE SETTLEMENT
AGREEMENT AND ORDER ON
CONSENT FOR ENGINEERING
EVALUATION / COST ANALYSIS
INVESTIGATION**

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I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Settlement Agreement and Order on Consent (“Settlement”) is entered into voluntarily by the United States Environmental Protection Agency (“EPA”) and Mt. Emmons Mining Company (“Respondent”). This Settlement provides for the performance of an Engineering Evaluation/Cost Analysis Investigation (“EE/CA”) pursuant to 40 C.F.R. § 300.415 of the National Oil and Hazardous Substance Pollution Contingency Plan (“NCP”) by Respondent at Operable Unit 3 (“OU 3”) of the Barker Hughesville Mining District Site (“Site”) generally located in Cascade and Judith Basin Counties, Montana. The Site and OU3 are shown on the maps in Appendix A.

2. This Settlement is issued under the authority vested in the President of the United States by sections 104, 106(a), 107, and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act (“CERCLA”). This authority was delegated to the Administrator of EPA on January 23, 1987, by Executive Order 12580, 52 Fed. Reg. 2923 (Jan. 29, 1987), and further delegated to Regional Administrators by EPA Delegation Nos. 14-14C (Administrative Actions through Consent Orders, Jan. 18, 2017) and 14-14D (Cost Recovery Non-Judicial Agreements and Administrative Consent Orders, Jan. 18, 2017). These authorities were further redelegated to the EPA Region 8 Associate Regional Counsel for Enforcement.

3. EPA has notified the State of Montana (the “State”) of this action pursuant to section 106(a) of CERCLA.

4. EPA and Respondent recognize that this Settlement has been negotiated in good faith and that the actions undertaken by Respondent in accordance with this Settlement do not constitute an admission of any liability. Respondent does not admit, and retains the right to controvert in any subsequent proceedings other than proceedings to implement or enforce this Settlement, the validity of the findings of facts, and conclusions of law and determinations in Sections IV and V of this Settlement. Respondent agrees to comply with and be bound by the terms of this Settlement and agrees not to contest the basis or validity of this Settlement or its terms.

II. PARTIES BOUND

5. This Settlement is binding upon EPA and upon Respondent and its successors. Unless EPA otherwise consents, (a) any change in ownership or corporate or other legal status of Respondent, including any transfer of assets, or (b) any Transfer of any portion of the Site, does not alter any of Respondent’s obligations under this Settlement.

6. Respondent shall provide notice of this Settlement to officers, directors, employees, agents, contractors, subcontractors, or any person representing Respondent with respect to the Site or the Work. Respondent is responsible for ensuring that such parties act in accordance with the terms of this Settlement.

III. DEFINITIONS

7. Terms not otherwise defined in this Settlement have the meanings assigned in CERCLA or in regulations promulgated under CERCLA. Whenever the terms set forth below are used in this Settlement, the following definitions apply:

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

“Day” or “day” means a calendar day. In computing any period under this Settlement, the day of the event that triggers the period is not counted and, where the last day is not a working day, the period runs until the close of business of the next working day. “Working Day” means any day other than a Saturday, Sunday, or federal or State holiday.

“Engineering Evaluation/Cost Analysis” or “EE/CA” means an engineering evaluation/cost analysis of removal alternatives prepared in accordance with the NCP and EPA’s *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA*, OSWER Directive No. 9360.0-32, August 1993.

“Effective Date” means the effective date of this Settlement as provided in Section XXV.

“EPA” means the United States Environmental Protection Agency.

“Fund” means the Hazardous Substance Superfund established under section 9507 of the Internal Revenue Code, 26 I.R.C. § 9507.

“Future Response Costs” means all costs (including direct, indirect, payroll, contractor, travel, and laboratory costs) that the United States pays after the Effective Date in implementing, overseeing, or enforcing this Settlement, including: (i) in developing, reviewing and approving deliverables generated under this Settlement; (ii) in overseeing Respondent’s performance of the Work; (iii) in implementing community involvement activities under ¶ 23; (iv) in assisting or taking action to obtain access under ¶ 38; (v) in taking action under ¶ 43 (Access to Financial Assurance); (vi) in taking response action described in ¶ 69 because of Respondent’s failure to take emergency action under ¶ 27; (vii) in implementing a Work Takeover under ¶ 34; and (viii) in enforcing this Settlement, including all costs paid under Section XIV (Dispute Resolution) and all litigation costs.

“Including” or “including” means “including but not limited to.”

“Interest” means interest at the rate specified for interest on investments of the Fund, as provided under section 107(a) of CERCLA, compounded annually on October 1 of each year. The applicable rate of interest will be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year. As of the date EPA signs this Settlement, rates are available online at <https://www.epa.gov/superfund/superfund-interest-rates>.

“NCP” means the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to section 105 of CERCLA, codified at 40 C.F.R. part 300, and any amendments thereto.

“OU 3” means Operable Unit 3 of the Site, known as the Liberty Mine Area and generally depicted on the map shown in Appendix A.

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

“Parties” means EPA and Respondent.

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

“Respondent” means Mt. Emmons Mining Company.

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

“Settlement” means this Administrative Settlement Agreement and Order on Consent, all appendixes attached hereto (listed in Section XXI), and all deliverables approved under and incorporated into this Settlement. If there is a conflict between a provision in Sections I through XXV and a provision in any appendix or deliverable, the provision in Sections I through XXV controls.

“Site” means the Barker Hughesville Mining District Superfund Site, located in the Little Belt Mountains near the town of Monarch in Cascade and Judith Basin Counties, Montana, depicted generally on the map attached as Appendix A.

“Special Account” means the special account within the Fund established for the Site by EPA pursuant to section 122(b)(3) of CERCLA.

“State” means the State of Montana.

“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 EPA.

“Waste Material” means (a) any “hazardous substance” under section 101(14) of CERCLA; (b) any pollutant or contaminant under section 101(33) of CERCLA; (c) any “solid waste” under section 1004(27) of RCRA; and (d) any “hazardous waste” under State law.

“Work” means all obligations of Respondent under Sections VII (Coordination and Supervision) through XI (Indemnification and Insurance).

“Work Plan” means the document attached as Appendix B to this Settlement which describes the activities Respondent will perform to prepare an EE/CA, and any modifications made thereto in accordance with this Settlement.

“Work Takeover” means EPA’s assumption of the performance of any of the Work in accordance with ¶ 34.

IV. FINDINGS OF FACT

8. The Site encompasses approximately 9600 acres in the Little Belt Mountains of the Helena-Lewis and Clark National Forest.

9. Historic mining operations at the Site resulted in deposits of waste rock, mill tailings, fluvial deposits, and acid mine drainage that release hazardous substances, including aluminum, arsenic and other heavy metals (cobalt, copper, cadmium, iron, thallium, lead, manganese, silver, and zinc) into the environment.

10. EPA listed the Site on the National Priorities List pursuant to section 105 of CERCLA on September 13, 2001, 66 F.R. 47583.

11. Respondent formerly leased mining claims within the Site, including certain mining claims associated with the Liberty Mine Area. Respondent accessed underground mine workings through the Danny T portal.

12. Solid and aqueous mining-related waste, including waste rock, contaminated soils and sediments, fluvial deposits and discharging adits, exist in connection with the Liberty Mine Area and release hazardous substances into the environment.

V. CONCLUSIONS OF LAW AND DETERMINATIONS

13. Based on the Findings of Fact in Section IV, EPA has determined that:

- a. The Site is a “facility” as defined by section 101(9) of CERCLA.
- b. 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.
- c. Respondent is a “person” as defined by section 101(21) of CERCLA.
- d. Respondent is a responsible party under section 107(a) of CERCLA. Respondent was the “owner” and/or “operator” of the facility at the time of disposal of hazardous substances at the facility, as defined by section 101(20) of CERCLA, and within the meaning of section 107(a)(2) of CERCLA.
- e. The conditions described in Section IV (Findings of Fact) constitute an actual or threatened “release” of a hazardous substance from the facility as defined by section 101(22) of CERCLA.
- f. The actions required by this Settlement are necessary to protect the public health, welfare, or the environment, are in the public interest, 42 U.S.C. § 9622(a), are consistent with CERCLA and the NCP, 42 U.S.C. §§ 9604(a)(1), 9622(a), and will expedite effective remedial action and minimize litigation, 42 U.S.C. § 9622(a).

g. EPA has determined that Respondent is qualified to conduct the Work within the meaning of Section 104(a) of CERCLA, 42 U.S.C. § 9604(a), and will carry out the Work properly and promptly, in accordance with Sections 104(a) and 122(a) of CERCLA, 42 U.S.C. §§ 9604(a) and 9622(a), if Respondent complies with the terms of this Settlement.

VI. ORDER AND AGREEMENT

14. Based upon the Findings of Fact, Conclusions of Law, and Determinations set forth above, it is hereby Ordered and Agreed that Respondent shall comply with all provisions of this Settlement as follows:

VII. COORDINATION AND SUPERVISION

15. Respondent's Project Coordinator

a. Respondent has proposed, and EPA has not disapproved the following Project Coordinator: Barbara Nielsen, 4340 Cotton Center, Suite 110, Phoenix, Arizona 85040, bnielsen@fmi.com. Respondent's Project Coordinator will be responsible for administration of all actions by Respondent required by this Settlement.

b. Respondent's Project Coordinator must have sufficient technical expertise to coordinate the Work. To the greatest extent possible, the Project Coordinator shall be present on Site or readily available during Site work.

c. Notice or communication relating to this Settlement from EPA to Respondent's Project Coordinator constitutes notice or communication to Respondent.

d. Respondent may change its Project Coordinator by following the procedures under ¶ 16.

16. Procedures for Notice and Disapproval

a. Respondent has proposed, and EPA has not disapproved the following contractor: Arcadis U.S., Inc., 46 N. Last Chance Gulch, Suite 2A, Helena, Montana 59601. Respondent shall notify EPA of the names, titles, contact information, and qualifications of any additional contractors or subcontractors retained to perform the Work at least 30 days prior to commencement of such Work.

b. EPA may issue notices of disapproval regarding any proposed Project Coordinator, contractor, or subcontractor, as applicable. If EPA issues a notice of disapproval, Respondent shall, within 30 days, submit to EPA a list of supplemental proposed Project Coordinators, contractors, or subcontractors, as applicable, including a description of the qualifications of each.

c. EPA may disapprove the proposed Project Coordinator, contractor, or subcontractor, 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.

17. **EPA Remedial Project Manager.** EPA designates Roger Hoogerheide of the Superfund and Emergency Management Division, Region 8, as its Remedial Project Manager (“RPM”). The RPM has the authorities described in the NCP, including oversight of Respondent’s implementation of the Work, authority to halt, conduct, or direct any Work, or to direct any other removal action undertaken at the Site. The RPM’s absence from the Site is not a cause for stoppage of work. EPA may change its RPM and will notify Respondent of any such change.

VIII. PERFORMANCE OF THE WORK

18. Respondent shall perform the Work in accordance with this Settlement, including all EPA-approved, conditionally approved, or modified deliverables as required by this Settlement. The Work includes all actions necessary to implement the Work Plan attached as Appendix B, including the submission of an EE/CA for EPA’s review and approval.

19. For any regulation or guidance referenced in the Settlement, 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 receives notification from EPA of the modification, amendment, or replacement.

20. **Work Plan.** Respondent has submitted and EPA has approved the Work Plan attached as Appendix B. The Work Plan includes a description of, and an expeditious schedule for, the actions required by this Settlement. The Work Plan describes all community impact mitigation activities to be performed to: (a) reduce impacts (e.g., air emissions, dust, odor, traffic, noise, temporary relocation, negative economic effects) to residential areas, schools, playgrounds, healthcare facilities, or recreational public areas frequented by community members (“Community Areas”) during implementation of the Work; (b) conduct monitoring in Community Areas of impacts from the implementation of the Work; (c) communicate validated sampling data; and (d) make adjustments during the implementation of the Work in order to further reduce negative impacts to affected Community Areas. The Work Plan contains information about impacts to Community Areas that is sufficient to assist EPA’s Community Involvement Coordinator in performing the evaluations described in the *Superfund Community Involvement Handbook*, OLEM 9230.0-51 (Mar. 2020). The Handbook is located at <https://www.epa.gov/superfund/superfund-community-involvement-tools-and-resources#handbook>.

21. **Health and Safety Plan.** Respondent has developed a Health and Safety Plan (“HASP”) that meets the requirements of 29 C.F.R. § 1910.120 for developing the HASP, that describes all activities to be performed to protect on-site personnel and area residents from physical, chemical, biological and all other hazards related to performance of Work under this Settlement. This HASP was prepared in accordance with EPA’s *Emergency Responder Health and Safety Manual*, OSWER 9285.3-12 (July 2005 and updates), available on the Agency’s website at <https://www.epaossc.org/HealthSafetyManual/manual-index.htm>. In addition, the Respondent has ensured that the HASP complies with all currently applicable Occupational Safety and Health Administration (“OSHA”) regulations found at 29 C.F.R. part 1910. Respondent shall implement the HASP during the pendency of the Work. The HASP is included in the Work Plan, attached as Appendix B.

22. Quality Assurance, Sampling, and Data Analysis

a. Respondent shall use quality assurance, quality control, and other technical activities and chain of custody procedures for all samples consistent with EPA's *Environmental Information Quality Policy*, CIO 2105) and EPA's *Environmental Information Procedure* (CIO 2105-P-01) at <https://www.epa.gov/irmpoli8/environmental-information-quality-policy> and the most recent version of *Quality Management Systems for Environmental Information and Technology Programs – Requirements with Guidance for Use* (ASQ/ANSI E-4).

b. Respondent has submitted and EPA has approved a Quality Assurance Project Plan in the UFP-QAPP format (Optimized UFP-QAPP Worksheets, 2012), developed in accordance with the most recent versions of EPA's *Quality Assurance Project Plan Standard* (CIO 2105-S-02), EPA's *Guidance for Quality Assurance Project Plans* (EPA/240/R-02/009), EPA's *Guidance on Systematic Planning Using the Data Quality Objectives* (EPA/240/B-06/001), EPA's *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8), and any other relevant data quality guidances. The Quality Assurance Project Plan includes a completed EPA Region 8 CERCLA Optimized UFP-QAPP Crosswalk. The Quality Assurance Project Plan is included in the Work Plan, attached as Appendix B.

c. Respondent shall ensure that EPA personnel and its authorized representatives are allowed access at reasonable times to laboratories used by Respondent in implementing this Settlement. In addition, Respondent shall ensure that such laboratories analyze all samples submitted by EPA pursuant to the Quality Assurance Project Plan for quality assurance monitoring, and that sampling and field activities are conducted in accordance with the *EPA QA Field Activities Procedure*, CIO 2105-P-02.1 (Sept. 23, 2014) available at <http://www.epa.gov/irmpoli8/epa-qa-field-activities-procedures>. Respondent shall ensure that the laboratories it utilizes for the analysis of samples taken pursuant to this Settlement meet the competency requirements set forth in the *Policy to Assure Competency of Laboratories, Field Sampling, and Other Organizations Generating Environmental Measurement Data under Agency-Funded Acquisitions* (Directive No. FEM-2011-01) (Nov. 2016) available at <http://www.epa.gov/measurements/documents-about-measurement-competency-under-acquisition-agreements> and that the laboratories perform all analyses according to EPA-accepted methods. Accepted EPA methods are documented in EPA's Contract Laboratory Program (<http://www.epa.gov/clp>), SW 846 *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (<https://www.epa.gov/hw-sw846>), *Standard Methods for the Examination of Water and Wastewater* (<http://www.standardmethods.org/>), 40 C.F.R. part 136, *Air Toxics - Monitoring Methods* (<http://www3.epa.gov/ttnamti1/airtox.html>).

d. Upon request, Respondent shall provide split or duplicate samples to EPA or its authorized representatives. Respondent shall notify EPA not less than seven days prior to any sample collection activity unless shorter notice is agreed to by EPA. In addition, EPA has the right to take any additional samples that EPA deems necessary. Upon request, EPA may provide to Respondent split and/or duplicate samples in connection with EPA's oversight sampling.

e. Respondent shall submit to EPA all sampling and test results and other data obtained or generated by or on behalf of Respondent or in connection with the implementation of this Settlement.

23. **Community Involvement.** EPA has the lead responsibility for implementing community involvement activities at the Site, including updating the existing community involvement plan, in accordance with the NCP and EPA guidance. As requested by EPA, Respondent shall participate in community involvement activities, including participation in (a) the preparation of information regarding the Work for dissemination to the public (including compliance schedules and progress reports), with consideration given to the specific needs of the community, including translated materials and mass media and/or Internet notification and (b) public meetings that may be held or sponsored by EPA to explain activities at or relating to the Site.

24. **Deliverables: Specifications and Approval**

a. **General Requirements for Deliverables.** Respondent shall submit all deliverables to EPA in electronic form, unless otherwise specified by the RPM.

b. **Technical Specifications for Deliverables.** Sampling and monitoring data should be submitted in standard Region 8 Electronic Data Deliverable format prescribed in the Work Plan. Other delivery methods may be allowed by the RPM if electronic direct submission presents a significant burden or as technology changes.

c. **Approval of Deliverables.** After review of any deliverable required to be submitted for EPA approval under the Settlement, EPA shall: (1) approve, in whole or in part, the deliverable; (2) approve the submission upon specified conditions or required revisions to the deliverable; (3) disapprove, in whole or in part, the deliverable; or (4) any combination of the foregoing. If EPA requires revisions, EPA will provide a deadline for the resubmission, and Respondent shall submit the revised deliverable by the required deadline. Once approved or approved with conditions or required revisions, Respondent shall implement the deliverable in accordance with the EPA-approved schedule. Upon approval, or subsequent modification, by EPA of any deliverable, or any portion thereof: (1) such deliverable, or portion thereof, and any subsequent modifications, will be incorporated into and enforceable under the Settlement; and (2) Respondent shall take any action required by such deliverable, or portion thereof. Respondent shall not commence or perform any Work except in conformance with the terms of this Settlement.

25. **Off-Site Shipments**

a. Respondent may ship hazardous substances, pollutants and contaminants from the Site to an off-site facility only if it complies with section 121(d)(3) of CERCLA and 40 C.F.R. § 300.440. Respondent will be deemed to be in compliance with section 121(d)(3) of CERCLA and 40 C.F.R. § 300.440 regarding a shipment if Respondent obtains a prior determination from EPA that the proposed receiving facility for such shipment is acceptable under the criteria of 40 C.F.R. § 300.440(b).

b. Respondent may ship Waste Material from the Site to an out-of-state waste management facility only if, prior to any shipment, it provides written notice to the appropriate state environmental official in the receiving facility's state and to the RPM. This written notice requirement will not apply to any off-site shipments when the total quantity of all

such shipments does not exceed 10 cubic yards. The written notice must include the following information, if available: (1) the name and location of the receiving facility; (2) the type and quantity of Waste Material to be shipped; (3) the schedule for the shipment; and (4) the method of transportation. Respondent also shall notify the state environmental official referenced above and the RPM of any major changes in the shipment plan, such as a decision to ship the Waste Material to a different out-of-state facility. Respondent shall provide the written notice before the Waste Material is shipped.

c. Respondent may ship Investigation Derived Waste (“IDW”) from the Site to an off-site facility only if it complies with section 121(d)(3) of CERCLA, 40 C.F.R. § 300.440, EPA’s *Guide to Management of Investigation Derived Waste*, OSWER 9345.3-03FS (Jan. 1992) (<https://semspub.epa.gov/work/03/136166.pdf>), and any IDW-specific requirements contained in the Work Plan. Wastes shipped off-site to a laboratory for characterization, and RCRA hazardous wastes that meet the requirements for an exemption from RCRA under 40 C.F.R. § 261.4(e) shipped off-site for treatability studies, are not subject to 40 C.F.R. § 300.440.

26. Permits

a. As provided in CERCLA § 121(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 shall submit timely and complete applications and take all other actions necessary to obtain all such permits or approvals.

b. Respondent may seek relief under the provisions of Section XIII (Force Majeure) of the Settlement for any delay in the performance of the Work resulting from a failure to obtain, or a delay in obtaining, any permit or approval referenced in ¶ 26.a and required for the Work, provided that it has submitted timely and complete applications and taken all other actions necessary to obtain all such permits or approvals.

c. Nothing in the Settlement constitutes a permit issued under any federal or state statute or regulation.

27. **Emergency Response.** If any event occurs during performance of the Work that causes or threatens to cause a release of Waste Material on, at, or from the Site and that either constitutes an emergency situation or that may present an immediate threat to public health or welfare or the environment, Respondent shall: (a) immediately take all appropriate action to prevent, abate, or minimize such release or threat of release; (b) immediately notify the RPM or, in the event of their unavailability, notify the National Response Center at (800) 424-8802 of the incident or Site conditions; and (c) take such actions in consultation with the RPM or authorized EPA officer and in accordance with all applicable provisions of this Settlement, including any applicable deliverable approved by EPA.

28. **Release Reporting.** Upon the occurrence of any event during performance of the Work that Respondent is required to report under CERCLA § 103 or section 304 of the

Emergency Planning and Community Right-to-Know Act (“EPCRA”), 42 U.S.C. § 11004, Respondent shall immediately orally notify the RPM and the National Response Center at (800) 424-8802. Respondent shall also submit a written report to EPA within seven days after the onset of such event, (a) describing the event, and (b) all measures taken and to be taken: (1) to mitigate any release or threat of release, (2) to mitigate any endangerment caused or threatened by the release; and (3) to prevent the reoccurrence of any such a release or threat of release. The reporting requirements under this Paragraph are in addition to the reporting required by CERCLA §§ 103 and 111(g) or EPCRA § 304.

29. **Progress Reports.** Commencing on the Effective Date and until issuance of Notice of Completion of Work under ¶ 32, Respondent shall submit written progress reports to EPA and the State on a monthly basis, or as otherwise directed in writing by the RPM. These reports must describe all significant developments during the preceding reporting period, including the actions performed and any problems encountered, analytical data received during the reporting period, and the developments anticipated during the next reporting period, including a schedule of actions to be performed, anticipated problems, and planned resolutions of past or anticipated problems. In addition to written progress reports, upon request of the RPM, Respondent shall coordinate conference calls to include Respondent, EPA, the State, and their respective contractors to discuss Respondent’s implementation of the Work Plan.

30. **Additional Activities.** If EPA determines that additional actions not included in the Work Plan or other approved plans are necessary to protect public health or welfare or the environment, EPA will notify Respondent of that determination. Respondent also may request modification of the approved Work Plan or other deliverables. EPA may notify Respondent of any modification needed under the foregoing two sentences. Respondent shall, within 30 days thereafter, submit a revised work plan and other deliverables as necessary to EPA for approval. Respondent shall implement the revised Work Plan and any other deliverables upon EPA’s approval in accordance with the procedures of ¶ 24 in accordance with the approved provisions and schedule. This Paragraph does not limit the RPM’s authority to make oral modifications to any plan or schedule pursuant to Section XXII.

31. **Final Report**

a. Within 30 days after completion of all Work required by this Settlement other than the continuing obligations listed in ¶ 32.a, Respondent shall submit for EPA’s review and approval a final report regarding the Work. The final report must summarize the actions taken to comply with this Settlement; conform to the requirements of section 300.165 of the NCP (“OSC Reports”); and include all relevant documentation generated during the Work (e.g., manifests, invoices, bills, contracts, and permits) and an estimate of the total costs incurred to complete the Work.

b. The final report must also include the following certification signed by a responsible corporate official of a Respondent or Respondent’s Project Coordinator: “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.”

32. Notice of Completion of Work

a. If after reviewing the Final Report under ¶ 31, EPA determines that all Work, other than the continuing obligations, has been fully performed in accordance with this Settlement, EPA will provide notice to Respondent. A notice of completion of work is not a protectiveness determination and does not affect the following continuing obligations:

- (1) obligations under Section IX (Property Requirements);
- (2) payment of Future Response Costs; and
- (3) obligations under Section XIX (Records).

b. If EPA determines that any Work other than the continuing obligations has not been completed in accordance with this Settlement, EPA will so notify Respondent and provide a list of deficiencies to be corrected and a schedule for correcting them. Respondent shall promptly correct all identified deficiencies in accordance with the schedule provided and shall submit a modified Final Report following completion of such work. Subsequent determinations by EPA regarding completion of Work shall be handled in accordance with this Paragraph.

33. Compliance with Applicable Law. Nothing in this Settlement affects Respondent’s obligations to comply with all applicable state and federal laws and regulations, except as provided in section 121(e) of CERCLA, and 40 C.F.R. §§ 300.400(e) and 300.415(j). In accordance with 40 C.F.R. § 300.415(j), all on-site actions required pursuant to this Settlement shall, to the extent practicable, as determined by EPA, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements (“ARARs”) under federal environmental or state environmental or facility siting laws. The activities conducted in accordance with this Settlement, if approved by EPA, will be deemed to be consistent with the NCP as provided under section 300.700(c)(3)(ii).

34. Work Takeover

a. If EPA determines that Respondent: (1) has ceased implementation of any portion of the Work required under this Section; (2) is seriously or repeatedly deficient or late in performing the Work required under this Section; or (3) is implementing the Work required under this Section in a manner that may cause an endangerment to public health or welfare or the environment, EPA may issue a notice of Work Takeover to Respondent, including a description of the grounds for the notice and a period of time (“Remedy Period”) within which Respondent shall remedy the circumstances giving rise to the notice. The Remedy Period will be 30 days, unless EPA determines in its unreviewable discretion that there may be an endangerment, in which case the Remedy Period will be 10 days.

b. If, by the end of the Remedy Period, Respondent does not remedy to EPA's satisfaction the circumstances giving rise to the notice of Work Takeover, EPA may notify Respondent and, as it deems necessary, commence a Work Takeover.

c. EPA may conduct the Work Takeover during the pendency of any dispute under Section XIV but shall terminate the Work Takeover if and when: (1) Respondent remedies, to EPA's satisfaction, the circumstances giving rise to the notice of Work Takeover; or (2) upon the issuance of a final determination under Section XIV that EPA is required to terminate the Work Takeover.

IX. PROPERTY REQUIREMENTS

35. If any property where access is needed to implement this Settlement is owned or controlled by Respondent, Respondent shall, commencing on the Effective Date, provide EPA, the State, and their representatives, including contractors, with access at all reasonable times to the property for the purpose of conducting any activity related to this Settlement. Where any action under this Settlement is to be performed in areas owned or controlled by someone other than Respondent, Respondent shall use best efforts to obtain all necessary agreements for access, enforceable by Respondent and EPA, within 45 days after the Effective Date, or as otherwise specified in writing by the RPM.

36. As used in this Section, "best efforts" means the efforts that a reasonable person in the position of Respondent would use 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, as required by this Section. If Respondent cannot accomplish what is required through "best efforts" in a timely manner, it shall notify EPA, and include a description of the steps taken to achieve the requirements. If EPA deems it appropriate, it may assist Respondent, or take independent action, to obtain such access.

37. Respondent shall, prior to entering into a contract to Transfer any of its property that is part of the Site, or 60 days prior to a Transfer of such property, whichever is earlier, (a) give written notice to the proposed transferee that the property is subject to this Settlement; and (b) give written notice to EPA and the State of the proposed Transfer, including the name and address of the transferee. Respondent also agrees to require that their successors comply with this Section IX and Section XIX (Records).

38. Notwithstanding any provision of the Settlement, EPA and the State retain all of their access authorities and rights, as well as all of their rights to require land, water, or other resource use restrictions, including related enforcement authorities under CERCLA, RCRA, and any other applicable statute or regulations.

X. FINANCIAL ASSURANCE

39. **Applicability.** To incentivize the expeditious completion of the Work required under Section VIII (Performance of the Work), the requirements of this Section X (Financial Assurance) will become applicable if EPA has not issued the Notice of Completion of Work pursuant to Paragraph 32 on or before March 15, 2027. The amount of financial assurance

Respondent must secure will be determined by the EPA in its unreviewable discretion, based on the estimated cost of the remaining Work as of March 15, 2027.

40. The financial assurance must: (a) be one or more of the mechanisms listed below, in a form substantially identical to the relevant sample documents available from EPA; and (b) be satisfactory to EPA. As of the date of signing this Settlement, the sample documents can be found under the “Financial Assurance - Settlements” category on the Cleanup Enforcement Model Language and Sample Documents Database at <https://cfpub.epa.gov/compliance/models/>. Respondent may use multiple mechanisms if they are limited to surety bonds guaranteeing payment, letters of credit, trust funds, or some combination thereof. The following are acceptable mechanisms:

- a. a surety bond guaranteeing payment, performance of the Work, or both, that is issued by a surety company among those listed as acceptable sureties on federal bonds as set forth in Circular 570 of the U.S. Department of the Treasury;
- b. an irrevocable letter of credit, payable to EPA or at the direction of EPA, that is issued by an entity that has the authority to issue letters of credit and whose letter-of-credit operations are regulated and examined by a federal or state agency; or
- c. a trust fund established for the benefit of EPA that is administered by a trustee that has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency.

41. Respondent shall seek EPA’s approval of the form of Respondent’s financial assurance by March 31, 2027. Within 14 days after the EPA’s approval, Respondent shall secure all executed or otherwise finalized mechanisms or other documents consistent with the EPA-approved form of financial assurance and shall submit such mechanisms and documents to EPA in accordance with ¶ 78.

42. Respondent shall diligently monitor the adequacy of the financial assurance. If Respondent becomes aware of any information indicating that the financial assurance provided under this Section is inadequate or otherwise no longer satisfies the requirements of this Section, Respondent shall notify EPA of such information within seven days. If EPA determines that the financial assurance provided under this Section is inadequate or otherwise no longer satisfies the requirements of this Section, EPA will notify Respondent of such determination. Respondent shall, within 30 days after notifying EPA or receiving notice from EPA under this Paragraph, secure and submit to EPA for approval a proposal for a revised or alternative financial assurance mechanism that satisfies the requirements of this Section. EPA may extend this deadline for such time as is reasonably necessary for Respondent, in the exercise of due diligence, to secure and submit to EPA a proposal for a revised or alternative financial assurance mechanism, not to exceed 60 days. Respondent shall follow the procedures of ¶ 44 (Modification of Amount, Form, or Terms of Financial Assurance) in seeking approval of, and submitting documentation for, the revised or alternative financial assurance mechanism. Respondent’s inability to secure financial assurance in accordance with this Section does not excuse performance of any other requirement of this Settlement.

43. Access to Financial Assurance

a. If EPA issues a notice of a Work Takeover under ¶ 34.b, then, in accordance with any applicable financial assurance mechanism, EPA may require: (1) the performance of the Work; and/or (2) that any funds guaranteed be paid in accordance with ¶ 43.d.

b. If EPA is notified that the issuer of a financial assurance mechanism intends to cancel the mechanism, and Respondent fails to provide an alternative financial assurance mechanism in accordance with this Section at least 30 days prior to the cancellation date, the funds guaranteed under such mechanism must be paid prior to cancellation in accordance with ¶ 43.d.

c. If, upon issuance of a notice of a Work Takeover under ¶ 34, EPA is unable for any reason to promptly secure the resources guaranteed under any applicable financial assurance mechanism, whether in cash or in kind, to continue and complete the Work, then EPA is entitled to demand an amount, as determined by EPA, sufficient to cover the cost of the remaining Work to be performed. Respondent shall, within 10 days after such demand, pay the amount demanded as directed by EPA.

d. Any amounts required to be paid under this ¶ 43 must be, as directed by EPA: (i) paid to EPA in order to facilitate the completion of the Work by EPA, the State, or by another person; or (ii) deposited into an interest-bearing account, established at a duly chartered bank or trust company that is insured by the FDIC, in order to facilitate the completion of the Work by another person. If payment is made to EPA, EPA may deposit the payment into the Fund or into the Special Account to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the Fund.

44. Modification of Amount, Form, or Terms of Financial Assurance. At any time agreed to by the Parties, Respondent may request to change the form, terms, or amount of the financial assurance mechanism. Respondent shall submit any such request to EPA in accordance with ¶ 41, and shall include an estimate of the cost of the remaining Work, an explanation of the bases for the cost calculation, and a description of the proposed changes, if any, to the form or terms of the financial assurance. EPA will notify Respondent of its decision regarding the request. Respondent may modify the form, terms, or the amount of the financial assurance mechanism only in accordance with: (a) EPA's approval; or (b) any resolution of a dispute on the appropriate amount of financial assurance under Section XIV. Any decision made by EPA on a request submitted under this Paragraph to change the form or terms of a financial assurance mechanism shall not be subject to challenge by Respondent pursuant to the dispute resolution provisions of this Settlement or in any other forum. Respondent shall submit to EPA, within 30 days after receipt of EPA's approval, or consistent with the terms of the resolution of the dispute, documentation of the change to the form, terms, or amount of the financial assurance instrument.

45. Release, Cancellation, or Discontinuation of Financial Assurance. Respondent may release, cancel, or discontinue any financial assurance provided under this Section only: (a) if EPA issues a Notice of Completion of Work under ¶ 32; (b) in accordance with EPA's

approval of such release, cancellation, or discontinuation; or (c) if there is a dispute regarding the release, cancellation, or discontinuance of any financial assurance, in accordance with the agreement or final decision resolving such dispute under Section XIV.

XI. INDEMNIFICATION AND INSURANCE

46. Indemnification

a. The United States does not assume any liability by entering into this Settlement or by virtue of any designation of Respondent as EPA's authorized representative under section 104(e)(1) of CERCLA. Respondent shall indemnify and save and hold harmless the United States, its officials, agents, employees, contractors, subcontractors, and representatives for or from any claims or causes of action arising from, or on account of, negligent or other wrongful acts or omissions of Respondent, its officers, directors, employees, agents, contractors, subcontractors, and any persons acting on Respondent's behalf or under its control, in carrying out activities under this Settlement, including any claims arising from any designation of Respondent as EPA's authorized representatives under section 104(e)(1) of CERCLA. Further, Respondent agrees to pay EPA all costs it incurs including attorneys' fees and other expenses of litigation and settlement arising from, or on account of, claims made against the United States based on negligent or other wrongful acts or omissions of Respondent, its officers, directors, employees, agents, contractors, subcontractors, and any persons acting on its behalf or under its control in carrying out activities under with this Settlement. EPA may not be held out as a party to any contract entered into by or on behalf of Respondent in carrying out activities under this Settlement. The Respondent and any such contractor may not be considered an agent of EPA.

b. EPA shall give Respondent notice of any claim for which EPA plans to seek indemnification in accordance with this ¶ 46, and shall consult with Respondent prior to settling such claim.

47. Respondent covenants not to sue and shall not assert any claim or cause of action against the United States for damages or reimbursement or for set-off of any payments made or to be made to the United States, arising from or on account of any contract, agreement, or arrangement between Respondent and any person for performance of Work or other activities on or relating to the Site, including claims on account of construction delays. In addition, Respondent shall indemnify and save and hold harmless the United States with respect to any claims for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between Respondent and any person for performance of work at or relating to the Site, including claims on account of construction delays.

48. **Insurance.** Respondent shall secure, by no later than 15 days before commencing any on-site Work, the following insurance: (a) commercial general liability insurance with limits of liability of \$1 million per occurrence; (b) automobile liability insurance with limits of liability of \$1 million per accident; and (c) umbrella liability insurance with limits of liability of \$5 million in excess of the required commercial general liability and automobile liability limits. The insurance policy must name EPA as an additional insured with respect to all liability arising out of the activities performed by or on behalf of Respondent under this Settlement. Respondent

shall maintain this insurance until the first anniversary after EPA's issuance of the Notice of Completion of Work under ¶ 32. In addition, for the duration of this Settlement, Respondent shall satisfy, or shall ensure that its contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of Respondent in furtherance of this Settlement. Prior to commencement of the Work, Respondent shall provide to EPA certificates of such insurance and a copy of each insurance policy. Respondent shall resubmit such certificates and copies of policies each year on the anniversary of the Effective Date. If Respondent demonstrates by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering 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 shall ensure that all submittals to EPA under this Paragraph identify the Barker Hughesville Mining District Superfund Site, Cascade and Judith Basin Counties, Montana, and the EPA docket number of this case.

XII. PAYMENTS FOR RESPONSE COSTS

49. Payments for Future Response Costs

a. **Periodic Bills.** On a periodic basis, EPA will send Respondent a bill for Future Response Costs incurred by the United States. The bill will include a certified cost summary, listing direct and indirect costs paid by EPA, its contractors, and subcontractors. Respondent may initiate a dispute under Section XIV regarding a Future Response Cost billing, but only if the dispute relates to one or more of the following issues: (1) whether EPA has made an arithmetical error; (2) whether EPA has included a cost item that is not within the definition of Future Response Costs; or (3) whether EPA has paid excess costs as a direct result of an EPA action that was inconsistent with a specific provision or provisions of the NCP. Respondent shall specify in the Notice of Dispute the contested costs and the basis for the objection.

b. **Payment of Bill.** Respondent shall pay the bill, or if it initiates dispute resolution under Section XIV, the uncontested portion of the bill, if any, within 30 days after receipt of the bill. Respondent shall pay the contested portion of the bill determined to be owed, if any, within 30 days after the determination regarding the dispute. Each payment for: (i) the uncontested bill or portion of bill, if late, and; (ii) the contested portion of the bill determined to be owed, if any, must include an additional amount for Interest accrued from the date of receipt of the bill through the date of payment. Respondent shall make all payments at <https://www.pay.gov> using the "EPA Miscellaneous Payments Cincinnati Finance Center" link, and including references to the Site Name, Docket Number, and Site/Spill ID number and the purpose of the payment. Respondent shall send notices of this payment to EPA and include these references.

50. **Deposit of Payments.** EPA may, in its unreviewable discretion, deposit the amounts paid under ¶ 49 in the Fund, in the Special Account, or both. EPA may, in its unreviewable discretion, retain and use any amounts deposited in the Special Account to conduct or finance response actions at or in connection with the Site, or transfer those amounts to the Fund.

XIII. FORCE MAJEURE

51. “Force majeure,” for purposes of this Settlement, means any event arising from causes beyond the control of Respondent, of any entity controlled by Respondent, or of Respondent’s contractors that delays or prevents the performance of any obligation under this Settlement despite Respondent’s best efforts to fulfill the obligation. Given the need to protect public health and welfare and the environment, the requirement that Respondent exercises “best efforts to fulfill the obligation” includes using best efforts to anticipate any potential force majeure and best efforts to address the effects of any potential force majeure (a) as it is occurring and (b) following the potential force majeure such that the delay and any adverse effects of the delay are minimized to the greatest extent possible. “Force majeure” does not include financial inability to complete the Work, or increased cost of performance.

52. If any event occurs for which Respondent will or may claim a force majeure, Respondent shall notify EPA’s RPM by email. The deadline for the initial notice is three days after the date Respondent first knew or should have known that the event would likely delay performance. Respondent shall be deemed to know of any circumstance of which any contractor of, subcontractor of, or entity controlled by Respondent knew or should have known. Within seven days thereafter, Respondent shall send a further notice to EPA that includes: (a) a description of the event and its effect on Respondent’s completion of the requirements of the Settlement; (b) a description of all actions taken or to be taken to prevent or minimize the adverse effects or delay; (c) the proposed extension of time for Respondent to complete the requirements of the Settlement; (d) a statement as to whether, in the opinion of Respondent, such event may cause or contribute to an endangerment to public health or welfare, or the environment; and (e) all available proof supporting its claim of force majeure. Failure to comply with the notice requirements herein regarding an event precludes Respondent from asserting any claim of force majeure regarding that event, provided, however, that if EPA, despite the late or incomplete notice, is able to assess to its satisfaction whether the event is a force majeure under ¶ 51 and whether Respondent has exercised best efforts under ¶ 52, EPA may, in its unreviewable discretion, excuse in writing Respondent’s failure to submit timely or complete notices under this Paragraph.

53. EPA will notify Respondent of its determination whether Respondent is entitled to relief under ¶ 51, and, if so, the duration of the extension of time for performance of the obligations affected by the force majeure. An extension of the time for performance of the obligations affected by the force majeure shall not, of itself, extend the time for performance of any other obligation. Respondent may initiate dispute resolution under Section XIV regarding EPA’s determination within 15 days after receipt of the determination. In any such proceeding, Respondent has the burden of proving that it is entitled to relief under ¶ 51 and that its proposed extension was or will be warranted under the circumstances.

54. The failure by EPA to timely complete any activity under the Settlement is not a violation of the Settlement, provided, however, that if such failure prevents Respondent from timely completing a requirement of the Settlement, Respondent may seek relief under this Section.

XIV. DISPUTE RESOLUTION

55. Unless otherwise provided in this Settlement, Respondent shall use the dispute resolution procedures of this Section to resolve any dispute arising under this Settlement.

56. A dispute will be considered to have arisen when Respondent sends a written notice of dispute (“Notice of Dispute”) to EPA. Disputes arising under this Settlement must in the first instance be the subject of informal negotiations between the Parties. If Respondent objects to any EPA action taken pursuant to this Settlement, it shall send EPA a Notice of Dispute describing the objection(s) within seven days after such action. The period for informal negotiations may not exceed 30 days after the dispute arises, unless EPA otherwise agrees. If the Parties cannot resolve the dispute by informal negotiations, the position advanced by EPA is binding unless Respondent initiates formal dispute resolution under ¶ 57.

57. Formal Dispute Resolution

a. **Statements of Position.** Respondent may initiate formal dispute resolution by submitting, within seven days after the conclusion of informal dispute resolution under ¶ 55, an initial Statement of Position regarding the matter in dispute. EPA’s responsive Statement of Position is due within 20 days after receipt of the initial Statement of Position. All Statements of Position must include supporting factual data, analysis, opinion, and other documentation. If appropriate, EPA may extend the deadlines for filing statements of position for up to 15 days and may allow the submission of supplemental statements of position.

b. **Formal Decision.** The Director of the Superfund & Emergency Management Division, EPA Region 8, will issue a formal decision resolving the dispute (“Formal Decision”) based on the statements of position and any replies and supplemental statements of position. The Formal Decision is binding on Respondent, and shall be incorporated into and become an enforceable part of this Settlement.

58. **Escrow Account.** For disputes regarding a Future Response Cost billing, Respondent shall: (a) establish, in a duly chartered bank or trust company, an interest-bearing escrow account that is insured by the Federal Deposit Insurance Corporation (“FDIC”); (b) remit to that escrow account funds equal to the amount of the contested Future Response Costs; and (c) send to EPA a copy of the transmittal letter and check paying the uncontested Future Response Costs, and a copy of the correspondence that established and funded the escrow account, including the name of the bank, the bank account number, and a bank statement showing the initial balance in the account. EPA may, in its unreviewable discretion, waive the requirement to establish the escrow account. Respondent shall cause the escrow agent to pay the amounts due to EPA under ¶ 49, if any, by the deadline for such payment in ¶ 49. Respondent is responsible for any balance due under ¶ 49 after the payment by the escrow agent.

59. The initiation of dispute resolution procedures under this Section does not extend, postpone, or affect in any way any requirement of this Settlement, except as EPA agrees. Stipulated penalties with respect to the disputed matter will continue to accrue, but payment is stayed pending resolution of the dispute, as provided in ¶ 62.

XV. STIPULATED PENALTIES

60. Unless the noncompliance is excused under Section XIII (Force Majeure), Respondent is liable to EPA for the following stipulated penalties:

a. for any failure: (1) to pay any amount due under Section XII (Payments for Response Costs); (2) to establish and maintain financial assurance in accordance with Section X (Financial Assurance); (3) to establish any escrow account required under ¶ 58; and (4) to submit timely or adequate deliverables specified in the Work Plan, including the EE/CA:

Period of Noncompliance	Penalty Per Noncompliance Per Day
1st through 14th day	\$500
15th through 30th day	\$1,000
31st day and beyond	\$2,000

61. **Work Takeover Penalty.** If EPA commences a Work Takeover under ¶ 34, Respondent is liable for a stipulated penalty in the amount of \$100,000. This stipulated penalty is in addition to the remedy available to EPA under ¶ 43 (Access to Financial Assurance).

62. **Accrual of Penalties.** Stipulated penalties accrue from the date performance is due, or the day a noncompliance occurs, whichever is applicable, until the date the requirement is completed or the final day of the correction of the noncompliance. Nothing in this Settlement prevents the simultaneous accrual of separate penalties for separate noncompliances with this Settlement. Stipulated penalties accrue regardless of whether Respondent has been notified of its noncompliance, and regardless of whether Respondent has initiated dispute resolution under Section XIV, provided, however, that no penalties will accrue as follows:

a. with respect to a submission that EPA subsequently determines is deficient, during the period, if any, beginning on the 31st day after EPA's receipt of such submission until the date that EPA notifies Respondent of any deficiency; or

b. with respect to a matter that is the subject of dispute resolution under Section XIV, during the period, if any, beginning on the 21st day after EPA's Statement of Position is received until the date of the Formal Decision under ¶ 57.b.

63. **Demand and Payment of Stipulated Penalties.** EPA may send Respondent a demand for stipulated penalties. The demand will include a description of the noncompliance and will specify the amount of the stipulated penalties owed. Respondent may initiate dispute resolution under Section XIV within 30 days after receipt of the demand. Respondent shall pay the amount demanded or, if it initiates dispute resolution, the uncontested portion of the amount demanded, within 30 days after receipt of the demand. Respondent shall pay the contested portion of the penalties determined to be owed, if any, within 30 days after the resolution of the dispute. Each payment for: (a) the uncontested penalty demand or uncontested portion, if late, and; (b) the contested portion of the penalty demand determined to be owed, if any, must include an additional amount for Interest accrued from the date of receipt of the demand through the date of payment. Respondent shall make payment at <https://www.pay.gov> using the link for "EPA Miscellaneous Payments Cincinnati Finance Center," including references to the Site Name,

Docket Number, and Site/Spill ID number and the purpose of the payment. Respondent shall send notices of this payment to EPA. The payment of stipulated penalties and Interest, if any, does not alter any obligation by Respondent under the Settlement.

64. Nothing in this Settlement limits the authority of EPA to seek any other remedies or sanctions available by virtue of Respondent's noncompliances with this Settlement or of the statutes and regulations upon which it is based, including penalties under sections 106(b) and 122(l) of CERCLA, and punitive damages pursuant to section 107(c)(3), provided, however, that EPA may not seek civil penalties under section 122(l) of CERCLA for any noncompliance for which a stipulated penalty is provided for in this Settlement, except in the case of a willful noncompliance with this Settlement or in the event that EPA assumes performance of a portion or all of the Work pursuant to ¶ 34 (Work Takeover).

65. Notwithstanding any other provision of this Section, EPA may, in its unreviewable discretion, waive any portion of stipulated penalties that have accrued under this Settlement.

XVI. COVENANTS BY EPA

66. **Covenants for Respondent.** Subject to ¶ 68, EPA covenants not to sue or to take administrative action against Respondent under sections 106 and 107(a) of CERCLA regarding the Work and Future Response Costs.

67. The covenants under ¶ 66: (a) take effect upon the Effective Date; (b) are conditioned on the complete and satisfactory performance by Respondent of the requirements of this Settlement; (c) extend to the successors of Respondent but only to the extent that the alleged liability of the successor of the Respondent is based solely on its status as a successor of the Respondent; and (d) do not extend to any other person.

68. **General Reservations.** Notwithstanding any other provision of this Settlement, EPA reserves, and this Settlement is without prejudice to, all rights against Respondent regarding the following:

- a. liability for failure by Respondent to meet a requirement of this Settlement;
- b. liability for performance of response action other than the Work;
- c. liability for damages for injury to, destruction of, or loss of natural resources, and for the costs of any natural resource damage assessments;
- d. liability arising from the past, present, or future disposal, release or threat of release of Waste Materials outside of the Site; and
- e. criminal liability.

69. Subject to ¶ 66, nothing in this Settlement limits any authority of EPA to take, direct, or order all appropriate action to protect human health and the environment or to prevent,

abate, respond to, or minimize an actual or threatened release of Waste Material on, at, or from the Site, or to request a Court to order such action.

XVII. COVENANTS BY RESPONDENT

70. Covenants by Respondent

a. Subject to ¶ 71, Respondent covenants not to sue and shall not assert any claim or cause of action against the United States under CERCLA, section 7002(a) of RCRA, the United States Constitution, the Tucker Act, 28 U.S.C. § 1491, the Equal Access to Justice Act, 28 U.S.C. § 2412, the State Constitution, State law, or at common law regarding the Work, Future Response Costs, and this Settlement.

b. Subject to ¶ 71, Respondent covenants not to seek reimbursement from the Fund through CERCLA or any other law for costs of the Work, Future Response Costs, or any claim arising out of response actions at or in connection with the Site.

71. **Respondent's Reservation.** The covenants in ¶ 70 do not apply to any claim or cause of action brought, or order issued, after the Effective Date by the United States to the extent such claim, cause of action, or order is within the scope of a reservation under ¶¶ 68.a through 68.e.

XVIII. EFFECT OF SETTLEMENT; CONTRIBUTION

72. The Parties agree that: (a) this Settlement constitutes an administrative settlement under which Respondent has, as of the Effective Date, resolved its liability to EPA for the Work and Future Response Costs as specified ¶ 66, within the meaning of sections 113(f)(2), 113(f)(3)(B), and 122(h)(4) of CERCLA; and (b) Respondent is entitled, as of the Effective Date, to protection from contribution actions or claims as provided by sections 113(f)(2) and 122(h)(4) of CERCLA, or as may be otherwise provided by law, for the “matters addressed” in this Settlement. The “matters addressed” in this Settlement are the Work and Future Response Costs, provided, however, that if EPA exercises rights against Respondent under the reservations in ¶¶ 68.a through 68.e, the “matters addressed” in this Settlement do not include those response costs or response actions that are within the scope of the exercised reservation.

73. Respondent shall, with respect to any suit or claim brought by it for matters related to this Settlement, notify EPA at least 60 days before the initiation of such suit or claim. Respondent shall, with respect to any suit or claim brought against it for matters related to this Settlement, notify EPA within 10 days after service of the complaint on Respondent. In addition, Respondent shall notify EPA within 10 days after service or receipt of any Motion for Summary Judgment and within 10 days after receipt of any order from a court setting a case for trial.

74. **Res Judicata and Other Defenses.** In any subsequent administrative or judicial proceeding initiated against Respondent by EPA or by the United States on behalf of EPA for injunctive relief, recovery of response costs, or other appropriate relief relating to the Site, Respondent shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, claim preclusion (res judicata), issue preclusion (collateral estoppel), claim-

splitting, or other defenses based upon any contention that the claims raised by the United States in the subsequent proceeding were or should have been brought in the instant case.

75. Nothing in this Settlement creates any rights in, or grants any defense or cause of action to, any person not a Party to this Settlement. Except as provided in Section XVII (Covenants by Respondent), each of the Parties expressly reserves any and all rights (including pursuant to section 113 of CERCLA), defenses, claims, demands, and causes of action that each Party may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto. Nothing in this Settlement diminishes the right of the United States under section 113(f)(2) and (3) of CERCLA to pursue any person not a party to this Settlement to obtain additional response costs or response action and to enter into settlements that give rise to contribution protection pursuant to section 113(f)(2).

XIX. RECORDS

76. **Respondent's Certification.** Respondent certifies that: (a) it has implemented a litigation hold on documents and electronically stored information relating to the Site, including information relating to its potential liability under CERCLA regarding the Site, since the notification of potential liability by the United States or the State; and (b) it has fully complied with any and all EPA requests for information under sections 104(e) and 122(e) of CERCLA, and section 3007 of RCRA.

77. Retention of Records and Information

a. Respondent shall retain, and instruct its contractors and agents to retain, the following documents and electronically stored data ("Records") until 10 years after the Notice of Completion of the Work under ¶ 32.a ("Record Retention Period"):

- (1) All records regarding Respondent's liability and the liability of any other person under CERCLA regarding the Site;
- (2) All reports, plans, permits, and documents submitted to EPA in accordance with this Settlement, including all underlying research and data; and
- (3) All data developed by, or on behalf of, Respondent in the course of performing the Work.

b. At the end of the Record Retention Period, Respondent shall notify EPA that it has 90 days to request the Respondent's Records subject to this Section. Respondent shall retain and preserve its Records subject to this Section until 90 days after EPA's receipt of the notice. These record retention requirements apply regardless of any corporate record retention policy.

78. Respondent shall provide to EPA, upon request, copies of all Records and information required to be retained under this Section. Respondent shall also make available to 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.

79. Privileged and Protected Claims

a. Respondent may assert that all or part of a record requested by EPA is privileged or protected as provided under federal law, in lieu of providing the record, provided that Respondent complies with ¶ 79.b, and except as provided in ¶ 79.c.

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

c. Respondent shall not make any claim of privilege or protection regarding: (1) any data regarding the Site, including 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 in accordance with this Settlement.

80. Confidential Business Information Claims. Respondent is entitled to claim that all or part of a record submitted to EPA under this Section is Confidential Business Information ("CBI") that is covered by section 104(e)(7) of CERCLA and 40 C.F.R. § 2.203(b). Respondent shall segregate all records or parts thereof submitted under this Settlement which it claims is CBI and label them as "claimed as confidential business information" or "claimed as CBI." Records that a submitter properly labels in accordance with the preceding sentence will be afforded the protections specified in 40 C.F.R. part 2, subpart B. If the records are not properly labeled when they are submitted to EPA, or if EPA notifies the submitter that the records are not entitled to confidential treatment under the standards of section 104(e)(7) of CERCLA or 40 C.F.R. part 2, subpart B, the public may be given access to such records without further notice to the submitter.

81. Notwithstanding any provision of this Settlement, EPA retains all of its information gathering and inspection authorities and rights, including enforcement actions related thereto, under CERCLA, RCRA, and any other applicable statutes or regulations.

XX. NOTICES AND SUBMISSIONS

82. All agreements, approvals, consents, deliverables, modifications, notices, notifications, objections, proposals, reports, waivers, and requests specified in this Settlement must be in writing unless otherwise specified. Whenever a notice is required to be given or a report or other document is required to be sent by one Party to another under this Settlement, it must be sent as specified below. All notices under this Section are effective upon receipt, unless otherwise specified. In the case of emailed notices, there is a rebuttable presumption that such notices are received on the same day that they are sent. Any Party may change the method, person, or address applicable to it by providing notice of such change to all Parties.

As to EPA: *via email to:*
Hoogerheide.Roger@epa.gov
Re: Site/Spill ID # 085N

As to *via email to:*
Respondent: bnielsen@fmi.com

XXI. APPENDIXES

83. The following appendixes are attached to and incorporated into this Settlement:

“Appendix A” is a map of the Site and a map of OU3 within the Site.

“Appendix B” is the Work Plan.

XXII. MODIFICATIONS

84. The RPM may modify the Work Plan and any schedule in writing or by oral direction. EPA will promptly memorialize in writing any oral modification, which will be effective on the date of the RPM’s oral direction. Any other requirements of this Settlement may be modified in writing by mutual agreement of the parties.

85. If Respondent seeks permission to deviate from the Work Plan or any schedule, Respondent’s Project Coordinator shall submit a written request to EPA for approval outlining the proposed modification and its basis. Respondent may not proceed with a requested deviation until receiving oral or written approval from the RPM pursuant to ¶ 84.

86. No informal advice, guidance, suggestion, or comment by the RPM or other EPA representatives regarding any deliverable submitted by Respondent relieves Respondent of its obligation to obtain any formal approval required by this Settlement, or to comply with all requirements of this Settlement, unless it is formally modified.

XXIII. SIGNATORIES

87. The undersigned representative of EPA and the undersigned representative of Respondent certify that he or she is fully authorized to enter into the terms and conditions of this Settlement and to execute and legally bind such party to this Settlement.

XXIV. INTEGRATION

88. This Settlement constitutes the entire agreement among the Parties regarding the subject matter of the Settlement and supersedes all prior representations, agreements and understandings, whether oral or written, regarding the subject matter of the Settlement.

XXV. EFFECTIVE DATE

89. This Settlement is effective when it is signed by the Regional Administrator or his delegate.

IT IS SO AGREED AND ORDERED:

**BY THE U.S. ENVIRONMENTAL
PROTECTION AGENCY:**

CHRISTOPHE
R THOMPSON

Digitally signed by
CHRISTOPHER THOMPSON
Date: 2026.03.02 09:49:58
-07'00'

Dated

Christopher Thompson
Associate Regional Counsel for Enforcement
U.S. EPA Region 8

AARON
URDIALES

Digitally signed by
AARON URDIALES
Date: 2026.03.02
09:40:08 -07'00'

Dated

Aaron Urdiales
Director, Superfund and Emergency Management
Division
U.S. EPA Region 8

Signature Page for Settlement Regarding the Barker Hughesville Mining District Superfund Site

FOR: Mt. Emmons Mining Company

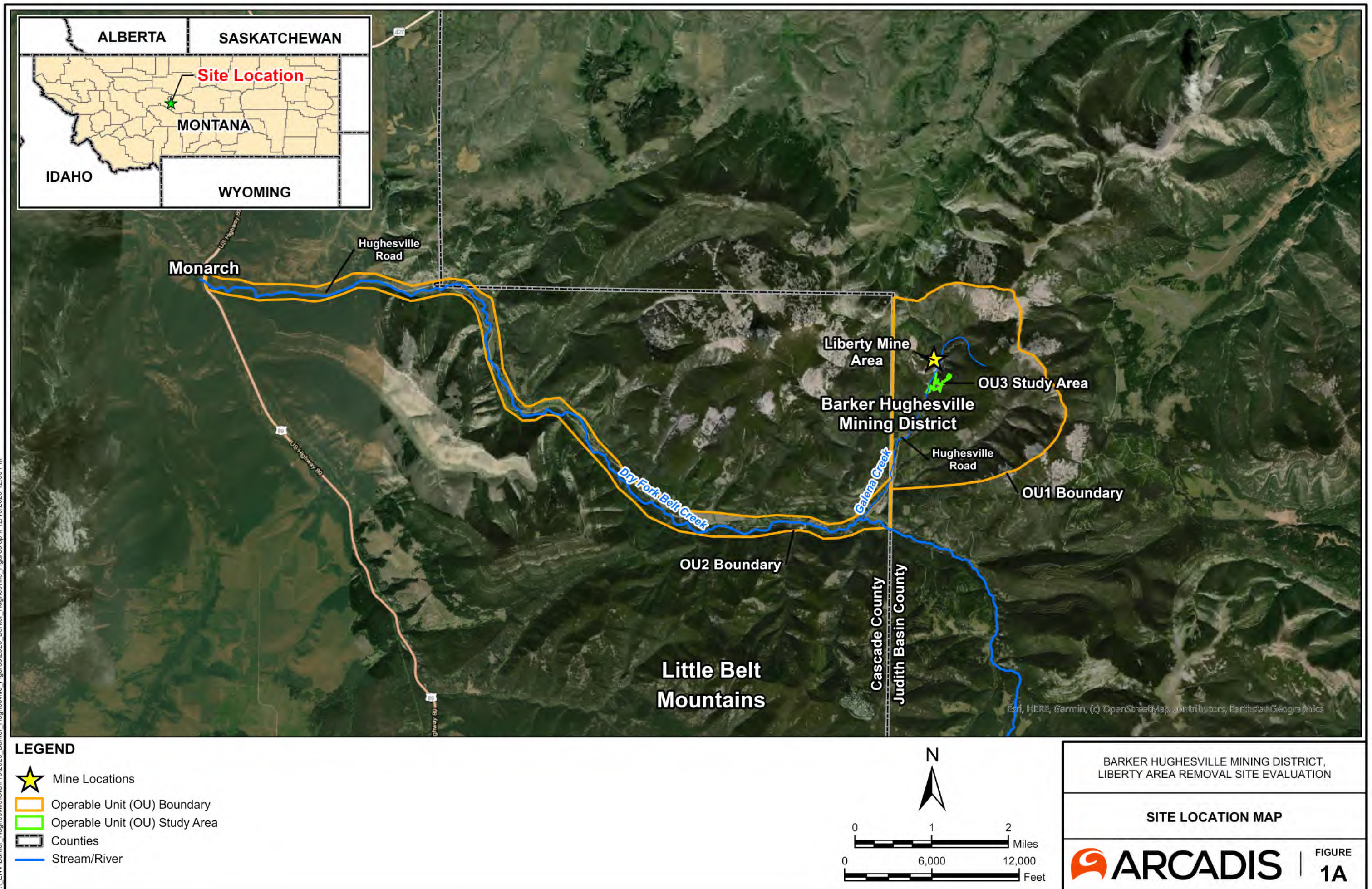
William Cobb Digitally signed by William Cobb
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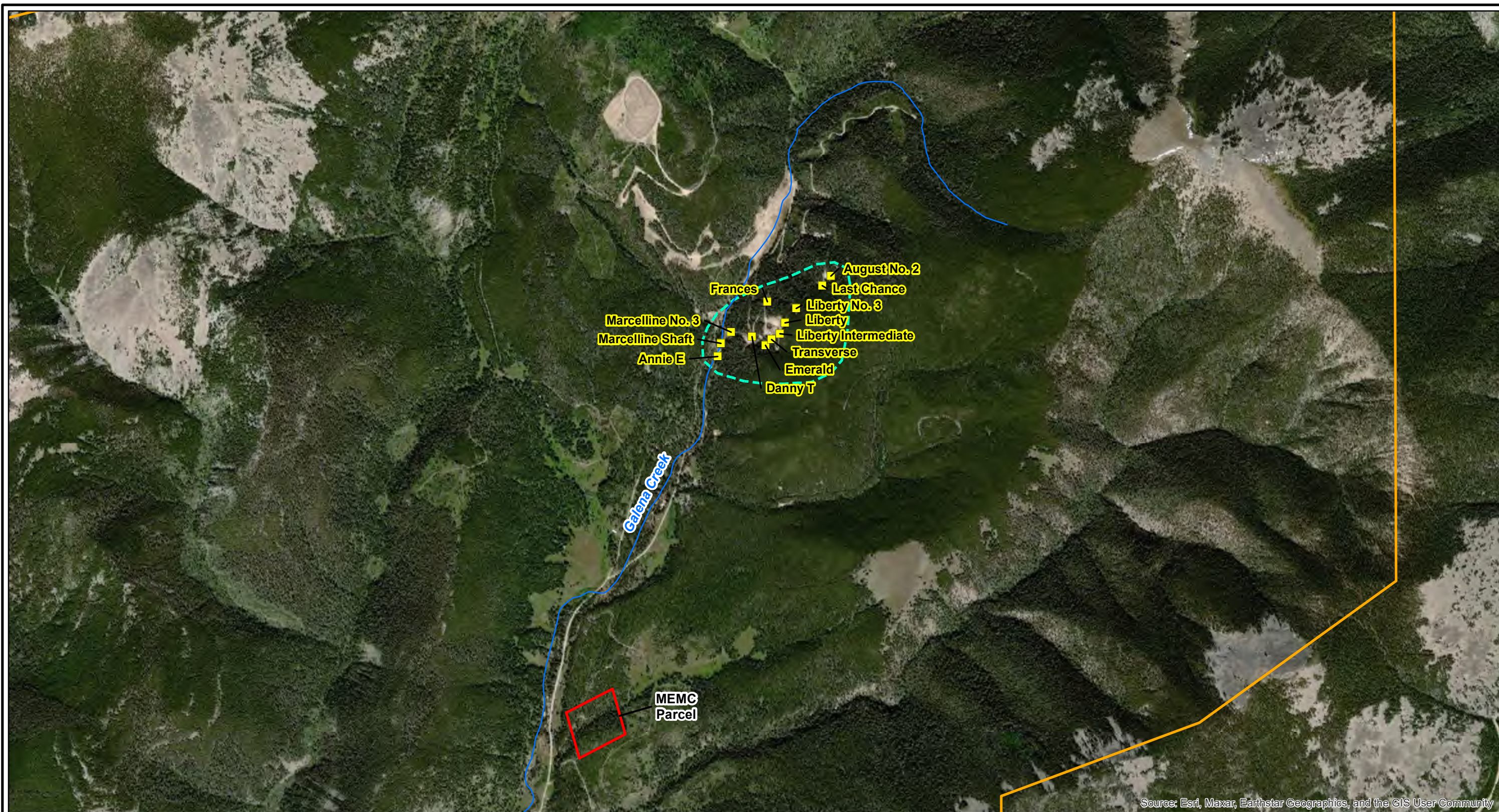
Dated

Name: William Cobb
Title: Vice President

Appendix A

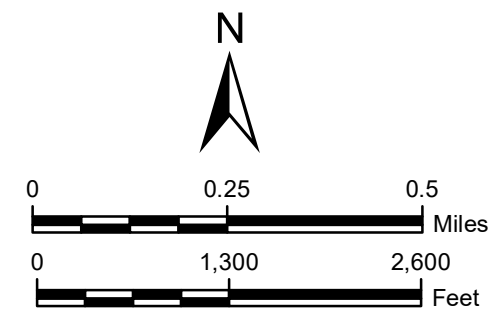
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LEGEND

-  Adit Location
-  Barker Hughesville Mining District
-  Liberty Area
-  Mt. Emmons Mining Company Parcel
-  Stream/River



BARKER HUGHESVILLE MINING DISTRICT,
LIBERTY AREA REMOVAL SITE EVALUATION

LIBERTY MINE AREA



FIGURE
1B

Appendix B

Mt. Emmons Mining Company

Final Liberty Mine Area Engineering Evaluation/Cost Analysis Investigation Work Plan

December 10, 2025

Final Liberty Mine Area Engineering Evaluation/Cost Analysis Work Plan

Prepared By:

Arcadis U.S., Inc.
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Prepared For:

Mt. Emmons Mining Company

Our Ref:

30088505

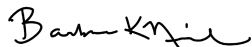
Arcadis U.S., Inc., on behalf of Mt. Emmons Mining Company hereby submits this Work Plan for an Engineering Evaluation/Cost Analysis Investigation for a portion of the Barker Hughesville Mining District Superfund Site pursuant to the terms and conditions of the Administrative Settlement Agreement and Order on Consent for Engineering Evaluation/Cost Analysis Investigation as entered into by the United States Environmental Protection Agency and Mt. Emmons Mining Company.



Prepared by Allen Long, PE
Technical Expert
Arcadis U.S., Inc.



Reviewed by Oscar Sorensen, PMP
Vice President
Arcadis U.S., Inc.



Issued by Barbara Nielsen
Manager, Remediation Projects
Mt. Emmons Mining Company

**Roger
Hoogerheide**

Digitally signed by Roger
Hoogerheide
Date: 2026.02.12 11:45:46
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Approved by Roger Hoogerheide
Remedial Project Manager and Delegated Quality
Assurance Approving Official,
United States Environmental Protection Agency

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Appendices

Appendix A. Quality Assurance Project Plan (QAPP) 2025

Appendix B. Standard Operating Procedures and Technical Guidance Instructions (SOP/TGI)

Appendix C. Site Specific Health, Safety, and Environmental Plan Barker Hughesville and Carpenter-Snow Creek Mining District Cascade and Judith Basin Counties, Montana, 2025

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	11/21/2022		Draft Work Plan Addendum	J. Gilbert
	1	01/25/2023		Work Plan	J. Gilbert
	2	03/09/2023		Revised Work Plan	J. Gilbert
	3	04/24/2023		Revised Work Plan	J. Gilbert
	4	10/17/2025		Revised Work Plan	A. Long
	5	12/10/2025		Revised Work Plan	A. Long

Acronyms and Abbreviations

ABA	Acid Base Accounting
Arcadis	Arcadis U.S., Inc.
ASAO	Administrative Settlement Agreement and Order on Consent
bgs	below ground surface
BHMD	Barker Hughesville Mining District Superfund Site
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	constituent of potential concern
DEQ	Montana Department of Environmental Quality
DQO	Data Quality Objective
EE/CA	Engineering Evaluation/Cost Analysis
GLO	General Land Office
GPS	global positioning system
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IPaC	Information for Planning and Consultation
IQR	interquartile range
JSA	Job Safety Analysis
MEMC	Mt. Emmons Mining Company
MIW	Mine Influenced Water
MNHP	Montana Natural Heritage Program
MS/MSD	Matrix Spike/Matrix Spike Duplicates
MWAM	Montana Wetland Assessment Method
MWMP	Meteoric Water Mobility Procedure
NAD83	North American Datum 1983
NAVD 88	North American Vertical Datum 1988
NCP	National Contingency Plan
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places

Final Liberty Mine Area Engineering Evaluation/Cost Analysis Work Plan

NWI	National Wetlands Inventory
OHWM	ordinary high water mark
OSC	On-Scene Coordinator
OU	Operable Unit
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
RI Report	Remedial Investigation Report
RSL	Regional Screening Level
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
SPT	standard penetration testing
TGI	Technical Guidance Instruction
the Site	Baker Hughesville Mining District Superfund Site
Work Plan	2025 Liberty Mine Area Engineering Evaluation/Cost Analysis Work Plan
UAV	Unmanned Aerial Vehicle
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTL	Upper Tolerance Limits
XRF	X-Ray Fluorescence

1 Introduction

On behalf of Mt. Emmons Mining Company (MEMC), Arcadis U.S., Inc. (Arcadis) prepared this 2025 Liberty Mine Area Engineering Evaluation/Cost Analysis (EE/CA) Work Plan (Work Plan) at the Barker Hughesville Mining District Superfund Site (BHMD; the Site), located in Cascade and Judith Basin Counties, Montana to facilitate data collection and assessment of mine features associated with the Liberty Mine Area (Figure 1A and Figure 1B). The Liberty Mine Area is located in the BHMD and is defined in this Work Plan as operable unit (OU3; Figure 2). This area contains waste rock piles, draining adits, and streamside deposits as well as abandoned and/or collapsed mine adits and dilapidated buildings. Two perennially flowing adits (the Danny T Adit and the Marcelline Shaft) and one rarely flowing adit (the August No. 2 Adit) are also included in the OU3 Area.

2 Mine Background and Setting

Previous investigations, assessments, and characterization have been conducted in the BHMD beginning in the 1960's. This section provides details about the investigative history of the BHMD.

2.1 Site Setting and History

The BHMD is located in the Little Belt Mountains within the Dry Fork Belt Creek Watershed (Figure 1A and Figure 1B). The BHMD currently includes three operable units (OUs): OU1 (Galena Creek), OU2 (Dry Fork Belt Creek), and OU3 (Liberty Mine Area). The BHMD has been explored for silver and lead ore deposits since 1879, and mining of these deposits continued throughout the district until the ores began to be depleted in 1883. Several attempts to restore exploration and mining activity have occurred from the 1930s to the 1980s, including reopening several mines and adits. There has been minimal exploration and mining activity since the 1980s (Remedial Investigation Report [RI Report]; CDM Federal Programs Corporation [CDM] 2016).

Regulatory involvement at the BHMD began in 1965, but site investigation work largely started in the 1990s. The BHMD was formally included on the National Priorities List in 2001 due to risks to public health and the environment stemming from concentrations of hazardous substances associated with unsecured mine waste and mine-impacted waters that exceed regulatory screening levels and/or background concentrations. The site includes more than 45 abandoned mines, mills, and multiple tailings sites, which are scattered across the BHMD. The abandoned mines and mills are primarily located within the OU1 Galena Creek drainage, which feeds into Dry Fork Belt Creek (OU2) (CDM 2016).

OU3 is part of the abandoned mines within the BHMD located in the middle reach of Galena Creek. It has been characterized in the RI Report and informally elsewhere as the Liberty Mine Complex. OU3 consists of multiple waste piles, buildings, load-out structures, and several adits (MEMC 2017).

Two of the mine openings within OU3 (the Danny T Adit and the Marcelline Shaft) have been observed flowing. The Danny T Adit has been observed flowing year-round, while the Marcelline Shaft has only been observed flowing into Galena Creek during spring high flows (i.e., mid-May to mid-July). Water exiting the Danny T Adit reportedly consists of drainage from the upper mine workings including the upper three levels of the Liberty Mine (CDM 2016). The Danny T Adit area consists of a collapsed adit; a debris field in front of the adit; a metal building and a 2-inch, 60-degree V trapezoidal flume. After exiting the adit, the water discharges from a 6-inch polyvinyl chloride pipe placed through collapsed debris in front of the Danny T Adit and passes through the flume. After flowing through

the flume, surface water flows largely unchannelized over a waste rock pile before discharging into Galena Creek during high flows. The discharge infiltrates into the subsurface before reaching Galena Creek during base flows.

The Marcelline Shaft consists of a mine access shaft covered with cultural debris (i.e., a collapsed shaft house). Just above the shaft house is an upper portal as well as a collapsed stope that allows surface water and groundwater to infiltrate into the underground workings. Samples from the Marcelline Shaft are retrieved directly from the standing water in the shaft. Water from the Marcelline Shaft flows over and through a moss mat consisting mainly of copper wire moss from the genus *Pohlia nutans*. During high flow sampling events, there is sufficient flow to collect a sample before it enters Galena Creek.

2.2 Previous Assessments

The first historical regulatory involvement began in 1965 with the State of Montana collecting water samples from both the Galena and Dry Fork Belt Creek drainage areas. This was in response to Montana Fish and Game reports that mine-associated drainage was affecting water quality and fisheries in Dry Fork Belt Creek. Additional investigations were conducted through the Department of State Lands in 1979, but subsequent investigations did not occur until 1990 (CDM 2016)

The following list provides a brief summary of previous district investigations; these investigations and their results are detailed in the RI Report:

- 1991 – Preliminary Site Assessment (State of Montana);
- 1993 to 1995 – Abandoned Mine Site Survey (State of Montana);
- 2001 – Listing on the United State Environmental Protection Agency’s (USEPA’s) National Priorities List;
- 2004 – Agency for Toxic Substance and Disease Registry Health Assessment;
- 2004 and 2005 – Technical Memorandum on Abandoned Mines at Barker-Hughesville (USEPA);
- 2007 – Screening Level Ecological Risk Assessment (USEPA);
- 2008 through 2013 – Block P Mine Complex Removal Evaluation and Oversight (USEPA and Montana Department of Environmental Quality [DEQ]);
- 2010 – Total Maximum Daily Load Development for Belt Creek (DEQ);
- 2009 – 2012 – Semi-annual sampling of BHMD (USEPA); and
- 2010, 2011, and 2012 – Montana Fish Wildlife and Parks Aquatic Testing .
- 2013 – 2024 – Semi-annual sampling (USEPA)
- 2016 – Treatability Study – Remedial Investigation Report – (CDM)
- 2017 – 2019 – Treatability testing of Danny T water (MEMC)
- 2024 – Background, roads and trails sampling and repository siting (HGL)

Information contained in these documents has been used to develop this workplan and will be used in subsequent data reporting. These data are considered non-direct measurements and therefore historical data used in the reporting of this study will be managed in accordance with the project Quality Assurance Project Plan (QAPP) (Appendix A).

2.3 Investigation Objectives

The purpose of this workplan is to provide a dataset of solid media (i.e., waste rock, soils, road fills, sediments and fluvial wastes) and adit water quality, flow rate, cultural and biological surveys, repository and borrow source investigations and sufficient engineering information (i.e. ABA data, geotechnical samples, survey data, etc.). Once completed, this data will compliment historical data collected and will be used to develop and complete an EE/CA for a suite of removal alternatives. Following public review and comment, USEPA will issue an Action Memorandum that will select a set of removal alternatives that addresses both the solid and aqueous source impacted media at OU3.

This Work Plan outlines a study of OU3 with respect to material delineation, as well as identification of site features including support features such as a potential waste rock repository, a borrow source location, and/or identification of potential areas suitable for the construction of a treatment system for treatment of adit water. A provisional location for a mine influenced water (MIW) treatment system is identified near the Liberty Mine Area in front of the Danny T adit. This investigation will consider geochemistry, flows, and local topography to determine dimensions and identify potential constructability considerations for a MIW treatment system. The results of the investigation will be summarized in an EE/CA that summarizes collected data; defines the removal action objectives; evaluates and compares alternatives for solid and aqueous media, and updates cost estimates for each removal alternative. Once an EE/CA has been accepted by USEPA and sufficient time provided to allow for public review and comment, EPA will issue an Action Memorandum selecting the removal alternatives that address impacted media at Liberty Mine Area.

A QAPP has been generated for the work conducted by Arcadis as detailed in this workplan. The 2025 QAPP can be found in Appendix A.

3 Project Management

The responsibilities and contact information for key project personnel are listed in Exhibit 1 and Exhibit 2 below.

3.1 United States Environmental Protection Agency

Mr. Roger Hoogerheide is the USEPA Remedial Project Manager (RPM) for the Barker Hughesville Mining District Superfund Site. Angela Frandsen is a USEPA hydrogeologist for the Barker Hughesville Mining District Superfund Site. The USEPA is the lead agency for OU3 and is responsible for regulatory oversight of the project and coordinates activities with the other regulatory Agencies and stakeholders. The USEPA is the lead agency for OU1 and is responsible for regulatory oversight. The USEPA is the support agency for OU2.

3.2 United States Forest Service

Mr. Steve Opp is the United States Forest Service (USFS) On-Scene Coordinator for the Barker Hughesville Mining District Superfund Site. Ms. Linsey Smith supports Mr. Opp. Ms. Smith and Mr. Opp have the responsibilities on behalf of the USFS on the projects and will provide regulatory coordination and technical guidance to the USEPA. The USFS is the lead agency for OU2 and is responsible for regulatory oversight. The USFS is the support agency for OU1 and OU3.

3.3 Montana Department of Environmental Quality

Ms. Amber Nichols is the DEQ Project Officer for the Barker Hughesville Mining District Superfund Site. Ms. Nichols will represent the state of Montana and has the responsibilities on behalf of the DEQ and will provide technical assistance and regulatory coordination with the USEPA and USFS.

3.4 Mt. Emmons Mining Company

MEMC is responsible for successful completion of the work described and approved in this plan. MEMC will provide project technical guidance and project oversight for the activities conducted under this Work Plan. Mrs. Barbara Nielsen is MEMC's Remediation Projects Manager and primary project contact for this project. Mrs. Nielsen will be assisted by Dr. Leonard Santisteban who is the project Chief Environmental Scientist and will provide technical guidance to the project; and by Mr. Jordan Sisson who is the Project Lead and Technical Advisor and will provide technical guidance to the project.

3.5 Arcadis U.S., Inc.

Arcadis has been contracted by MEMC and will conduct the investigation and prepare the EE/CA as outlined in this Work Plan. The project team for Arcadis consists of Mr. Dylan Davis, Project Manager, who will be the primary contact for project work for Arcadis. Mr. Davis will be assisted by Mrs. Anne Thatcher, a technical expert and lead technical advisor for the project; by Allen Long, PE, a Principal Engineer, and the geotechnical engineering advisor for the project; and by Mr. Todd Church, Geochemist, who is the Project Chemist and will provide geochemical support for the project. Mr. Todd Church will coordinate laboratory analyses and reporting with Amanda Carlson, Project Manager for Energy Laboratories, Inc. of Helena, Montana. Additional project execution support for Arcadis will be provided by Mr. Kyle Spaulding, a Project Geologist and Task Manager. Mr. Spaulding will provide technical planning and execution support for the project. He will be supported by additional Arcadis staff as necessary.

Final Liberty Mine Area Engineering Evaluation/Cost Analysis Work Plan

Exhibit 1 Organizational Chart (Showing Reporting and Communication Lines)

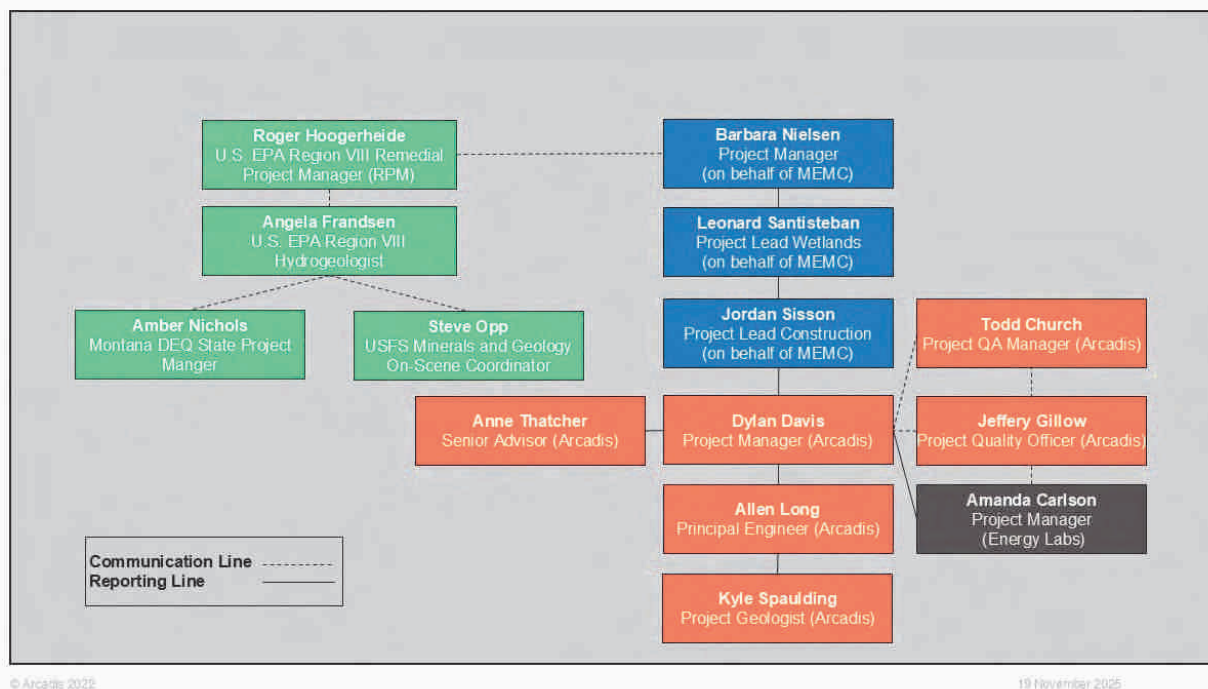


Exhibit 2 Project Personnel Contact

Point of Contact	Title/Responsibility	E-mail Address	Phone Number
Roger Hoogerheide	USEPA Region VIII Remedial Project Manager	hoogerheide.roger@epa.gov	406-457-5031
Angela Frandsen	USEPA Region VIII Hydrogeologist	frandsen.angela@epa.gov	406-457-5032
Steve Opp	USFS On-Scene Coordinator	james.s.opp@usda.gov	406-495-3716
Linsey Smith	USFS Environmental Engineer	linsey.smith@usda.gov	406-566-4005
Amber Nichols	DEQ Project Officer	amber.nichols@mt.gov	406-431-2253
Barb Nielsen	Project Manager (on behalf of MEMC)	bnielsen@fmi.com	602-366-8270
Leonard Santisteban	Project Lead Water Treatment (on behalf of MEMC)	lsantist@fmi.com	520-488-2675

Point of Contact	Title/Responsibility	E-mail Address	Phone Number
Jordan Sisson	Project Lead Construction (on behalf of MEMC)	jsisson@fmi.com	520-437-8678
Dylan Davis	Project Manager (Arcadis)	dylan.davis@arcadis.com	406-519-0155
Anne Thatcher	Senior Technical Advisor (Arcadis)	anne.thatcher@arcadis.com	562-544-6443
Allen Long	Engineer of Record (Arcadis)	allen.long@arcadis.com	724-934-9562
Todd Church	Project Chemist – Technical Support (Arcadis)	todd.church@arcadis.com	315-671-9627
Kyle Spaulding	Project Geologist – Project Task Manager (Arcadis)	kyle.spaulding@arcadis.com	406-422-7722
Jeffrey Gillow	Quality Officer	jeffrey.gillow@arcadis.com	303-330-6866
Amanda Carlson	Project Manager – Geochemical Technical Advisory, Laboratory (Liaison Energy Lab, Helena, MT)	acarlson@energylab.com	406-442-0711

3.6 Project Schedule and Deliverables

The project schedule for this Work Plan will commence in 2026 based on the USEPA's approval to proceed to sample and collect data, as shown in Exhibit 3, which is provided at the end of the text. Note that the project schedule assumes that weather and site entry also permit safe access to site features.

3.7 Distribution List

Electronic copies of this Work Plan, and potential updates that reflect completed work, will be provided to the USEPA Remedial Project Manager by the MEMC Remediation Project Manager. A signed copy of this Work Plan will be provided to the USEPA for filing with the Superfund site file for the Barker Hughesville Mining District Superfund Site at the USEPA office in Helena, Montana.

3.8 Special Training/Certifications

Personnel completing work under this Work Plan will have the necessary training and skills to safely and completely accomplish the work. Arcadis will be responsible for ensuring these trainings are provided using qualified training

personnel. The project team will document that the work is performed by personnel that have current and appropriate training, knowledge, skills and qualifications to perform the work outlined in this Work Plan.

3.9 Field Changes

Though this Work Plan outlines the general field and analytical tasks, it may become necessary to implement modifications to sampling and/or analysis presented herein. Prior to field mobilization, a call will be held with the USEPA and other appropriate stakeholders to confirm that field changes are acceptable to USEPA and how field changes will be documented and document these changes pursuant to the Administrative Settlement Agreement and Order on Consent (ASAOC). If a situation is encountered where significant changes to the planned work are to be implemented, the USEPA Remedial Project Manager will be notified and a verbal and written approval will be obtained prior to implementation of changes. These changes will be documented in the Final Report pursuant to the ASAOC.

4 Sampling Program, Rationale and Locations

This section describes the field sampling protocols to be followed for solid media and adit water characterization as well as the general protocols for aquatic resource and biological surveys, cultural resource records review, geotechnical sampling, background sampling, survey data, and repository/borrow source area investigations. Field sampling protocols will follow industry methods and best practices. Data validation will be performed on appropriate samples in accordance with the QAPP. Note that access agreements for access to private and National Forest System land are needed prior to the commencement of field work. MEMC will be responsible for contacting landowners and acquiring access.

4.1 Data Quality Objectives

The Data Quality Objectives (DQOs) process comprises the following seven steps, briefly described from the USEPA guidance (USEPA 2006a).

2. **State the problem.** Concisely describe the problem to be studied. Review previous studies and existing information to gain a sufficient understanding to define the problem. Identify the planning team members including the decision-makers. For each data gap category, present the problem statement. Planning team members and decision-makers are the same for each data collection activity.
3. **Identify the goals of the study.** State how environmental data will be used in meeting objectives and solving the problem, identify study questions, define alternative outcomes.
4. **Identify the information inputs.** Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.
5. **Define the boundaries of the study.** Specify the time periods and spatial boundaries to which decisions will apply. Determine when and where data should be collected. Define the target population of interest.
6. **Develop the analytic approach.** Define the statistical parameter of interest, specify the screening level and Derived Concentration Guideline Level and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions. Define an “if... then...” statement.

7. **Specify performance or acceptance criteria.** Define the decision-makers' tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.
8. **Develop the plan for obtaining data.** Evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all DQOs.

Details associated with Steps 1 through 7 of the overall Work Plan DQOs are presented sequentially in this section.

4.1.1 State the Problem (DQO Step 1)

The Site is a historic mining district composed of more than 45 abandoned mines, waste rock dumps, fluvial mine waste deposits, impacted soils, millsites, road fills, and tailing sites contained within the Galena Creek Watershed. OU3 is located within the middle of the Galena Creek watershed and represents several collapsed mine adits and associated waste rockpiles and fluvial deposits. It is generally located between the August No. 2 Adit to the north and the Annie E. Adit to the south (Figure 1B). The RI Report identified solid media (waste rock) in this area as containing metals above background concentrations, including arsenic, lead, manganese, and thallium (CDM 2016). In addition, the Liberty Mine Area contains at least two known mine discharges: the Danny T Adit and the Marcelline Shaft. The potential for flow from August No. 2 adit exists but will be field verified. Water emanating from these adits typically has a pH lower than neutral and contains metals, primarily aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc. While the RI Report and subsequent investigations include a characterization-level assessment of solid media and adit water from the Liberty Mine Area, additional data collection will be used to supplement the assessment of potential removal alternatives.

The primary purpose of this Work Plan is to further determine the possible extent of the chemical impact in solid and aqueous source media and to achieve the following objectives:

- Further delineate the horizontal and vertical extent of impacted solid media at OU3 by characterizing the surface and subsurface solid media at sufficient depth to confirm the presence or absence of impacts based on native background solid media concentrations and regional screening levels and provide volumetric estimates that can be used for assessing potential removal alternatives.
- Establish background levels based on the host geology and surficial soil types that directly represent OU3 that the solid media (waste rock piles) are sourced from.
- Provide additional geochemical information on draining adit water to support the geochemical assessment, loading calculations, and estimate of passive treatment alternatives.
- Provide continuous flow monitoring where safe and reasonable to implement. Design and level of effort will be considered before implementation. Continuous flow data will be collected for one year using a data logger and downloaded during periodic site visits or at the end of the one-year period at a minimum.
- Expand the desktop assessment as well as field assessment of additional locations not considered by USEPA's contractor within the Dry Fork Belt Creek Watershed that may be conducive to repository construction and/or borrow material as part of solid media removal alternatives.
- Conduct a desktop review and field survey for potential aquatic, biological, and cultural resources to provide additional information necessary for assessment of removal alternatives.

4.1.2 Identify the Goals of the Study (DQO Step 2)

To meet the objectives, the following fundamental questions will need to be answered during the investigation:

Fundamental Questions	Alternative Actions
What is the extent of impacted solid media within OU3 with respect to volume and metals impact in the soil?	If impact above background and Regional Screening Levels for solid media is detected, the extent of the impact will be evaluated as part of the planning for potential future removal action.
Is there chemical impact present in the solid media?	If impact above background and Regional Screening Levels for solid media is detected, the extent of the impact will be evaluated as part of the planning for potential removal action.
Is the quantity and geochemistry of draining adit water impacted and, if so, is the quantity of water conducive to passive treatment alternatives?	The impact in draining adit water will be evaluated in terms of both geochemistry and flow. These data will be used to determine the dimensions of treatment alternatives.
Is a provisionally identified location suitable for a near-site repository location?	The MEMC and other appropriate parcels located on public and private lands will be characterized as both a potential repository location and a borrow source. These locations will be assessed for geotechnical suitability as well as proximity to other area features. Results of the characterization will be used to determine whether a potential repository site is suitable or unsuitable for consideration and thus whether it is an appropriate parcel for facilitating on site disposal of solid media and removal action substrate.
Are there sensitive aquatic resources cultural resources and available habitats within OU3 and the repository and borrow areas that are potentially suitable for federal and state listed threatened or endangered species?	Wetlands and non-wetland waters within OU3 and the repository and borrow areas will be delineated. Wetland functional assessments will be completed for the wetlands identified during the aquatic resource delineation survey to determine a baseline functional value in the event that they are impacted by future removal action activities. Reconnaissance-level baseline surveys to inventory plant species (including special-status plants and noxious weeds) and classify vegetation and habitat types. Available habitats will be further evaluated to determine if they are potentially suitable for federal and state listed threatened or endangered species. An archaeological background research of the Liberty Mine Area and any repository or borrow locations as well as everything within a 1-mile buffer will also be conducted. Depending on the results of the background research and whether the area has been previously documented to a high standard within the last 10 years, an in-person review to document cultural features may be conducted.

4.1.3 Identify Information Inputs (DQO Step 3)

The following inputs are required to answer the fundamental questions identified in Step 2 above:

- Review the historical data from previous investigations including the data from the RI Report and data from the recent monitoring memoranda completed by Arcadis and USEPA's contractors. Historical data will be combined with new data collected in accordance with this Work Plan to provide an overall summary dataset.
- Determine the locations where data gaps exist and may require further delineation for impacted soils by reviewing the historical data.
- Obtain metals data for all background samples and potential impacted surface and subsurface solid media (waste rock, road fills, fluvial deposits and nearby background soils) within OU3. Impacted solid media will be

determined in the field based on observations and XRF screening. Additionally, 50 percent of the solid media samples will be analyzed for Acid Base Accounting (ABA), Synthetic Precipitation Leaching Procedure (SPLP), and Meteoric Water Mobility Procedure (MWMP) testing. Geotechnical samples will also be collected for index parameter testing (e.g., grain size) and limited shear strength testing (e.g., direct shear) to provide baseline data to support removal alternative design. Carbonate (inorganic carbon) and sulfur forms will also be collected in waste rock samples as they are critical for predicting and managing the potential for Acid Mine Drainage.

- Use site observations and geochemical data to define impacted geographic areas. Areas of impacted solid media will be assessed against a topographic survey to calculate likely volumes of impacted material.
- Obtain flow data and inorganic geochemical samples from the Danny T Adit, Marcelline Shaft, and August No. 2 areas to support alternative removal evaluation.
- Aquatic resources and biological surveys will evaluate biological condition data; physical habitat data; reference conditions and existing stressor information. The cultural resources records review provides crucial background information on known historic properties and the potential for encountering new ones. Key informational inputs include location and descriptions of previously recorded archaeological sites, historic buildings and structures, and districts as well as areas of potential effect where a project could have an effect on cultural resources.

The specific preliminary constituents of potential concern (preliminary constituents of potential concern [COPCs]) for waste rock, as identified in the RI Report (CDM 2016), are as follow:

- Arsenic;
- Cadmium;
- Copper;
- Lead;
- Manganese;
- Thallium; and
- Zinc.

The specific preliminary COPCs for adit water identified in Danny T Adit and Marcelline Shaft water (total and/or dissolved concentrations) are as follows:

- Aluminum;
- Arsenic;
- Beryllium
- Cadmium;
- Cobalt
- Copper;
- Iron;
- Lead;
- Manganese;
- Thallium; and
- Zinc.

This list of preliminary COPCs was chosen because these constituents have been detected in solid media and/or adit discharge samples near the Liberty Mine Area at concentrations above risk-based screening levels. These COPCs are expected to be collocated with areas of historical mining activities. The preliminary COPCs will be evaluated by an USEPA-certified analytical laboratory analysis in accordance with USEPA Standard Methods and subject to the data validation requirements of the QAPP.

The analytical methods that will be used for the laboratory analysis of COPCs are identified in Table 1 and Table 2 and the Work Plan QAPP (Appendix A).

4.1.4 Define the Boundaries of the Study (DQO Step 4)

The proposed boundary of OU3 is defined in Figure 2.

The following four types of analysis will be performed on waste rock samples:

- Waste rock and soils (including streamside deposits) – metals, ABA, SPLP and MWMP analyses on 50 percent of collected metals samples as well as two geotechnical samples collected for index properties and shear strength at each waste rock location. Carbonate (inorganic carbon) and sulfur forms will also be collected in waste rock samples as they are critical for predicting and managing the potential for Acid Mine Drainage.
- Waste rock samples will be collected from the 0 to 6-inch depth interval and a 6 to 24-inch depth interval. Additional depth samples may be collected based on the observed depth of waste rock during test pit excavation.
- Soil samples will be collected at locations adjacent to and beyond visual extent identified waste rock areas using XRF as described in Section 5.1.2.
- A single surface water grab sample will be collected from flows emanating from the Danny T Adit and Marcelline Shaft in June 2026 (Exhibit 3). If August No. 2 indicates outflow, this will be sampled as well.
- Standard quality assurance practices also dictate duplicates and various blanks.
- These samples will be analyzed for metals, major ions, and select inorganic physiochemical parameters (i.e., pH, and specific conductivity). Continuous flow data, including pH, temperature and specific conductivity, will be collected from the mine features using an on-site flume with data logging capabilities. The system will be battery powered and the data will be downloaded quarterly or as weather conditions permit.

The following types of analysis will be performed on background samples:

- All samples will be sieved in the field and office and analyzed for TAL metals

The following types of analyses will be performed on repository and borrow source samples:

- Samples will be analyzed for index classification testing (Unified Soil Classification System [USCS] Soil Classification including gradation, Atterberg limits, and moisture content) as well as for characterization metals analysis similar to the background sample locations described above. Table 3 of the workplan details specific ASTM International standard testing methods for the considered repository analyses.

Practical constraints and obstacles may impede the sampling and interfere with the planned data collection. For example, the weather conditions at the Site may prevent collecting samples as scheduled. Also, the geological and physical conditions encountered at the sampling locations may interfere with the collection of a desired sample. If these conditions exist, it may be necessary to adjust the sampling schedule and possibly choose alternate sampling locations. Also, laboratory data may not meet the quality assurance criteria or reporting limit criteria, and it may be necessary to re-sample locations. However, adhering to the data measurement objectives (DQO Step 6) will help mitigate these risks. Any deviations from this Work Plan will be documented in the Final Report.

4.1.5 Develop the Analytic Approach (DQO Step 5)

The purpose of this step is to integrate the outputs from the previous steps into a statement that defines the conditions that would cause the decision-maker to choose among alternative actions. The following primary decision rules will be used to answer the fundamental questions:

- The nature and extent of the impacts will be evaluated.
- Solid and aqueous media will be characterized to determine potential risks, proximity to surface water, and/or assessing potential alternative actions.
 - Analytical sampling performed to support background levels and waste rock characterization will be subject to quality controls (e.g., data validation, duplicates, matrix spikes, etc.) identified in the QAPP
 - All other sampling (e.g., treatability [ABA], leachability [SPLP and MMWP], geotechnical parameters, agronomics, aquatic resources, flow rates, and survey data to support engineering evaluations and cost estimates are not subject to the quality controls in the QAPP

The parameters of interest are the absolute concentrations and the mean concentrations of each preliminary COPC in each survey area defined as Annie E Waste Area, August No. 2 Waste Area, Danny T Waste Area, Liberty Waste Area, Last Chance Waste Area, Liberty Intermediate Waste Area, Liberty No. 3 Waste Area, Marceline Waste Area, and Transverse Waste Area (Figure 1B). The primary alternative hypothesis will be that the concentrations or mean concentrations of the measured preliminary COPCs are significantly greater than comparison levels as defined below. The null hypothesis will be that the concentrations or mean concentrations of the measured preliminary COPCs are less than or equal to the comparison levels. To reject the null hypothesis analyses of collected samples will be used to assess the concentration of COPCs with respect to comparison levels.

In order to develop the decision rules to evaluate the null and alternative hypotheses, comparison levels must be used to evaluate the preliminary COPC concentrations. For the purposes of this study, background soil concentrations established at locations in this assessment will be used as comparison values for solid media. The Montana Water Quality Standards Groundwater Human Health Standard will be used as comparison values for SPLP and MWMP metals/metalloids (USEPA 2019; Table 1) collected from waste rock. Adit surface water analytical results will be compared to the Montana Water Quality Standards Acute and Chronic Aquatic Life Benchmarks and Human Health Standards for Surface Water for total and dissolved metals/metalloids (MDEQ 2019; Table 5). In addition, a local background area will be sampled to identify background soils near OU3. The background locations are shown on Figure 2 and will be field-verified that the sample locations are not disturbed by previous mining.

Prior to calculating background levels, the dataset will be evaluated for statistical outliers using a three-step process. First, potential outliers will be identified by visual inspection of graphical representations of the data (i.e., probability plots, time-series charts, and/or box-and-whisker plots). Second, datasets will be tested for normality using Shapiro-Wilks test. If the dataset is normally distributed (or can be normalized by transformation), then a statistical outlier test will be used. If the dataset cannot be normalized, then Tukey's interquartile range (IQR) test will be used. Lastly,

the potential outliers will be tested using a quantitative outlier test (i.e., Dixon's Test, Rosner's Test) at five percent significance or Tukey's IQR test. Identified statistical outliers will be investigated and explanations for data outliers (e.g., data quality issues, data recording errors) will be documented before an outlier is removed.

Upper Tolerance Limits (UTLs) are the USEPA recommended interval estimator statistic to be used for establishing background levels (USEPA 2002a, 2009, 2022b). The UTL 95-95 represents the statistic such that 95 percent of observations (current and future) from the target population will be less than or equal to the UTL 95-95 with a coverage coefficient of 0.95. The UTL 95-95 represents the 95% upper confidence limit of the 95th percentile of the population distribution (USEPA 2022b). If the dataset includes five or more detected values, the UTL 95-95 will be calculated using USEPA ProUCL 5.2 (USEPA 2022b). If the dataset includes less than five detected values, the maximum detected value will be used to represent background. If the dataset is entirely comprised of non-detect values, the maximum detection limit will be used to represent background.

The maximum of the established background levels and the previously mentioned screening levels (USEPA Region 9 RSLs) will be used as a comparison level for determining extent of the waste rock piles and associated impacted areas.

Comparison levels (maximum of screening levels and background as outlined above) are not cleanup goals but are established concentrations that are risk-based and/or are recommended concentrations based on state or federal guidance. These comparison levels therefore may not be appropriate cleanup levels. The selected comparison levels constitute initial guidelines, not final cleanup goals, and were used to guide the DQO process. Subsequent comparison levels will be developed during the removal action process.

4.1.6 Develop Performance or Acceptance Criteria (DQO Step 6)

This step specifies the decision-maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in environmental data. These acceptable limits on decision errors allow decision-makers to generate resource-effective sampling designs while limiting uncertainties in the collected data.

In general, collected analytical data will be evaluated in accordance with this QAPP for precision, accuracy, representativeness, completeness, comparability, and sensitivity. Reviewed data deemed usable by the validation process will be considered acceptable.

4.1.7 Develop the Detailed Plan for Obtaining Information (DQO Step 7)

The objective of this section is to develop the process for collection and measurement of the decision inputs. The sampling program was designed to support the individual DQOs identified with each type of data need. In addition, the sampling design was developed to meet the tolerance criteria outlined in the previous section. Sampling procedures and methods of collection for site media (soil/sediment/water) will follow Arcadis' SOPs listed as TGIs in Appendix B.

The consequence of the decision error will need to be balanced against the cost of limiting the possibility of these errors. These errors will be managed using precise and accurate analytical methods and a number of samples along with duplicate samples. Samples will need to be collected to minimize a false rejection decision error and to minimize the risk of not identifying solid and aqueous media that contain metals at concentrations greater than

screening criteria. The approach to overcoming the large number of samples is to minimize duplication and unnecessary samples by evaluating the existing data, field visit observations, historical photographs, physical setting, documented past practice, and process history. However, the approach to overcoming the risk is to systematically perform sampling, even in areas where the impacts may not be present.

Primary solid media samples (waste rock) will be collected after waste rock piles have been identified. Samples will be collected from test pits excavated into waste rock piles following SOP guidance in Appendix B (specifically, SOP for Test Pits/Test Trenches and TGI for Soil Drilling and Sample Collection). Shallow soil samples will be collected generally by hand excavation from areas adjacent to the waste rock piles or fluvial/sediment deposits in proximity to Galena Creek following the aforementioned SOP in Appendix B. A minimum of one test pit and a maximum of three test pits per survey area will be excavated. A minimum of two samples will be collected from each test pit (Figure 2). Collected sample data from test pits will be combined with composite sample data from the RI Report to provide an overall characterization and delineation of each identified area.

Soil sample locations will be selected to delineate the horizontal and vertical characteristics of the solid media (e.g., waste rock, soils, road fills, sediments and fluvial wastes) and potentially impacted areas.

In addition to flow monitoring data that will be downloaded from an onsite datalogger, the adit water will be collected via grab samples utilizing SOP guidelines listed in Appendix B (TGI for Surface Water Sample Collection). The Danny T Adit and Marcelline Shaft have been monitored in the RI Report, by MEMC (2017) by Arcadis (2022) and by TechLaw (2017, 2018, 2019, 2022, 2023, 2024). Surface water samples have also been collected from GC-30 (upgradient) and GC-20 (downgradient) of OU3. Samples have been collected routinely in both high- and low- flow time periods; therefore, an established characterization dataset exists. Sampling data collected in this investigation will supplement the overall existing dataset.

To minimize unacceptable errors, laboratory analyses with a high degree of confidence and extensive quality assurance/quality control and documentation procedures will need to be employed. Therefore, National Environmental Accreditation Conference certified Energy Labs will be employed.

4.2 Project Task Summary

The following summary provides a brief description of the primary technical tasks associated with delineation of site features and determination and summary of findings for the Liberty Mine Area as outlined this Work Plan. These tasks are discussed in detail in Section 5. Results of the tasks identified below will be provided in an EE/CA and/or Final Report following completion of tasks.

This Work Plan includes the elements of a Sampling and Analysis Plan and a Field Sampling Plan, and includes a QAPP. This Work Plan has been developed in general accordance with the USEPA's Requirements for Quality Assurance Project Plans, EPA QA/R-5 (USEPA 2001), and is generally consistent with the National Contingency Plan, and includes data elements required in USEPA's Region 8 Quality Assurance Document Review Crosswalk, Guidance for Quality Assurance Project Plans (QA/G-5), EPA/240/R-02/009 (USEPA 2001, 2002b), Guidance for Quality Assurance Project Plans (QA/R-5) EPA/240/B-01/003 (USEPA 2006b), and Uniform Federal Policy for Quality Assurance Project Plans, Parts 1-3, EPA/505/B-04/900A-900C (USEPA 2005).

All quality documents shall meet the requirements defined by the Environmental Information Quality Policy CIO 2105 and Environmental Information Quality Procedure CIO 2105-P-01. A UFP-QAPP shall be developed for any activities involving environmental information operations. The prepared QAPP shall follow the UFP-QAPP format. EPA-505-B-04-900A, *Uniform Federal Policy for Quality Assurance Project Plans*, Version 1, March 2005. Part 2A

(revised): *Optimized UFP-QAPP worksheets* – March 2012 and Part 2B *Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities* available at <https://www.epa.gov/fedfac/uniform-federal-policy-quality-assurance-project-plans-training-materials> were referred to in the development of the UFP-QAPP.

Sampling and analysis will be focused within OU3. Defensibility of data obtained during the investigation will be ensured by following the USEPA-approved sample collection protocols in the field and laboratory, including the use of USEPA-approved analytical methods conducted by a USEPA certified commercial laboratory (Appendix A and B).

4.2.1 Task 1 – Solid Media Sampling

Solid media in OU3 (i.e., waste rock, soils, road fills, fluvial deposits and/or in stream sediments) will be delineated and characterized; material extents may include the west side of Galena Creek from below Block P excavation area to near the Annie E Adit (Figure 2). To complete this task, field work will be conducted to assess and delineate solid media within OU3 and provide updated volumetric estimates and geotechnical and geochemical characterization of materials that will be included in the site characterization section of the EE/CA.

4.2.2 Task 2 – Topographic Survey

Initially, a topographic survey will be conducted of the OU3 area to outline extents of solid materials and provide detailed topographic information to support volumetric calculations. Upon selection of a borrow source and repository area, an additional topographic survey will be performed in these areas. Each topographical survey will be performed by aerial drone to collect both LiDAR topographic data as well as aerial photography. A property boundary survey will also be performed in the OU3 area, identified borrow source(s), repository location(s), and/or potential treatment system location(s).

4.2.3 Task 3 – Mine Water Characterization and Sampling

Two mine openings are known to periodically discharge water to the ground surface near OU3: the Danny T Adit and the Marcelline Shaft. As part of the field investigation, water emanating from the Danny T Adit, the Marcelline Shaft, and the August No. 2 Adit (if flowing) will be sampled, and their flows will have continuous monitoring using an onsite datalogger and pH/SC/T logger (if possible) to provide updated outflow measurements and water quality information. This data will be added to previous water quality datasets (e.g., RI Report data, TechLaw and MEMC collected data) and summarized.

4.2.4 Task 4 – Aquatic Resource and Biological Surveys

To identify sensitive aquatic resources, Arcadis will delineate wetlands and non-wetland waters within OU3 and the repository and borrow areas. Wetland functional assessments will be completed for the wetlands identified during the aquatic resource delineation survey to determine a baseline functional value in the event that they are impacted by future removal action activities.

Within OU3 and the repository and borrow areas, Arcadis will also conduct reconnaissance-level baseline surveys to inventory plant species (including special-status plants and noxious weeds) and classify vegetation and habitat types. Available habitats within the areas of survey will be further evaluated to determine if they are potentially suitable for federal and state listed threatened or endangered species.

4.2.5 Task 5 – State Historic Preservation Office Records Search

A records search will be conducted through the State of Montana State Historic Preservation Office (SHPO) to determine if nearby site features have been reported and documented. The site characterization section of the EE/CA will either provide a summary of what is present (if it has not been previously documented) or provide an update to the site condition (if features have been previously documented). An Inadvertent Discovery Plan (less than 1 page) will be prepared that outlines steps to be taken if cultural resources are uncovered during field activities.

4.2.6 Task 6 – Repository Siting Evaluation

To support the development of removal alternatives and/or revised engineering cost estimates, Arcadis will assess a nearby identified parcel of land (Mount Emmons Mining Claim – MEMC parcel, Figure 3) that may be used for a repository (if required) and/or borrow source. An alternative location on National Forest System lands will also be assessed in the field for possible repository siting (Figure 4). This investigation will include up to approximately 1 test pit excavation per acre within the proposed repository area. Temporary piezometers, with at least one installed with a continuous logging transducer, will be installed in approximately 20% of the test pit locations and monitored for shallow groundwater levels.

4.2.7 Task 7 – Borrow Source Investigation

Arcadis will also assess an MEMC parcel (MEMC parcel – Figure 3) as well as areas that are near OU3 for potential borrow source location. Field investigations will coincide with the repository field investigation. This investigation will include up to approximately 1 test pit excavation per acre within the proposed borrow area(s) to determine depth, consistency, and suitability of materials for use as a cover and/or liner material. Temporary piezometers will be installed in approximately 20% of the test pit locations and monitored for shallow groundwater levels.

4.2.8 Task 8 – Treatment System Siting Analysis

Prior to commencing field work, Arcadis will use approximated dimensions to conduct a desktop study using topography to determine a potential location for a treatment system. Following the identification of the treatment system area and consultation with the regulatory agencies and landowner, a site visit will ground truth the potential treatment system location with respect to topography, stormwater, proximity to waste rock, or other site features.

Once field work is completed, MEMC and Arcadis will assess the treatment system dimensions and operation design based on measured flow rates, landowner consultation and anticipated aqueous geochemistry from the Danny T Adit, Marcelline Shaft, and August No.2 if flowing. A preliminary geochemical assessment and loading analysis will be completed to determine the likely influent considerations into the treatment system as well as to determine likely treatment system size and potential media needs.

Results of both the treatment system siting analysis and the site visit will be incorporated into the EE/CA. Consideration of the Marcelline Shaft, which is located down gradient of the proposed treatment system location, will be given. Specifically, the ability to pump and/or store water in the event of power failure will be evaluated.

5 Methods and Procedures

Section 5 describes the methods and procedures that will be followed during the execution of tasks under this Work Plan. This includes field data collection sampling and analysis, surveys (including desktop surveys as necessary) are outlined below.

Tasks outlined below will be completed under the guidance of Arcadis and MEMC technical advisors and will be coordinated by the Arcadis Project Manager. The project work will follow TGIs as well as the project QAPP as appropriate. Technical procedures including instrumentation calibration and maintenance, equipment decontamination, management of wastes, and sample labeling and tracking are included in the project QAPP (Appendix A). The project QAPP is included in Appendix A, SOPs/TGIs are included in Appendix B and the Health Safety and Environmental Plan is included in Appendix C. Prior to the commencement of tasks, the project team will meet and review the Work Plan, QAPP, Health Safety and Environmental Plan, and SOPs/TGIs.

5.1 Solid Media Sampling

5.1.1 Background Soil Sampling

Background levels will be established based on the host geology and surficial soil types that directly represent OU3 that the solid media (waste rock, soils, road fills, sediments and fluvial wastes) are sourced from. This can be referenced from Figure 2.5 - 1 of the 2016 Remedial Investigation Report (CDM 2016) and Figure 2.1 of the 2024 Field Sampling Plan for the Background Soil Sample Investigation (HGL, 2024), indicating the primary geologic source for waste rock within OU3 consists of the Hughesville Stock and Mixes Baldy – Anderson Peak Laccolith. These units are both igneous intrusive complexes. Background sampling will be targeted within this geologic zone with the consideration of the current United States Department of Agriculture (USDA) surface soil taxonomy classification (Figure 2). The local soil type (for solid media samples) for OU3 that would best represent background concentrations is the USDA Soil Taxonomy Type 2268F (USDA 2023).

Up to twelve confirmation background sample locations of unimpacted solid media (soil) will be identified and sampled based on observed site conditions and proximity to the impacted solid media (i.e., upgradient from waste rock site), the absence of mine features, an assessment of established soil horizons, and general accessibility. These samples will be collected from 0 to 6 inches in depth. Approximate proposed locations are provided on Figure 2.

A 5-point composite sample approach will be used and will be sampled in accordance with Arcadis TGI – Soil Drilling and Sample Collection (Appendix B). The following general procedure will be performed:

1. Locate the planned sample location using a resource-grade GPS device or an iPad.
2. Establish a center subsample point based on the planned location, and mark the location (e.g., with a pin flag). Inspect the sample and subsample locations and surrounding area for signs of mine waste or past mining activities and adjust the location to the nearest undisturbed area in the immediate vicinity of the planned sample location.
3. Establish 4 peripheral subsample locations approximately 20 ft north, 20 ft south, 20 ft east, and 20 ft west of the center point and mark these locations. Confirm the subsample locations are also on undisturbed areas.

4. Remove surface debris (sticks, stones, duff, snow, sod), or other vegetation from each subsample location.
5. Excavate small pits at each of the five subsample locations using decontaminated hand tools (shovel, spade, trowel, or similar implements) that is rinsed and cleaned between each composite or disposable scoops. Place excavated soil in a pile for backfilling.
6. Collect a 0- to 0.5-ft sample aliquot from each pit by scraping material from the pit sidewalls and placing the material in a zip top bag. Remove and discard loose vegetation, detritus, and large rocks by hand during sample collection.
7. Screen the soil through a disposable #10 screen to remove soil larger than 2 millimeters as the soil is added to the sample bag. Collect approximately equal volumes of soil from each subsample location, to provide a minimum total composite volume of approximately 0.6 to 1.0 gallons (2 to 4 kilograms).
8. Thoroughly homogenize the composite sample inside the zip top bag after all five subsamples have been collected by mechanical agitation with the disposal scoop, hand mixing and turning the bag multiple times until the contents are well mixed and visually homogenous.
9. Complete field sample collection forms, photograph the sample location, and record GPS coordinates (latitude and longitude) of the center point.
10. Backfill subsample locations.
11. Decontaminate reusable soil sampling equipment between composites, if used, as described in Section 6.
12. Transport the sample to the field office for further sieving.
13. In the field office, the soil will be allowed to air dry and will then be sieved through a #100 screen to remove particles larger than 150 micrometers. This final total sieved volume will be placed back into the zip top mixing bag.
14. If using a sample jar, use a scoop to collect a sample from the mixing bag and place it in the soil sample jar using light hand pressure until the jar is filled with 8 ounces of sieved soil for laboratory analysis.
15. If using a zip top bag, ensure the sample bag is filled with 8 ounces of sieved soil for laboratory analysis and place the labeled zip top bag in a second zip top bag.
16. As soon as feasible, place the soil sample in a cooler with ice to achieve an approximate sample temperature of 4 ± 2 degrees Celsius.
17. Decontaminate reusable soil sieving equipment as described in Section 6.

All samples will be stored on ice in coolers and transported to the laboratory for analysis of TAL metals in accordance with the QAPP (Appendix A).

5.1.2 Waste Rock Sampling

Solid media samples will be collected from the identified waste rock piles in OU3 as well as fluvial deposits in stream sediment, road fills and from the surrounding native soils. In general, soil samples will be collected from test pits either hand-excavated or excavated using mechanical means (i.e., backhoe or small excavator). Composite samples will be collected at each test pit from 0 to 6 inches and 6 to 24 inches, and greater than 24 inches (if warranted) below ground surface. Each composite sample will consist of 5 aliquots to provide a representative sample.

An additional opportunistic depth sample may be collected to determine the total waste rock depth, and/or to determine the potential for leaching from waste rock into underlying soils. Up to 10 opportunistic samples may be collected; at least three of these samples will be collected from underlying soils or regolith to assess the potential for leaching. Associated quality control samples will be collected at an interval of 5 percent as outlined in the QAPP (Appendix A). Sample locations pertaining to type and locale have been tabulated in Table 3.

For waste rock and tailing piles, the location will first be identified in the field and a perimeter established based on field observations. Field observations include but are not limited to an assessment of established soils, observations of discoloration of soil, mineralogy, presence of cultural debris, and/or pile geometry with respect to other mine features or native soils.

The general methods of establishing the extent of sampling are:

1. Establish a perimeter. A perimeter will be delineated using concentration scan information from X-Ray Fluorescence (XRF) analyses within guidelines of the USEPA SW-846 Test Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment. The XRF will be used to identify areas where the waste rock COPCs are detected and elevated. Waste perimeters and sampling locations will be determined based on the initial field scanning using the XRF. The XRF will be used to scan areas where solid media samples will be collected in-situ. Up to five locations around the downslope edges of waste pile or lateral edge of the fluvial deposit will be screened using XRF. Each XRF location will be prepared as follows:
 - Make sure the sample location is not saturated with water and especially standing water.
 - Remove any large or non-representative debris from the soil surface before analysis. This debris includes larger rocks, leaves, vegetation, roots, and concrete.
 - Make the soil surface as smooth as possible so that the XRF meter window has good contact with the soil surface without damaging the XRF window. This may require some leveling of the surface with a stainless-steel trowel.
 - Additional technical guidance is listed in Appendix B -TGI for Screening Soil for Metals with Portable X-Ray Fluorescence Analyzer.

For each XRF location that exhibits concentrations above 80% target analytes comparison levels for lead and zinc [(as defined by the higher of background values or USEPA Region 9 RSLs (Table 4)], an additional XRF location will be screened 5 feet outward (i.e., away from the pile). This process will be repeated until XRF results are below 80% target analytes comparison levels. Outer exterior locations that exhibit concentrations below 80% of target analytes comparison levels will be sampled and tested via laboratory analysis as representing unimpacted material to confirm the boundary of the waste pile or fluvial deposit. Because the XRF will only be used as a field-guidance tool to inform sampling activities scan results will not be submitted in reporting documentation. The use of the field XRF analyzer will follow manufacturer instructions and generally use the Screening Soil for Metals with Portable X-Ray Fluorescence Analyzer (Appendix B). Each XRF location will be demarked using pin-flags and by collecting global positioning system (GPS) data using a mapping grade GPS unit (sub-meter accuracy). If timing allows, the perimeter will later be surveyed during survey operations.

2. Inside the perimeter, the area will be divided into halves if the general diameter is less than 100 feet. If a pile is observed to be 20 feet or less in diameter, a single test pit location will be sampled. If the solid media pile is larger than 100 feet in diameter, the pile will be divided into thirds. Test pit samples will be located in the centers of the pile divisions. Test pits will be excavated using mechanical methods (e.g., tracked excavator) from the identified test pit locations. If access is limited, test pits may be hand-dug. Excavation implements – excavator, shovels will be used to excavate test pits, however samples will be collected from test pit sidewalls that will be scraped using disposable sampling equipment. If test pit sample locations are deeper than 24-inches, a volume of material will be retrieved using the excavator and a sample will be collected from within that volume.
3. Solid media composite samples will be collected from up to three different vertical horizons in the test pits: 0 to 6 inches, 6 to 24 inches, and greater than 24 inches. Samples from deeper than 24 inches will be

collected at the base of the observed impacted solid media if warranted. A field duplicate sample not associated with the geotechnical sampling, will be collected for every 20 solid media samples collected. Additionally, up to two geotechnical samples will be collected for each solid media pile (up to 20 total).

4. Composite soil samples will also be collected from an adjacent soil; a soil sample will be collected from each of four cardinal locations around the pile at a single depth interval (0 to 6 inches), composited, and analyzed for reference to test pit location sampling. The field XRF analyzer will be used to guide the soil sample locations with respect to identified solid media as outlined above.

The geologic strata of each test pit will be logged by an Arcadis geologist for standard geologic and geotechnical parameters including textural properties, grain size, sorting, color, mineralogy, and other characteristics. Specific geotechnical laboratory testing include:

- Moisture content (ASTM 2216)
- Grain size analysis – no hydrometer (ASTM D6913)
- Atterberg limits (ASTM D4318)
- USCS classification (ASTM D2487)
- Remolded direct shear (ASTM D3080)
- Standard proctor (ASTM D698)

Following test pit logging and sampling, test pits will be backfilled using removed solid media and compacted using the excavator. Test pit excavation, soil characterization and sampling will be conducted under specific SOP/TGI's as listed in Appendix B (SOP Test Pit Excavation).

5.1.3 Deep Waste Rock Sampling and Geotechnical Analysis

In addition to the test pit samples discussed above, soil borings will be advanced within the OU3 area for two intended purposes:

1. Vertically delineate the extent of waste rock in areas where waste rock depths may exceed the reach of an excavator; and
2. Provide geotechnical data as input into a future slope stability analysis.

Proposed soil boring locations are shown on Figure 2. Nine soil borings will be advanced via hollow stem augers with standard penetration testing (SPT) sampling. Actual drilling depths will vary based on geology (e.g., depth to bedrock) but the following depths are estimated:

- Seven soil borings advanced to 15 feet below ground surface (bgs) or auger refusal
- Two soil borings advanced to 60 feet bgs or auger refusal

Samples will be collected continuously (every 2 feet) for first 10 feet and then once every 5 feet thereafter.

Soil boring locations within waste rock areas will be analyzed using XRF. The deepest sample that exceeds 80% target analytes comparison levels for lead and zinc will be logged and noted as such. The next underlying sample will be sent for analytical laboratory analysis on metals. This sample is intended to confirm vertical delineation of the waste rock.

Soil boring locations outside waste rock areas will not be analyzed using XRF and are intended for geotechnical purposes only. These soil borings are intended to provide input into a future slope stability analysis, which is necessary due to potential design implications from the steep slopes.

Samples in all soil borings will be tested for the geotechnical laboratory testing described in the previous section, with the exception of direct shear testing, which will not be performed in these samples.

5.2 Laboratory Analysis

Solid media samples collected will be analyzed by a laboratory for a characterization suite of metals, inorganic chemistry, geotechnical index properties, and shear strength. Additionally, 50 percent of the solid media samples will be analyzed for ABA, total and dissolved leachable metals under short-term kinetic (SPLP and MWMP) preparation methods to characterize the leachability of waste rock and streamside deposits. Carbonate (inorganic carbon) and sulfur forms will also be collected in waste rock samples as they are critical for predicting and managing the potential for Acid Mine Drainage. Native background soil samples will be analyzed for a characterization suite of metals only. Proposed analytical methods for soils are presented in Table 1. Associated Laboratory quality control samples (Field Duplicates, and Matrix Spike/Matrix Spike Duplicates [MS/MSD]) will be collected in accordance with the QAPP (Appendix A).

5.3 Topographic Survey

Initially, a topographic survey will be conducted of the OU3 area to outline extents of solid materials and provide detailed topographic information to support volumetric calculations. Upon identification of a borrow source and repository area, an additional topographic survey will be performed in these areas. Each topographical survey will be performed by an unmanned aerial vehicle (UAV) to collect both LiDAR topographic data as well as aerial photography. The UAV will be operated by a licensed UAV pilot. Results of the survey will be provided in North American Datum 1983 (NAD83) – Montana State Plan system (horizontal) and North American Vertical Datum 1988 (NAVD 88). A LiDAR / DEM (Digital Elevation Model) Accuracy Report will be prepared and submitted with the survey results.

A property boundary survey will also be performed in the OU3 area, identified borrow source(s), repository location(s), and/or potential treatment system location(s).

The location and elevation of each test pit will be surveyed using a survey-grade GPS unit, with sub-meter accuracy. The sampling crew will place a stake in the center of the backfilled test pit location and will mark the measuring point on any installed piezometers. Survey data collected will include the sample station identifier latitude, longitude, and elevation.

5.4 Mine Water Characterization and Sampling

5.4.1 Methods

Field monitoring and sampling of the Danny T Adit, Marcelline Shaft, and August No. 2 Adit (if flowing) will include the collection of continuous flow monitoring using an onsite datalogger for a period of one year in addition to the collection of aqueous samples from the adits. The Danny T Adit has an existing fiberglass trapezoidal flume for continuous flow monitoring, a precipitation gauge (previously installed), and a PVC pipe for facilitating sample collection. A grab sample will be collected from the Danny T Adit flow, which typically flows at approximately 5 gallons per minute from a discharge pipe installed in the collapsed adit portal.

In addition to the observations and monitoring at the Danny T Adit, an aqueous sample will be collected from the Marcelline Shaft, which typically only flows during high-flow events. If any potential outflow occurs from August No.2, aqueous samples will be collected accordingly. Given the recent collapse of the shaft house, the area will be assessed to determine the safest way to collect water in the shaft throughout the year. If the adit shaft is observed flowing, flow monitoring data will be collected using a portable flume, visual observation, and/or a volumetric method (e.g., bucket-and-stopwatch method). In order to obtain accurate flow measurements, a generalized point of outflow from the adit or shaft itself will be targeted to ensure accuracy and avoid any interference from surrounding overland sheet flow.

5.4.2 Laboratory Analysis

A single grab sample will be collected from the Danny T outfall pipe and from the Marcelline Shaft for inorganic constituent analyses (Table 5). Field water quality parameters, including pH, temperature, oxidation-reduction potential, conductivity, and dissolved oxygen, will be measured at the time of sample collection following the procedures from the TGI Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Appendix B – TGI - Surface Water Sample Collection).

The Danny T outfall pipe location allows for the collection of adit water directly into laboratory-supplied bottles. For adit water collected for dissolved analyses, surface water will be filtered on site at the time of collection from 1-liter polyethylene bottles using a 0.45-micron field filter and peristaltic pump. The field duplicate sample will be collected using the same method. It is anticipated that one field duplicate and one MS/MSD sample will be collected (Appendix A). All samples will be field preserved in accordance with the above mentioned TGI.

5.5 Aquatic Resource and Biological Surveys

5.5.1 Aquatic Resource Delineation

Before performing the aquatic resource delineation, Arcadis will conduct a desktop assessment to identify potential aquatic resources within the survey area and build an understanding of the ecology, land use, and general physiography in the surrounding region. The following datasets will be reviewed as part of the desktop assessment:

- Aerial imagery (ESRI, Google Earth);
- Federal Emergency Management Agency (FEMA) National Flood Hazard Layer Dataset (NFHL);
- Natural Resources Conservation Service (NRCS) Web Soil Survey;
- U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI);
- U.S. Geological Survey (USGS) 7.5 Minute Topographic Maps;
- Hydraulic Analysis and Floodplain Mapping Report (Tetra Tech, 2025);
- BHMD OU1 floodplain and aquatic resource delineation (HGL, pending);
- USGS National Hydrography Dataset (NHD) Flowlines and Waterbodies; and
- USGS Watershed Boundary Dataset (WBD) Hydrologic Unit Code 8 (HUC-8) Subbasins.

Digital data collected during the desktop assessment will be migrated to field GPS units using the ArcGIS Field Maps application to facilitate field delineation and verification of aquatic resources.

Field staff will complete an aquatic resource delineation survey in accordance with the multi-parameter approach (hydrophytic vegetation, hydric soils, and wetland hydrology) described in the U.S. Army Corps of Engineers (USACE) Wetlands Delineation Manual (Environmental Laboratory 1987) and the 2010 USACE Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0; Environmental Laboratory 2010). Field staff will also follow SOP guidance for wetlands included in Appendix B (Aquatic Resource Delineation and Assessment).

Arcadis will collect data to evaluate the presence of wetlands in locations that visually exhibit surface indicators of potential wetland characteristics (e.g., presence of potentially hydrophytic vegetation indicative of wetlands, hydrology indicators present at the surface, or depressional areas exhibiting different characteristics from the surrounding uplands) and/or were included as an aquatic feature on NWI maps. The 2022 Western Mountains, Valleys, and Coast Regional Wetland Plant List (USACE 2023) will be used to determine the wetland indicator status for plant species. Data points and wetland boundaries will be mapped in the field using a GPS unit capable of submeter accuracy.

For non-wetland waters, the ordinary high water mark (OHWM) will be mapped based on conditions observed using the National Ordinary High Water Mark Field Delineation Manual for Rivers and Streams (Final Version) (USACE 2025) and the OHWM Regulatory Guidance Letter No. 05-05 (USACE 2005). Field staff will also adhere to the SOP guidance for non-wetland waters included in Appendix B (Aquatic Resource Delineation and Assessment). Field personnel will collect data to delineate the OHWM in channelized areas that exhibit one or more OHWM indicators as observed during the field survey. OHWM indicators will be mapped in the field using a GPS unit capable of submeter accuracy. Field staff will also follow SOP guidance for wetland functional assessment included in Appendix B (Aquatic Resource Delineation and Assessment).

Streams will be classified as perennial, intermittent, or ephemeral features, and the length of stream within the areas of survey will be determined. Each aquatic resource will also be classified using Classification of Wetlands and Deepwater Habitats of the United States (Cowardin Classification; Cowardin et al. 1979).

Erosional features (i.e., gullies) will be documented during the aquatic resource delineation survey to identify areas of channelized runoff and inform surface water management for reclamation and design.

Aerial imagery, digital topographic maps, field observations, and desktop resources will be used to establish channelized surface connections outside of the areas of survey to determine connectivity to other aquatic resources.

5.5.2 Wetland Functional Assessments

Wetland functional assessments will be completed for the wetlands identified during the aquatic resource delineation survey to determine a baseline functional value in the event that they are impacted by removal action activities. The Montana Wetland Assessment Method (MWAM; Berglund and McEldowney 2008) will be used to assess the function and value of wetlands within the areas of survey. Field staff will also follow SOP guidance for wetland functional assessment included in Appendix B (Aquatic Resource Delineation and Assessment).

5.5.3 Biological Surveys

Arcadis will conduct reconnaissance-level baseline surveys to inventory plant species (including special-status species plants and noxious weeds), classify vegetation and habitat types, and evaluate potential suitable habitat for federal and state listed species within the Liberty Mine Area and the repository and borrow areas.

Current USFWS and Montana Natural Heritage Program (MNHP) lists for special status plants were reviewed. One species, whitebark pine (*Pinus albicaulis*), is a federally threatened species in Judith Basin County according to the USFWS Information for Planning and Consultation (IPaC) Official Species List (USFWS 2025). Eight state-listed species of concern were identified by the MNHP that are known to occur or have the potential to occur in Judith Basin County (MNHP 2025a): musk-root (*Adoxa moschatellina*), short-styled columbine (*Aquilegia brevistyla*), long-styled thistle (*Cirsium longistylum*), marsh thistle (*Equisetum palustre*), meadow horsetail (*Equisetum pratense*), matted prickly-phlox (*Leptodactylon caespitosum*), Platte cinquefoil (*Potentilla plattensis*), and northern rattlesnake plantain (*Goodyera repens*). Biologists will review suitable habitat for these species and document those habitats within the areas of survey, as well as document occurrences as part of the plant species inventory; however, no species-specific surveys will be completed.

Current MNHP state and county lists for noxious weeds will be reviewed to aid in identifying and mapping distributions within the areas of survey. A noxious weed survey will be performed concurrent with aquatic resource and biological surveys. During field surveys, biologists will document areas of infestation of state and county listed noxious weeds. The following categories will be used to classify the estimated size of each infestation: individuals, less than 0.5 acre, 1 acre, greater than 1 acre, and scattered throughout. A preliminary review of state and county noxious weed lists identified 46 state listed species, of which 16 are located within Judith Basin County, and one county listed (yellow mignonette [*Reseda lutea*]) species (MNHP 2025b).

The United States Fish and Wildlife Service (USFWS) IPaC Official Species List identified three federally threatened wildlife species: the Canada lynx (*Lynx canadensis*), grizzly bear (*Ursus arctos horribilis*), and the North American wolverine (*Gulo gulo luscus*); and two proposed threatened species: the monarch butterfly (*Danaus plexippus*) and Suckley's cuckoo bumble bee (*Bombus suckleyi*) with potential to occur within or near the areas of survey (USFWS 2025). The MNHP identified 63 state wildlife species of concern with potential to occur in Judith Basin County. Species-specific surveys will not be completed; however, direct observations of wildlife, including federal and state listed species, will be recorded, and potential suitable habitat for listed species within the areas of survey will be documented.

5.6 State Historic Preservation Office – Records Search

To comply with the National Historic Preservation Act (NHPA), Arcadis must conduct archaeological background research of the project area as well as everything within a 1-mile buffer (altogether, this comprises the Records Search Area). Arcadis will first request records from the Montana SHPO to identify any previously recorded cultural resources in the Records Search Area. Arcadis will also review other pertinent resources in the Records Search Area including the National Register of Historic Places (NRHP), the Montana State Historic Register, General Land Office (GLO) plats, GLO land patents, historical USGS topographic maps, and historical aerial photographs. Arcadis will review all these records to determine the adequacy of previous documentation.

Depending on the results of the background research, Arcadis will conduct a review of the project area. Note, the amount of the project area subject to in-person review depends on several factors such as land jurisdiction. If identified cultural features in the project area have been previously documented to a high standard within the last 10 years, an Arcadis archaeologist will visit the Site to confirm the previous documentation's adequacy. However, if the previous documentation (if any) of any cultural resources is inadequate, Arcadis will conduct an unknown amount of survey and documentation to document cultural resources and evaluate them for the NRHP. What cultural resources must be preserved will hinge on this evaluation and subsequent consultation with the USFS and Montana SHPO. Any cultural resources (e.g., archaeological sites, historic buildings, mining features) deemed

eligible for the NRHP would have to be avoided or mitigated before the commencement of project work. An Inadvertent Discovery Plan (less than 1 page) will be prepared that outlines steps to be taken if cultural resources are uncovered during field activities.

5.7 Repository Siting Evaluation

Arcadis will complete a desktop repository siting analysis of the Galena Creek and Upper Dry Fork Belt Creek watersheds using a Geographic Information System as well as onsite observations to screen a list of criteria to identify areas where a potential repository may be suitable. Although Arcadis will perform their own desktop evaluation, previous findings by the USEPA (HGL, 2025) will be utilized. Desktop identified areas will then be ground-truth assessed and combined with other tasks outlined in this Work Plan (e.g., borrow source area sampling, field observations of subsurface water during test pits, etc.) to further determine suitability. Criteria included in the analysis will include:

- Available Area
- Slope
- Available Capacity
- Groundwater Concerns
- Surface Water Concerns
- Geotechnical Concerns
- Geochemistry Concerns
- Suitable Soils
- Potential Borrow Source
- Land Ownership
- Accessibility
- Haul Distance
- Distance from Residences
- Visibility
- Short-Term Impacts
- Human Health and Safety
- Environmental Protectiveness
- Feasibility
- Cost

In addition, Arcadis and MEMC have identified the MEMC parcel (Figure 3) and USFS parcel (Figure 4) as potential locations for both a local repository for solid media and a potential borrow source for repository and/or other on-site removal alternatives.

Arcadis has completed a site reconnaissance and provisional desktop survey of the MEMC parcel (Figure 3). In general, the area may include suitable areas for a potential repository as well as for borrow material. Although the topography is variable, several areas are relatively flat (i.e., have slopes less than 10 percent). An unnamed creek flows through the central portion of the parcel, however, there appears to be sufficient space within the parcel to

remain outside of the creek valley. The northern portion of property is accessible by an existing road and appears to be an appropriate size to accommodate a repository, staging location, and/or borrow source. Access agreements will be obtained to allow crossing into MEMC-owned property.

The MEMC and USFS parcels and up to two alternative suitable repositories identified in the desktop analysis above will be located in the field and repository perimeters will be identified and surveyed. Test pits will be advanced within an identified repository area and logged by an Arcadis geologist to determine the presence of historical debris, native soils, and/or other materials that may or may not be conducive to repository construction.

Arcadis will collect up to 18 bulk samples that will be analyzed for geotechnical and geochemical material properties Table 3. Temporary piezometers will be installed in test pit locations and monitored for shallow groundwater levels. At least one piezometer will be installed to a depth applicable to monitor groundwater conditions near potential repository locations on any potential repository locations.

5.8 Repository Sampling and Analysis

Samples collected from selected locations in the Liberty Mine Area and from the MEMC parcel will be analyzed for index classification testing (Unified Soil Classification System [USCS] Soil Classification including gradation, Atterberg limits, and moisture content) as well as for characterization metals analysis similar to the background sample locations described above. Table 3 details specific ASTM International standard testing methods for the considered repository analyses. One bulk sample per location will be collected from test pits.

5.9 Borrow Source Investigation

The MEMC parcel is of sufficient size such that a potential borrow source area that may be used as backfill for excavated area and/or cover material during construction may exist. The MEMC parcel may be considered for this purpose is discussed in previous sections, shown on Figure 3. Representative samples will be collected and analyzed for geotechnical material properties (e.g., USCS soil classification, moisture content, Atterberg limits, remolded direct shear, specific gravity, standard proctor) and constituent analysis (e.g., total metals/metalloids and agronomic parameters, Table 3). Test pits will be logged by an Arcadis geologist to determine the presence of historical debris, native soils, and/or other materials that may or may not be conducive to repository construction. One bulk sample per test pit will be collected.

6 Decontamination

All equipment brought to the Site will be inspected for weeds/debris and decontaminated prior to arrival to avoid contamination of the investigation areas. Dirty or contaminated equipment will be sent off-site for decontamination and will be re-inspected to verify cleanliness before allowing use at the Site.

In general, disposable sampling equipment will be used to collect samples. All disposable sampling equipment will be disposed in accordance with Arcadis TGI - investigation-derived waste handling and storage. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If solid media samples are collected using reusable equipment; soil sampling equipment will be cleaned and decontaminated prior to use at each composite/location. Non-disposable sampling equipment, such as trowels and shovels will be decontaminated as follows:

- Wash the equipment in low- or non-phosphate detergent (e.g., Alconox® or Liqui-Nox® solutions made as directed by the manufacturer).
- Rinse twice with potable water.
- Rinse once with de-ionized or distilled water.
- Handle rinse water as Investigation Derived Waste (IDW).

To minimize water volume used in decontamination of equipment, as an alternate procedure disposable paper towels can be used to wipe the soil sampling equipment. If samples are collected directly from the excavator bucket, the excavator bucket will be cleaned with wet towels prior to collecting each soil sample. Rinsate samples will be collected from any non-disposable and re-used equipment.

Large sampling equipment (excavators, backhoes, drill rigs, trucks, and trailers, etc.) will have gross soil debris removed through mechanical means (shovels or stiff bristle brushes) and will be power washed as necessary before moving to a new investigation area. This decontamination step is required to prevent foreign material and noxious weeds from being transported between areas. The same procedures used for decontamination between investigation areas will be used during final decontamination.

Additional details on decontamination procedures are provided in associated task TGIs as well as in the Water and Soil Sampling TGI (Appendix B).

7 Investigation Derived Waste

Generation of Investigation Derived Waste (IDW), including equipment decontamination wastewater, rinsate, soil cuttings, sample containers, and personal protective equipment (PPE), is expected to be minimal. Soil cuttings will be returned to the excavation once work at each location is complete.

Decontamination wastewater, rinsate, sample containers, and PPE will be characterized as needed and shipped to an off-site facility for analytical testing, in accordance with Section 121(d)(3) of CERCLA, 40 C.F.R. § 300.440, EPA's Guide to Management of Investigation Derived Waste (OSWER 9345.3-03FS, Jan. 1992), and any IDW-specific requirements outlined in the Work Plan. <https://semspub.epa.gov/work/03/136166.pdf>.

8 Data Validation, Evaluation and Usability

Upon receipt of the laboratory data reports, the data described below will undergo the data validation process by Arcadis.

- Analytical sampling performed to support background levels and waste rock characterization will be subject to quality controls (e.g., data validation, duplicates, matrix spikes, etc.) identified in the QAPP
- All other sampling (e.g., treatability [ABA], leachability [SPLP and MMWP], geotechnical parameters, agronomics, aquatic resources, flow rates, and survey data to support engineering evaluations and cost estimates are not subject to the quality controls in the QAPP

The validation team will conduct, at a minimum, 20 percent validation on Level 2A laboratory data reports (Tier II) for each analytical parameter from the laboratory in accordance with the QAPP (Appendix A).

Validated and acceptable field data collected outlined in this plan will be documented in Final Report pursuant to the ASAO.

9 Health and Safety

Arcadis has developed a site-specific Health, Safety and Environmental Plan (HSEP) in Appendix C to guide field activities and mitigate hazards associated with identified safety and health risks. Job Safety Analyses (JSAs) have been developed and appended to the HSEP. The HSEP meets the requirements of 29 C.F.R. § 910.120 for developing the HASP, that describes all activities to be performed to protect on-site personnel and area residents from physical, chemical, biological and all other hazards related to performance of Work under this Work Plan. This HSEP was prepared in accordance with *EPA's Emergency Responder Health and Safety Manual*, OSWER 9285.3-12 (July 2005 and updates), available on the Agency's website at <https://www.epaossc.org/HealthSafetyManual/manual-index.htm>. In addition, the Respondent has ensured that the HSEP complies with all currently applicable Occupational Safety and Health Administration ("OSHA") regulations found at 29 C.F.R. part 1910.

10 Community Involvement

The following community involvement activities will be performed during the implementation of the investigation activities.

10.1 Impact Mitigation

The following potential community area impacts are identified in the EPA's Superfund Community Involvement Handbook (USEPA 2020): air emissions, dust, odor, traffic, noise, temporary relocation, negative economic effects. These will be mitigated as described below, however, given the remoteness of the Site, most mitigation efforts will be minimal.

- Air emissions – Field vehicles will generally be limited to a drill rig, small excavator and small support pickup trucks. Air emissions from such few vehicles is not anticipated to impact any community areas.
- Dust – Dust production during test pitting and drilling activities is not anticipated to be sufficient enough to impact community areas. Vehicular traffic along the gravel service roads would produce temporary dust while traversing but these roads will only be traversed a handful of times each day such that the dust production is minimal.
- Fire – All vehicles will be limited to non-vegetated areas (e.g., dirt/gravel roads) and equipped with fire extinguishers. In addition, a water truck will be parked near working activities and available to spray water on a fire that may occur. Water for the truck will be collected off-site from a permitted facility.
- Odor – No odor is anticipated as a result of investigation activities.
- Noise – Noise created from drilling activities, especially during standard penetration test drilling, could be a nuisance to anyone nearby. To minimize disturbance, drilling activities will be limited to normal business hours (7 am to 5 pm). Noise from test pitting and vehicles is not anticipated to be sufficient enough to impact community areas.
- Temporary relocation – No temporary relocation activities will occur as part of the investigation activities.
- Negative economic effects – Given the relatively small nature of field activities and limited impact to community areas, no negative economic effects are anticipated. Conversely, field staff will require lodging and meals, which will provide a small economic benefit to the community areas.

- Traffic – Appropriate traffic control measures will be implemented. These may include the use of traffic cones, warning signs, barricades and flaggers. Coordination with municipal or state transportation agencies will be conducted as necessary to ensure compliance with local regulations.

10.2 Monitoring

Given the anticipated minimal impact to community areas, monitoring will be limited to visual dust monitoring. If dust plumes are observed leaving the site, dust control measures will be implemented. These may include watering or shutting down field activities.

10.3 Communicate Validated Sampling Data

Upon completion of data validation, the sampling data will be tabulated and compared to comparison levels. After USEPA approval, sampling and monitoring data should be submitted in a format that allows for input into USEPA's Scribe database. In addition, any geospatial, computer-aided design and drafting or any other non-standard (e.g., boring logs) drawings or figures will be submitted electronically to USEPA as part of the Final Report. The tables, laboratory data reports and data validation reports will be provided in a format that allows USEPA to post on the BHMD Site Profile Page.

10.4 Implementation Adjustments

Adjustments to the implementation of the Work Plan will be made to reduce negative impacts to affected community areas. Such adjustments may include revision of working hours or implementation of dust control measures.

11 Reporting

11.1 Progress Reports

Written progress reports will be submitted monthly and will describe all significant developments during the preceding reporting period, including the actions performed and any problems encountered, analytical data received during the reporting period, and the developments anticipated during the next reporting period, including a schedule of actions to be performed, anticipated problems, and planned resolutions of past or anticipated problems. In addition to written progress reports, upon request of the RPM, MEMC shall coordinate conference calls to include USEPA, the State, USFS and their respective contractors to discuss MEMC's implementation of the Work Plan.

11.2 EE/CA

An EE/CA will be prepared after data collection, data validation, and desktop analyses have been completed following EPA's *Guidance on Conducting Non Time Critical Removal Actions Under CERCLA* (EPA 1993). The EE/CA will include the following, but will not be limited to:

- Site characterization
- Identification of removal action objectives
- Identification of removal action alternatives
- Analysis of removal action alternative using selection criteria (effectiveness, implementability, cost)
- Comparative analysis of removal action alternatives
- Recommended removal action alternative

11.3 Final Report

Upon completion of all work defined within this Work Plan a final report will be submitted. The final report must summarize the actions taken to comply with the ASAOC; conform to the requirements of section 300.165 of the National Contingency Plan (NCP) ("OSC Reports"); and include all relevant documentation generated during the Work (e.g., manifests, invoices, bills, contracts, and permits) and an estimate of the total costs incurred to complete the Work. The final report will also include the raw data, data validation reports, completeness assessments usability assessment, logs, pictures, etc. as well as the following certification signed by a responsible corporate official of Arcadis:

"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."

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Exhibit 3 – Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors	1st Quarter	F	M	2nd Quarter	A	M	J	3rd Quarter	J	A	S	4th Quarter	O	N	D	1st Quarter	J
1	Workplan Preparation (Ongoing)																					
2	Task 1: Solid Media Sampling	85 days	Mon 5/4/26	Fri 8/28/26																		
3	Background Sampling	60 days	Mon 5/4/26	Fri 7/24/26																		
4	Collection of background samples from area extents	10 days	Mon 5/4/26	Fri 5/15/26																		
5	Laboratory testing	20 days	Mon 5/18/26	Fri 6/12/26	4																	
6	Statistical analysis	5 days	Mon 6/15/26	Fri 6/19/26	5																	
7	Soil Media Sampling	55 days	Mon 6/15/26	Fri 8/28/26																		
8	Waste rock delineation/sampling	5 days	Mon 6/15/26	Fri 6/19/26																		
9	Soil sampling	5 days	Mon 6/22/26	Fri 6/26/26	8																	
10	Road fills	5 days	Mon 6/29/26	Fri 7/3/26	9																	
11	Sediment sampling	5 days	Mon 7/6/26	Fri 7/10/26	10																	
12	Fluvial wash sampling	5 days	Mon 7/13/26	Fri 7/17/26	11																	
13	Solid media sample analysis and data validation	30 days	Mon 7/20/26	Fri 8/28/26	12																	
14	Task 2: Topographic Survey	95 days	Mon 3/2/26	Fri 7/10/26																		
15	Access agreement coordination	22 days	Mon 3/2/26	Tue 3/31/26																		
16	Conduct topographic survey of OU3	5 days	Mon 6/1/26	Fri 6/5/26	15																	
17	Conduct topographic survey of identified borrow area(s)	5 days	Mon 6/8/26	Fri 6/12/26	16																	
18	Conduct topographic survey of repository area(s)	5 days	Mon 6/15/26	Fri 6/19/26	17																	
19	Conduct property boundary survey in OU-3, selected borrow area(s), selected repository area(s), and potential BTS siting location	5 days	Mon 6/22/26	Fri 6/26/26	18																	
20	Task 3: Adit Water Characterization and Sampling	60 days	Mon 6/1/26	Fri 8/21/26																		
21	Collect samples from Danny T Adit, Marcelline Shaft, and August No. 2 Adit (if flowing)	5 days	Mon 6/1/26	Fri 6/5/26																		
22	Maintain and install additional data loggers to monitor water	55 days	Mon 6/8/26	Fri 8/21/26																		
23	Installation of continuous flow meter in Danny T adit	5 days	Mon 6/8/26	Fri 6/12/26	21																	
24	Installation of continuous flow meter in Marcelline adit	5 days	Mon 6/15/26	Fri 6/19/26	23																	
25	Installation of continuous flow meter in August No 2 adit	5 days	Mon 6/22/26	Fri 6/26/26	24																	

Project: BH_2026

Date: Fri 9/26/25

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only

External Tasks

External Milestone

Deadline

Progress

Manual Progress

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ID	Task Name	Duration	Start	Finish	Predecessors	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter
26	Water sample analysis and data validation	40 days	Mon 6/29/26	Fri 8/21/26	25					
27	Task 4: Aquatic Resource and Biological Surveys	150 days	Mon 2/2/26	Fri 8/28/26						
28	Desktop biological assessment	15 days	Mon 2/2/26	Fri 2/20/26						
29	Access agreement coordination	22 days	Mon 3/2/26	Tue 3/31/26						
30	Wetland delineation of OU3, repository and borrow areas	65 days	Mon 6/1/26	Fri 8/28/26						
31	Baseline biological survey	15 days	Mon 6/1/26	Fri 6/19/26						
32	Identify available habitats	5 days	Mon 6/1/26	Fri 6/5/26						
33	Plant species identification	5 days	Mon 6/8/26	Fri 6/12/26	32					
34	Habitat identification	5 days	Mon 6/15/26	Fri 6/19/26	33					
35	Task 5: State Historic Preservation Office Records Search	90 days	Mon 2/2/26	Fri 6/5/26						
36	Request records from Montana SH	20 days	Mon 2/2/26	Fri 2/27/26						
37	Conduct records search for nearby futures	21 days	Mon 3/2/26	Mon 3/30/26	36					
38	Update site conditions	21 days	Tue 3/31/26	Tue 4/28/26	37					
39	Site visit to confirm findings	5 days	Mon 6/1/26	Fri 6/5/26	38					
40	Task 6: Repository Siting Investigation	130 days	Mon 2/2/26	Fri 7/31/26						
41	Desktop assessment of alternative repository locations	20 days	Mon 2/2/26	Fri 2/27/26						
42	Access agreement coordination	22 days	Mon 3/2/26	Tue 3/31/26						
43	Ground truth desktop assessment	5 days	Mon 6/1/26	Fri 6/5/26						
44	Repository sampling, analysis, and data validation	30 days	Mon 6/22/26	Fri 7/31/26						
45	Task 7: Borrow Source Investigation	107 days	Mon 2/2/26	Tue 6/30/26						
46	Desktop assessment of alternative borrow source	20 days	Mon 2/2/26	Fri 2/27/26						
47	Access agreement coordination	22 days	Mon 3/2/26	Tue 3/31/26						
48	Investigate MEMC borrow source and alternative locations	22 days	Mon 6/1/26	Tue 6/30/26						
49	Task 8: BTS Siting Analysis	45 days	Mon 6/8/26	Fri 8/7/26						
50	Conduct desktop study to determine BTS location	30 days	Mon 6/22/26	Fri 7/31/26						
51	Perform geochemical assessment and loading analysis	40 days	Mon 6/8/26	Fri 7/31/26	21					
52	Site visit to identify BTS location determined from desktop study	5 days	Mon 8/3/26	Fri 8/7/26	51					
53	Tasks 9: Deliverables	80 days	Mon 8/31/26	Fri 12/18/26						

Project: BH_2026

Date: Fri 9/26/25

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

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Manual Summary

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External Tasks

External Milestone

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Progress

Manual Progress

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ID	Task Name	Duration	Start	Finish	Predecessors	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			1st Quarter		
						J	F	M	A	M	J	J	A	S	O	N	D	J		
54	Data Validation Report, Report Findings, EE/CA	80 days	Mon 8/31/26	Fri 12/18/26	2,14,20,27,35,40,															
Project: BH_2026 Date: Fri 9/26/25		Task		Project Summary		Manual Task		Start-only		Deadline										
		Split		Inactive Task		Duration-only		Finish-only		Progress										
		Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress										
		Summary		Inactive Summary		Manual Summary		External Milestone												
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Tables

Table 1
Laboratory Analytical Methods - Soil
Draft Final Liberty Mine Area
Engineering Evaluation/Cost Analysis Work Plan
Barker Hughesville Mining District Superfund Site
Cascade and Judith Ridge Counties, Montana

Analytical Suite	Analysis	Laboratory Method
Waste Rock Characterization		
Geochemical	Total Metals/Metalloids ^a	USEPA 6010B/6020A
	Total Mercury	USEPA 7471B
	SPLP Metals/Metalloids ^{ab}	USEPA SW1312/6020A
	SPLP Mercury ^b	USEPA SW1312/7470A
	SPLP pH ^b	USEPA SW1312/9045C
	SPLP Alkalinity ^b	USEPA SW1312/9040
	SPLP Sulfate ^b	USEPA SW1312/300.0
	MWMP Metals/Metalloids ^a	ASTM E2242/USEPA 6020A
	MWMP Mercury	ASTM E2242/USEPA 7470A
	MWMP pH	ASTM E2242/USEPA 9045C
	MWMP Alkalinity	ASTM E2242/USEPA 9040
	MWMP Sulfate	ASTM E2242/USEPA 300.0
	Inorganic Carbon	Sobek Modified
	Sulfur Forms ^c	Sobek Modified
	Acid Base Accounting	Sobek Modified
Geotechnical	USCS Soil Classification	ASTM D2487
	Grain Size	ASTM D6913
	Atterberg Limits	ASTM D4318
	Moisture content	ASTM D2216
	Direct Shear	ASTM D3080
General Soil Background Characterization		
Geochemical	Total Metals/Metalloids ^a	USEPA 6020A
	Total Mercury	USEPA 7471B
Repository Characterization		
Geochemical	Total Metals/Metalloids ^a	USEPA 6010B/6020
Geotechnical	USCS Soil Classification	ASTM D2487
	Atterberg Limits	ASTM D4318
	Moisture content	ASTM D2216
Borrow Source Characterization		
Geochemical	Total Metals/Metalloids ^a	USEPA 6010B/6020
Geotechnical	USCS Soil Classification	ASTM D2487
	Atterberg Limits	ASTM D4318
	Moisture content	ASTM D2216
	Direct Shear	ASTM D3080
	Specific Gravity	ASTM D854
	Standard Proctor	ASTM D698
Agronomic	Nitrogen, Nitrate	ASA33-8
	Phosphorous	ASA24-5
	Potassium	USEPA 6010B/6020
	Soil pH	SW9045D/AASHTO T 289-91

Notes:

^a Total metals/metalloids will be digested using USEPA Soil Preparation Method 3050B and will include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

^b SPLP tests will be a modified test that will include a 0.45 micron filtration and a site-specific leachate water pH

^c Sulfur forms include total sulfur, pyritic sulfur, and sulfate sulfur.

Acronyms and Abbreviations:

AASHTO = American Association of State Highway and Transportation Officials

ASA = American Standards Association

ASTM = ASTM International

MWMP = Meteoric Water Mobility Procedure

SPLP = synthetic precipitation leaching procedure

USCS = United Soil Classification System

USEPA = United States Environmental Protection Agency

Table 2
Laboratory Analytical Methods - Surface Water
Draft Final Liberty Mine Area
Engineering Evaluation/Cost Analysis Work Plan
Barker Hughesville Mining District Superfund Site
Cascade and Judith Ridge Counties, Montana

Analytical Suite	Analysis	Laboratory Method
Field Parameters	Flow	--
	pH	--
	Temperature	--
	Oxidation-Reduction Potential	--
	Specific Conductivity	--
	Dissolved Oxygen	--
Geochemical	Total Metals/Metalloids ^A	USEPA 200.7/200.8
	Total Mercury	USEPA 245.7
	Dissolved Metals/Metalloids ^A	USEPA 200.7/200.8
	Dissolved Mercury	USEPA 245.7
	Chloride	USEPA 300.0
	Fluoride	USEPA 300.0
	Phosphorus	USEPA 365.1
	Sulfate	USEPA 300.0
	Iron, Ferrous	SM 2340B
	Nitrate/Nitrite as Nitrogen	USEPA 353.2
	Conductivity @ 25 °C	SM 2510B
	Laboratory pH	SM 4500-H+B
	Bicarbonate as CaCO ₃	SM 2320B - Titration
	Carbonate as CaCO ₃	SM 2320B - Titration
	Hydroxide as CaCO ₃	SM 2320B - Titration
	Acidity as CaCO ₃	SM 2320B - Titration
	Total Alkalinity ^B	SM 2320B - Titration
	Hardness (total and dissolved)	USEPA 2340B
	Cation-Anion Balance	Calculation
	Sum of Anions	Calculation
	Sum of Cations	Calculation

Note:

^A Total metals/metalloids include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

Acronyms and Abbreviations:

-- = not applicable

@ = at

°C = degrees Celsius

CaCO₃ = Calcium Carbonate

SM = Standard Method

USEPA = United States Environmental Protection Agency

Table 3
Sample Locations
 Draft Final Liberty Mine Area
 Engineering Evaluation/Cost Analysis Work Plan
 Barker Hughesville Mining District Superfund Site
 Cascade and Judith Ridge Counties, Montana



Sample Location Prefix	Waste Rock Area	Location Type	Composite/Grab	4Sample Depth Interval (inches unless indicated otherwise)	1USEPA 6010B Metals	2SPLP Analysis (method SW1312)	MWMP (ASTM E2242)	Carbonate (Inorganic Carbon from Sobek Modified)	Sulfur Forms (Sobek Modified)	3Acid Base Accounting (Sobek Modified)	Total Metals/ Metalloids (USEPA 6020A)	Total Mercury (USEPA 7471B)	USCS Soil Classification (ASTM D2487)	Grain Size (ASTM D6913)	Atterberg Limits (ASTM D4318)	Moisture Content (ASTM D2216)	Direct Shear (ASTM D3080)	Sample Total
Specific Analyses included in each analytical method listed here are detailed in Tables 1 and 2																		
AE-1	Annie E Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
AE-2	Annie E Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
AE-3	Annie E Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
AES-N	Annie E Waste Area - Adjacent Soils	Adjacent Sol Sample - North of Waste Area	Composite	0 to 6	X							X						2
AES-S	Annie E Waste Area - Adjacent Soils	Adjacent Sol Sample - South of Waste Area	Composite	0 to 6	X							X						2
AES-E	Annie E Waste Area - Adjacent Soils	Adjacent Sol Sample - East of Waste Area	Composite	0 to 6	X							X						2
AES-W	Annie E Waste Area - Adjacent Soils	Adjacent Sol Sample - West of Waste Area	Composite	0 to 6	X							X						2
AE-GT-1	Annie E Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
AE-GT-2	Annie E Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
A2-1	August No. 2 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
A2-2	August No. 2 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
A2-3	August No. 2 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
A2-N	August No. 2 Waste Area - Adjacent Soils	Adjacent Sol Sample - North of Waste Area	Composite	0 to 6	X							X						2
A2-S	August No. 2 Waste Area - Adjacent Soils	Adjacent Sol Sample - South of Waste Area	Composite	0 to 6	X							X						2
A2-E	August No. 2 Waste Area - Adjacent Soils	Adjacent Sol Sample - East of Waste Area	Composite	0 to 6	X							X						2
A2-W	August No. 2 Waste Area - Adjacent Soils	Adjacent Sol Sample - West of Waste Area	Composite	0 to 6	X							X						2
A2-GT-1	August No. 2 Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
A2-GT-2	August No. 2 Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
DT-1	Danny T Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
DT-2	Danny T Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
DT-3	Danny T Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
DTS-N	Danny T Waste Area - Adjacent Soils	Adjacent Sol Sample - North of Waste Area	Composite	0 to 6	X							X						2
DTS-S	Danny T Waste Area - Adjacent Soils	Adjacent Sol Sample - South of Waste Area	Composite	0 to 6	X							X						2
DTS-E	Danny T Waste Area - Adjacent Soils	Adjacent Sol Sample - East of Waste Area	Composite	0 to 6	X							X						2
DTS-W	Danny T Waste Area - Adjacent Soils	Adjacent Sol Sample - West of Waste Area	Composite	0 to 6	X							X						2
DT-GT-1	Danny T Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
DT-GT-2	Danny T Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
L-1	Liberty Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
L-2	Liberty Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
L-3	Liberty Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
LS-N	Liberty Waste Area - Adjacent Soils	Adjacent Sol Sample - North of Waste Area	Composite	0 to 6	X							X						2
LS-S	Liberty Waste Area - Adjacent Soils	Adjacent Sol Sample - South of Waste Area	Composite	0 to 6	X							X						2
LS-E	Liberty Waste Area - Adjacent Soils	Adjacent Sol Sample - East of Waste Area	Composite	0 to 6	X							X						2
LS-W	Liberty Waste Area - Adjacent Soils	Adjacent Sol Sample - West of Waste Area	Composite	0 to 6	X							X						2
L-GT-1	Liberty Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
L-GT-2	Liberty Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LC-1	Last Chance Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
LC-2	Last Chance Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
LC-3	Last Chance Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
LCS-N	Last Chance Waste Area - Adjacent Soils	Adjacent Sol Sample - North of Waste Area	Composite	0 to 6	X							X						2
LCS-S	Last Chance Waste Area - Adjacent Soils	Adjacent Sol Sample - South of Waste Area	Composite	0 to 6	X							X						2

Table 3
Sample Locations
 Draft Final Liberty Mine Area
 Engineering Evaluation/Cost Analysis Work Plan
 Barker Hughesville Mining District Superfund Site
 Cascade and Judith Ridge Counties, Montana



Sample Location Prefix	Waste Rock Area	Location Type	Composite/Grab	*Sample Depth Interval (inches unless indicated)	¹ USEPA 6010B Metals	² SPLP Analysis (method SW1312)	MWMP (ASTM E2242)	Carbonate (Inorganic Carbon from Sobek Modified)	Sulfur Forms (Sobek Modified)	³ Acid Base Accounting (Sobek Modified)	Total Metals/ Metalloids (USEPA 6020A)	Total Mercury (USEPA 7471B)	USCS Soil Classification (ASTM D2487)	Grain Size (ASTM D6913)	Atterberg Limits (ASTM D4318)	Moisture Content (ASTM D2216)	Direct Shear (ASTM D3080)	Sample Total
LCS-E	Last Chance Waste Area - Adjacent Soils	Adjacent Soil Sample - East of Waste Area	Composite	0 to 6	X							X						2
LCS-W	Last Chance Waste Area - Adjacent Soils	Adjacent Soil Sample - West of Waste Area	Composite	0 to 6	X							X						2
LC-GT-1	Last Chance Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LC-GT-2	Last Chance Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LI-1	Liberty Intermediate Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
LI-2	Liberty Intermediate Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
LI-3	Liberty Intermediate Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
LI-N	Liberty Intermediate Waste Area - Adjacent Soils	Adjacent Soil Sample - North of Waste Area	Composite	0 to 6	X							X						2
LI-S	Liberty Intermediate Waste Area - Adjacent Soils	Adjacent Soil Sample - South of Waste Area	Composite	0 to 6	X							X						2
LI-E	Liberty Intermediate Waste Area - Adjacent Soils	Adjacent Soil Sample - East of Waste Area	Composite	0 to 6	X							X						2
LI-W	Liberty Intermediate Waste Area - Adjacent Soils	Adjacent Soil Sample - West of Waste Area	Composite	0 to 6	X							X						2
LI-GT-1	Liberty Intermediate Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LI-GT-2	Liberty Intermediate Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LN3-1	Liberty No. 3 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
LN3-2	Liberty No. 3 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
LN3-3	Liberty No. 3 Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
LN3S-N	Liberty No. 3 Waste Area - Adjacent Soils	Adjacent Soil Sample - North of Waste Area	Composite	0 to 6	X							X						2
LN3S-S	Liberty No. 3 Waste Area - Adjacent Soils	Adjacent Soil Sample - South of Waste Area	Composite	0 to 6	X							X						2
LN3S-E	Liberty No. 3 Waste Area - Adjacent Soils	Adjacent Soil Sample - East of Waste Area	Composite	0 to 6	X							X						2
LN3S-W	Liberty No. 3 Waste Area - Adjacent Soils	Adjacent Soil Sample - West of Waste Area	Composite	0 to 6	X							X						2
LN3-GT-1	Liberty No. 3 Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
LN3-GT-2	Liberty No. 3 Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
M-1	Marcelline Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
M-2	Marcelline Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
M-3	Marcelline Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X	X		X						5
MS-N	Marcelline Waste Area - Adjacent Soils	Adjacent Soil Sample - North of Waste Area	Composite	0 to 6	X							X						2
MS-S	Marcelline Waste Area - Adjacent Soils	Adjacent Soil Sample - South of Waste Area	Composite	0 to 6	X							X						2
MS-E	Marcelline Waste Area - Adjacent Soils	Adjacent Soil Sample - East of Waste Area	Composite	0 to 6	X							X						2
MS-W	Marcelline Waste Area - Adjacent Soils	Adjacent Soil Sample - West of Waste Area	Composite	0 to 6	X							X						2
MS-GT-1	Marcelline Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
MS-GT-2	Marcelline Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
T-1	Transverse Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
T-2	Transverse Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X	X	X	X	X			X						6
T-3	Transverse Waste Area	Rockpile Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
TS-N	Transverse Waste Area - Adjacent Soils	Adjacent Soil Sample - North of Waste Area	Composite	0 to 6	X							X						2
TS-S	Transverse Waste Area - Adjacent Soils	Adjacent Soil Sample - South of Waste Area	Composite	0 to 6	X							X						2
TS-E	Transverse Waste Area - Adjacent Soils	Adjacent Soil Sample - East of Waste Area	Composite	0 to 6	X							X						2
TS-W	Transverse Waste Area - Adjacent Soils	Adjacent Soil Sample - West of Waste Area	Composite	0 to 6	X							X						2
T-GT-1	Transverse Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
T-GT-2	Transverse Waste Area - Geotechnical Sample	Geotechnical Sample	Grab	Surface									X	X	X	X	X	5
GB-1	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6								X	X					2
GB-2	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6								X	X					2
GB-3	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6								X	X					2
GB-4	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6								X	X					2

Table 3
Sample Locations
Draft Final Liberty Mine Area
Engineering Evaluation/Cost Analysis Work Plan
Barker Hughesville Mining District Superfund Site
Cascade and Judith Ridge Counties, Montana



Sample Location Prefix	Waste Rock Area	Location Type	Composite/Grab	*Sample Depth Interval (inches unless indicated)	¹ USEPA 6010B Metals	¹ SPLP Analysis (method SW1312)	MWMP (ASTM E2242)	Carbonate (Inorganic Carbon from Sobek Modified)	Sulfur Forms (Sobek Modified)	³ Acid Base Accounting (Sobek Modified)	Total Metals/ Metalloids (USEPA 6020A)	Total Mercury (USEPA 7471B)	USCS Soil Classification (ASTM D2447)	Grain Size (ASTM D6913)	Atterberg Limits (ASTM D4318)	Moisture Content (ASTM D2216)	Direct Shear (ASTM D3080)	Sample Total
GB-5	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-6	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-7	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-8	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-9	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-10	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-11	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
GB-12	Unimpacted Soil Area - Upgradient of Waste Areas	General Soil Background	Composite	0 to 6							X	X						2
RF-1	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-2	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-3	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-4	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-5	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-6	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-7	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
RF-8	Access Road Rockfill Area	Road Rockfill Surface Sample	Composite	0 to 6, 6 to 24, 24+	X			X	X			X						4
SB-1	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-2	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-3	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-4	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-5	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-6	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-7	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-8	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
SB-9	Soil Boring	Deep Waste Rock and Geotechnical Sample	Composite	Every 2' for first 10', 1 per 5' thereafter	X			X	X			X	X	X	X	X		8
DT-SW-1	Danny T Adit - Outflow	Surface Water Sample ⁵	Grab	--	Surface Water Grab Samples will include the following:													2
MS-SW-1	Marcelline Shaft - Outflow	Surface Water Sample ⁵	Grab	--	USEPA 200.7/200.8, USEPA 245.7, USEPA 300.0, USEPA 353.2, USEPA 365.1, SM 2320B - Titration, SM 2340B, SM 2510B, SM 4500-H+B													2
A2-SW-1	August No. 2 Adit - Outflow	Surface Water Sample ⁵	Grab	--														2
Total Sample Count																		432

Notes:
¹ Laboratory Metals Analysis using USEPA Soil Preparation Method 3050B/Analysis 6010B
² SPLP Analysis (method SW1312); MWMP (ASTM E2242) will be sampled at 50% of locations
³ Acid Base Accounting (Sobek Modified) will be sampled at 20% of locations
⁴ Up to 10 representative samples may be collected; at least three of these samples will be collected from underlying soils or regolith to assess the potential for leaching
⁵ Water will be collected from the adits and shafts in the table if it is flowing

Abbreviations:
 % = percent
 ASTM = ASTM International
 MWMP = Meteoric Water Mobility Procedure
 SPLP = Synthetic Precipitation Loading Procedure
 USCS = Unified Soil Classification System
 USEPA = United States Environmental Protection Agency

Table 4
Screening Levels - Soil
Draft Final Liberty Mine Area
Engineering Evaluation/Cost Analysis Work Plan
Barker Hughesville Mining District Superfund Site
Cascade and Judith Ridge Counties, Montana

Analyte	Units	USEPA Regional Screening Levels for Soil ^a			
		Industrial		Residential	
		Carcinogenic	Non-carcinogenic	Carcinogenic	Non-carcinogenic
Aluminum	mg/kg	--	1,100,000	--	77,000
Antimony	mg/kg	--	470	--	31
Arsenic	mg/kg	3	480	0.67	34
Barium	mg/kg	--	220,000	--	15,000
Beryllium	mg/kg	6,900	2,300	1,600	160
Cadmium	mg/kg	9,300	980	2,100	70
Calcium	mg/kg	--	--	--	--
Chromium	mg/kg	--	--	--	--
Cobalt	mg/kg	1,900	350	420	23
Copper	mg/kg	--	47,000	--	3,100
Iron	mg/kg	--	820,000	--	55,000
Lead	mg/kg	--	800	--	400
Magnesium	mg/kg	--	--	--	--
Manganese	mg/kg	--	26,000	--	1,800
Mercury	mg/kg	--	46	--	11
Nickel	mg/kg	--	--	--	--
Potassium	mg/kg	--	--	--	--
Selenium	mg/kg	--	5,800	--	390
Silver	mg/kg	--	5,800	--	390
Sodium	mg/kg	--	--	--	--
Thallium	mg/kg	--	7	--	0.47
Vanadium	mg/kg	--	5,800	--	390
Zinc	mg/kg	--	350,000	--	23,000

Notes:

^a Total metals/metalloids include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

Abbreviations:

-- = not applicable

mg/kg = milligrams per kilogram

USEPA = United States Environmental Protection Agency

Reference:

USEPA. 2022. Regional Screening Levels Summary Table (TR=1E-06, THQ=1.0). Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>. Accessed August 4,

Table 5
Screening Levels - Surface Water
Draft Final Liberty Mine Area
Engineering Evaluation/Cost Analysis Work Plan
Barker Hughesville Mining District Superfund Site
Cascade and Judith Ridge Counties, Montana



Analyte	Fraction	Units	Acute Aquatic Life Benchmark	Chronic Aquatic Life Benchmark	Human Health Standard
Aluminum ^a	dissolved	mg/L	0.750	0.087	--
Arsenic	total	mg/L	0.340	0.150	0.010
Cadmium ^b	total	mg/L	0.49 @ 25 mg/L H	0.25 @ 25 mg/L H	0.005
Chromium ^{bc}	total	mg/L	579 @ 25 mg/L H	27.7 @ 25 mg/L H	0.100
Copper ^b	total	mg/L	3.79 @ 25 mg/L H	2.85 @ 25 mg/L H	1.300
Iron	total	mg/L	--	1.000	--
Lead ^b	total	mg/L	13.98 @ 25 mg/L H	0.545 @ 25 mg/L H	0.015
Mercury	total	mg/L	0.0017	0.00091	0.00005
Nickel ^b	total	mg/L	145 @ 25 mg/L H	16.1 @ 25 mg/L H	0.100
Selenium	total	mg/L	0.020	0.005	0.050
Silver ^b	total	mg/L	0.374 @ 25 mg/L H	--	0.100
Zinc ^b	total	mg/L	37 @ 25 mg/L H	37 @ 25 mg/L H	7.400

Notes:

^aScreening levels for alluminum are applicable only for a pH range of 6.5 to 9.0.

^bHardness-based screening levels will be recalculated based on hardness results.

^cThe Aquatic Life Benchmarks shown are for Chromium, trivalent. The Human Health Standard shown is for Chromium, all forms.

Abbreviations:

@ = at

-- = not applicable

H = hardness

mg/L = milligrams per liter

Reference:

2019. Montana Department of Environmental Quality, Planning, Prevention, and Assistance Division - Water Quality Standards Section. Circular DEQ-7, Montana Numeric Water Quality Standards, June.

Figures

City: Olathe, Created By: Last Saved By: Hally
Project: Project 1
Project Path: C:\Users\Hally\Documents\Barker Hughesville\Figures\005 Barker Hughesville
Printed: 12/10/2025 12:38 PM



City: Clark County, Created By: Last Saved By: Nalley
Project (Project #):
P:\ENR\Barker Hughesville\GIS\Projects\2025 Barker Hughesville Figures.aprx 11/17/2025 9:37 AM



LEGEND

- Proposed Background Sample Location
- Proposed Road Fill Sample Location
- Proposed Geotechnical Boring Location
- Previously Collected Surface Water Location
- Creek
- Underground Mine Workings
- Access Road

- Waste Rock/Stream-Side Deposit Area
- OU3 Study Area
- Proposed Treatment Location
- USDA Soil**
 - 1164G
 - 1168F
 - 1251F
 - 2268F

Notes:

- 1) Outlined waste rock piles do not necessarily represent all known piles, nor do they represent the exact known limits of waste rock.
- 2) Additional waste rock pile locations may be field located.

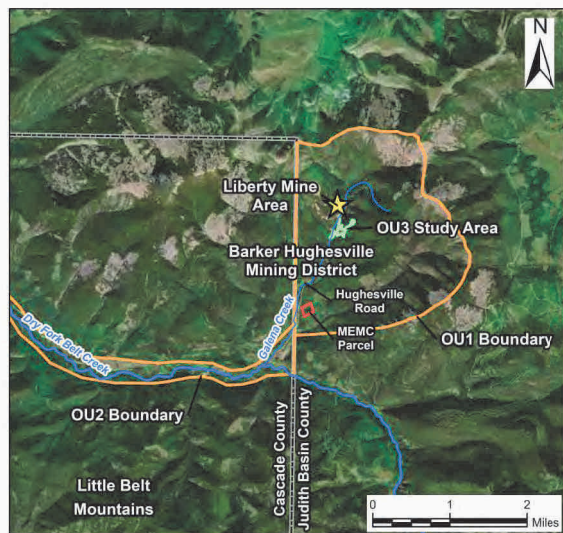


0 330 660 Feet

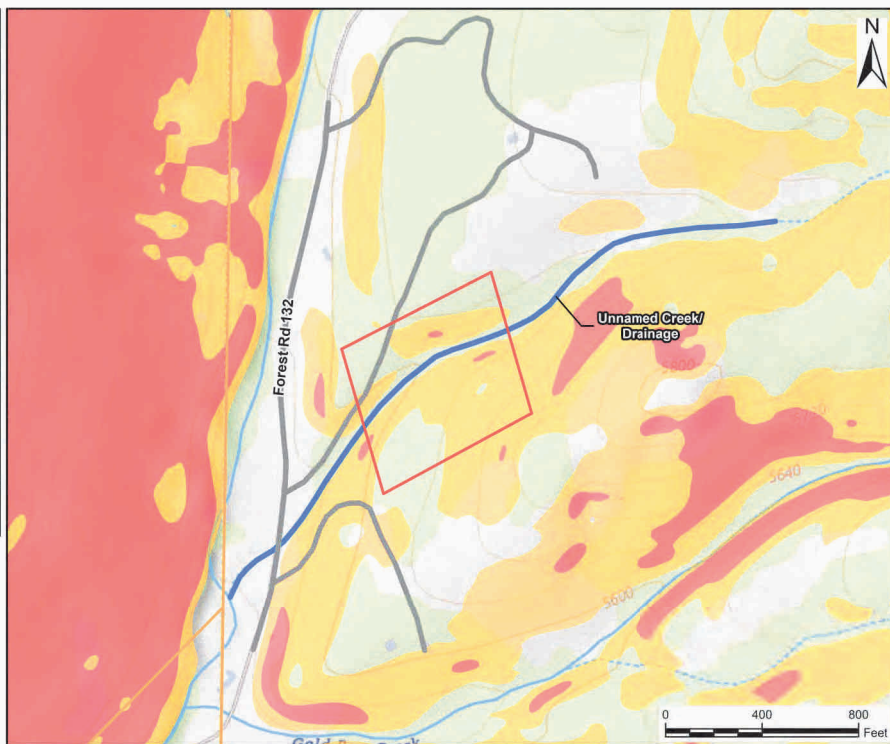
BARKER HUGHESVILLE MINING DISTRICT,
LIBERTY AREA REMOVAL SITE EVALUATION

SAMPLING LOCATIONS





VICINITY MAP



PROPOSED REPOSITORY

LEGEND

- Mine Locations
- Operable Unit (OU) Boundary
- Operable Unit (OU) Study Area
- Mt. Emmons Mining Company Parcel
- Counties
- Unnamed Creek/Drainage
- Road
- 10% - 20% Slope
- >20% Slope

NOTE:
 1) Contour Interval = 40 ft

BARKER HUGHESVILLE MINING DISTRICT,
 LIBERTY AREA REMOVAL SITE EVALUATION

PROPOSED REPOSITORY
 (MEMC-OWNED PROPERTY)

Appendix A

Quality Assurance Project Plan (QAPP) 2025

EPA REGION 8 OPTIMIZED UFP-QAPP REVIEW CROSSWALK

This crosswalk is used to review Uniform Federal Policy-Quality Assurance Project Plans (UFP-QAPPs) submitted to EPA Region 8 for review. Items from this crosswalk are discussed in detail in the *Intergovernmental Data Quality Task Force Optimized UFP-QAPP Worksheets* [Intergovernmental Data Quality Task Force Optimized UFP-QAPP Worksheets](#), March 2012, and *EPA Quality Assurance Project Plan Standard CIO 2105-S-02* [EPA Quality Assurance Project Plan Standard CIO 2105-S-02](#) (S-2 Standard).

The UFP-QAPP must include all required elements of the Optimized UFP-QAPP Worksheets and the S-2 Standard, which are listed in this crosswalk. It must also include all figures, attachments, and appendices (e.g., SOPs, forms, etc.). Oversight of a potentially responsible party (PRP) may utilize the EPA Region 9 Superfund Streamlined Oversight UFP-QAPP Template. Cited directives and regulations provided within this crosswalk are for clarity and convenience. Please ensure the directive(s), regulation(s), requirement(s), and language are adhered to within the UFP-QAPP.

This crosswalk is a controlled document. Do not modify the crosswalk format or document type. Information in the “Elements” column within the crosswalk describe requirements and may not be modified.

UFP-QAPP PREPARER MUST COMPLETE AS PART OF THE SUBMISSION			
New/Revised and Annual Review UFP-QAPP and Crosswalk Completion Requirements:			
New/Revised UFP-QAPP – UFP-QAPPs have a period of applicability of up to 5 years from the date of EPA Regional QA Manager (RQAM) or Delegated Approving Official (DAO) approval. Newly developed UFP-QAPPs must go through the complete review process in order to receive approval. UFP-QAPPs that have reached the end of their period of applicability must undergo a full revision by the UFP-QAPP Preparer and then go through the complete EPA review process in order to receive approval. In addition, if there are significant changes to the project, the UFP-QAPP must undergo a full revision by the UFP-QAPP Preparer and then go through the complete EPA review process in order to receive approval, even if the period of applicability has not yet expired. Annual Review – A UFP-QAPP must be reviewed at least annually by the UFP-QAPP Preparer to confirm its suitability and evaluate its effectiveness for the project. Crosswalk Requirements – This crosswalk will remain with the UFP-QAPP for the entire period of applicability. The primary crosswalk is used to document the full review of the New or Revised UFP-QAPP, including comments, responses, and resolution. The Annual Review Crosswalks in Attachment 1 are used to document each annual review of the UFP-QAPP. Further instructions are provided in Attachment 1.			
UFP-QAPP Prepared for: <i>(Check appropriate box below)</i>			
☐ GRANT RECIPIENT 2 CFR 1500.12	☐ CONTRACTOR 48 CFR 46	☐ INTERAGENCY AGREEMENT (IA)	☐ EPA PROGRAM ☒ POTENTIALLY RESPONSIBLE PARTY (PRP)
Organization: <i>(grant recipient, contractor, IA, EPA Program, PRP)</i>	Mt. Emmons Mining Company (MEMC)	Organization Point of Contact (POC): <i>(Name, Title, Email)</i>	Barb Nielsen Project Manager (MEMC) bnielsen@fmi.com
Document Title:	Barker Hughesville Mining District Superfund Site Quality Assurance Project Plan Cascade and Judith Basin Counties, Montana	UFP-QAPP Preparer: <i>(If different than Organization POC)</i>	Arcadis U.S., Inc.
Document Version and Date:	None provided	Contract, Grant, or IA Number:	NA
UFP-QAPP Period of Performance:	Up to 5 years from the date of RQAM or DAO Approval	EPA Project Officer/Program Manager: <i>(Name, Email)</i>	Roger Hoogerheide, Remedial Project Manager
Documents to be submitted with the UFP-QAPP and Crosswalk:			
UFP-QAPPs written by a Grantee, Interagency Partner, or EPA Work Plan (WP), Statement of Work (SOW), Performance Work Statement (PWS), Research Proposal (RP), or Agency Agreement UFP-QAPPs written by an EPA Contractor - Task Order Work Assignment/SOW, reference to the contractor’s approved QMP, Contract SOW (if QMP has not been approved) - The QA Reviewer must determine (with the EPA CO or PO) if a QARF was completed for the environmental information operations (EIO) described in the UFP-QAPP UFP-QAPPs written by the PRP Court Order/Administrative Settlement – The UFP QAPP is an attachment to a workplan that will accompany an Administrative Settlement Agreement and Order on Consent. The ASAOC is anticipated to be finalized in early 2026			

EPA QA REVIEWER MUST COMPLETE AS PART OF THE REVIEW			
<i>All submissions and responses must be tracked in this Crosswalk. Information in blue and green are the suggested approach to ensuring that each review process is independently tracked.</i>			
EPA Technical Reviewer: <i>(Name, Email)</i>		Date Received for QA Review:	1st Review: MM/DD/YYYY 2nd Review: MM/DD/YYYY

EPA QA Reviewer: (Name, Email)	Roger Hoogerheide Hoogerheide.roger@epa.gov	Date Review Completed:	1 st Review: 11/05 – 11/14/2025 2 nd Review: MM/DD/YYYY
EPA QA Reviewer (QA Branch or DAO)?	QAB ☐ DAO ☒ QAB ID#:	EPA QA Approving Official: (Name, Email)	Roger Hoogerheide Hoogerheide.roger@epa.gov
Regulatory Authority or Funding Mechanism:			
Grant ☐ / Contract ☐ / IA (FFA/CERCLA) ☐ / Court Order ☐ / EPA Program ☐ / Other ☒ ASAOC		WP/SOW/PWS/TO/PP/RP Date:	TBD
Funding Amount \$	N/A	Performance Period:	May 2026 – March 2027
QA document(s) reviewed:			
Stand-alone UFP-QAPP?	Yes ☐ No ☒	QA document consistent with WP/SOW/TO/PP/RP?	Yes ☒ / No ☐ / NA ☐
All attachments included?	Yes ☒ / No ☐ / NA ☐		

FOR THE UFP-QAPP PREPARER AND EPA QA REVIEWER

Crosswalk Instructions for New UFP-QAPPs:

- The Sampling and Analysis Plan (SAP) or Field Sampling Plan (FSP) must be submitted with the UFP-QAPP or must be a stand-alone document that meets all required UFP-QAPP Optimized Worksheets and QAPP Standard elements.
- If an element is not applicable, an explanation must be provided in the UFP-QAPP and in the Comments column of the crosswalk.
- Processes may either be described or referenced in the UFP-QAPP; all references must be readily accessible within the organization **and** provided in or as attachments to the UFP-QAPP.
- Elements marked with an asterisk (*) include requirements of the QAPP Standard (S-2) and must be included in the UFP-QAPP.
- “EPA Notes” are notes, recommendations, or observations that may improve the UFP-QAPP; they are not directives and do not require compliance. “EPA Comments” require the author to address for compliance with the UFP-QAPP Optimized Worksheets and S-2 Standard elements.
- An “NA” in the Acceptable column signifies agreement that the element is not applicable and the reason is included and appropriate.
- In addition to addressing concerns in the Summary of EPA Comments (below), the organization must also respond to the issues identified in the Comment column under “**Organization Response (date)**.” An authorized EPA QA reviewer will respond to the revision(s) under “**EPA Resolved (date)**.”

Summary of EPA Comments (highlight significant concerns/issues):

1. EPA Comment: In worksheet #6, please revise to include the pathway for communication (e.g., email, phone). timeframe for notification (e.g., within 24 hours, 1 week, etc.), and any required documentation for each communication driver
Organization Response (date): Worksheet #6 has been revised to address this comment. 11/20/2025
EPA Resolved (date):
2. EPA Comment: In worksheet #13, please describe how the secondary data will be evaluated to ensure they are of the type and quality necessary to support their intended uses and determine limitations on their uses
Organization Response (date): Worksheet #13 has been revised to address this comment. 11/20/2025
EPA Resolved (date):
3. EPA Comment: In worksheet #19, please describe or reference procedures for how supplies and services are inspected and accepted, including the responsible party (may also be included in Worksheets #22 or #25)
Organization Response (date): Inspection and acceptance criteria are already provided in Worksheet #22. Some of the column headers have been revised in this worksheet to make this clearer.
EPA Resolved (date):

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
Worksheets #1 & 2: Title and Approval Page		
A. Includes the site/project name and site location	Yes	Included
B. Includes "Quality Assurance Project Plan" (or "Sampling and Analysis Plan" or "Field Sampling Plan") in the title and revision number*	Yes	"Sampling and Analysis Plan" or "Field Sampling Plan" not included in title and no revision number included. Revision page is provided in workplan and does not need to be repeated in the UFP QAPP
C. Includes the contract/work assignment number*	Yes	None provided. Since this will accompany an ASAOC that is not finalized this is not needed
D. Lead Organization (Federal Facility or PRP) Project Manager (name/title/signature/date) and Quality Manager (name/title/signature/date)	Yes	Barb Nielsen, MEMC Project Manager Provided without signatures and dates. This is the first draft being reviewed by EPA. Signatures will be provided when it is finalized. MEMC needs to identify who the in house QA Manager that will sign the UFP QAPP
E. Investigative Organization/Prime Contractor (organization performing EIO activities) Project Manager (name/title/signature/date) and Quality Officer (name/title/signature/date)	Yes	Arcadis Provided without signatures and dates. This is the first draft being reviewed by EPA. Signatures will be provided when it is finalized
F. EPA Region 8 Remedial Project Manager/Project Officer (names/signatures/date) and Regional QA Manager (RQAM)/Delegated Approving Official (DAO) (names/signatures/date)	Yes	Roger Hoogerheide Provided without signatures and dates. This is the first draft being reviewed by EPA. Signatures will be provided when it is finalized. RPM is also the DAO
G. State Regulatory Agency, if applicable (name/title/signature/date)	Yes	MDEQ; Amber Nichols, Project Officer. Signature and date missing. Signature and date missing. This is the first draft being reviewed by EPA. Signatures will be provided when it is finalized
H. Other stakeholders, if applicable	Yes	USFS, Steve Opp, On Scene Coordinator This is the first draft being reviewed by EPA. Signatures will be provided when it is finalized
I. Lists plans and reports from previous investigations relevant to the project	Yes	7. Plans and reports from previous investigations relevant to this project: A. 2016 – Remedial Investigation Report for Barker-Hughesville Mining District Superfund Site, Cascade and Judith Basin Counties, MT, prepared for US Environmental Protection Agency. Quality Assurance Project Plan Barker Hughesville Mining District Superfund Site www.arcadis.com 4 B. 2017 – Mt. Emmons Mining Company Lab-Scale Treatability Study of Danny T Mine Adit Discharge, Barker Hughesville Mining District Superfund Site Cascade and Judith Basin Counties, MT. C. 2022 – Danny T Adit Flow and Water Quality Monitoring November 2020 to November 2021, Barker-Hughesville Mining District Superfund Site, MT, prepared by Arcadis. Additional reports finalized in 2025 have been added to list as well as a cultural resource report completed in 2012
J. Specifies that the UFP-QAPP will be reviewed annually to confirm suitability/effectiveness. The review must be documented using the R8 UFP-QAPP Crosswalk. Any substantial changes will be documented and approved before implementation. Minor changes will be documented and submitted to the approving authority in writing annually.*	Yes	Notes: 1 The UFP-QAPP will be reviewed annually to confirm suitability/effectiveness. The review must be documented using the R8 UFP-QAPP Crosswalk. Any substantial changes will be documented and approved before implementation. Minor changes will be documented and submitted to the approving authority in writing annually.
K. Identifies and addresses other QA planning documents with relevant requirements (e.g., QMPs)*	Yes	8. Other QA planning documents with relevant requirements: A. Laboratory Quality Assurance Manual (Attachment 1) B. Laboratory Standard Operating Procedures (Attachment 2)

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
Worksheets #3 & 5: Project Organization and UFP-QAPP Distribution		
A. A project organization chart is provided that depicts key personnel, lines of authority, and lines of communication among the regulatory agencies, lead agency, investigative organization/prime contractor, and subcontractors	Yes	Yes, it is provided.
B. Identifies recipients of controlled copies of the UFP-QAPP	Yes	Yes, it does.
C. Indicates that a complete copy of UFP-QAPP modifications will be maintained on file*	Yes	Yes, it does.
D. Identifies the Operations Manager/Project Manager, Quality Manager, Senior Manager (i.e., individuals identified above for Worksheets 1 & 2, Elements D and E)*	Yes	Yes, it does.
E. Identifies the individual responsible for maintaining the UFP-QAPP*	Yes	Yes, Dylan Davis.
F. Identifies approval authority for the UFP-QAPP*	Yes	Yes, Barbara Nielsen
G. Describes how independence is ensured between QA and operations*	Yes	Yes, it does. (Staff with QA roles have separate reporting lines than staff within operations to maintain independence from each other. Additionally, Arcadis maintains an "Integrity Line" through which employees can anonymously report integrity issues.
Worksheets #4, 7 & 8: Personnel Qualifications and Sign-off Sheet		
A. Lists key project personnel for each organization performing tasks defined in the UFP-QAPP	Yes	Yes, it does.
B. Lists individuals' project titles or roles; qualifications; and any specialized/non-routine training, certifications, or clearances required by the project, including how training/certification is provided, skills assured, and documented*	Yes	Yes, it does.
C. Identifies the individual(s) responsible for ensuring personnel are qualified and for documenting training*	Yes	Yes, Barb Nielsen.
D. Includes space for individuals to sign and date that they have read the UFP-QAPP and will implement it as it is written	Yes	Yes, that space is provided.
Worksheet #6: Communication Pathways		
A. Identifies specific issues (communication drivers) that trigger the need to communicate with other project personnel or stakeholders (e.g., unexpected events, emergencies, non-conformances, stop work orders, approval of amendments to the UFP-QAPP, delays or changes to field work, laboratory data quality issues, etc.)	Yes	Yes, present. Comments have been provided. Once comments have been accepted it is good
B. For each communication driver, includes the pathway for communication (e.g., email, phone). timeframe for notification (e.g., within 24 hours, 1 week, etc.), and any required documentation	Yes	Emails and phone numbers are provided but timelines were not included. Provided as a major comment in beginning of checklist
C. Includes the necessary contact information (i.e., phone numbers or email addresses) for each communication driver	Yes	Emails and phone numbers are provided.
Worksheet #9: Project Planning Session Summary		
A. Provides a worksheet for each internal and external project planning session held by phone, web-conferencing, and/or face-to-face	Yes	Yes, provided.
B. Identifies all scoping session participants (project managers, information generators, information reviewers, QA personnel, data users, and all other stakeholders)	Yes	Yes, provided.

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
C. Describes key decisions or agreements reached and action items	Yes	Yes, provided.
Worksheet #10: Conceptual Site Model		
A. The CSM includes the following:		
B. Background information/site history	Yes	Yes, with incorporation of Agency comments
C. Sources of known or suspected hazardous waste	Yes	Yes, with incorporation of Agency comments
D. Known or suspected contaminants or classes of contaminants	Yes	Yes, with incorporation of Agency comments
E. Primary release mechanism	Yes	Yes, with incorporation of Agency comments
F. Secondary contaminant migration	Yes	Yes, with incorporation of Agency comments
G. Fate and transport considerations	Yes	Yes, with incorporation of Agency comments
H. Potential receptors and exposure pathways	Yes	Yes, with incorporation of Agency comments
I. Land use considerations	Yes	Yes, with incorporation of Agency comments
J. Key physical aspects of the site (e.g., site geology, hydrology, topography, climate)	Yes	Yes, with incorporation of Agency comments
K. Current interpretation of nature and extent of contamination to the extent that it will influence project-specific decision-making	Yes	Yes, with incorporation of Agency comments
L. Includes a separate CSM for each site, as applicable	Yes	No separate CSMs needed since all work will be done at OU3 in Barker Hughesville Mining District
Worksheet #11: Project/Data Quality Objectives		
A. Provides project quality objectives (PQOs) or data quality objectives (DQOs) using a systematic planning process (e.g., EPA's Data Quality Objectives Process, EPA-QA/G-4, February 2006; U.S. Army Corps of Engineers' Technical Project Planning Process, EM 200-1-2, February 2016)	Yes	Yes
B. Describes the environmental decisions to be made	Yes	Yes
C. Describes the level of data quality needed to ensure that the environmental decisions are based on sound scientific data	Yes	Yes
D. For environmental technology (i.e., systems, devices and their components, and methods or techniques that measure or remove pollutants or contaminants or prevent them from entering the environment), the UFP-QAPP states the purpose of the technology, as well as the physical parameters/processes and specific systems, devices, and components*	Yes	Yes
Worksheet #12: Measurement Performance Criteria		
A. Provides a worksheet for each type of field or laboratory measurement; for analytical methods, criteria are determined for each matrix, analytical group or method, and concentration level	Yes	Yes
B. Provides quantitative measurement performance criteria in terms of precision, accuracy/bias, and sensitivity for both field and laboratory measurements	Yes	Yes
Worksheet #13: Secondary Data Uses and Limitations		
A. Identifies sources of secondary data	Yes	Yes
B. Discusses the rationale for using this data its relevance to the project (i.e., how the secondary data will be used)	Yes	Yes
C. Describes how the secondary data will be evaluated to ensure they are of the type and quality necessary to support their intended uses and determine limitations on their uses		No, there is no text to provide guidance. Please include in revision Text has been added.

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
D. For modeling projects, QC activities include model calibration/validation (may also be included in Worksheets #34 or #35)*	Yes	No, there is no text to provide the necessary information. I don't recall that any modelling is proposed and feel that this data element isn't required
E. For existing information projects, includes systemic, independent secondary review (if required), and QC of databases/spreadsheets (may also be included in Worksheets #34 or #35)*		No, there is no text to provide the necessary information. (also, not in WS# 34 or #35.) Please include in revision This has been added.
Worksheets #14 & 16: Project Tasks & Schedule		
Includes a project schedule showing specific tasks (on-site and off-site), the person or group responsible for their execution, planned start and end dates, and any associated deliverables to be produced	Yes	Yes
Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits		
A. Includes a worksheet for each type of field or laboratory measurement; criteria are determined for each matrix, analytical group or method, and concentration level	Yes	Yes
B. For each critical contaminant/analyte of concern, lists the project action limit (actual numerical criteria) and the reference upon which it is based (regulatory limits or risk-based limits). If critical contaminants/analytes of concern have not yet been identified, lists target analytes, their screening levels, and the reference upon which they are based.	Yes	Yes
C. Provides laboratory-specific detection and quantitation limits for comparison to project action limit	Yes	Yes
D. Includes laboratory documentation that demonstrates precision and bias at the laboratory-specific quantitation limit (at lowest calibration standard)	Yes	Yes
E. In cases where a project action limit is less than the laboratory quantitation limit, the analyte is identified and the UFP-QAPP includes an explanation of how the analyte results will be evaluated	Yes	Not a factor. No PAL applied.
Worksheet #17: Sampling Design and Rationale		
A. Describes the sampling design and the basis for its selection, including the following:	Yes	Yes, with incorporation of Agency comments
B. Physical boundaries for the area under study, including maps or diagrams	Yes	Yes, available in appendices.
C. Time period being represented by the collected data	Yes	Yes, with incorporation of Agency comments
D. Descriptions and basis for dividing the site into sampling units (e.g., decision units, exposure units, etc.) that support the decision statements documented in Worksheet #11	Yes	Yes, with incorporation of Agency comments
E. Basis for the number and placement of samples within sampling units	Yes	Yes, with incorporation of Agency comments
F. Descriptions of how actual sample positions will be located once in the field (include maps or diagrams)	Yes	Yes, available in appendices.
G. Includes the decision process for changing sample locations if a sample cannot be collected where planned	Yes	Yes, with incorporation of Agency comments
H. Process for determining sample locations in the field (if applicable)	Yes	Yes, with incorporation of Agency comments

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
I. Contingencies in the event field conditions are different than expected and could affect the sampling design	Yes	Yes. "In the event field conditions are different than expected or a sample location cannot be collected where planned and could affect the sampling design, the field geologist will use their best judgment to determine the plan of action and confirm with the team."
Worksheet #18: Sampling Locations and Methods		
A. Lists each individual sample planned for collection, including field QC samples	Yes	Yes, once comments are addressed
B. Detailed sampling SOPs are referenced in the worksheet and attached to the UFP-QAPP	Yes	Yes
C. Includes a map with locations marked	Yes	Yes, in appendix
Worksheets #19 & 30: Sample Containers, Preservation, Hold Times and Analytical Services		
A. Includes a separate worksheet for each laboratory used	Yes	Yes
B. Includes the laboratory name, sample receipt address, point of contact, phone number, and email address	Yes	Yes
C. Lists the required accreditation certification for each laboratory	Yes	Yes
D. Laboratory accreditation certificates are current and attached to the UFP-QAPP	Yes	Yes, and available in an appendix.
E. For each analyte/analyte group, identifies the sample matrix, method/SOP number, required container(s) (number, size, and type per sample), preservation, preparation holding time, analytical holding time, and data package turnaround	Yes	Yes
F. If applicable, identifies a backup laboratory that will be used if the primary laboratory cannot be used. Note that if a backup laboratory is identified, all applicable UFP-QAPP worksheets (e.g., Worksheets #15, #23, #24, #25, #28, etc.) must include the required information for the backup laboratory.	Yes	None identified and none needed as the type of samples being collected are standard samples in mine reclamation and Energy Laboratories has multiple laboratories in Montana should the Helena laboratory not be able to analyze the samples
G. Describes or references procedures for how supplies and services are inspected and accepted, including the responsible party (may also be included in Worksheets #22 or #25)*		No procedures available in this worksheet. Provided as a summary comment in beginning of checklist Inspection and acceptance criteria are found in Worksheet #22.
H. Specifies elements that vendors are responsible for and to verify their work/adherence to the UFP-QAPP (may also be included in Worksheets #22 or #25)*		No specific elements available in this worksheet. Please include in revision This is included in Worksheet #25.
Worksheet #20: Field QC Summary		
For each matrix and analyte/analytical group, lists the number of primary field samples to be collected, the type and number of field QC samples to be collected, and the total number of analyses (field and field QC samples combined) that will be sent to the analytical laboratory	Yes	Provided.
Worksheet #21: Field SOPs		
A. Lists SOPs (title, revision, date, and originating organization) containing detailed procedures for all field activities, including sample collection; sample preservation; equipment use; equipment cleaning and decontamination; equipment testing, maintenance, and inspection; and sampling handling and custody	Yes	Yes
B. Identifies person(s) responsible for maintaining SOPs*	Yes	Yes

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
C. Notes any project-specific options or modifications to an SOP, if applicable*	Yes	None identified. I feel this is addressed in worksheet #6
D. Field SOPs are attached to the UFP-QAPP	Yes	Yes
Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection		
A. Provides a list of all in-situ testing instruments and field equipment, including tools, gauges, and pumps*	Yes	Yes
B. Documents the procedures for calibrating, maintaining, testing, and/or inspecting all field equipment	Yes	Yes, in an appendix
C. Identifies the individual(s) responsible for field equipment	Yes	Yes
D. Includes frequency, acceptance criteria, and corrective action or references and attaches the relevant SOP or manufacturer's instructions	Yes	Yes
Worksheet #23: Analytical SOPs		
A. Lists SOPs (title, revision, and date) containing the specific sample preparation and analytical procedures to be used to perform on-site or fixed-laboratory analysis for each matrix/analytical group and indicates whether the procedure produces screening or definitive data	Yes	Yes
B. Identifies person(s) responsible for maintaining SOPs*	Yes	Yes
C. Notes any project-specific options or modifications to an SOP, if applicable*	Yes	Yes
D. Analytical SOPs are attached to the UFP-QAPP	Yes	Yes, in an appendix.
Worksheet #24: Analytical Instrument Calibration		
A. Identifies all analytical instruments and equipment, whether used in the field or the laboratory*	Yes	Yes
B. For each instrument, identifies the calibration procedure, calibration range, frequency, acceptance criteria, corrective action, title/position responsible for corrective action, and SOP reference	Yes	Yes
Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection		
Lists all analytical instrument/equipment that requires maintenance, testing, and inspection activities; lists the specific maintenance, testing, and inspection activity; frequency; acceptance criteria; corrective action; title/position responsible for corrective action; and reference for those activities (e.g., SOP, laboratory quality manual)	Yes	Yes, available in appendices.
Worksheets #26 & 27: Sample Handling, Custody, and Disposal		
A. Describes the responsibilities and SOP references for maintaining custody of samples from collection through disposal	Yes	Yes
B. Indicates the method of sample delivery (shipper/carrier)	Yes	Yes
C. Indicates the number of days from reporting until sample disposal	Yes	Yes, in Lab SOPs
D. Referenced SOPs are attached to the UFP-QAPP	Yes	Yes, in an appendix
E. Examples of forms, sample labels, chains-of-custody, and sample custody logs documentation are attached to the UFP-QAPP*	Yes	Yes, in an appendix

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
F. Describes or references the process for tracing the path of environmental information from generation to final use/storage, including record keeping, document control, and electronic media (may also be included in Worksheet #29)*	Yes	Yes
G. Describes or references any hardware/software and forms/checklists to be used (may also be included in Worksheet #29)*	Yes	Yes
Worksheet #28: Analytical Quality Control and Corrective Action		
A. Includes a separate worksheet for each sample matrix, analytical method, and concentration level	Yes	Yes
B. Identifies the type, number, and frequency of QC sample collection (field) or QC sample analysis (laboratory), along with the method/SOP acceptance criteria, corrective action, and title/position responsible for corrective action	Yes	Yes
C. Information that is duplicated in Worksheets #12, #15, and #28 is consistent	Yes	Yes
Worksheet #29: Project Documents and Records		
A. Includes a comprehensive list of the documents and records that will be generated for the project, including sample collection and field records, project assessments, and laboratory records	Yes	Yes
B. Includes requirements for laboratory data deliverable contents consistent with the expected stages selected for data validation	Yes	Yes
C. Provides electronic data deliverable (EDD) requirements consistent with project-specific requirements	Yes	Yes
D. Describes or references final disposition of records, documents, reports, information, and records retention time*	Yes	Yes
E. Describes how management reports will be transmitted and distributed, including distribution to the project Operations/Project Manager, project QA Manager, and EPA. Describes the oversight responsibility to make sure these mechanisms are in place (may also be included in Worksheets #31, 32 & 33).*	Yes	Yes
Worksheets #31, 32 & 33: Assessments and Corrective Action		
A. Lists the required number, frequency, and type of assessments with approximate dates and responsible party/organization for conducting the assessments	Yes	Yes
B. For each assessment listed, identifies the individual(s) and organization responsible for responding to assessment findings, assessment response documentation, and timeframe for response	Yes	Yes
C. For each assessment listed, identifies the responsibility for implementing the corrective action	Yes	Yes
D. For each assessment listed, identifies the responsibility for monitoring corrective action implementation	Yes	Yes
Worksheet #34: Data Verification and Validation Inputs		
A. Identifies the planning documents (e.g., UFP-UFP-QAPP, contract, field SOPs, laboratory SOPs), field records, and laboratory records that will be used during data verification and validation	Yes	Yes

Element	Acceptable (Yes/No/NA) (Completed by EPA QA Reviewer)	Comments (Completed by QAPP Author and EPA QA Reviewer)
B. Indicates whether each item will be used for verification (completeness), validation (conformance to specifications), or both	Yes	Yes
Worksheet #35: Data Verification Procedures		
A. Describes the procedures that will be used for data verification (e.g., field records, laboratory records, assessment reports, corrective action reports, etc.)	Yes	Yes
B. For each record reviewed, references the document containing the requirements and responsible person/organization	Yes	Yes
Worksheet #36: Data Validation Procedures		
A. Describes the procedures that will be used to validate project data, including specific SOP references, if applicable	Yes	Yes
B. Referenced data validation SOPs are attached to the UFP-QAPP, if applicable	Yes	Yes, in an appendix
C. Validation procedures define the validation stage code and validation approach (e.g., percent of data packages to be validated, percent of raw data to be reviewed, percent of results to be recalculated, and any differences by matrix)	Yes	Yes
D. Data qualifiers that will be applied during data validation are listed and defined (e.g., U, UJ, J +/-, X, R). Note that data qualifiers applied during data validation are different than laboratory qualifiers that appear in the laboratory data package (i.e., laboratory qualifiers should not be considered final or absolute).	Yes	Yes
E. Validation checklists that will be used by the data validator are attached to the UFP-QAPP	Yes	Yes, included in an appendix
Worksheet #37: Data Usability Assessment		
A. Describes the procedures for performing the data usability assessment, including interim steps and statistics, equations, and computer algorithms to be used to assess the data	Yes	Yes
B. Describes the documentation that will be generated during the usability assessment (e.g., data usability report)	Yes	Yes
C. Identifies the individual(s) responsible for reconciling the data to the project DQOs and preparing the data usability report	Yes	Yes
D. Describes how usability assessment results will be presented so they identify trends, relationships (correlations), deviations, and anomalies	Yes	Yes
E. Describes how each data quality indicator (DQI) (i.e., precision, accuracy/bias, representativeness, completeness, comparability, and sensitivity) will be calculated and evaluated, including the QC activity that will be used to assess each DQI and any applicable formulas and methods		Step 2 has a partial statement. Added language from another QAPP. Please modify to reflect procedures that Arcadis adheres to. Added language is good, no changes necessary.
F. Provides a completeness goal for the project		A completeness goal is not noted. A completeness goal of 90% has been added with the language provided
G. Describes the circumstances under which data would be rejected (i.e., data that do not meet measurement performance criteria and project DQOs) and removed from the final data set	Yes	Yes, in Step 3.

Element	Acceptable (Yes/No/NA) <i>(Completed by EPA QA Reviewer)</i>	Comments <i>(Completed by QAPP Author and EPA QA Reviewer)</i>
H. Discusses resolution of potential data gaps		Not noted. Please expand with revised QAPP Added a new Step 3
I. Discusses how limitations in the final data set will be documented and communicated to all end data users and stakeholders		Though not explicitly noted, the indication is that it will be discussed in the data usability report.
J. Indicates that the data usability report will discuss whether DQOs have been met and whether data is of sufficient quality and quantity to be used for its intended purpose and to make decisions about the site		Though not explicitly noted, the indication is that it will be discussed in the data usability report.
END		

ATTACHMENT 1

EPA REGION 8 UFP-QAPP REVIEW CROSSWALK FOR ANNUAL REVIEWS

[to be completed at least 60 days prior to the anniversary date of EPA RQAM or DAO approval]

PURPOSE:

The Annual Review Crosswalk is used to document UFP-QAPP annual reviews, as well as concurrence with the annual review by the RQAM or DAO.

All organizations are required to review their UFP-QAPP at least annually to confirm its suitability and evaluate its effectiveness for the project. Although the approved UFP-QAPP should be implemented as written, changes to original plans may be needed. Minor changes to the project throughout each year during the UFP-QAPP's period of applicability will be documented using this Annual Review Crosswalk.

If significant changes are made to the project, the revised UFP-QAPP, including all figures, attachments and appendices, must be submitted to EPA for review and re-approval. When significant changes are made, the revised UFP-QAPP shall include a revision history page that briefly summarizes the changes made. When significant changes are made, no work under the revised UFP-QAPP shall be performed until the UFP-QAPP is reviewed and approved by the RQAM or DAO.

Minor UFP-QAPP Changes – Those changes that **do not** affect the project objectives, the organization's mission or structure, or the details of project QA/QC implementation.

Significant UFP-QAPP Changes – Changes that **do** affect the project objectives, the organization's mission or structure, or the details of project QA/QC implementation, including, but not limited to:

- Changes in the scope of the project resulting in new or revised project objectives (e.g., adding new sample matrices or analytical methods)
- Changes in implementation, such as how information will be collected, produced, evaluated, or used (e.g., adding new field or laboratory testing equipment, adding or changing the analytical laboratory, etc.)
- Changes in the design, construction, operation, or application of environmental technology
- Changes in the statement of work or workplan
- Expiration of the UFP-QAPP
- Changes in the organization's mission or structure, such as delegation status of UFP-QAPPs
- Changes in performance or acceptance criteria as to how results will be assessed for acceptance

The Annual Review Crosswalk is a controlled document. Do not modify the crosswalk format or document type.

INSTRUCTIONS:

UFP-QAPPs have a period of applicability of up to 5 years from the date of RQAM or DAO approval. Attached is an Annual Review Crosswalk for years 2, 3, 4, and 5 of the 5-year period of applicability. For the Year 2 annual review, complete the page titled, "Annual Review Crosswalk - Year 2." Follow the same process for each subsequent annual review until the end of the period of applicability.

This crosswalk with full review comments and resolutions, as well as each Annual Review Crosswalk, will remain with the UFP-QAPP for its entire period of applicability.

Note: *Maintain the original approved UFP-QAPP intact (official PDF copy with all signatures). For minor changes to the approved UFP-QAPP, the organization is responsible for ensuring all project personnel are made aware of the changes once EPA has concurred that the annual review is complete. EPA recommends that the organization make a copy of the Annual Review Crosswalk and attach it to the front of the approved UFP-QAPP where it is highly visible to all UFP-QAPP users.*

Please submit the following to EPA when each annual review is complete:

- Complete Crosswalk documenting the original review comments and all Annual Review Crosswalks with the current year's annual review information completed
- Original approved UFP-QAPP with all signatures, attachments, and appendices
- Workplan, Research Plan, Project Plan, Statement of Work, Task Order, Court Order, etc.
- Other relevant, important documents

ANNUAL REVIEW CROSSWALK – YEAR 2

To Be Completed by the UFP-QAPP Preparer:			
Annual Review Completed By: <i>(Name, Title, Contact Info)</i>		Annual Review Completion Date:	MM/DD/YYYY
Attestation of the Annual Review:			
☐ Minor changes are documented in the table below.			
☐ The UFP-QAPP was reviewed, but no changes are necessary for the project.			

To Be Completed by the EPA QA Reviewer:			
QA Reviewer: <i>(Name, Email)</i>		Date Completed:	MM/DD/YYYY
EPA QA Reviewer (QA Branch or DAO)?	QAB ☐ DAO ☐		
	QAB ID#:		
Attestation of Annual Review:			
☐ The EPA QA Reviewer concurs no significant changes were made to the document and the annual review is complete.			
☐ The EPA QA Reviewer concluded that significant changes were made to the document and a full review will be conducted. The UFP-QAPP preparer has been contacted to make revisions to the UFP-QAPP, identify the changes in a revision history page, and submit a new Crosswalk to EPA to initiate the review and approval process.			

RECORD OF MINOR CHANGES MADE TO THE PROJECT			
UFP-QAPP Section <i>(Completed by the UFP-QAPP Preparer)</i>	UFP-QAPP Page Number(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Full Description of Change(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Comments <i>(Completed by the UFP-QAPP Preparer and EPA QA Reviewer)</i>

ANNUAL REVIEW CROSSWALK – YEAR 3

To Be Completed by the UFP-QAPP Preparer:			
Annual Review Completed By: <i>(Name, Title, Contact Info)</i>		Annual Review Completion Date:	MM/DD/YYYY
Attestation of the Annual Review:			
☐ Minor changes are documented in the table below.			
☐ The UFP-QAPP was reviewed, but no changes are necessary for the project.			

To Be Completed by the EPA QA Reviewer:			
QA Reviewer: <i>(Name, Email)</i>		Date Completed:	MM/DD/YYYY
EPA QA Reviewer (QA Branch or DAO)?	QAB ☐ DAO ☐		
	QAB ID#:		
Attestation of Annual Review:			
☐ The EPA QA Reviewer concurs no significant changes were made to the document and the annual review is complete.			
☐ The EPA QA Reviewer concluded that significant changes were made to the document and a full review will be conducted. The UFP-QAPP preparer has been contacted to make revisions to the UFP-QAPP, identify the changes in a revision history page, and submit a new Crosswalk to EPA to initiate the review and approval process.			

RECORD OF MINOR CHANGES MADE TO THE PROJECT			
UFP-QAPP Section <i>(Completed by the UFP-QAPP Preparer)</i>	UFP-QAPP Page Number(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Full Description of Change(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Comments <i>(Completed by the UFP-QAPP Preparer and EPA QA Reviewer)</i>

ANNUAL REVIEW CROSSWALK – YEAR 4

To Be Completed by the UFP-QAPP Preparer:			
Annual Review Completed By: <i>(Name, Title, Contact Info)</i>		Annual Review Completion Date:	MM/DD/YYYY
Attestation of the Annual Review:			
☐ Minor changes are documented in the table below.			
☐ The UFP-QAPP was reviewed, but no changes are necessary for the project.			

To Be Completed by the EPA QA Reviewer:			
QA Reviewer: <i>(Name, Email)</i>		Date Completed:	MM/DD/YYYY
EPA QA Reviewer (QA Branch or DAO)?	QAB ☐ DAO ☐		
	QAB ID#:		
Attestation of Annual Review:			
☐ The EPA QA Reviewer concurs no significant changes were made to the document and the annual review is complete.			
☐ The EPA QA Reviewer concluded that significant changes were made to the document and a full review will be conducted. The UFP-QAPP preparer has been contacted to make revisions to the UFP-QAPP, identify the changes in a revision history page, and submit a new Crosswalk to EPA to initiate the review and approval process.			

RECORD OF MINOR CHANGES MADE TO THE PROJECT			
UFP-QAPP Section <i>(Completed by the UFP-QAPP Preparer)</i>	UFP-QAPP Page Number(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Full Description of Change(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Comments <i>(Completed by the UFP-QAPP Preparer and EPA QA Reviewer)</i>

ANNUAL REVIEW CROSSWALK – YEAR 5

To Be Completed by the UFP-QAPP Preparer:			
Annual Review Completed By: <i>(Name, Title, Contact Info)</i>		Annual Review Completion Date:	MM/DD/YYYY
Attestation of the Annual Review:			
☐ Minor changes are documented in the table below.			
☐ The UFP-QAPP was reviewed, but no changes are necessary for the project.			

To Be Completed by the EPA QA Reviewer:			
QA Reviewer: <i>(Name, Email)</i>		Date Completed:	MM/DD/YYYY
EPA QA Reviewer (QA Branch or DAO)?	QAB ☐ DAO ☐		
	QAB ID#:		
Attestation of Annual Review:			
☐ The EPA QA Reviewer concurs no significant changes were made to the document and the annual review is complete.			
☐ The EPA QA Reviewer concluded that significant changes were made to the document and a full review will be conducted. The UFP-QAPP preparer has been contacted to make revisions to the UFP-QAPP, identify the changes in a revision history page, and submit a new Crosswalk to EPA to initiate the review and approval process.			

RECORD OF MINOR CHANGES MADE TO THE PROJECT			
UFP-QAPP Section <i>(Completed by the UFP-QAPP Preparer)</i>	UFP-QAPP Page Number(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Full Description of Change(s) <i>(Completed by the UFP-QAPP Preparer)</i>	Comments <i>(Completed by the UFP-QAPP Preparer and EPA QA Reviewer)</i>

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QAPP Worksheet #1&2 – Title and Approval Page

Contract/work assignment number: Attachment to a work plan (Work Plan, Arcadis 2025) that will accompany an Administrative Settlement Agreement and Order on Consent

1. Project Identifying Information

- a. Site name/project name: Barker Hughesville Mining District Superfund Site
- b. Site location/number: Cascade and Judith Basin Counties, Montana

2. Lead Organization: On behalf of Mt. Emmons Mining Company (MEMC)

- i. Name: Barb Nielsen
- ii. Title: Project Manager
- iii. Signature: 
- iv. Date: 1/16/26

3. Lead Organization: On behalf of Mt. Emmons Mining Company (MEMC)

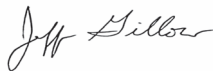
- i. Name: Jessica Szaro
- ii. Title: Quality Manager
- iii. Signature: 
- iv. Date: 1/19/2026

4. Other Stakeholders

a. Primary Contractor: Arcadis

- i. Name: Dylan Davis
- ii. Title: Project Manager
- iii. Signature: 
- iv. Date: 1/14/26

b. Primary Contractor: Arcadis

- i. Name: Jeffrey Gillow
- ii. Title: Quality Officer
- iii. Signature: 
- iv. Date: 1/14/26

c. Support Agency: Montana Department of Environmental Quality (MDEQ)

- i. Name: Amber Nichols
- ii. Title: Project Officer
- iii. Signature: 
- iv. Date: 01/22/2026

DocuSigned by:

C80B6FD56287496...
01/22/2026

Quality Assurance Project Plan
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d. Lead Agency: United States Environmental Protection Agency (USEPA)

- i. Name: Roger Hoogerheide
- ii. Title: Region VIII Remedial Project Manager
- iii. Signature: Roger
- iv. Date: Hoogerheide

Digitally signed by Roger
Hoogerheide
Date: 2026.01.20 14:14:23 -07'00'

e. Support Agency: United States Forest Service (USFS)

- i. Name: Steve Opp
- ii. Title: On-Scene Coordinator
- iii. Signature: JAMES OPP
- iv. Date:

Digitally signed by JAMES
OPP
Date: 2026.01.20 14:30:28
-07'00'

5. Plans and reports from previous investigations relevant to this project:

- A. 2016 – Remedial Investigation Report for Barker-Hughesville Mining District Superfund Site, Cascade and Judith Basin Counties, MT, prepared for US Environmental Protection Agency.
- B. 2017 – Mt. Emmons Mining Company Lab-Scale Treatability Study of Danny T Mine Adit Discharge, Barker Hughesville Mining District Superfund Site Cascade and Judith Basin Counties, MT.
- C. 2022 – Danny T Adit Flow and Water Quality Monitoring November 2020 to November 2021, Barker-Hughesville Mining District Superfund Site, MT, prepared by Arcadis.
- D. 2024 – Background, roads and trails sampling and repository siting. prepared by HGL
- E. 2025 – Hydraulic Analysis and Floodplain Mapping Report. Prepared by Tetra Tech
- F. 2012 – The Town of Neihart, Carpenter-Snow Creek, and Barker-Hughesville Superfund Sites, Montana *§106 Determination of Eligibility for the National Register of Historic Places and Effect Analysis for EPA CERCLA Actions. Prepared by Heritage Stewardship Group*

6. Other QA planning documents with relevant requirements:

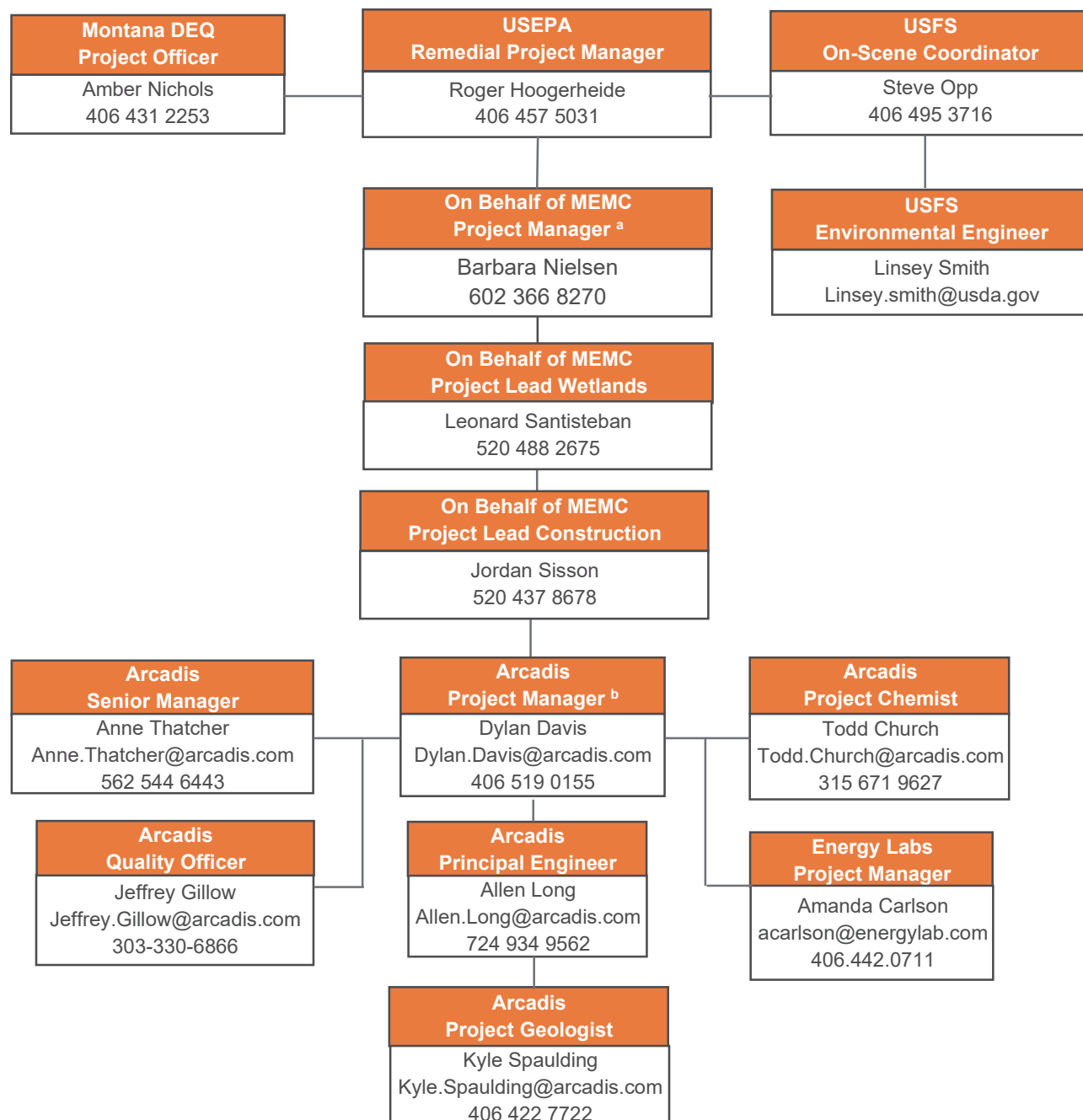
- A. Laboratory Quality Assurance Manual (Attachment 1)
- B. Laboratory Standard Operating Procedures (Attachment 2)

Notes:

¹ The UFP-QAPP will be reviewed annually to confirm suitability/effectiveness. The review must be documented using the R8 UFP-QAPP Crosswalk. Any substantial changes will be documented and approved before implementation. Minor changes will be documented and submitted to the approving authority in writing annually.

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QAPP Worksheet #3&5 – Project Organization and QAPP Distribution



Notes:

^a Indicates recipient and approval authority for the UFP-QAPP

^b Indicates individual responsible for maintaining the UFP-QAPP

^c A complete copy of UFP-QAPP modifications will be maintained on file.

^d Staff with QA roles have separate reporting lines than staff within operations to maintain independence from each other. Additionally, Arcadis maintains an "Integrity Line" through which employees can anonymously report integrity issues.

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QAPP Worksheet #4, 7, & 8 – Personnel Qualifications and Sign-Off Sheet

Name	Project Title/Role	Education/Experience/Specialized Training/Certifications	You have read the UFP-QAPP and will implement it as it is written Signature	Date
Arcadis				
Dylan Davis	Project Manager	Bachelor of Science (B.S.) Geosciences, OSHA HAZWOPER 40hr, e-Rail Safe		1/14/2026
Anne Thatcher	Senior Technical Advisor	Bachelor of Art (B.A.) Biology and Chemistry, 37 years of experience, OSHA HAZWOPER 40hr, MSHA		1/14/2026
Allen Long	Principal Engineer – Geotechnical and Engineering Support	Bachelor of Science (B.S.) Geotechnical Engineering, Master of Science (M.S.) Geotechnical Engineering, 25 years of experience, Construction Document Technologist (CDT), PE - AL, FL, IL, KS, KY, MD, MT, NM, OH, OK, PA, VA, WV		1/14/2026
Todd Church	Project Chemist – Technical Support	Bachelor of Science (B.S.) Environmental Management, 38 years of experience		1/14/2026

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Name	Project Title/Role	Education/Experience/Specialized Training/Certifications	You have read the UFP-QAPP and will implement it as it is written Signature	Date
Kyle Spaulding	Project Geologist – Project Task Manager	Bachelor of Science (B.S.) Geology, Master of Science (M.S.) Geophysics, 11 years of experience, OSHA HAZWOPER 40hr, MSHA		1/14/2026
MEMC				
Barb Nielsen*	Project Manager	Bachelor of Science (BS) Geological Engineering. Over 40 years of investigation, remediation, and reclamation experience. OSHA 40 hour HAZWOPER and Supervisor training and MSHA.		1/16/26
Leonard Santisteban	Project Lead Wetlands	Bachelor of Science (BS) Wildlife Ecology, Master of Science (MS) Wildlife Ecology, Doctor of Philosophy (PhD) Biology. Twelve years of experience in Bioremediation. OSHA HAZWOPER 40 hour, MSHA		1/19/2026
Jordan Sisson	Project Lead Construction	20 years of reclamation and remediation experience, 40hr and 8hr Supervisor HAZWOPER, MSHA		1/19/2026

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Name	Project Title/Role	Education/Experience/Specialized Training/Certifications	You have read the UFP-QAPP and will implement it as it is written Signature	Date
USEPA Region VII				
Roger Hoogerheide	Remedial Project Manager		Roger Hoogerheide Digitally signed by Roger Hoogerheide Date: 2026.02.12 11:49:28 -07'00'	
Angela Frandsen	Hydrogeologist		ANGELA FRANDSEN Digitally signed by ANGELA FRANDSEN Date: 2026.02.12 12:09:49 -07'00'	
USDA- USFS				
Steve Opp	On-Scene Coordinator		JAMES OPP Digitally signed by JAMES OPP Date: 2026.02.12 13:36:32 -07'00'	
Linsey Smith	Environmental Engineer		LINSEY SMITH Digitally signed by LINSEY SMITH Date: 2026.02.12 12:30:51 -07'00'	
Montana DEQ				
Amber Nichols	Project Officer		Amber Nichols	2/12/2026

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Name	Project Title/Role	Education/Experience/Specialized Training/Certifications	You have read the UFP-QAPP and will implement it as it is written Signature	Date
Energy Lab				
Amanda Carlson	Project Manager – Geochemical Technical Advisory, Laboratory Liaison	Bachelor of Arts (B.A.) in Chemistry, 17 years of experience in Quality Assurance, 12 years as an Assistant Laboratory Manager		1/14/2026

Note:

The project personnel sign-off table above documents key project personnel who have read the applicable sections of and will perform required activities in accordance with this QAPP.

*Individual responsible for ensuring personnel are qualified and for documenting trainings.

QAPP Worksheet #6 – Communications Pathways

Communication Driver	Organization	Name	Contact Information	Procedure (e.g., timing, pathways, documentation)
Regulatory agency interface	USEPA	Roger Hoogerheide	406 457 5031 hoogerheide.roger@epa.gov	Reports provided to USEPA Remedial Project Manager via email in accordance with the schedule provided in the Work Plan
Stop work due to safety issues	Arcadis	Dylan Davis	406 519 0155 dylan.davis@arcadis.com	As needed, communicate to MEMC PM and MEMC Health and Safety via phone within 1 hour. MEMC PM will notify EPA RPM via email within 24 hours.
QAPP changes prior to field work	Arcadis	Dylan Davis	406 519 0155 dylan.davis@arcadis.com	As needed, communicate to project team via email within one week with a hard copy revised QAPP to follow

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Communication Driver	Organization	Name	Contact Information	Procedure (e.g., timing, pathways, documentation)
QAPP changes during project execution	Arcadis	Dylan Davis	406 519 0155 dylan.davis@arcadis.com	As needed, communicate to project team via email within 24 hours with a hard copy revised QAPP to follow
Sample receipt variances	Energy Lab	Amanda Carlson	ACarlson@energylab.com	Upon discovery, notify Arcadis PM and MEMC PM via email within 24 hours. Arcadis PM will notify EPA RPM via email within 48 hours.
Laboratory quality control variances	Energy Lab	Amanda Carlson	ACarlson@energylab.com	Upon discovery, notify Arcadis PM and MEMC PM via email within 24 hours. Arcadis PM will notify EPA RPM via email within 48 hours.
Analytical corrective actions	Energy Lab	Amanda Carlson	ACarlson@energylab.com	Upon discovery, notify Arcadis PM and MEMC PM via email within 24 hours with a hard copy analytical report to follow. Arcadis PM will notify EPA RPM via email within 48 hours.
Data verification issues, e.g., incomplete records	Arcadis	Todd Church	315 671 9627 todd.church@arcadis.com	Upon discovery, notify Arcadis PM via email within 24 hours and hard copy data validation report to follow.
Data validation issues, e.g., non-compliance with procedures	Arcadis	Todd Church	315 671 9627 todd.church@arcadis.com	Upon discovery, notify Arcadis PM via email within 24 hours and hard copy data validation report to follow.
Data review corrective actions	Arcadis	Todd Church	315 671 9627 todd.church@arcadis.com	Upon discovery, notify Arcadis PM via email within 24 hours and hard copy data validation report to follow.

Note:

Every Arcadis employee, subcontractor, and client representative at the Site has the responsibility to stop the work of a co-worker or subcontractor if issues (e.g., change in working conditions, employee behavior) arise.

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QAPP Worksheet #9 – Project Planning Session Summary

Work on this project is ongoing. Numerous project team meetings and conference calls have been held since project initiation to discuss project logistics/issues. See table below for 2025 scoping session meeting.

Project Name	Barker Hughesville Mining District Superfund Site	
Site Name	Barker Hughesville and Carpenter Snow Creek	
Site Location	Cascade and Judith Basin Counties, Montana	
Meeting Location	Virtual	
Date	June 27, 2025	
Purpose	Meeting with EPA, MDEQ and USFS to discuss the next steps.	
Meeting Title	Agency comments on the QAPP Attachment A of the Liberty Mine Area workplan	
Participants	Hoogerheide, Roger (USEPA Region VIII – Remedial Project Manager) Frandsen, Angela (USEPA Region VIII – Remedial Project Manager) Long, Allen (Arcadis – Engineer of Record) Thatcher, Anne (Arcadis – Senior Technical Advisor) Opp, James (USFS – On-Scene Coordinator) Smith, Linsey (USFS – Environmental Engineer) Nichols, Amber (MT DEQ – Project Officer)	
Key Decision	Use new UFP-QAPP Crosswalk	

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QAPP Worksheet #10 – Conceptual Site Model

The Barker Hughesville Mining District Superfund Site (BHMD or Site) is located in the Little Belt Mountains within the Dry Fork Belt Creek Watershed. The BHMD includes three operable units (OUs): OU 1 (Galena Creek), OU 2 (Dry Fork Belt Creek) and OU3 (Liberty Mine Area) (see Figure 2 in the Work Plan). The BHMD has been explored for silver and lead ore deposits since 1879, and mining of these deposits continued throughout the district until the ores began to be depleted in 1883. Several attempts to restore exploration and mining activity have occurred from the 1930s to the 1980s, including reopening several mines and adits. There has been minimal exploration and mining activity since the 1980s (Remedial Investigation Report [RI Report]; CDM Federal Programs Corporation [CDM] 2016).

Regulatory involvement at the BHMD began in 1965, but investigation work largely started in the 1990s. The BHMD was formally included on the National Priorities List in 2001 due to risks to public health and the environment stemming from concentrations of hazardous substances associated with unsecured mine waste and mine-impacted waters that exceed regulatory screening levels and/or background concentrations. The specific preliminary constituents of potential concern that have been detected in the waste rock include arsenic, cadmium, copper, lead, manganese, thallium, and zinc whereas the specific preliminary constituents of potential concern that have been identified in mine discharge samples include aluminum, arsenic, cadmium, copper, iron, lead, selenium, thallium, and zinc.

The Site includes more than 45 abandoned mines, mills, and multiple tailings sites, which are scattered across the BHMD. The abandoned mines and mills are primarily located within the OU1 Galena Creek drainage, which feeds into Dry Fork Belt Creek (CDM 2016).

The Liberty Mine Area (OU3) is part of the abandoned mines within the BHMD located in the middle reach of Galena Creek. It has been characterized in the RI Report and informally elsewhere as the Liberty Mine Complex. The Liberty Mine Area consists of multiple waste piles, buildings, load-out structures, and several adits (MEMC 2017).

Mining waste is a source of contamination, resulting in mine-influenced water that acts as a secondary source of contamination. Additionally, mining activities such as crushing and grinding of ore deposits can result in the mobilization of metals as fine-grained particulates transported by wind or water. Releases from the primary source results in further contamination of adjacent media such as surface soil, surface water, sediment and groundwater. This media becomes a secondary source that can continue to release and transport contaminants through precipitation, runoff, erosion, infiltration, leaching, and adsorption/desorption.

Two of the mines within the Liberty Mine Area (the Danny T Adit and the Marcelline Shaft) have been observed flowing. The Danny T Adit has been observed flowing year-round, while the Marcelline Shaft has been observed flowing into Galena Creek only during spring high flows (i.e., mid-May to mid-July). Water exiting the Danny T Adit reportedly consists of drainage from the upper mine workings including the upper three levels of the Liberty Mine (CDM 2016). The Danny T Adit area consists of a collapsed adit; a debris field in front of the adit; a metal building

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and a 2-inch, 60-degree V trapezoidal flume. Mine influenced water discharges from a 6-inch polyvinyl chloride pipe placed through collapsed debris in front of the Danny T Adit and passes through the flume. After flowing through the flume, mine influenced water flows largely unchanneled over a waste rock pile and down a sparsely vegetated steep hillside before discharging into Galena Creek during high flows. The discharge infiltrates into the subsurface before reaching Galena Creek during base flows.

The Marcelline Shaft consists of a mine access shaft covered with debris (i.e., a collapsed shaft house, ladder, and access doorway). Just uphill of the shaft house is an upper portal as well as a collapsed stope that allows surface water and groundwater to infiltrate into the underground workings. Samples from the Marcelline Shaft have been retrieved directly from the standing water in the shaft but the shaft house collapsed further in 2024 making it unsafe to collect the sample from the shaft. Water from the Marcelline Shaft flows over and through a moss mat consisting mainly of copper-wire moss (*Pohlia nutans*). During high flow sampling events, there is sufficient flow to collect a sample before it enters Galena Creek.

The topography at the site varies based on location, with a steeper slope and higher stream gradients in the northern part of OU1 and eastern portion of OU2. OU3 is on a steep north facing slope and Galena Creek is constrained by steep slopes on either side of the creek. This slope and gradient results in thin and disconnected aquifers and discharge to adjacent creeks. In locations of less steep stream gradients, floodplains are broader, and aquifers are thicker and more continuous, gaining water from adjacent creeks. The topography in OU2 is generally less steep, resulting in depositional areas of a lower-intensity environment.

There is a relatively thin (between 1.25 and 9 feet thick) alluvial aquifer near Galena Creek in OU1 composed of a mix of sand, gravel and cobbles, where groundwater is generally less than five feet below the ground surface. OU1 and OU3 are identified as the primary source of mine-related contamination onsite, with alluvial groundwater that is generally more impacted than in OU2. Groundwater monitoring in 2012 showed that alluvial groundwater contamination in OU1 was greatest in the vicinity of the Block P Mill Tailings, Block P Mine (MW-17), and Danny T Mine (12-MW05). Removal actions in both Block P locations were conducted and resulted in decreases in groundwater contamination. The alluvial water quality in OU2 is relatively good, with exceptions of wells and temporary well locations nearest to the confluence of Dry Fork Belt Creek and Galena Creek (MW011, WP012, WP014, WP016), and occasional exceedances in wells located in test pits with mine waste (WP080 and WP084). As MW-11, WP012, WP016 are located just south of Block P Mill Tailings, the contamination in these wells is directly related to that seen in Block P Mill Tailings.

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QAPP Worksheet #11 – Project/Data Quality Objectives

Step 1: State the Problem

The Barker Hughesville Mining District is a historic mining district composed of more than 45 abandoned mines, mills, and tailing sites contained within the Galena Creek Watershed. The Liberty Mine Area or OU3 is located within this district and represents several collapsed mine adits and associated waste rockpiles. It is generally located between the August No. 2 Adit to the north and the Annie E. Adit to the south. The RI Report identified waste rock in OU3 as containing metals above background concentrations, including arsenic, lead, manganese, and thallium. In addition, the Liberty Mine Area contains at least two known mine discharges: the Danny T Adit and the Marcelline Shaft (sporadic, intermittent flow). Water emanating from these adits/shaft typically has a pH lower than neutral and contains metals, primarily aluminum, arsenic, cadmium, copper, iron, lead, manganese, and zinc. While the RI Report includes a characterization-level assessment of waste rock and adit water from the Liberty Mine Area, additional data collection will be used to supplement the assessment of potential remedial alternatives.

The primary purpose of this work plan is to further determine the possible extent of the chemical impact in the waste rock, adit water, and soils and to achieve the following objectives:

- Further delineate the horizontal and vertical extent of waste rock at the Liberty Area by characterizing the surface and subsurface waste rock at sufficient depth to confirm the presence or absence of impacts and provide volumetric estimates that can be used for assessing potential removal action alternatives.
- Background levels will be based on the host geology and surficial soil types that best directly represent the Liberty Area that the waste rock piles are sourced from. This can be referenced from Figure 2.5 - 1 of the 2016 Remedial Investigation Report (CDM Federal Programs Corporation [CDM] 2016), indicating the primary geologic source for waste rock within the Liberty Area consists of the Hughesville Stock and Mixes Baldy – Anderson Peak Laccolith. These units are both igneous intrusive complexes. Thus, background sampling will be targeted within this geologic zone with the consideration of the current United States Department of Agriculture (USDA) surface soil taxonomy classification. The local soil type for the Liberty Area that would best represent background concentrations is the USDA Type 2268F (USDA 2023).
- Provide additional geochemical information on draining adit water to support the geochemical assessment, loading calculations, and estimate of passive treatment alternatives.

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- Conduct limited desktop assessment as well as field assessment of locations within the Galena Creek Watershed that may be conducive to repository construction and/or borrow material as part of solid media remedial alternatives.
- Conduct a desktop review and field survey for potential aquatic, biological, and cultural resources to provide additional information necessary for assessment of removal action alternatives.

Step 2: Identify the Goals of the Study

To meet the objectives, the following fundamental questions will need to be answered during the investigation:

What is the extent of impacted solid media within the Liberty Mine Area with respect to volume and metals impact in the soil?

If impact above background and Regional Screening Levels for solid media is detected, the extent of the impact will be evaluated as part of the planning for potential future action.

Is there chemical impact present in the solid media?

If impact above background and Regional Screening Levels for solid media is detected, the extent of the impact will be evaluated as part of the planning for potential removal action.

Is the quantity and geochemistry of draining adit water impacted and, if so, is the quantity of water conducive to passive removal alternatives?

The level of impact in draining adit water will be evaluated in terms of both geochemistry and flow. These data will be used to determine the dimensions of passive treatment alternatives.

Is a provisionally identified location suitable for a near-site repository location?

The MEMC site and other appropriate parcels located on public and private lands will be characterized as both a potential repository location and a borrow source. These locations will be assessed for geotechnical suitability as well as proximity to other area features. Results of the characterization will be used to determine the usefulness of an appropriate parcel for facilitating on site disposal of solid media and passive remediation substrate.

Step 3: Identify Information Inputs

The following inputs are required to answer the fundamental questions identified in Step 2 above:

- Review the historical data from previous investigations including the data from the RI Report and data from the recent monitoring memoranda completed by Arcadis and EPA's

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contractors. Historical data will be combined with new data collected in accordance with this Work Plan to provide an overall summary dataset.

- Determine the locations to further delineate for impacted soils by reviewing the historical data.
- Obtain metals data for all background samples and surface and subsurface waste rock and nearby soils within the Liberty Mine Area. Additional chemical data on waste rock will include analyzing 50 percent of samples for Synthetic Precipitation Leaching Procedure (SPLP) and Meteoric Water Mobility Procedure (MWMP) testing. Geotechnical samples will also be collected for index parameter testing (e.g., grain size) (e.g., grain size) and limited shear strength testing (e.g., direct shear) to provide baseline data to support removal alternative design.
- Use site observations and geochemical data to define impacted geographic areas. Areas of impacted solid media will be assessed against a topographic survey to calculate likely volumes of impacted material.
- Obtain flow data and inorganic geochemical samples from the Danny T Adit, August No. 2 Adit, and Marcelline Shaft (if water is flowing) to support removal alternative evaluation.
- Aquatic resources and biological surveys will evaluate biological condition data; physical habitat data; reference conditions and existing stressor information. The cultural resources records review provides crucial background information on known historic properties and the potential for encountering new ones. Key informational inputs include location and descriptions of previously recorded archaeological sites, historic buildings and structures, and districts as well as areas of potential effect where a project could have an effect on cultural resources.

The specific preliminary constituents of potential concern (preliminary constituents of potential concern [COPCs]) for waste rock, as identified in the RI Report (CDM 2016), are as follows:

- Arsenic;
- Cadmium;
- Copper;
- Lead;
- Manganese;
- Thallium; and
- Zinc.

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The specific preliminary COPCs for adit water identified in Danny T Adit and Marcelline Shaft water (total and/or dissolved concentrations) are as follows:

- Aluminum;
- Arsenic;
- Beryllium
- Cadmium;
- Cobalt
- Copper;
- Iron;
- Lead;
- Manganese;
- Selenium;
- Thallium; and
- Zinc.

This list of preliminary COPCs was chosen because these constituents have been detected in waste rock and adit discharge samples above background and RSLs near the Liberty Mine Area. These COPCs are expected to be collocated and proportional, where present, due to mining activities. The preliminary COPCs will be evaluated by an EPA-certified analytical laboratory analysis.

The analytical methods that will be used for the laboratory analysis of COPCs are identified in Table 2 and Table 3 of the Work Plan.

Step 4: Define the Boundaries of the Sampling

The Liberty Mine Area is within the Galena Creek Watershed and is defined spatially as mine features between and including the August No. 2 Adit to the north, the Annie E. Adit to the south, the Galena Creek riparian area to the west, and the top of the topographic ridge to the east (Figure 2 of the Work Plan).

The following types of analysis will be performed on waste rock samples:

1. Waste rock and soils (including streamside deposits) – metals, Acid Base Accounting (ABA), SPLP and MWMP analyses on 50 percent of collected metals samples as well as two geotechnical samples collected for index properties and shear strength at each waste rock location. Carbonate (inorganic carbon) and sulfur forms will also be collected in waste rock samples as they are critical for predicting and managing the potential for acid mine drainage.

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2. Waste rock samples will be collected from the 0 to 6-inch depth interval and a 6 to 24-inch depth interval. Additional depth samples may be collected based on the observed depth of waste rock during test pit excavation.
3. Soil samples will be collected from the 0- to 6-inch depth interval at the four cardinal locations adjacent to visual extent identified waste rock areas and analyzed for metals. Soil/waste rock contacts will need to be determined in the field to ensure no misrepresentation.

The following types of analysis will be performed on adit/shaft samples:

1. A single surface water grab sample will be collected from flows emanating from the Danny T Adit, August No. 2 Adit, and Marcelline Shaft in June 2026 (Figure 3 of the Work Plan). These samples will be analyzed for metals, major ions, and select inorganic chemical parameters. Flow data will be collected from the mine features using an established on-site flume, visual observation, and/or a volumetric method (e.g., bucket-and-stopwatch method).

The following types of analysis will be performed on background samples:

1. All samples will be sieved in the field and office and analyzed for TAL metals.

The following types of analyses will be performed on repository and borrow source samples:

1. Samples will be analyzed for index classification testing (Unified Soil Classification System [USCS] Soil Classification including gradation, Atterberg limits, and moisture content) as well as for characterization metals analysis similar to the background sample locations described above. Table 3 of the Work Plan details specific ASTM International standard testing methods for the considered repository analyses.

Practical constraints and obstacles may impede the sampling and interfere with the planned data collection. For example, the weather conditions at the Site may prevent collecting samples as scheduled. Also, the geological and physical conditions encountered at the sampling locations may interfere with the collection of a desired sample. If these conditions exist, it may be necessary to adjust the sampling schedule and possibly choose alternate sampling locations. Also, laboratory data may not meet the quality assurance criteria or reporting limit criteria, and it may be necessary to re-sample locations. However, adhering to the data measurement objectives (DQO Step 6) will help mitigate these risks.

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Step 5: Develop the Analytic Approach

The purpose of this step is to integrate the outputs from the previous steps into a statement that defines the conditions that would cause the decision-maker to choose among alternative actions. The following primary decision rules will be used to answer the fundamental questions:

- The nature and extent of the impacts will be evaluated.
- The levels of impacts and vertical and horizontal extent will be considered when determining potential risks and/or assessing potential alternative actions.

The parameters of interest are the absolute concentrations and the mean concentrations of each preliminary COPC in each survey area defined as Annie E Waste Area, August No. 2 Waste Area, Danny T Waste Area, Liberty Waste Area, Last Chance Waste Area, Liberty Intermediate Waste Area, Liberty No. 3 Waste Area, Marceline Waste Area, and Transverse Waste Area (Figure 1B of the workplan). The primary alternative hypothesis will be that the concentrations or mean concentrations of the measured preliminary COPCs are significantly greater than comparison levels as defined below. The null hypothesis will be that the concentrations or mean concentrations of the measured preliminary COPCs are less than or equal to the comparison levels. Sample results will be used to assess the concentration of COPCs with respect to comparison levels.

In order to develop the decision rules to evaluate the null and alternative hypotheses, comparison levels must be used to evaluate the preliminary COPC concentrations. For the purposes of this study, background soil concentrations established at locations in this assessment will be used as comparison values for solid media and the Montana Water Quality Standards Groundwater Human Health Standard for SPLP and MWMP metals/metalloids (USEPA 2019; Table 1). Adit surface water analytical results will be compared to the Montana Water Quality Standards Acute and Chronic Aquatic Life Benchmarks for total and dissolved metals/metalloids (USEPA 2019; Table 2). In addition, a local background area will be sampled to identify background soils near the Liberty Area. The background locations will be field located; however, these will generally be located topographically above the Liberty Area using soils that are not disturbed by previous mining. The location of sample collection efforts will be discussed and agreed upon by the Agencies.

Prior to calculating background levels, the dataset will be evaluated for statistical outliers using a three-step process. First, potential outliers will be determined by visual inspection of graphical representations of the data (i.e., probability plots, time-series charts, and/or box-and-whisker plots) and removed from the dataset. Second, datasets will be tested for normality using the Shapiro-Wilks test. If the dataset is normally distributed (or can be normalized by transformation), then a statistical outlier test will be used. If the dataset cannot be normalized, then Tukey's interquartile range (IQR) test will be used. Lastly, the potential outliers will be

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tested using a quantitative outlier test (i.e., Dixon's Test, Rosner's Test) at five percent significance or Tukey's IQR test. Statistical outliers determined using an outlier test will be identified and retained in the dataset unless egregious data quality issues are identified.

Upper Tolerance Limits (UTLs) are the USEPA recommended interval estimator statistic to be used for establishing background levels (USEPA 2002a, 2009, 2022b). The 95-95UTL represents the statistic such that 95 percent of observations (current and future) from the target population will be less than or equal to the 95-95UTL with a coverage coefficient of 0.95. If the dataset includes five or more detected values, the 95-95UTL will be calculated using USEPA ProUCL 5.2 (USEPA 2022b). If the dataset includes less than five detected values, the maximum detected value will be used to represent background. If the dataset is entirely comprised of non detect values, the maximum detection limit will be used to represent background.

The maximum of the established background levels and the previously mentioned screening levels (USEPA Region 9 RSLs) will be used as a comparison level for determining extent of the waste rock piles and associated impacted areas.

Comparison levels (maximum of screening levels and background as outlined above) are not cleanup goals but are established concentrations that are risk-based and/or are recommended concentrations based on state or federal guidance. These comparison levels therefore may not be appropriate cleanup levels. The selected comparison levels constitute initial guidelines, not final cleanup goals, and were used to guide the Data Quality Objectives (DQO) process. Subsequent comparison levels will be developed during the removal action process.

Step 6: Specify Performance or Acceptance Criteria

This step specifies the decision-maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in environmental data. These acceptable limits on decision errors allow decision-makers to generate resource-effective sampling designs while limiting uncertainties in the collected data.

In general, collected analytical data will be evaluated in accordance with this QAPP for precision, accuracy, representativeness, completeness, comparability, and sensitivity. Reviewed data deemed usable by the validation process will be considered acceptable.

Step 7: Develop the Plan for Obtaining Data

The objective of this section is to develop the process for collection and measurement of the decision inputs. The sampling program was designed to support the individual DQOs identified with each type of data need. In addition, the sampling design was developed to meet the tolerance criteria outlined in the previous section. Sampling procedures and methods

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of collection for site media (soil/sediment/water) will follow Arcadis' SOPs listed as TGLs in Appendix B of the Work Plan.

The consequence of the decision error will need to be balanced against the cost of limiting the possibility of these errors. These errors will be managed using precise and accurate analytical methods and a number of samples along with duplicate samples. Samples will need to be collected to minimize a false rejection decision error and to minimize the risk of not identifying solid and aqueous media that contain metals at concentrations greater than screening criteria. The approach to overcoming the large number of samples is to minimize duplication and unnecessary samples by evaluating the existing data, field visit observations, historical photographs, physical setting, documented past practice, and process history. However, the approach to overcoming the risk is to systematically perform sampling, even in areas where the impacts may not be present.

Primary waste rock samples will be collected after waste rock piles have been identified. Samples will be collected from test pits excavated into waste rock piles following SOP guidance in Appendix B of the Work Plan (specifically, QP 3.08 Field Sampling Measurements and Observations and TGI for Soil Drilling and Sample Collection). Shallow soil samples will be collected generally by hand excavation from areas adjacent to the waste rock piles or Galena Creek following the aforementioned SOP in Appendix B of the Work Plan. A minimum of one test pit and a maximum of three test pits will be excavated. A minimum of two samples will be collected from each test pit (Figure 2 of the Work Plan). Collected sample data from test pits will be combined with composite sample data from the RI Report to provide an overall characterization and delineation of each identified waste rockpile.

Soil sample locations will be selected to delineate the horizontal and vertical characteristics of the solid media (e.g., waste rock, fluvial deposits, and soils) and potentially impacted areas.

Adit water will be collected via grab samples utilizing SOP guidelines listed in Appendix B of the Work Plan (TGI for Surface Water Sample Collection). The Danny T Adit and Marcelline Shaft have been monitored in the RI Report, by MEMC (2017) by Arcadis (2022) and by TechLaw (2017, 2018, 2019, 2022, 2023, 2024). Surface water samples have also been collected from GC-30 (upgradient) and GC-20 (downgradient) of the Liberty Mine Area. Samples have been collected routinely in both high- and low- flow time periods; therefore, an established characterization dataset exists. Sampling data collected in this investigation will supplement the overall existing dataset.

To minimize unacceptable errors, laboratory analyses with a high degree of confidence and extensive quality assurance/quality control and documentation procedures will need to be employed. Therefore, National Environmental Accreditation Conference certified subcontract laboratories will be employed.

QAPP Worksheet #12-1 – Measurement Performance Criteria (Metals in Water and Soil)

Matrix	Water and Soil	
Analytical Group	Metals by USEPA Method 200.7/SW846 6010D / ELI SOP 50-052-13 Metals by EPA 200.8/SW-846 6020B / ELI SOP 50-340-00	
DQIs	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria¹
Overall Precision	Field Duplicates	Water: RPD: $\leq 30\%$; if one or both results is < 5 times the RL, the control limit is ± 2 times RL Soil: RPD: $\leq 50\%$; if one or both results is < 5 times the RL, the control limit is ± 3 times RL
Overall accuracy/bias (contamination)	Method Blanks, Field Blanks, and Equipment Blanks (as required)	SW-846 6020B: No target analyte concentrations $\geq \frac{1}{2}$ RL or $> \frac{1}{10}$ the amount measured in any sample or $> \frac{1}{3}$ the regulatory compliance limit USEPA Method 200.8: No target analyte concentrations $\geq$ RL or $> \frac{1}{10}$ the amount measured in any sample or $> \frac{1}{3}$ the regulatory compliance limit
Analytical Accuracy/Bias (laboratory)	LCS/LCSD	%R per laboratory control limits
Analytical Accuracy/Bias (laboratory)	MS/MSD	%R per laboratory control limits
Analytical Precision (laboratory)	Matrix Duplicate, MS/MSD, or LCS/LCSD	RPD per laboratory control limits
Analytical Accuracy/Bias (laboratory)	Post Digestion Spike	%R: 75-125%

Matrix	Water and Soil	
Analytical Group	Metals by USEPA Method 200.7/SW846 6010D / ELI SOP 50-052-13 Metals by EPA 200.8/SW-846 6020B / ELI SOP 50-340-00	
DQIs	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria ¹
Analytical Precision (laboratory)	Serial Dilution (1:5 dilution)	If analyte concentration greater than 25-times the RL in the original sample, results of dilution within 20% of the undiluted sample

Note:

¹ Laboratory limits are included in **Appendix B**. The limits provided are current as of the date of this QAPP. The laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #12-2 – Measurement Performance Criteria (Mercury in Water and Soil)

Matrix	Water and Soil	
Analytical Group	Mercury by SW-846 7473B / ELI SOP 50-0005-01	
DQIs	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria¹
Overall Precision	Field Duplicates	Water: RPD: $\leq 30\%$; if one or both results is <5 times the RL, the control limit is ± 2 times RL Soil: RPD: $\leq 50\%$; if one or both results is <5 times the RL, the control limit is ± 3 times RL
Overall accuracy/bias (contamination)	Method Blanks, Field Blanks, and Equipment Blanks (as required)	SW-846 7471B and USEPA 245.1: No target analyte concentrations $\geq$ RL or $> 1/10$ the amount measured in any sample or $> 1/3$ the regulatory compliance limit
Analytical Accuracy/Bias (laboratory)	LCS/LCSD	%R per laboratory control limits
Analytical Accuracy/Bias (laboratory)	MS/MSD	%R per laboratory control limits
Analytical Precision (laboratory)	Matrix Duplicate, MS/MSD, or LCS/LCSD	RPD per laboratory control limits
Analytical Precision (laboratory)	Serial Dilution (1:5 dilution)	If analyte concentration greater than 25-times the RL in the original sample, results of dilution within 10% of the undiluted sample

Note:

¹ Laboratory limits are included in **Appendix B**. The limits provided are current as of the date of this QAPP. The laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #12-3 – Measurement Performance Criteria (Radium in Water and Soil)

Matrix	Water and Soil	
Analytical Group	Alpha Emitting Radium Isotopes in Non-Drinking Water (Based on EPA 903.0 rev 1980) / ELI-C-SOP 50-207-07	
DQIs	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria¹
Overall Precision	Field Duplicates	Water: RPD: $\leq 30\%$; if one or both results is <5 times the RL, the control limit is ± 2 times RL Soil: RPD: $\leq 50\%$; if one or both results is <5 times the RL, the control limit is ± 3 times RL
Overall accuracy/bias (contamination)	Method Blanks, Field Blanks, and Equipment Blanks (as required)	SW-846 7471B and USEPA 245.1: No target analyte concentrations $\geq$ RL or $> 1/10$ the amount measured in any sample or $> 1/3$ the regulatory compliance limit
Analytical Accuracy/Bias (laboratory)	LCS/LCSD	%R per laboratory control limits
Analytical Accuracy/Bias (laboratory)	MS/MSD	%R per laboratory control limits
Analytical Precision (laboratory)	Matrix Duplicate, MS/MSD, or LCS/LCSD	RPD per laboratory control limits
Analytical Precision (laboratory)	Serial Dilution (1:5 dilution)	If analyte concentration greater than 25-times the RL in the original sample, results of dilution within 10% of the undiluted sample

Note:

¹ Laboratory limits are included in **Appendix B**. The limits provided are current as of the date of this QAPP. The laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #12-4 – Measurement Performance Criteria (RADIUM-228 in Water)

Matrix	Water	
Analytical Group	Alpha Emitting Radium Isotopes in Non-Drinking Water (Based on EPA 903.0 rev 1980) / ELI-C-SOP 50-207-07	
DQIs	QC Sample and/or Activity Used to Assess Measurement Performance	Measurement Performance Criteria¹
Overall Precision	Field Duplicates	Water: RPD: $\leq 50\%$; if one or both results is < 5 times the RL, the control limit is ± 2 times RL
Overall accuracy/bias (contamination)	Method Blanks, Field Blanks, and Equipment Blanks (as required)	No target analyte concentrations $\geq \frac{1}{2}$ RL or $> 1/10$ the amount measured in any sample or $> 1/3$ the regulatory compliance limit
Analytical Accuracy/Bias (laboratory)	LCS/LCSD	%R per laboratory control limits
Analytical Accuracy/Bias (laboratory)	MS/MSD	%R per laboratory control limits
Analytical Precision (laboratory)	Matrix Duplicate, MS/MSD, or LCS/LCSD	RPD per laboratory control limits
Analytical Accuracy/Bias (laboratory)	Tracers/Carriers	%R per laboratory control limits
Completeness	Percentage of usable data calculated at data assessment	Greater than both 90% sample collection and 90% laboratory analysis. Completeness is a measure of the amount of valid data obtained compared to the amount expected under ideal conditions. The requirement for completeness is 90% for the samples. Following completion of the analytical testing, the %C will be calculated.

Note:

¹ Laboratory limits are included in **Appendix B**. The limits provided are current as of the date of this QAPP. The laboratory will utilize their current limits at the time of analysis.

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QAPP Worksheet #13 – Secondary Data Uses and Limitations

Data Type	Source	Data Uses Relative to Current Project	Evaluation of Data and Limitations on Data Use
Remedial Investigation Report	Remedial Investigation Report (CDM, 2016)	Historical site information and results of remedial investigations.	Data will be reviewed prior to use to ensure the appropriate type and quality necessary to support intended use and determine limitations. This may include systemic and independent secondary review and QC of databases/spreadsheets.
Lab-Scale Treatability Study	Lab-Scale Treatability Study of Danny T Mine Adit Discharge (MEMC, 2017)	Historical site information and results of remedial investigations.	Data will be reviewed prior to use to ensure the appropriate type and quality necessary to support intended use and determine limitations. This may include systemic and independent secondary review and QC of databases/spreadsheets.
Data Summary Memorandum	Data Summary Memorandum – Danny T Adit Flow and Water Quality Monitoring, November 2017 to November 2021 (Arcadis, 2022)	Historical site information and results of remedial investigations.	Data will be reviewed prior to use to ensure the appropriate type and quality necessary to support intended use and determine limitations. This may include systemic and independent secondary review and QC of databases/spreadsheets.

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QAPP Worksheet #14/16 – Project Tasks & Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Lab analysis	Energy Labs	Upon sample receipt	2 weeks after receipt	Level IV laboratory deliverables	2 weeks following sample receipt
Data validation	Arcadis	Upon receipt of laboratory data deliverable	4-6 weeks following receipt of laboratory data deliverable	Summary of Findings Report	2-4 weeks following receipt of laboratory deliverables
Solid media sampling	Arcadis	Ongoing	Ongoing	Soil Boring Logs; Field Notes; Soil Sampling Report	To Be Determined based on field activities
Adit water characterization and sampling	Arcadis	Beginning of month 2 of the project	End of month 2 of the project	Data added to previous water quality datasets (e.g., RI Report data, TechLaw and MEMC collected data)	To Be Determined based on field activities
Aquatic, Biological and Cultural Resource Surveys	Arcadis	Beginning of month 2 of the project	End of month 2 of the project	Aerial imagery, digital topographic maps, field observation notes; federal and state listed species documentation and Inadvertent Discovery Plan.	To Be Determined based on field activities
Repository/Borrow Source Investigation	Arcadis	Beginning of month 2 of the project	End of month 2 of the project	Field notes, Annual Report	To Be Determined based on field activities

Analyte	CAS Number	Units	Project Action Limit ¹	PAL Reference	Project Quantitation Limit Goal ²	Reporting Limit ³	Method Detection Limit ³
Metals by USEPA Method 200.8/6020B							
Aluminum	7429-90-5	mg/L	NA	NA	0.005	0.005	0.004
Antimony	7440-36-0	mg/L			0.001	0.001	0.0007
Arsenic	7440-38-2	mg/L	NA	NA	0.0005	0.0005	0.0003
Barium	7440-39-3	mg/L	NA	NA	0.0005	0.0005	0.0002
Beryllium	7440-41-7	mg/L	NA	NA	0.0005	0.0005	0.0002
Cadmium	7440-43-9	mg/L	NA	NA	0.0001	0.0001	0.00003
Chromium	7440-47-3	mg/L	NA	NA	0.001	0.001	0.0004
Cobalt	7440-48-4	mg/L	NA	NA	0.0005	0.0005	0.0001
Copper	7440-50-8	mg/L	NA	NA	0.001	0.001	0.0003
Iron	7439-89-6	mg/L	NA	NA	0.025	0.025	0.02
Lead	7439-92-1	mg/L	NA	NA	0.0005	0.0005	0.0002
Manganese	7439-96-5	mg/L	NA	NA	0.0005	0.0005	0.0004
Nickel	7440-02-0	mg/L	NA	NA	0.001	0.001	0.0005
Selenium	7782-49-2	mg/L	NA	NA	0.0005	0.0005	0.0003
Silver	7440-22-4	mg/L	NA	NA	0.00004	0.00004	0.000009
Thallium	7440-28-0	mg/L	NA	NA	0.0001	0.0001	0.00005
Uranium	7440-61-1	mg/L	NA	NA	0.0005	0.0005	0.00004
Vanadium	7440-62-2	mg/L	NA	NA	0.01	0.01	0.001
Zinc	7440-66-6	mg/L	NA	NA	0.01	0.01	0.006
Mercury by USEPA Method 245.1/7473							

Analyte	CAS Number	Units	Project Action Limit ¹	PAL Reference	Project Quantitation Limit Goal ²	Reporting Limit ³	Method Detection Limit ³
Mercury	7439-97-6	mg/L	NA	NA	0.002	0.002	0.0016
Radium-228 by USEPA 903.0							

Notes:

- ¹ Underground Collection Tank samples are collected for project strategy purpose and not compliance, hence there are no applicable Project Action Levels.
- ² The project quantitation limit goal is set at the laboratory RL.
- ³ Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this QAPP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.

Notes:

- ¹ NJDEP soil remediation criteria for VOCs and SVOCs are promulgated in N.J.A.C. 7:26D. The Migration to Groundwater Soil Remediation Standard applies to unsaturated soil concentrations above the water table. The Nonresidential Direct Contact Soil Remediation Standard is based on the most conservative of the ingestion-dermal or the inhalation standards. Shaded cells indicate that the listed criteria is less than the laboratory RL or MDL.
- ² The project quantitation limit goal is set at the laboratory RL.
- ³ Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this APP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.
- ¹ The project quantitation limit goal is set at the laboratory RL.
- ² Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this QAPP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.

QAPP Worksheet #15-2 – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits for Soil

Analyte	CAS Number	Units	Project Action Limit ¹	PAL Reference	Project Quantitation Limit Goal ²	Reporting Limit ³	Method Detection Limit ³
Metals by USEPA Method 200.8/6020B							
Aluminum	7429-90-5	mg/Kg	NA	NA	10	10	8.02
Antimony	7440-36-0	mg/Kg			0.25	0.25	0.17
Arsenic	7440-38-2	mg/Kg	NA	NA	0.1	0.1	0.08
Barium	7440-39-3	mg/Kg	NA	NA	0.25	0.25	0.14
Beryllium	7440-41-7	mg/Kg	NA	NA	0.1	0.1	0.06
Cadmium	7440-43-9	mg/Kg	NA	NA	0.025	0.025	0.01
Chromium	7440-47-3	mg/Kg	NA	NA	0.25	0.25	0.08
Cobalt	7440-48-4	mg/Kg	NA	NA	0.25	0.25	0.03
Copper	7440-50-8	mg/Kg	NA	NA	0.5	0.5	0.4
Iron	7439-89-6	mg/Kg	NA	NA	25	25	22
Lead	7439-92-1	mg/Kg	NA	NA	0.25	0.25	0.22
Manganese	7439-96-5	mg/Kg	NA	NA	0.25	0.25	0.06
Nickel	7440-02-0	mg/Kg	NA	NA	0.25	0.25	0.13
Selenium	7782-49-2	mg/Kg	NA	NA	0.025	0.025	0.07
Silver	7440-22-4	mg/Kg	NA	NA	0.1	0.1	0.07
Thallium	7440-28-0	mg/Kg	NA	NA	0.25	0.25	0.05
Uranium	7440-61-1	mg/Kg	NA	NA	0.25	0.25	0.01
Vanadium	7440-62-2	mg/Kg	NA	NA	0.25	0.25	0.16

Analyte	CAS Number	Units	Project Action Limit ¹	PAL Reference	Project Quantitation Limit Goal ²	Reporting Limit ³	Method Detection Limit ³
Zinc	7440-66-6	mg/Kg	NA	NA	5	5	1.5
Mercury by USEPA Method 245.1/7473							
Mercury	7439-97-6	mg/Kg	NA	NA	0.002	0.002	0.0016
Radium-228 by USEPA 903.0							

Notes:

¹ Underground Collection Tank samples are collected for project strategy purpose and not compliance, hence there are no applicable Project Action Levels.

² The project quantitation limit goal is set at the laboratory RL.

³ Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this QAPP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.

Notes:

¹ NJDEP soil remediation criteria for VOCs and SVOCs are promulgated in N.J.A.C. 7:26D. The Migration to Groundwater Soil Remediation Standard applies to unsaturated soil concentrations above the water table. The Nonresidential Direct Contact Soil Remediation Standard is based on the most conservative of the ingestion-dermal or the inhalation standards. Shaded cells indicate that the listed criteria is less than the laboratory RL or MDL.

² The project quantitation limit goal is set at the laboratory RL.

³ Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this APP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.

¹ The project quantitation limit goal is set at the laboratory RL.

² Concentrations detected less than the RL but greater than the MDL must be reported with the appropriate qualifier ("J" = the result is an estimated quantity). RLs and MDLs as of the date of this QAPP are listed; the laboratory will utilize their current limits at the time of analysis. Not detected results will be reported at the laboratory RL.

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QAPP Worksheet #17 – Sampling Design and Rationale

Sampling Approach

The primary objective is to provide a delineation dataset of solids (i.e., waste rock, and/or soils) and adit water quality, aquatic resources, cultural and biological surveys, repository and borrow source investigations and flow rate. Sampling and analysis will be focused on the Liberty Mine Area, collected from May to August. Defensibility of data obtained during the investigation will be ensured by following the USEPA-approved sample collection protocols in the field and laboratory, including the use of USEPA-approved analytical methods conducted by a USEPA certified commercial laboratory (Appendix A of the Work Plan). In the event field conditions are different than expected or a sample location cannot be collected where planned and could affect the sampling design, the field geologist will use their best judgment to determine the plan of action and confirm with the team.

Mine Water Characterization and Sampling

Two mine openings and a shaft are known to periodically discharge water to the ground surface near the Liberty Area: the Danny T Adit, August No. 2 Adit, and the Marcelline Shaft. As part of the field investigation, water emanating from the Danny T Adit and the Marcelline Shaft will be sampled, and their flows will be measured (if possible) to provide updated water quality information. This data will be added to previous water quality datasets (e.g., RI Report data, TechLaw and MEMC collected data) and summarized.

Soil Objectives:

Solid materials in the Liberty Mine Area (i.e., waste rock, soils, fluvial deposits, background and/or in stream sediments) will be delineated (except background) and characterized; material extents may include the west side of Galena Creek from below Block P excavation area to near the Annie E Adit (Figure 2 of the Work Plan). To complete this task, field work will be conducted to assess and delineate solid media within the Liberty Mine Area and provide updated volumetric estimates and geotechnical and geochemical characterization of materials that will be included in the site characterization section of the EE/CA.

Solid media samples collected will be analyzed by a laboratory for a characterization suite of metals, inorganic chemistry, geotechnical index properties, and shear strength. Additionally, 20 percent of the solid media samples will be analyzed for ABA and 50 percent of the samples will be analyzed for total and dissolved leachable metals under short-term kinetic (SPLP and MWMP) preparation methods to characterize the leachability of waste rock and streamside deposits. Carbonate (inorganic carbon) and sulfur forms will also be collected in waste rock samples since these analyses are critical for predicting and managing the potential for Acid Mine Drainage. The balance between acid-generating sulfur minerals and acid-neutralizing carbonate

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minerals determines the long-term environmental impact of the waste rock. Native soil samples will be analyzed for a characterization suite of metals only. Associated Laboratory quality control samples (Field Duplicates, and Matrix Spike/Matrix Spike Duplicates [MS/MSD]) will be collected in accordance with this QAPP.

Aquatic, Biological and Cultural Resource Surveys

To potentially identify sensitive aquatic resources, Arcadis will delineate wetlands and non-wetland waters within the Liberty Mine Area and the Repository and Borrow Areas. Wetland functional assessments will be completed for the wetlands identified during the aquatic resource delineation survey to determine a baseline functional value in the event that they are impacted by future removal action activities.

Within the Liberty Mine Area and the repository and borrow areas, Arcadis will also conduct reconnaissance-level baseline surveys to inventory plant species (including special-status plants and noxious weeds) and classify vegetation and habitat types. Available habitats within the areas of survey will be further evaluated to determine if they are potentially suitable for federal and state listed threatened or endangered species.

An archaeological background research of the Liberty Mine Area and any repository or borrow locations as well as everything within a 1-mile buffer will also be conducted. Depending on the results of the background research and whether the area has been previously documented to a high standard within the last 10 years, an in-person review to document cultural features may be conducted.

Repository Siting Evaluation

To support the development of removal alternatives and/or revised engineering cost estimates, Arcadis will assess a nearby identified parcel of land (Mount Emmons Mining Claim – MEMC parcel, Figure 3 of the Work Plan) that may be used for a repository (if required) and/or borrow source. Alternative locations that may be within the Liberty Mine Area will be assessed in the field for possible repository siting. Temporary piezometers will be installed in test pit locations and monitored for shallow groundwater levels.

Borrow Source Investigation

Arcadis will also assess a MEMC parcel (Figure 3 of the Work Plan) as well as areas that are within the Liberty Mine Area for potential borrow source location. Field investigations will coincide with the repository field investigation. This investigation will include up to 10 test pit excavations within the proposed borrow area to determine depth, consistency, and suitability of materials for use as a cover and/or liner material. Temporary piezometers will be installed in test pit locations and monitored for shallow groundwater levels.

QAPP Worksheet #18 – Sampling Locations and Methods

Sampling Location	Matrix	Type	Analyte/Analytical Group	Sampling SOP ¹	Comments
Annie E Waste Area – AE-1	Rockpile Surface Sample	Composite	USEPA 6010B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	
Annie E Waste Area – AE-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Annie E Waste Area – AE-3	Rockpile Surface Sample	Composite	Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Annie E Waste Area – AES-N, AES-S, AES-S, AES-W	Soil Samples	Composite	USEPA 6010B Metals	1, 2, 3, 7, 9, 11, 13	
AE-GT-1, AE-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
August No. 2 Waste Area – A2-1, A2-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
August No. 2 Waste Area – A2-3	Rockpile Surface Sample	Composite	Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
August No. 2 Waste Area – A2-GT-1, A2-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Danny T Waste Area – DT-1	Rockpile Surface Sample	Composite	USEPA 6010B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	

Sampling Location	Matrix	Type	Analyte/Analytical Group	Sampling SOP ¹	Comments
Danny T Waste Area – DT-2, DT-3	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Danny T Waste Area – DTS-N, DTS-S, DTS-E, DTS-W	Soil Sample	Composite	USEPS 6010B Metals	1, 2, 3, 7, 9, 11, 13	
Danny T Waste Area – DT-GT-1, DT-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Liberty Waste Area – L-1, L-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Liberty Waste Area – L-3	Rockpile Surface Sample	Composite	USEPA 6010B Metals, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Liberty Waste Area – LS-N, LS-S, LS-E, LS-W	Soil Sample	Composite	USEPA 6010B	1, 2, 3, 7, 9, 11, 13	
Liberty Waste Area – L-GT-1, L-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Last Chance Waste Area – LC-1, LC-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Last Chance Waste Area – LC-3	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	
Adjacent to Last Chance Waste Area – LCS-N, LCS-S, LCS-E, LCS-W	Soil Sample	Composite	USEPA 60101B Metals	1, 2, 3, 7, 9, 11, 13	

Sampling Location	Matrix	Type	Analyte/Analytical Group	Sampling SOP ¹	Comments
Last Chance Waste Area – LC-GT-1, LC-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Liberty Intermediate Waste Area – LI-1	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	
Liberty Intermediate Waste Area – LI-2, LI-3	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Liberty Intermediate Waste Area – LI-N, LI-S, LI-E, LI-W	Soil Sample	Composite	USEPA 60101B Metals	1, 2, 3, 7, 9, 11, 13	
Liberty Intermediate Waste Area – LI-GT-1, LI-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Liberty No. 3 Waste Area – LN3-1	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	
Liberty No. 3 Waste Area – LN3-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Liberty No. 3 Waste Area – LN3-3	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Liberty No. 3 Waste Area – LN3S-N, LN3S-S, LN3S-E, LN3S-W	Soil Sample	Composite	USEPA 6010B Metals	1, 2, 3, 7, 9, 11, 13	
Liberty No. 3 Waste Area – LN3-GT-1, LN3-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	

Sampling Location	Matrix	Type	Analyte/Analytical Group	Sampling SOP ¹	Comments
Marceline Waste Area – M-1	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Marceline Waste Area – M-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Marceline Waste Area – M-3	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms, Acid Base Accounting	1, 2, 3, 7, 9, 11, 13	
Adjacent to Marceline Waste Area – MS-N, MS-S, MS-E, MS-W	Soil Sample	Composite	USEPA 6010B Metals	1, 2, 3, 7, 9, 11, 13	
Marceline Waste Area – MS-GT-1, MS-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	
Transverse Waste Area – T-1,	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Transverse Waste Area – T-2	Rockpile Surface Sample	Composite	USEPA 6010B Metals, SPLP, MWMP, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Transverse Waste Area – T-3	Rockpile Surface Sample	Composite	USEPA 60101B Metals, Inorganic Carbon, Sulfur Forms	1, 2, 3, 7, 9, 11, 13	
Adjacent to Transverse Waste Area – TS-N, TS-S, TS-E, TS-W	Soil Sample	Composite	USEPA 6010B Metals	1, 2, 3, 7, 9, 11, 13	
Transverse Waste Area – T-GT-1, T-GT-2	Geotechnical Sample	Grab	USCS Soil Classification, Atterberg Limits, Moisture Content, Direct Shear	1, 2, 3, 5, 7, 9, 11, 13	

QAPP Worksheet #19&30 – Sample Containers, Preservation, and Hold Times

Samples will be sent to Energy Laboratories, Inc. for analysis. Selected analyses as indicated in Worksheet #23. Primary communication and shipping to the subcontracted laboratories will be handled by Energy Laboratories.

Energy Laboratories, Inc.

2393 Salt Creek Hwy, PO Box 247

Casper, WY 82602-0247

Contact: Amanda B. Carlson

Phone: 406.442.0711

Email: acarlson@energylab.com

List any required accreditations/certifications: are included in Appendix A.

Sample Delivery Method: FedEx or UPS for overnight delivery or courier to the laboratory

Analyte/ Analyte Group	Matrix	Method/SOP ¹	Container(s) (number, size & type per sample) ¹	Preservation	Extraction Holding Time ²	Analytical Holding Time ²
Metals	Soil	SW-846 6020B / ED-MT-034	1 x 8oz. glass jar	Cool to < 6°C	6 months (inclusive of digestion and analysis)	
Mercury	Soil	SW-846 7471B / ED-MT-035	1 x 8oz. glass jar	Cool to < 6°C	28 days (inclusive of digestion and analysis)	
Mercury	Water	USEPA Method 245.1 / ED-MT-017	1 x 250mL plastic bottle	Nitric acid (HNO ₃) to pH < 2; Cool to < 6°C	28 days (inclusive of digestion and analysis)	
Metals	Water	USEPA Method 200.8 / ED-MT-029	1 x 250mL plastic bottle	HNO ₃ to pH < 2; Cool to < 6°C	6 months (inclusive of digestion and analysis)	

Analyte/ Analyte Group	Matrix	Method/SOP ¹	Container(s) (number, size & type per sample) ¹	Preservation	Extraction Holding Time ²	Analytical Holding Time ²
Radium-228	Water	USEPA Method 903.0 / ELI-C-SOP 50-207- 07	3 x 1-L plastic bottle	HNO ₃ to pH < 2	6 months (inclusive of digestion and analysis)	

Notes:

¹ The laboratory should be consulted prior to sample collection, as it may be possible to combine sample volume for multiple analyses in one sample container.

² All holding times are measured from date of collection. It is imperative that all samples are submitted to the laboratory with ample time for the analysis to be completed within the holding time. Missing a holding time is unacceptable and may result in unusable data if the holding time is missed.

QAPP Worksheet #20 – Field QC Summary

Matrix	Analyte/Analytical Group ¹	Field Samples	Field Duplicates	MS/MSD ²	Equipment Blanks ³	Trip Blanks
Soil	Metals SW-846 6020B / ED-MT-034	TBD / If requested	TBD / If requested	TBD / If requested	TBD / If requested	NA
Soil	Mercury SW-846 7471B / ED-MT-035	TBD / If requested	TBD / If requested	TBD / If requested	TBD / If requested	NA
Water	Mercury USEPA Method 245.1 / ED-MT-017	Semi-Annual (groundwater): 22 per event	1/20	1/20	1/day	NA
Water	Mercury USEPA Method 245.1 / ED-MT-017	Annual (vent): 6 per event	NA	NA	NA	NA
Water	Metals USEPA Method 200.8 / ED-MT-029	Semi-Annual (groundwater): 22 per event	1/20	1/20	1/day	NA
Water	Metals USEPA Method 200.8 / ED-MT-029	Annual (vent): 6 per event	NA	NA	NA	NA

Notes:

¹ See Worksheet #23 for SOP title, revision number, and date details.

² MS/MSD or laboratory duplicate (whichever is applicable to the method) will be collected at a frequency of 1 per 20 field samples. Site-specific MS/MSD or laboratory duplicate samples will not be collected in association with solid and liquid waste samples.

³ Equipment blanks will be collected when non-dedicated equipment is used to collect field samples. The equipment blanks will typically be collected at a frequency of 1 per 20 field samples.

QAPP Worksheet #21 – Field SOPs

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	Equipment Type	Modified for Project? (Yes/No)	Comments
1	QP 3.08 - Field Sampling, Measurements and Observations, Rev. 1, 10/11/2021	Arcadis	See SOP for specific equipment needs	No	Provides a consistent process for the execution of activities associated with field sampling, measurements, and observations.
2	QP 3.06 – Field Activities Documentation, Rev. 1, 11/30/2021	Arcadis	Field documentation equipment	No	Provide a standard procedure for the documentation of fieldwork activities.;
3	Soil Description, Rev. 4, 6/14/2022	Arcadis	See SOP for specific equipment needs	No	Describes proper soil description procedures based on visual inspection and testing of soil cores and samples.
4	Soil Drilling and Sample Collection, Rev. 2, 4/8/2022	Arcadis	See SOP for specific equipment needs	No	Describes general drilling procedures and methods to be used to field screen and collect soil samples for laboratory analysis
5	Surface Sediment Sampling with Grab Samplers, Rev. 1, 6/13/2022	Arcadis	See SOP for specific equipment needs	No	Describes procedures to sample surface sediment with grab samplers.
6	Water-Level Monitoring Using Data Logging Instruments, 3/16/2022	Arcadis	See SOP for specific equipment needs	No	Describes procedures to measure and record water-levels using data logging instruments.
7	Sample Chain of Custody, Rev. 3, 3/28/2022	Arcadis	NA	No	Describes procedures for required documentation during the collection of environmental field samples and transfer of custody to a laboratory.
8	Surface Water Sample Collection, Rev. 2, 6/13/2022	Arcadis	Water sampling equipment	No	Describes procedures and methods for surface water sampling.
9	Hazardous Weather Procedures, Rev. 3, 2/4/2019	Arcadis	See SOP for specific equipment needs	No	Describes procedures to deal with hazardous weather.
10	In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater, Rev. 1, 4/5/2022	Arcadis	Multiparameter water quality meter	No	Describes procedures to measure water quality parameters in the field.

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	Equipment Type	Modified for Project? (Yes/No)	Comments
11	Investigation-Derived Waste Handling and Storage, Rev. 1, 5/15/2020	Arcadis	Waste generated during site activities	No	Describes the procedures to manage investigation-derived waste, both hazardous and nonhazardous, generated during site activities.
12	Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells, Rev. 2, 4/5/2022	Arcadis	Water sampling equipment	No	Describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology.
13	Resource Conservation and Recovery Act (RCRA) Waste Characterization Sampling, 5/20/2021	Arcadis	See SOP for specific equipment needs	No	Describes procedures for collecting waste characterization samples from materials which are subject to the RCRA definition of solid waste.

Notes:

1. The field sampling SOPs are located in Appendix B of this QAPP.
2. Arcadis will maintain SOPs and update them as needed.

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Frequency	Maintenance Activity	Inspection Activity	Acceptance Criteria	Corrective Action
X-Ray Florescence (XRF) Field Analyzer	Calibrated according to manufacturer recommendations	Inspect to confirm in working order, return to rental company or manufacturer	Inspect that instrument is clean, inspect for battery life	According to vendor criteria	Do not use if any parameter is not calibrated to within specified range of error
Global Positioning Unit (GPS)	Calibrated according to manufacturer recommendations, GPS points will be converted into standard geospatial data	Inspect to confirm in working order, return to rental company or manufacturer	Inspect that instrument is clean, inspect for battery life	According to vendor criteria	Do not use if any parameter is not calibrated to within specified range of error
Multi-Meter	Calibrated according to manufacturer recommendations	Clean each probe and flow through cell (if used) daily with deionized water and alconox. Replace probes as necessary. Replace batteries as necessary.	Inspect that instrument is clean, inspect for battery life, and inspect for damage to cables or other parts of the instrument	According to vendor criteria	Do not use if any parameter is not calibrated to within specified range of error
Turbidity Meter	Calibrated according to manufacturer recommendations	Rinse vials or tubing (as applicable) with deionized water prior to filling with sample. Inspect to confirm in working order, return to rental company or manufacturer	Inspect that instrument is clean, inspect for battery life, place a clean cuvette filled with distilled water into the meter and adjust the instrument to read zero	According to vendor criteria	Do not use if any parameter is not calibrated to within specified range of error

Field Equipment	Calibration Frequency	Maintenance Activity	Inspection Activity	Acceptance Criteria	Corrective Action
Peristaltic Pump	No calibration required	Inspect to confirm in working order, return to rental company or manufacturer	No calibration required, only verification of proper function needed	According to vendor criteria	Do not use if any parameter is not calibrated to within specified range of error

Note: ¹ Laboratory QC limits are current as of the date of this QAPP. Laboratory will utilize their current limits at the time of analysis.
² Field Team Lead is responsible for field equipment.

QAPP Worksheet #23 – Analytical SOPs

SOP #	Title, Revision Number, and Revision Date	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
ELI SOP 50-0005-01	EPA METHOD 7473 DIRECT MERCURY ANALYSIS BY THERMAL DECOMPOSITION, AMALGAMATION, AND ATOMIC ABSORPTION SPECTROPHOTOMETRY ELI SOP 50-0005-01, Revision Date 2/19/2025	Definitive	Mercury / Water	Cold Vapor Atomic Absorption (CVAA)	Energy Laboratories, Inc.	No
ELI SOP 50-052-13	EPA METHOD 200.7/SW846 6010D ELEMENTAL ANALYSIS OF WATER AND WASTES BY ICP-OES ELI SOP 50-052-13, Rev. DATE, 1/28/2025	Definitive	Metals / Water	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Energy Laboratories, Inc.	No
ELI SOP 50-340-00	EPA METHOD 200.8/SW-846 6020B DETERMINATION OF METALS AND TRACE ELEMENTS IN WATER, WASTES AND SOLIDS BY INDUCTIVELY COUPLED PLASMA-MASS SPECTROMETRY (ICP-MS) ELI SOP 50-340-00, Rev, Date 1/29/2025	Definitive	Metals / Water	ICP-MS	Energy Laboratories, Inc.	No
ELI-C-SOP 50-207-07	Alpha Emitting Radium Isotopes in Non-Drinking Water (Based on EPA 903.0 rev 1980) ELI-C-SOP 50-207-07, Rev. Date, 1/21/2025	Definitive	Metals / Water	Spectrometer	Energy Laboratories, Inc.	No

Notes:

1. Copies of the laboratory SOPs are included in Appendix A. Listed SOPs are current as of the date of this QAPP; the laboratory will use its current SOP at the time of sample analysis.

QAPP Worksheet #24 – Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP-MS	Tune validation – mass calibration	Daily prior to sample analysis	Within 0.1 amu from mass unit	Terminate analysis, fix problem and repeat	Analyst, supervisor	ELI SOP 50-340-00
	Tune validation – resolution check	Daily prior to sample analysis	< 0.9 amu full width at 10% peak height	Terminate analysis, fix problem and repeat	Analyst, supervisor	
	Instrument stability check	Daily prior to sample analysis	< 5% RSD for five replicates	Terminate analysis, fix problem and repeat	Analyst, supervisor	
	Initial Calibration	Daily prior to sample analysis	$r^2 \geq 0.995$	Recalibrate	Analyst, supervisor	
	ICV	Once after each initial calibration, prior to sample analysis	Value of second source for all analytes within $\pm 10\%$ of expected value	Recalibrate	Analyst, supervisor	
	CCV	At the beginning and end of the analysis sequence, and after every 10 samples	All analytes within $\pm 10\%$ of expected value	Recalibrate, rerun 10 samples before failed CCV	Analyst, supervisor	
	Initial calibration blank (ICB)	After ICV	Must be less than $\frac{1}{2}$ the RL	Terminate analysis, fix problem, and repeat	Analyst, supervisor	
	Continuing calibration blank (CCB)	After every CCV	Less than the RL	Terminate analysis, fix problem, rerun 10 samples before failed CCB	Analyst, supervisor	
	Interference Check Solution	At the beginning of an analysis and after every 12 hours of analysis	$\pm 20\%$ of expected value or ± 2 -times the RL, whichever is greater	Terminate analysis, locate and correct problem, reanalyzed interference check solution and all samples	Analyst, supervisor	
CVAA	Initial Calibration	Daily prior to sample analysis	ED-MT-017: $r^2 \geq 0.998$ 6438: $r^2 \geq 0.995$	Recalibrate	Analyst, supervisor	ELI SOP 50-052-13
	ICV	Once after each initial calibration, prior to sample analysis	Value of second source for all analytes within $\pm 10\%$ of expected value	Recalibrate	Analyst, supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 10\%$ of expected value	Recalibrate, rerun 10 samples before failed CCV	Analyst, supervisor	
	ICB	After ICV	Must be less than the RL	Terminate analysis, fix problem, and repeat	Analyst, supervisor	
	CCB	After every CCV	Less than the RL	Terminate analysis, fix problem, rerun 10 samples before failed CCB	Analyst, supervisor	
FI-AFS	Initial Calibration	Daily prior to sample analysis	::%RSD $\leq 15\%$	Recalibrate	Analyst, supervisor	ELI SOP 50-052-13
	ICV	Once after each initial calibration, prior to sample analysis	Value of second source for all analytes within 78-121% of expected value	Recalibrate	Analyst, supervisor	
	CCV	After every 10 samples and at the end of the analysis sequence	%R 77-123%	Recalibrate, rerun 10 samples before failed CCV	Analyst, supervisor	
	ICB	After ICV	Must be less than the RL	Terminate analysis, fix problem, and repeat	Analyst, supervisor	
	CCB	After every CCV	Less than the RL	Terminate analysis, fix problem, rerun 10 samples before failed CCB	Analyst, supervisor	
Alpha Spectrometer	ICAL (Energy, efficiency and FWHM peak resolution)	Before initial use, following repair or loss of control and upon incorporation of new or changed instrument settings	Three isotopes within energy range of 3-6 MeV. Energy vs. channel slope equation <15 keV per channel. FWHM <100 keV for each peak used for calibration. Final peak energy within 20 keV of reference energy. Minimum of 3,000 net counts in each peak.	Correct problem, then repeat ICAL.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Alpha Spectrometer	ICV	After initial calibration	Minimum 2000 net counts. Efficiency within 95% - 105% of initial calibration value. FWHM ≤ 100 keV; each peak within ± 20 keV of corresponding calibration peaks in initial energy calibration.	Repeat ICV to check for error. If that fails, identify and correct problem and repeat ICV or ICAL and ICV, as appropriate.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07
Alpha Spectrometer	CCV (Pulser check)	Pulser verification daily, before analysis of samples	Energy response check will have a tolerance limit set at $\pm 3\%$ or control chart set at $\pm 3\sigma$	Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07
Alpha Spectrometer	CCV (Check source)	Monthly source check verification before analysis of samples	FWHM ≤ 100 keV; each peak within ± 40 keV of corresponding calibration peaks in initial energy calibration. Minimum 2000 net counts. Efficiency within 95-105% of initial calibration value.	Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07
Alpha Spectrometer	BSC Measurement	Before initial use or after initial calibration and monthly	Use a statistical test to determine a change in the background count rate value.	Check control chart for trends and recount. Determine cause, correct problem, re-establish BSC. If background activity has changed, re-establish BSC and reanalyze all impacted samples since last acceptable BSC.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07
Alpha Spectrometer	ICC	Performed weekly, at minimum, and after counting high activity samples	A statistical test is used to determine a change in the background count rate	Check control chart for trends and recount. Determine cause and correct problem. If background activity has changed, re-establish BSC and reanalyze all infected samples.	Laboratory Manager/Analyst	ELI-C-SOP 50-207-07

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
ICP/MS	Replace pump windings and gas tanks, check standard and sample flow	Monitor internal standard counts for variation	Instrument performance and sensitivity	As needed	CCV pass criteria	Replace windings, recalibrate, and reanalyze	Analyst/Supervisor	ELI SOP 50-340-00
CVAA	Replace disposables, flush lines, check lamp current and gas flow	Analytical standards	Instrument performance and sensitivity	As needed	CCV pass criteria	Recalibrate	Analyst/Supervisor	ELI SOP 50-052-13
FI-AFS	Replace disposables, check lamp	Analytical standards	Instrument performance and sensitivity	As needed	CCV pass criteria	Recalibrate	Analyst/Supervisor	ELI SOP 50-052-13
IC	Replace components as needed	Analytical standards	Instrument performance and sensitivity	As needed	CCV pass criteria	Recalibrate	Analyst/Supervisor	ED-GSC-022
Spectrophotometer	Replace components and tubing as needed	Analytical standards	Instrument performance and sensitivity	As needed	CCV pass criteria	Recalibrate	Analyst/Supervisor	ELI-C-SOP 50-207-07

Note:

SOP reference numbers correspond to analytical SOPs in Worksheet #23.

QAPP Worksheet #26&27 – Sample Handling, Custody, and Disposal

Sampling Organization: Arcadis
Laboratory: Eurofins Edison, Eurofins Lancaster, Pace Analytical
Method of sample delivery: FedEx or UPS for overnight delivery or courier to the laboratory
Number of days from reporting until sample disposal: At least 30 days after delivery of the final report, unless otherwise requested by the client

Activity	Organization and title or position of person responsible for the activity
Sample labelling	Arcadis Field Team Leader
Chain-of-custody form completion	Arcadis Field Team Leader
Packaging	Arcadis Field Team Leader
Shipping coordination	Arcadis Field Team Leader and Arcadis Project Manager
Sample receipt, inspection, & log-in	Eurofins Edison, Eurofins Lancaster, Pace Analytical, sample receiving staff
Sample custody and storage	Eurofins Edison, Eurofins Lancaster, Pace Analytical, analysts and Project Manager
Sample disposal	Eurofins Edison, Eurofins Lancaster, Pace Analytical, staff

QAPP Worksheet #28-1 – Quality Control Samples (Metals in Water and Soil)

Matrix		Water				
Analytical Group		Metals				
Analytical Method/SOP		Metals by USEPA Method 200.7/SW846 6010D / ELI SOP 50-052-13 Metals by EPA 200.8/SW-846 6020B / ELI SOP 50-340-00				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
Field Duplicate	1 per 20 field samples	Water RPD ≤ 40% Soil RPD ≤ 50%	Qualify data as appropriate	Data Validator	Overall precision	Water RPD ≤ 40%; if one or both results is <5 times the RL, the control limit is ±2 times RL Soil RPD ≤ 50%; if one or both results is <5 times the RL, the control limit is ±2 times RL

Matrix		Water				
Analytical Group		Metals				
Analytical Method/SOP		Metals by USEPA Method 200.7/SW846 6010D / ELI SOP 50-052-13 Metals by EPA 200.8/SW-846 6020B / ELI SOP 50-340-00				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
Method Blank	One per preparatory batch	Per laboratory SOP	Determine the source of the contamination. If required, re-extract and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If sample results are >10-times the MB concentration, the sample result may be reported with a "B" qualifier.	Analyst, supervisor	Overall accuracy/ bias	SW-846 6020B: No target analyte concentrations $\geq \frac{1}{2}$ RL or > 1/10 the amount measured in any sample or > 1/3 the regulatory compliance limit USEPA Method 200.8: No target analyte concentrations $\geq$ RL or > 1/10 the amount measured in any sample or > 1/3 the regulatory compliance limit
LCS/LCSD	One per preparatory batch	Per laboratory SOP	Correct problem, reprepare and reanalyzed LCS and all samples in associated batch.	Analyst, supervisor	Analytical accuracy/bias	Laboratory generated and analyte specific %R limits (see Worksheet #12-8)
MS/MSD	One per preparatory batch	Per laboratory SOP	Re-extract and reanalyze to confirm matrix interference.	Analyst, supervisor	Analytical accuracy/bias	Laboratory generated and analyte specific %R limits (see Worksheet #12-8)

Matrix		Water				
Analytical Group		Metals				
Analytical Method/SOP		Metals by USEPA Method 200.7/SW846 6010D / ELI SOP 50-052-13 Metals by EPA 200.8/SW-846 6020B / ELI SOP 50-340-00				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
LCS/LCSD, Matrix Duplicate, or MS/MSD	One per preparatory batch	Per laboratory SOP	Reanalyze samples.	Analyst, supervisor	Analytical precision	Laboratory generated and analyte specific %R limits (see Worksheet #12-8)
Post Digestion Spike	One per preparatory batch	Per laboratory SOP	Corrective action not applicable; failure confirms matrix effects	Analyst, supervisor	Analytical accuracy/bias	%R 75-125%
Serial Dilution (5-times dilution)	One per preparatory batch	Per laboratory SOP	Corrective action not applicable; chemical or physical interference effect should be suspected if failure	Analyst, supervisor	Analytical precision	If analyte concentration greater than 25-times the RL in the original sample, %D within ±20% of result of undiluted sample (original sample)

Note:

¹ Laboratory QC limits are current as of the date of this QAPP. Laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #28-2 – Quality Control Samples (Mercury in Water and Soil)

Matrix		Water and Soil				
Analytical Group		Mercury				
Analytical Method/SOP		Mercury by SW-846 7473B / ELI SOP 50-0005-01				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria ¹
Field Duplicate	1 per 20 field samples	Water RPD ≤ 40% Soil RPD ≤ 50%	Qualify data as appropriate	Data Validator	Overall precision	Water RPD ≤ 40%; if one or both results is <5 times the RL, the control limit is ±2 times RL Soil RPD ≤ 50%; if one or both results is <5 times the RL, the control limit is ±2 times RL
Method Blank	One per preparatory batch	Per laboratory SOP	Determine the source of the contamination. If required, re-extract and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If sample results are >10-times the MB concentration, the sample result may be reported with a "B" qualifier.	Analyst, supervisor	Overall accuracy/ bias	SW-846 7471B and USEPA 245.1: No target analyte concentrations ≥ RL or > 1/10 the amount measured in any sample or > 1/3 the regulatory compliance limit
LCS/LCSD	One per preparatory batch	Per laboratory SOP	Correct problem, reprepare and reanalyzed LCS and all samples in associated batch.	Analyst, supervisor	Analytical accuracy/bias	Laboratory generated and analyte specific %R limits (see Worksheet #12-9)

Matrix		Water and Soil				
Analytical Group		Mercury				
Analytical Method/SOP		Mercury by SW-846 7473B / ELI SOP 50-0005-01				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
MS/MSD	One per preparatory batch	Per laboratory SOP	Re-extract and reanalyze to confirm matrix interference.	Analyst, supervisor	Analytical accuracy/bias	Laboratory generated and analyte specific %R limits (see Worksheet #12-9)
LCS/LCSD, Matrix Duplicate, or MS/MSD	One per preparatory batch	Per laboratory SOP	Reanalyze samples.	Analyst, supervisor	Analytical precision	Laboratory generated and analyte specific %R limits (see Worksheet #12-9)
Serial Dilution (5-times dilution)	One per preparatory batch	Per laboratory SOP	Corrective action not applicable; chemical or physical interference effect should be suspected if failure	Analyst, supervisor	Analytical precision	If analyte concentration greater than 25-times the RL in the original sample, %D within $\pm 10\%$ of result of undiluted sample (original sample)

Note: ¹ Laboratory QC limits are current as of the date of this QAPP. Laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #28-3 – Quality Control Samples (Radium-228 in Water)

Matrix		Water				
Analytical Group		Alpha Emitting Radium Isotopes				
Analytical Method/SOP		Alpha Emitting Radium Isotopes by USEPA Method 903.0 / ELI SOP 50-207-07				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
Method Blank	One per preparation batch	ZBlank ≤3	Recount to confirm results. Inspect control chart for indication of significant bias. If required, reprepare and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor	Accuracy/Bias/Contamination	Acceptable results per stated QC Acceptance Limits
LCS	One per preparation batch	Recovery limits: 75-125% for Ra-228	Recount to confirm results. Inspect control chart for indication of significant bias. If required, reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor	Accuracy/Bias	Acceptable QC Acceptance Limits.
Duplicate	One per preparation batch	RPD limit of 25% or DER <3	Check for laboratory error. Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst, Supervisor	Precision/Accuracy/Bias	Acceptable QC Acceptance Limits.
Barium and Yttrium Carriers	Every sample	Recovery limits of 40-110%	Truncate carriers above 100% recovery to eliminate low biased results. Reprep and reanalyze sample if carrier is low (indicating high biased results) if there is activity in the sample above the RL. No reanalysis if matrix interference is noticed during sample preparation.	Analyst, Supervisor	Accuracy/Bias	Acceptable QC Acceptance Limits.

Matrix		Water				
Analytical Group		Alpha Emitting Radium Isotopes				
Analytical Method/SOP		Alpha Emitting Radium Isotopes by USEPA Method 903.0 / ELI SOP 50-207-07				
QC Sample	Frequency/No.	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria¹
Field Duplicate	One per 20 field samples	Groundwater and surface water: RPD ≤30% or RER <2 If one or both results is <5 times the RL, the control limit is ±2 times RL Soil and sediment: RPD ≤50% or RER <2 If one or both results is <5 times the RL, the control limit is ±3 times RL	Qualify data.	Data validator	Precision	Groundwater and surface water: RPD ≤30% or RER <2 If one or both results is <5 times the RL, the control limit is ±2 times RL Soil and Sediment: RPD ≤ 50% or RER < 2 If one or both results is <5 times the RL, the control limit is ±3 times RL

Note:

¹ Laboratory QC limits are current as of the date of this QAPP. Laboratory will utilize their current limits at the time of analysis.

QAPP Worksheet #29 – Project Documents and Records

SAMPLE COLLECTION AND FIELD RECORDS			
Record	Generation	Verification	Storage location/archival*
Field logbook or data collection sheets	Arcadis Field Team Leader	Arcadis Project Manager	Arcadis Project File
Chain-of-Custody Forms	Arcadis Field Team Leader	Arcadis Project Manager	Arcadis Project File Energy Labs
Sample Custody Seals	Arcadis Field Task Manager	Arcadis Project Manager	Arcadis Project File Energy Labs
Field Equipment, Calibration, and Maintenance Logs	Arcadis Field Task Manager	Arcadis Project Manager	Arcadis Project File
Field Audit	Arcadis Field Task Manager	Arcadis Project Manager	Arcadis Project File

PROJECT ASSESSMENTS			
Record	Generation	Verification	Storage location/archival
Data Analysis and Reporting	Arcadis Field Team Leader	Arcadis Project Manager	Arcadis Project File
Corrective Action Report	Arcadis Field Team Leader Energy Labs	Arcadis Project Manager	Arcadis Project File

LABORATORY RECORDS			
Record	Generation	Verification	Storage location/archival
Laboratory Data Reports	Energy Labs	Arcadis Project Manager	Arcadis Project File Energy Labs
Lab QA/QC related document	Energy Labs	Energy Labs Project Manager	Energy Labs
Laboratory Audit	Energy Labs	Arcadis Project Chemist Energy Labs Project Manager	Arcadis Project File Energy Labs

Record	Laboratory Analyses	Electronic Data Deliverables (EDDs)
Narrative	X	
COC	X	
Summary Results	X	X
QC Results	X	X
Raw Data (as required by the method)	X	
All communications such as phone and email record related to the project	X	

Note:

All documents will be kept on file for 5 years from the report approval date.

QAPP Worksheet #31, 32, & 33 – Assessments and Corrective Actions

ASSESSMENTS					
Assessment Type	Responsible Party and Organization*	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
Non-Conformance Report from the field	Arcadis Field Team Leader	Unknown	Within 48 hours from the occurrence	Non-Conformance Report and Corrective Action Report	Will submit to Arcadis, and MEMC at the end of each sampling event Will be submitted to the USEPA as a part of the monitoring event report
Field Record Verification (Field Audit Checklist)	Arcadis Task Manager/QA Manager	At the end of week for sampling event	At the end of week.	Field Record Verification Quality Assurance Form	Will submit to Arcadis, and MEMC at the end of each sampling event Will be submitted to the USEPA as a part of the monitoring event report
Non-Conformance Report from the lab	Energy Labs Project Manager Energy Labs Project Manager	Unknown	Within 48 hours from the occurrence	Non-Conformance Report and Corrective Action Report	Will submit to Arcadis, and MEMC at the end of each sampling event Will be submitted to the USEPA as a part of the monitoring event report
Laboratory Analysis Data Validation	Arcadis Data Validator Arcadis Project Chemist	Each data package	4 weeks after sample collection	Data validation report	2 weeks from data package received from laboratory

*Responsibilities include (1) conducting the assessments, (2) responding to assessment findings, response documentation and timeframe for response, and (3) implementing and monitoring corrective action.

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QAPP Worksheet #34 – Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	X	
Field Records			
5	Field logbooks	X	
6	Equipment calibration records	X	
7	Chain of custody forms	X	
8	Sampling diagrams/surveys	X	
9	Drilling logs	X	
10	Relevant correspondence	X	
11	Change orders/deviations	X	
12	Field audit reports	X	
13	Field corrective action reports	X	
Analytical Data Package			
14	Cover sheet/Laboratory identifying information	X	
15	Case narrative	X	
16	Internal laboratory chain of custody	X	
17	Sample receipt records	X	

Item	Description	Verification (completeness)	Validation (conformance to specifications)
18	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
19	Communication records	X	
20	MDL/QL establishment and verification	X	X
21	Standards traceability	X	
22	Instrument calibration records	X	X
23	Definition of laboratory qualifiers	X	
24	Results reporting forms	X	X
25	QC sample results	X	X
26	Correction action reports	X	
27	Raw data	X	X
28	EDD	X	

QAPP Worksheet #35 – Data Verification Procedures

Records Reviewed	Required Documents	Process Description	Responsible Person, Organization
Field logbook	NA	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that well numbers/names are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field measurement was performed, and results are documented.	Daily – Arcadis Field Team Leader At conclusion of field activities – Arcadis Project Manager
Chain-of-custody forms	Appendix B TGI, Field Forms	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Daily – Arcadis Field Team Leader At conclusion of field activities – Eurofins Edison Project Manager; Eurofins Lancaster Project Manager; Pace Analytical Project Manager
Laboratory Deliverable	UFP- QAPP worksheets 14 &16	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the CoCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Before release – Eurofins Edison Project Manager; Eurofins Lancaster Project Manager; Pace Analytical Project Manager Upon receipt – Arcadis Data Validator
Corrective Action Reports	UFP -QAPP worksheets 31, 32 & 33	For any non-compliance noted, verify that corrective action was implemented according to plan and documented in the final report to USEPA.	Arcadis QA Manager and Project Manager

QAPP Worksheet #36 – Data Validation Procedures

Data Validator: Arcadis

Analytical Group/Method¹:	Groundwater and Surface Water Metals: USEPA Method 200.8 Mercury: USEPA Method 245.1 Alpha Emitting Radkum Isotopes: USEPA Method 903.03	Soil (if required) Metals: SW-846 6020B Mercury: SW-846 7471B Alpha Emitting Radkum Isotopes: USEPA Method 903.03
Data deliverable requirements:	Level II and Level IV Analytical Report; Results and QC Summary (pdf) DOW EQUIS EDD	Level II and Level IV Analytical Report; Results and QC Summary (pdf) DOW EQUIS EDD
Analytical specifications:	See Worksheets #28-1, 28-2, and 28-3 and associated laboratory SOPs	See Worksheets #28-1, 28-2, 28-3, and associated laboratory SOPs
Measurement performance criteria:	See Worksheets #12-1, 12-2, and 12-3, and #28-1, 28-2, and 28-3	See Worksheets #12-1, 12-2, and 12-3, and #28-1, 28-2, and 28-3
Percent of data packages to be validated²:	100% Stage 2A	100% Stage 2A
Percent of raw data reviewed:	Raw data review is not required for Stage 2A validation.	Raw data review is not required for Stage 2A validation.
Percent of results to be recalculated:	Recalculation of results is not required for Stage 2A validation.	Recalculation of results is not required for Stage 2A validation.

Validation procedure: (manual validation will be performed on 100% of lab data)	USEPA National Functional Guidelines for Organic Superfund Methods Data Review, EPA 540-R-20-005, November 2020 (with reference to the historical USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, OSWER 9240.1-05A-P, October 1999, as appropriate) USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review, EPA 542-R-20-006, November 2020 (with reference to the historical USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, October 2004, as appropriate).	USEPA National Functional Guidelines for Organic Superfund Methods Data Review, EPA 540-R-20-005, November 2020 (with reference to the historical USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, OSWER 9240.1-05A-P, October 1999, as appropriate) USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review, EPA 542-R-20-006, November 2020 (with reference to the historical USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, October 2004, as appropriate).
Data validation codes:	100% S2AVM	100% S2AVM
Electronic Data Deliverable:	EQuIS Region 2 EDD and the NJDEP HAZSITE EDD	EQuIS Region 2 EDD and the NJDEP HAZSITE EDD
Data validation stage²:	Stage 2A	Stage 2A

Notes:

¹ Data for waste determination will not be validated.

² The validator will conduct a Stage 2A validation. If the Stage 2A validation indicates that the laboratory had issues with extracting, analyzing, and data processing the project samples, Arcadis will discuss the need for higher level validation with Rohm and Haas Chemicals LLC and USEPA

Data Validation Codes and Definitions:

Data Validation Codes	Definitions
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."
JN	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

QAPP Worksheet #37 – Data Usability Assessment

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Arcadis Project Manager
 Arcadis QA Manager
 Arcadis Project Chemist
 Arcadis Field Task Leader

Summarize the data usability assessment process including statistics, equations, and computer algorithms that will be used to analyze the data:

Step 1	Review the project's objectives and sampling activities Review the actual sampling records to make sure they are compliant with UFP-QAPP.
Step 2	Review the data validation outputs Review data validation reports. Perform basic calculations and summarize the data (using maps, tables, etc.). Look for patterns, trends, in the lab reported results and field measurements. Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, and UFP-QAPP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable lab and field QC sample results.
Step 3	Evaluation of Data Quality and Identification of Data Gaps The dataset will be reviewed to confirm that all planned samples have been collected and analyzed as specified. Any missing samples or parameters will be documented, and the potential impact on project DQOs will be evaluated. The Data Usability Assessment will identify any spatial, temporal, or analytical gaps in the dataset. The impact of these data gaps on the project's ability to make risk management decisions will be assessed. The Data Usability Assessment will include recommendations for follow-up sampling or data collection to address critical data gaps, if needed.
Step 4	Document data usability and draw conclusions Data validation will be used to determine if the data can be used as intended, considering implications of relative percent difference (RPD) between parent and field duplicate sample results, RPD and %recovery (%R) of matrix spike and matrix spike duplicate results, deviations of daily initial instrument calibrations verification to the initial instrument calibration curves, root cause analysis and corrective actions report when applicable. Data validator shall review all above mentioned reports and use the guidance listed in Worksheet #36 and apply appropriate data validation code and describe the process in the data usability report. Project chemist will decide if the non-compliant issue is severe enough to cause data rejection or not. Any rejected data will be reviewed closely and discussed in the data validation/usability report. Also, all results will be compared to historical data for each well. Prepare the data usability summary report which may be in the form of text and/or a table.

A Final Report will be generated after field activities have been conducted, and validated results of sample analyses have been received. The Final Report will discuss all precision, accuracy, representativeness, completeness, comparability, and sensitivity parameter results from the data validation and overall usability of the data for project objectives, including the following:

Precision:

- Field Duplicates: samples are collected during each event at a 10% frequency to demonstrate acceptable field precision.
- Laboratory Duplicates: are analyzed to demonstrate acceptable method precision at the laboratory. Lab duplicates are performed at a 5% frequency rate.
- Method of standard dilution performed, and method criteria met?
- MS/MSDs: are analyzed to demonstrate acceptable method precision at the laboratory.
- The measure of agreement among repeated measurements of the same sample location under identical, or substantially similar, conditions and which is expressed as the RPD between the sample pairs.
- Duplicate samples will be collected to demonstrate acceptable sampling precision and the correlation between samples. According to the EPA *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2020), if both the original sample and duplicate sample results are greater than five times the PQL and the RPD is less than or equal to 20% no qualification is required for surface water or groundwater; sediment and soil will be qualified with a 35% RPD. These requirements are laboratory guidelines which may not apply to all field situations. RPD values will be calculated using the following equation:
- $$RPD = 100 \times \frac{(\text{Sample Result} - \text{Duplicate Result})}{0.5(\text{Sample Result} + \text{Duplicate Result})}$$

Accuracy:

- MS/MSD: Are percent recovery (%R) criteria met?
- Laboratory control sample (LCS)/ LCS Duplicates: %R criteria met?
- Initial and continuing calibration recoveries met?
- Interference check sample recoveries met?
- Inductively coupled plasma serial dilution recoveries criteria met?

Representativeness:

- Sampling procedures and design criteria met?
- Holding times and preservation criteria met?
- Custody: all chain-of-custody forms complete and provided in data package?
- Blanks: contaminants present?

Completeness:

- The number of valid analytical results is comparable (90%) with the number determined necessary during establishment of DQOs.

Comparability:

- Data compares with similar analysis and data sets?

- Sample collection methods comparable to similar data sets?
- Laboratory analytical methods comparable to similar data sets?

Sensitivity:

- Method reporting limits met project objectives?

The data will be assessed for the following criteria:

- *Bias* – a systematic or persistent distortion of a measurement process that causes errors in one direction. The extent of bias will be determined by evaluating the laboratory initial calibration/continuing calibration verification, LCS/LCSD, blank spikes, MS/MSD, and method blanks.
- *Sensitivity* – is the smallest value of the stimulus that can be resolved with a given degree of confidence, i.e., the detection limit. The detection limits of the field and laboratory methods are within the range of previous detections found at the BHMD site.
- *Precision* – the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions and which is expressed as the RPD between the sample pairs. An acceptable RPD for water samples is 20%, and 35% for soil.
- *Representativeness* – the measure of the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, a process condition, or an environmental condition.
- *Completeness* – a measure of the amount of valid data obtained from a measurement system. Completeness will be assessed by the total number of samples collected versus the amount planned.
- *Comparability* – the qualitative term that expresses the confidence that two data sets can contribute to common interpretation and analysis; comparability is used to describe how well samples within a data set, as well as two independent data sets, are interchangeable.

Uncertainty of validated data will be discussed with the MEMC PM or designee to determine if the DQOs were met. If the DQOs were not met, they will be reviewed to determine if they are achievable and may be revised if necessary, and the data may be further evaluated to determine the impact to the project. Data usability and limitations will be evaluated by the MEMC PM or her designee and discussed in the Final Report.

REFERENCES

Arcadis. 2025. Liberty Mine Area Engineering Evaluation/Cost Analysis Investigation Work Plan.

Appendix B

**Standard Operating Procedures and Technical Guidance
Instructions (SOP/TGI)**

QP 3.08 – Field Sampling, Measurement, and Observations

Rev: 1

Rev Date: October 11, 2021

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	November 3, 2016	All	QP Issued	QMS
	1	October 11, 2021	All	Updated for QMS Relaunch October 12, 2021	Marc Killingstad David Gerber

Approval Signatures

Prepared by:	Marc Killingstad	10/11/2021
	Name (Preparer)	Date
Quality Reviewer:		10/11/2021
	Signature (Quality Reviewer)	Date
QMS Approver:		10/11/2021
	David Gerber)	Date

STATEMENT OF POLICY:

It is Arcadis Environment Business Line (ENV) policy that field sampling, measurements, and observations must be conducted and documented to facilitate later data interpretation, provide an evidentiary record and to demonstrate that field activities have been performed consistently and in accordance with approved site-specific project planning documents. Site-specific documents describing field sampling activities may include, but are not limited to, work plans, the Project Quality Plan (PQP), Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and Technical Guidance Instructions (TGIs), Quality Procedures (QPs), Health and Safety Plan (HASP), and/or other appropriate project documents associated with the sampling program.

1 Purpose

The objective of this Quality Procedure (QP) is to provide a consistent process for the execution of activities associated with field sampling, measurements, and observations. This QP, while focused on field sampling activities, should be performed in conjunction with QP 3.06 Field Activities Documentation.

2 Responsibilities

Certified Project Manager (CPM) – is responsible for implementation of this QP, including verification that site-specific project planning documents are followed (including approved deviation decisions, if necessary). Although a Field Supervisor may lead the sampling activities, the CPM is ultimately responsible for staff's adherence to this QP.

Quality Consultant – responsible for providing quality assurance and quality control (QA/QC) guidance to the CPM in implementing this procedure. Note that for Federal projects there are specific requirements for the QA officer assigned to a project.

Quality Reviewer – Is responsible for final review of this Quality Procedure (QP). Quality Reviewers may be a Quality Consultant, QMS Document Owner, Technical Solution Leader, Community of Practice Leader, or other qualified subject matter expert (SME).

Project Team Members – project participants who are involved in sampling activities are responsible for compliance with this procedure. Individuals involved in the sampling program will read and adhere to the site-specific project planning documents that direct their field activities.

3 Terms and Conditions

Work Plan – a document that describes proposed project activities.

Quality Assurance Project Plan (QAPP) – a document that prescribes the quality assurance/quality control procedures to be followed. Uniform Federal Policy (UFP)-QAPPs are now frequently required for environmental projects by most federal regulatory agencies. UFP-QAPP includes Worksheets used to document the entire project plan developed following the systematic planning process. For more details on the UFP-QAPP see: <http://www.epa.gov/fedfac/documents/qualityassurance.htm>. Note that if the project QAPP is written following the Uniform Federal Policy (UFP) that it will also contain a description of the sampling rationale and sampling locations as well as quality assurance/quality control requirements. The UFP-QAPP format is designed to capture

the entire systematic planning process. If a UFP-QAPP is written for a project, a separate FSP may not be required unless specified by the particular regulatory agency, client or contract.

Field Sampling Plan (FSP) – a document that describes the procedures and protocols necessary to complete field sampling and data collection activities.

Health and Safety Plan (HASP) – a document that describes the hazards of planned activities and the controls to be implemented to protect site personnel.

Data Quality Objective (DQO) – a statement that specifies the quality of data required to support the purposes and intent of the sampling and analysis activity. DQOs are based on the intended use of the data; as such, different data uses and needs may require different levels of data quality.

Technical Guidance Instruction (TGI) –TGIs may also be created or revised on a program or project specific basis. An TGI library is available on the [Environment Quality Management System SharePoint site](#).

4 Related Documents

- QP 3.06 - Field Activities Documentation
- QP 3.07 - Calibration and Control of Measuring and Test Equipment.

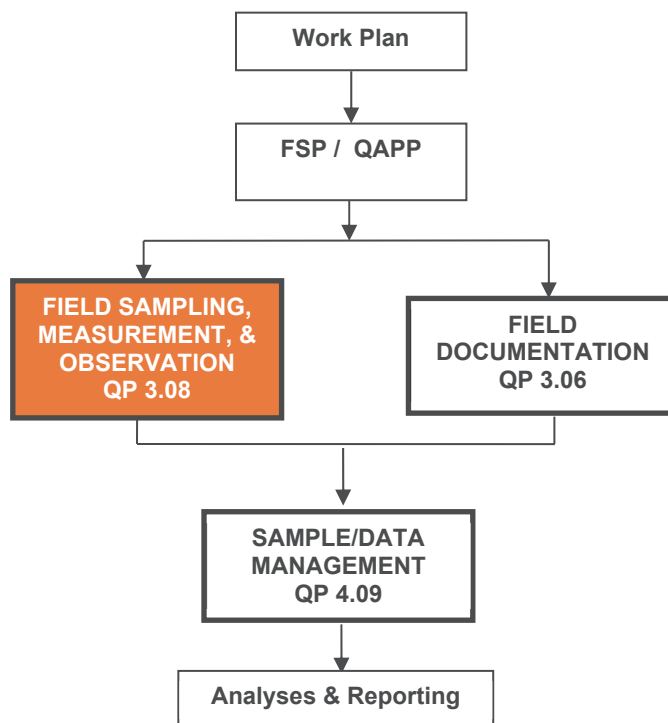
Forms such as purge logs, soil boring logs appropriate for the field sampling activity and observations.

Related documents are available in the [QMS Document Library](#).

5 Description of the Procedure

Sampling and data quality directly affect overall project success because sampling and other field activities are a critical and fundamental component of projects. Errors, mistakes, missed communications, or out-of-scope or out-of-compliance actions may have an adverse effect on a project. Because field conditions cannot be anticipated absolutely, procedures for a particular sampling program must include a formal process for making decisions and obtaining appropriate approvals for deviations necessitated by conditions. Within this context, the basic procedures and requirements for sampling and other field measurements and observations are outlined in the project documents (FSP, QAAP or Work Plan) and the associated procedures. Sample collection, data collection, and drilling locations should be documented (i.e., tape measurements with respect to site features, GPS measurements, and or survey by a licensed land surveyor). It is also recommended taking to the field site maps showing pre-existing and proposed sampling, drilling, data collection, and well locations. It is also recommended the field staff be aware of previous data measurements so field staff can note and communicate any significant changes.

The following flow chart provides the major components of a typical field characterization program and highlights where field sampling activities fit in.



1. Field Sampling, Measurement, and Observation Activities

Field operations are conducted to provide reliable information, data, and/or samples that meet the project and data quality objectives. It is essential that field sampling, measurement, and observation activities begin with the field team having a detailed familiarity with appropriate site-specific project planning documents, most notably the FSP. Time should be scheduled and budgeted for the field team members to review the plan(s) and ask questions. With a good understanding of what samples or data are to be collected, as well as where and why they are to be collected, field personnel will perform the following activities during the implementation of field characterization activities.

1.1 Briefing and Preparation

Before field activity begins, a kick-off meeting should be held to ensure that the project team understands the project objectives and the procedures that will be followed. The CPM and appropriate project office (including relevant technical lead(s)) and field personnel (e.g., Field Supervisor, Crew Leader, or entire crew) should engage in a briefing via telephone discussion or in person to review (in summary fashion) the following:

- Project objectives and project plans
- DQOs
- Sampling locations
- Applicable TGLs for the proposed activities
- Chain of command
- HASP (including site-specific Health and Safety concerns)
- Provisions for addressing deviations
- Communication plan

- Other special circumstances or information critical to the success of the sampling event and integrity of the data and documentation.

When possible, the CPM and/or Field Supervisor should perform a reconnaissance site visit prior to initiation of the sampling or other field activities to review sample locations and consider health and safety or other logistical challenges the site may present. The CPM must also ensure that any utility clearance requirements have been met. Finally, the CPM and/or Field Supervisor must verify that the necessary subcontracts, notifications, and approvals are in place, including coordination with client personnel, agency oversight personnel, access to private or public property (i.e., legal), and coordination with utility companies/agencies regarding the potential of buried, overhead, or other sensitive infrastructure that may affect project implementation and/or health and safety.

1.2 Standard Operating Procedures and Technical Guidance Instructions

Applicable TGIs must be followed to ensure consistency and quality in method and resulting data. A TGI library is available in the Environment Quality Management System SharePoint site. TGIs may also be created or revised on a program or project specific basis. Deviation from established procedure(s) during a data collection activity must be documented. Where plans and TGIs allow discretion (do A or B) or choice (exact sampling location) these decisions should be documented in the field notebook. In cases where the integrity of the data being collected may be jeopardized, field personnel must consider stopping associated work activities until the CPM or other project authority can be consulted as to what corrective action is warranted before work can recommence. Follow the hierarchy of regulatory, client, ENV in selecting and modifying methods and procedures.

1.3 Equipment and Instrumentation

The site-specific project planning documents will be reviewed to identify the types of equipment, instrumentation, and supplies that are needed for the sampling, measurement, observation, or other data collection activities. The selected equipment and instrumentation will meet the requirements of the specifications, methods, and procedures provided in the FSP, QAPP, HASP, or other planning document(s). Further, the Field Supervisor/Crew Leader is responsible for verifying that the equipment and instrumentation are in good working order, clean and, if necessary, properly calibrated and maintained before, during, and after use in the field. (See QP 3.07 Calibration and Control of Measuring and Test Equipment).

1.4 Physical Sample Management

It is extremely important that proper procedures be followed in the sample identification system employed for collected samples, the chain-of-custody procedures, and the manner in which the samples are tracked from collection point, through handling and shipment, and to receipt by the laboratory (including sampling techniques, sample volumes, holding times, preservation, packaging, and shipping procedures). Field personnel are responsible for obtaining the proper number and type of quality control samples, including but not necessarily limited to trip blanks, duplicates, matrix spikes, matrix spike duplicates, and equipment rinse blanks (these requirements should be specified in the site-specific project planning documents and reviewed prior to commencing the field program). These procedures are specified in the Work Plans, FSP, QAPP, and or HASP, or other project planning documents and shall be reviewed by field personnel prior to initiation of field activities. Deviation from established procedures could impact the integrity of the sample or activity; and must be justified, approved by the CPM, and be appropriately documented.

1.5 Qualitative Data Management

Based on requirements specified in site-specific project planning documents, field activities should adhere to applicable TGIs and be carried out in a consistent manner that is well documented in accordance with QP 3.06 Field Activities Documentation. This includes care in making and recording accurate and precise measurements and observations in a timely manner.

1.6 Decontamination and Investigation-Derived Waste

Field personnel will review and be familiar with required decontamination procedures, including those for cleaning field equipment, proper storage of cleaned field equipment, and for properly disposing of waste generated from decontamination procedures. If decontamination is conducted on site, the activities will be performed in a designated, controlled location that will not impact collected samples. Decontamination activities will be appropriately documented in the field notes, following the protocols specified in the FSP/QAPP or TGI and QP 3.06 Field Activities Documentation.

It is important to note that decontamination includes personal protective equipment as well as vehicles and equipment. It is critical that equipment used in one area not serve as a source of contamination of another. This may include weeds or affected soil/water (e.g., carried-in tires or equipment) that could be transported outside the designated work area. Work in surface waters potentially supporting amphibians and other ecological resources may require specific decontamination procedures between sampling events even if no pollutants are anticipated in the waters.

Field personnel will review and be familiar with required procedures for management of investigation-derived waste (IDW) generated as part of the proposed field activities including information/protocols for tracking, storing, labeling, inspecting, sampling, and shipping/disposing of all IDW generated from the proposed field activities. Wastes generated in the field will be collected, stored, and properly disposed in accordance with FSP/QAPP protocols.

1.7 Corrective Action

The CPM and field personnel will be familiar with site-specific project planning procedures designed to address deficiencies or deviations quickly and efficiently, so as not to unnecessarily hold up progress or compromise the integrity of the field effort. Based on the procedures established in the site-specific project planning documents, specific steps are taken as soon as a potential problem is identified. At a minimum, deficiencies or deviations must be reported to the CPM (through pre-established chain of command) and then fully documented to include the nature of the problem, the corrective action taken, and the person(s) responsible for correcting or otherwise addressing the problem. Site-specific project planning documents should contain site-specific corrective action procedures.

- END OF PROCEDURE -

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QP 3.06 – Field Activities Documentation

Rev: 1

Rev Date: November 30, 2021

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	November 8, 2016	All	QP Issued	QMS
	1	November 30, 2021	All	Updated Template for QMS Relaunch October 12, 2021	Matt Spurlin Brian Webb David Gerber

Approval Signatures

Prepared by:	Matt Spurlin / Brian Webb	11/30/2021
	Names (Preparers)	Date
Quality Reviewer:	 	11/30/2021
	Signatures (Quality Reviewers)	Date
QMS Approver:		11/30/2021
	David Gerber (QMS Approver)	Date

STATEMENT OF POLICY:

It is Arcadis Environment Business Line (ENV) policy that field activities must be documented to facilitate the interpretation of data; show compliance with project plans, work plans, and contract terms; and to serve as evidentiary records. Documentation reflecting activities performed must be legible, organized, and complete. Applicable regulatory and client requirements should be considered when documenting field activities. Project-specific requirements for documentation typically should be described in the Work Plan, Field Sampling Plan (FSP), and/or in the Quality Assurance Project Plan (QAPP).

1 Purpose

The purpose of this Quality Procedure (QP) is to provide a standard procedure for the documentation of fieldwork activities. This documentation pertains to site-related projects, but is not limited to the collection of samples, subsurface information, and oversight of construction activities. Field documentation must include, at a minimum, project title and number, date and times of activities, the identification of the employee performing the work, and the specifics of the work being performed.

2 Responsibilities

Certified Project Manager (CPM) – is responsible for the project-related administration of this QP.

Quality Consultant – is responsible for providing quality assurance and quality control guidance to the CPM in implementing this procedure. Note that for federal projects, there are specific requirements and qualifications for the QA Officer assigned to the project.

Project Team Members – who are assigned to document field activities, are responsible for compliance with this procedure.

Quality Reviewer – The Quality Reviewer is responsible for final review of this Quality Procedure (QP). Quality Reviewers may be a Quality Consultant, QMS Document Owner, Technical Solution Leader, Community of Practice Leader, or another qualified subject matter expert (SME).

3 Terms and Conditions

Field Sampling Plan (FSP) – A document that describes the procedures and protocols necessary to complete field sampling and data collection activities.

Work Plan – A document that describes proposed project activities.

Quality Assurance Project Plan (QAPP) – A document that prescribes the quality assurance/quality control (QA/QC) procedures to be followed. Uniform Federal Policy (UFP) QAPPs are now frequently required for environmental projects by most federal regulatory agencies. A UFP QAPP includes Worksheets used to document the entire project plan developed following the systematic planning process. For more details on the UFP QAPP see <http://www.epa.gov/fedfac/documents/qualityassurance.htm>. Note that if the project QAPP is written following the UFP format, it will also contain a description of the sampling rationale and sampling locations as well as QA/QC requirements. The UFP QAPP format is designed to capture the entire systematic planning

process. If a UFP QAPP is written for a project, a separate FSP is generally not required unless specified by the particular client or contract.

Technical Guidance Instruction (TGI) – Document describes the procedure and/or protocol necessary to conduct a specific activity.

4 Related Documents

Forms used for documenting field activities may be included as attachments to the FSP or the QAPP and may include the following examples:

- Chain-of-custody (COC) form;
- Sample data log;
- Field modification form;
- Sample receipt form;
- Corrective action form;
- Field activity log;
- Calibration log;
- Analysis request and chain-of-custody record;
- Daily quality control reports;
- Purge log;
- Soil boring log.

Examples of TGIs with forms and check-lists can be found in the [QMS Document Library](#).

5 Description of the Procedure

1. General Requirements

1.1 Documentation Format

Documentation of field activities provides an accurate and comprehensive record of the work performed sufficient for a technical peer to reconstruct the day's activities and confirm that necessary client, regulatory, contract, and work plan requirements were met. General requirements include:

- Use of field books (preferably bound) as the primary source for information collection and recording. Field books should be dedicated to the project and appropriately labeled.
- Use of a Field Activity Log is suggested to formally document activities and events as a supplement to bound field books. The Field Activity Log can be a standard or project-specific form or a bound field book. Preprinted standard forms are available for many activities and should be used whenever possible. These forms will provide prompts and request additional information that may be useful and/or needed. Project-specific field forms may be generated, or existing forms may be modified to meet specific project needs. Client-supplied forms may be substituted, as required.
- Appropriate header information is documented on the first page of notes for each day of fieldwork, including project title, project number, date, time, author, and relevant setting information such as weather conditions, topography, surface water conditions, observed site activities/uses, and other persons in field team. In addition, include on every page of notes the page number and date. Project-specific information depends on

the nature of work being performed and should be discussed by the project team prior to commencing fieldwork. As appropriate, dedicated field logs/journals or forms should be used. When Field Activity Log Forms are used, information fields that are not applicable should be noted as such with the symbol "N/A" or other appropriate notation.

- Field documentation entries shall be made using indelible ink.
- Data entries shall be legible. A single line should be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Units of measurement shall be specified. The level of accuracy shall be indicated (e.g., observed estimate vs. quantified census from direct count).
- Field records are to be maintained in project files unless otherwise specified by a client or stipulated by a contract.
- Unless addressed specifically by a client or stipulated by a contract, site photographs should be taken to document the general setting and landscape as well as site-specific issues/resources of interest. Photo locations and the compass direction of view should be recorded in the notes with the photo number.
- Alternatively, use of field tablets with data plans and electronic data collection software supported by Cloud services (e.g., Fulcrum Collector, Survey123) that are pre-loaded with appropriate data collection forms (e.g., method-specific sampling, soil logging, photo logs, H&S tailgate meetings, well/piezometer/lysimeter installations, electronic chain of custody, etc.). All forms adhere to the relevant documentation format requirements (described above and below this section) for data collection with conventional paper methods. Electronic data collection services, as well as training, are available to Arcadis field staff through the FieldNow® program and while optional are highly encouraged.

1.2 Documentation Entries

A chronology of field events should be recorded. General entry requirements include:

- Visitors to the site, including owner and regulatory agency representatives
- Summary of pertinent project communications with the client, regulators, or other site visitors during the fieldwork
- Other contractors or entities working on site
- A description of the day's field activities, generally in chronological sequence or in order of significance, using military time notation (e.g., 9:00 a.m. as 0900, and 5:00 p.m. as 1700)
- If applicable, calibration of measuring and test equipment and identification of the calibration standard(s) (use a Calibration Log, if available, with cross-reference entered into the field book)
- Field equipment identification, including information such as the type, manufacturer, model number, or other specific information
- If applicable sampling activities are being performed, weather information such as temperature, wind speed and direction, precipitation, time of measurement, and units
- Documentation of safety meeting (e.g., tailgates and tailboards) topics and attendees
- Verification of subsurface utility clearance in accordance with ENV policy
- Safety and/or monitoring equipment readings, including time of measurements and units
- If applicable, specific forms used for collection of data are referenced in the field notebook
- Subcontractor progress and/or problems encountered
- Changes in the scope of work
- Other unusual events.

2. Specific Requirements

2.1 Sample Collection

Sample collection data are documented in a bound field book, electronic field forms provided by the FieldNow® program, and/or on a Field Activity Log. Where both are being used, information contained in one is cross-referenced to the other. Entries such as the following examples should be consistent with the requirements in the project-specific Work Plan, FSP, and QAPP:

- Sample identification number, location taken, depth interval, sample media, sample preservative, collection time, and date
- Sample collection method and protocol
- Physical description of the sample (using a standard classification system for soil)
- If a composite sample, include the number, location(s), and depth(s) of grab samples incorporated in the composite
- Quality-related samples (e.g., field duplicates, trip blanks, equipment rinse, blanks matrix spikes, and matrix spike duplicates)
- Container description and sample volume
- Pertinent technical data, such as pH, conductivity, temperature, and head-space readings
- Pertinent technical comments
- Identification of personnel collecting the sample.

2.2 Sample Labeling

Sample labels must be prepared and attached to sample containers. Labels are either provided by the laboratory performing the analyses or are generated internally. Labels should be indelible and securely attached to the container. The information to be provided may include:

- Sample identification number
- Sample date, initials, or name of who collected the sample, and collection time
- Physical description of the sample (e.g., water, solid, gas, or other physical medium)
- Analytical parameters and method(s)
- Preservatives, if present
- Sample location and depth, if applicable
- Client.

Although this information is typically written out, it can also be recorded in an electronic tracking system if a bar code is used.

2.3 Analysis Request and Chain-of-Custody Record

A critical component of data collection is the documentation that the samples were obtained from specific locations and received by the laboratory or archive without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal or archive must be properly documented. Documentation will be accomplished through a COC record that documents each sample and identifies the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if at least one of the following criteria is met:

- The sample is in a person's actual possession
- The sample is in unobstructed view, after being in the person's actual possession
- The sample is locked and only accessible by the custodian after having been in the person's actual possession
- The sample is in a secured area, restricted to authorized personnel (e.g., laboratory).

An example COC form to be used by ENV personnel in collecting and shipping samples can be found on the corporate Intranet. A laboratory typically will not accept samples for analysis without a correctly prepared COC form. The COC must be signed by each individual who has the sample in his/her custody. Each sample shipped to a laboratory for analyses must be documented on the COC. Information on this form correlates with other supporting documentation, including the field logbook, sample labels, and sample collection logs.

The COC documents the elapsed time and the custodians of the sample from the time of its collection. The individuals who have physically handled the sample(s) or witnessed initial sample collection and packaging (sample team member) must be identified on the form. A sample team member relinquishes the sample by signing the COC. Individuals who either relinquish or receive samples must include their complete names, company affiliation, and the date and time the sample(s) were relinquished. The times that the samples are relinquished and received by the next custodian should coincide, with the exception of transfer by commercial carriers. These carriers will not be required to sign the COC.

If a sample is to be stored for a period of time (e.g., overnight), measures are taken to secure the sample container in a manner that only provides access to the custodian of record. If samples are relinquished to a commercial carrier (i.e., UPS or Federal Express), the carrier waybill number is recorded, and a copy of the waybill is attached to the COC. These documents are maintained with other field documentation. The original COC is sealed inside a zip-top plastic bag and placed inside the shipping container with the samples.

If corrections are made to the COC, the corrections should be made (single line through the error, initial, and date) by the originator of the change, and, if necessary, an explanation of the change should be provided. The documentation should be of a level of detail that clearly documents the change to a third-party reviewer.

Guidance for choosing a laboratory and completing analyses requests and COC can be found in QP 2.09-Subcontracting Laboratory Services and on the corporate Intranet for the Arcadis Laboratory Program (ALP) and should also be described in the project-specific planning documents (i.e., Work Plan, FSP, or QAPP).

The option to use the Electronic Chain of Custody (eCOC) form in conjunction with the appropriate sample application(s) may be available through the FieldNow® program but is currently limited to a select list of approved analytical laboratories. Use of the eCOC application is intended to reduce common transcription errors both by field staff and laboratory staff on a conventional handwritten paper COC. Once the eCOC form is completed and approved on the field tablet by field staff, a PDF version of the form is automatically emailed to each assigned team member. In addition, a dedicated or mobile printer is recommended for printing a hard copy of the completed eCOC to be included in each sample cooler to meet laboratory requirements.

2.4 Subsurface Logs

Test pits, soil borings, monitoring wells or rock coreholes wells, and piezometer installations are to be recorded in bound field books or electronic soil logging field form provided by the FieldNow® program and may be supplemented with prepared forms. Personnel completing the log are to supply the following information:

- Administrative and technical information included in the header.
- Types of equipment used (e.g., drill rig type, drilling tools used [including diameter and length], or backhoe model).
- Subcontractor/driller used.
- Descriptions of subsurface materials encountered, and the number and type of samples collected, if any.
- Subsurface exploration depth and units of measure.
- For drilling, length of recovery.
- Sample type and sample number for geotechnical or analytical samples collected. These data are to be also entered on the sample collection log (if used) and the sample label.
- Classification standard protocol used, if any (e.g., ASTM International Standard Penetration Test).
- Narrative description of the soil, sediment, or bedrock (using standard classification system) and other pertinent information.
- Additional data, such as background and sample vapor/gas readings, observation of sheens, non-aqueous-phase liquid, depth to water (if encountered), presence of (but generally not description of) odors, changes in drilling conditions, and other pertinent information.
- Description of the materials used to seal the boring unless it is completed as a well or piezometer.

When using the electronic soil logging field form, draft logs can be exported to appropriate formats through Arcadis's internal reporting services for QC. Revisions can be made to the soil logging forms using the field tablets, then re-synced to the server and re-exported to PDF as final draft.

2.5 Monitoring Well/Piezometer Installation

In addition to requirements in Section 2.4, subsequent well or piezometer development activities may involve transcription of field data from the field book onto a computer-based boring log. The field notebook or electronic soil logging/well construction field form provided by the FieldNow® program is to be used to identify the chronology and major events of the installation activity, and the computer-based boring log is to be used to correlate the geologic strata to the major elements of the monitoring well construction. Information to be collected and recorded must meet the regulatory and client requirements and may include the following:

- Location identity
- Screen and riser type, length, diameter, and location
- Diameter
- Total depth
- Sump location and depth and diameter
- Materials of construction (e.g., stainless steel, polyvinyl chloride, or other material)
- Seal type(s) and or depth(s)
- Sand or gravel pack type, including materials (e.g., silica) and gradation
- Depth to water before and after installation.

When using the electronic soil logging/well construction field form, draft logs can be exported to appropriate formats through Arcadis's internal reporting services for QC. Revisions can be made to the soil logging/well construction forms using the field tablets, then re-synced to the server and re-exported to PDF as final draft.

2.6 Air Sampling Logs

At a minimum, air sampling documentation should include:

- Start and finish time of sampling
- Sampling location
- Sampling method/media
- Volume sampled.

2.7 Construction, Demolition, Abandonment, and Related Activities

Monitoring and documentation of construction and comparable activities shall be documented in bound field books and/or on appropriate company forms and should include similar information as specified above, including information such as:

- Project name and number
- Owner or client name
- Contractor or subcontractors performing the work
- Contractor or subcontractor superintendent(s) and personnel (as available) on site
- Chronological sequence and description of work activities performed, including workday start and completion times
- Reference to contract sections, work plans, or specifications describing work being performed
- Reference to relevant permit conditions and regulatory requirements and/or reference to regulatory guidance documents controlling work approach
- Listing of all trades performing work by contractor and subcontractor
- Hours worked per trade
- Work hours per day per shift, if applicable
- Equipment on site (e.g., description, model number, size, and type) and hours of use
- Listing of equipment on site being left idle
- Description and quantity of materials used or incorporated, with reference to contract or specification item number, if feasible; include simple sketch of excavation with approximate dimension, if applicable
- Calculations with dimensions for quantities of material used or incorporated
- Delineation of the work area and access routes (e.g., fencing, flagging, or staking), confirmation that activities occurred within the work area or description of work occurring outside the delineated work area and justification (as needed), and characterization of impacts outside the designated work area
- Documentation of compliance with speed limits, dust control, erosion control best management practices, and other basic elements of construction activities as dictated by project work plans and applicable permits and regulatory criteria.

2.8 Daily Safety Meeting

A Daily Safety Meeting is to be conducted and documented each workday prior to the initiation of field activities, with on-site ENV personnel, contractors, subcontractors, and visitors if possible. Safety topics discussed are entered on the Daily Safety Meeting Form (available on the corporate Intranet). Topics discussed should include site-specific conditions, procedures to be followed that day, and protective equipment. A printed listing of the attendees at the meeting and their signatures should be included. Other required data are:

- Identification of the individual conducting the meeting and his/her signature
- Identification of the project supervisor and project manager.

The option to use the electronic H&S tailgate meeting field form is available through the FieldNow® program. The completed form can be exported to appropriate formats through Arcadis's internal reporting services for documentation purposes.

2.9 Calibration

Documentation of the calibration and calibration results shall be made for field equipment requiring calibration measuring and test equipment calibration data are recorded in the field book or on the Field Activity Log. Calibration data include the following:

- Unique identification of instrument being calibrated, including type, model, and serial number
- Date and time of calibration
- Standards used in the calibration, including standard identity, concentration, lot number, and manufacturer of the standard
- Instrument reading with respect to each calibration standard
- Comments, as necessary, regarding instrument performance.

2.10 Photographs and Videos

When the client allows, photographs and videos may be used to help document pre-, active, and post-field activities. In sensitive areas (e.g., secured, or confidential), the client must be contacted to evaluate security procedures concerning use of photographs or videos. Photographic and video documentation should include project title, project number, date, time, and description of conditions. The time should also be documented if time is important to a sequence of photographs.

Photographs are documented by numbering digital photographs and identifying the number and subject on the Field Activity Log or the electronic photograph log through the FieldNow® program. Individual prints may be marked with a stamp or preprinted self-adhesive labels, or by writing the project number and sequential number of each photograph and referencing the numbers in the field book, the Field Activity Log, or a dedicated photo log. Videos used for field documentation are to be identified by project title, project number, and description.

2.11 Subcontractor Preparedness Checklist

Prior to starting work, a review is to be made and documented of a subcontractor's preparedness to perform specified activities. This review may be documented on the Field Activities Log or on checklists that may be developed according to requirements for subcontracted work activities. Particular emphasis should be on site-specific issues that may require special consideration such as health and safety, access, and unique settings. These should be discussed in advance with the CPM and the client in developing and implementing the Scope of Work.

- END OF PROCEDURE -

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TGI – Soil Description

Rev: 4

Rev Date: June 14, 2022

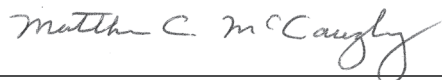
Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	May 20, 2008	17	Original SOP	Joe Quinnan Joel Hunt
	1	September 2016	15	Updated to TGI	Nick Welty Patrick Curry
	2	February 16, 2018	15	Updated descriptions, attachments and references in text	Nick Welty Patrick Curry
	3	April 15, 2022		Minor description edits, intro of grain-size K analysis, revised boring log template	Matt McCaughey Patrick Curry
	4	June 14, 2022		Updated date on cover page and header. Updated revision number from 3 to 4. Updated reference throughout document from ASTM D2488-06 to ASTM D-2488.17 . Change “25% silt and clay; 15% pebbles” to “20% silt and 20% clay” on page 10 of 23. Updates made to Section 8.2.1 Changed reference to Appendix B to Appendix A	

Approval Signatures

Prepared by:

6/14/2022



Matthew C. McCaughey, PG (Preparer)

Date

Reviewed by:

6/14/2022



Patrick Curry, PG (Subject Matter Expert)

Date

1 Introduction

This Arcadis Technical Guidance Instruction (TGI) describes proper soil description procedures based on visual inspection and testing of soil cores and samples. This document has been developed to emphasize field observation and documentation of details required to:

- Make hydrostratigraphic interpretations guided by depositional environment/geologic settings
- Provide information needed to understand the distribution of constituents of concern; properly design wells, piezometers, and/or additional field investigations; and develop appropriate remedial strategies.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI should be followed for unconsolidated material unless there is an established client-required specific procedure or regulatory-required specific procedure. In cases where there is a required specific procedure, it should be followed and should be referenced and/or provided as an appendix to reports that include soil classifications and/or boring logs. When following a required non-Arcadis procedure, additional information required by this TGI should be included in field notes with client approval.

This TGI incorporates elements from various standard systems such as ASTM D-2488-17, Unified Soil Classification System, Burmister and Udden Wentworth. However, none of these standard systems focus specifically on contaminant hydrogeology and remedial design. Therefore, although each of these systems contain valuable guidance and information related to correct descriptions, strict application of these systems can omit information critical to our clients and the projects that we perform.

This TGI includes the following attachments:

- **Attachment A** – Field Soil Description Guide
- **Attachment B** – Particle Size System Comparison
- **Attachment C** – Description of Logging Terms
- **Attachment D** – Blank Boring Log
- **Attachment E** – Completed Boring Log

This TGI does not address details of health and safety; drilling method selection; boring log preparation; sample collection; or laboratory analysis. Refer to other Arcadis procedure, guidance, and instructional documents, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan (HASP), as appropriate.

4 Personnel Qualifications

Soil descriptions should only be performed by Arcadis personnel or authorized sub-contractors with a degree in geology or a geology-related discipline. Field personnel will complete training on the Arcadis soil description TGI in the office and/or in the field under the guidance of an experienced field geologist with at least 2 years of prior experience applying the Arcadis soil description method.

5 Equipment List

The following equipment should be taken to the field to facilitate soil descriptions:

- Field book, field forms or digital devices to record soil descriptions
- Field book for supplemental notes
- This TGI for Soil Descriptions and any project-specific procedure, guidance, and/or instructional documents (if required)
- Field card showing Wentworth scale
- Munsell® soil color chart
- Tape measure divided into tenths of a foot
- Stainless steel knife or spatula
- Hand lens
- Water squirt bottle
- 4-ounce glass jars with lids (for collecting soil core samples)
- Personal protective equipment (PPE), as required by the HASP
- Digital camera

- Folding table

6 Cautions

Drilling and drilling-related hazards including subsurface utilities are discussed in other procedure documents and site-specific HASPs and are not discussed herein.

Soil samples may contain hazardous substances that can result in exposure to persons describing soils. Routes for exposure may include dermal contact, inhalation and ingestion. Refer to the project specific HASP for guidance in these situations.

7 Health and Safety Considerations

Field activities associated with soil sampling and description will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Know what hazardous substances may be present in the soil and understand their hazards. Always avoid the temptation to touch soils with bare hands, detect odors by placing soils close to your nose, or tasting soils.

8 Procedure

8.1 General Procedures

- Select the appropriate sampling method to obtain representative samples in accordance with the selected sub-surface exploration method, e.g., split-spoon or Shelby sample for hollow-stem drilling, acetate sleeves for direct push, bagged core for sonic drilling, etc.
- Proceed with field activities in required sequence. Although completion of soil descriptions is often not the first activity after opening sampler, identification of stratigraphic changes is often necessary to select appropriate intervals for field screening and/or selection of laboratory samples.
- Set up boring log field sheet.
 - Determine the proper units of measure. Drillers in both the US and Canada generally work in feet due to equipment specifications. Field geologists typically record drilling depths, core recovery, and sample intervals in feet and grain size in millimeters
 - Use the Arcadis standard boring log form (**Attachment D**). *Note that as of April 2022, several digital logging applications are available through the FieldNow™ program and the Fulcrum app. A future revision of this TGI, likely in early 2023, will emphasize digital logging methods and field boring log forms will no longer be acceptable. FieldNow is discussed further in Section 10.*
 - The boring log template includes a graphic log of the primary soil texture to support quick visual evaluation of grain size. The purpose of the graphic log is to quickly assess relative soil permeability. Note, for poorly sorted soils (e.g., glacial till), the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability. For example, for a dense sand/silt/clay till, the graphic log would reflect the silt/clay, rather than sand.

- Record depths along the left-hand side at a standard scale to aid in the use of this tool.
- Examine each soil core (this is different than examining each sample selected for laboratory analysis) and record the soil conditions in accordance with guidelines provided in Section 8.2.
- At the end of the boring, record the amount of drilling fluid used (if applicable) and the total depth logged.
- At a minimum, a written or digital boring log should be prepared with the following information:
 - Describe type of surface material (asphalt, grass, topsoil, gravel, etc.)
 - Describe the type of fill or non-native soils and estimated depth to native soils
 - Record sample intervals (soil cores, environmental and/or geotechnical samples)
 - Describe soil conditions in accordance with this TGI
 - Record moisture content and estimated depth to water table or saturated zone
 - Record the total depth and document why drilling was stopped (refusal, target depth achieved, etc.)

8.2 Soil Description Procedures

The standard soil description order is presented below.

- Depth
- PRIMARY TEXTURE
- Principal and Minor Components with Descriptors
 - % Modifiers and grain size fraction
 - Angularity for coarse sand and larger particles
 - Consistency or Density
 - Plasticity for silt and clay
 - Dilatancy for silt and silt-sand mixtures
- Sorting
- Moisture Content
- Color
- Notes

Depth. To measure and record the depth below ground surface (bgs) of top and bottom of each stratum, the following information should be recorded.

- Measured depth to the top and bottom of sampled interval. Use starting depth of sample based upon measured tool length information and the length of sample interval.
- Length of sample recovered, not including slough (material that has fallen into hole from previous interval), expressed as fraction with length of recovered sample as numerator over length of sampled interval as denominator (e.g., 36/60 for 36 inches recovered from 5-ft [60-inch] sampling interval).
- Thickness of each stratum measured sequentially from the top of recovery to the bottom of recovery.
- Any observations of sample condition or drilling activity that would help identify whether there was loss from the top of the sampling interval, loss from the bottom of the sampling interval, or compression of the sampling interval. Examples: 14/24, gravel in nose of spoon; or 36/60 bottom 12 inches of core empty.

Determination of Components. Obtain a representative sample of soil from a single stratum. If multiple strata are present in a single sample interval, each stratum should be described separately. More specifically, if the sample is from a 2-foot-long split-spoon where strata of coarse sand, fine sand and clay are present, then the resultant description should be of the three individual strata unless a combined description can clearly describe the interbedded nature of the three strata. Example: SAND, fine; with interbedded lenses of Silt and Clay, ranging between 1 and 3 inches thick.

Identify principal component and express volume estimates for minor components on logs using the following standard modifiers.

Modifier	Percent of Total Sample (by volume)
and	36 – 50
some	21 - 35
little	10 - 20
trace	<10

Determination of components is based on using the Udden-Wentworth particle size classification (see below) and measurement of the average grain size diameter. Each size class differs from the next larger class by a constant ratio of $\frac{1}{2}$. Due to visual limitations, the finer classifications of Wentworth's scale cannot be distinguished in the field and the subgroups are not included. Visual determinations in the field should be made carefully by comparing the sample to the Soil Description Field Guide (**Attachment A**) that shows Udden-Wentworth scale or by measuring with a ruler.

The following table summarized the modified Udden-Wentworth Scale for grain size classification. Note that gravel is a size category encompassing the granule, pebble, cobble, and boulder size classes.

Udden-Wentworth Scale (Modified by Arcadis, 2008)				
Size Category	Size Class	Millimeters	Inches	Standard Sieve #
Gravel (Cobble)	Boulder	256 – 4096	10.08+	
	Large cobble	128 - 256	5.04 -10.08	
	Small cobble	64 - 128	2.52 – 5.04	
Gravel (Pebble)	Very large pebble	32 – 64	0.16 - 2.52	
	Large pebble	16 – 32	0.63 – 1.26	
	Medium pebble	8 – 16	0.31 – 0.63	
	Small pebble	4 – 8	0.16 – 0.31	No. 5 +
	Granule	2 – 4	0.08 – 0.16	No.5 – No.10

Sand	Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
	Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
	Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
	Fine sand	1/8 - ¼	0.005 – 0.1	No.60 - No.120
	Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Fines	Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
	Clay (subgroups not included)	1/2048 – 1/256	0.00002 – 0.0002	

Identify components as follows. Remove particles greater than very large pebbles (64-mm diameter) from the soil sample. Record the volume estimate of the greater than very large pebbles. Examine the sample fraction of very large pebbles and smaller particles and estimate the volume percentage of the pebbles, granules, sand, silt and clay. Use the jar method, visual method, and/or wash method (Appendix X4 of ASTM D2488) to estimate the volume percentages of each category.

Sieve and hydrometer grain-size analysis can be used to vet the visual description, as well as used to estimate hydraulic conductivity. Lab or field sieve analysis is advisable to characterize the variability and facies trends within each hydrostratigraphic unit. It is recommended that sieve-hydrometer analysis be performed on representative samples from each soil type to estimate the fraction of each grain size category using ASTM D422 Standard Test Method for Particle-Size Analysis of Soils. If desired sieve sizes can be specified to follow the Udden-Wentworth classification (U.S. Standard sieve sizes 6; 12; 20; 40; 70; 140; and 270) to retain pebbles; granules; very coarse sand; coarse sand; medium sand; fine sand; and very fine sand, respectively.

Several empirical formulas provide a reliable means of estimating hydraulic conductivity (K) from grain-size distribution data, provided that the formation does not contain abundant fines that result in cohesive or plastic behavior or include cobble-sized grains (Payne et al. 2008). Grain-size analysis can help bracket the permeability of hydrostratigraphic units (HSUs) and identify order-of-magnitude spatial variations in K. Arcadis has completed modifications to the Excel-based program HydroGeoSieveXL (Devlin 2015) to process sieve data quickly and estimate K. The tool calculates estimated K values from grain-size data using 15 different empirical formulas. A decision matrix then selects which of the formulas is relevant for the soil type and calculates an average K.

Principal Component. The principal component is the size fraction or range of size fractions containing the majority of the volume. Examples: the principal component in a sample that contained 55% small to medium pebbles would be “PEBBLES, small to medium”; or the principal component in a sample that was 20% fine sand, 30% medium sand and 25% coarse sand would be “SAND, fine to coarse” or for a sample that was 40% silt and 45% clay the principal component would be “CLAY and SILT”.

The boring log form (**Appendix D**) includes a graphic log to visually illustrate a relative estimate of soil permeability. To use the graphic log, place an ‘X’ or shade the appropriate column for the primary soil texture. If the soils have a high percentage of a secondary soil texture (i.e., when the ‘and’ modifier’ is used), it’s acceptable to mark off the appropriate column for the secondary soil texture in this instance. However, care should be used to avoid marking off the columns for other minor soil textures because doing so will make it difficult to determine the relative soil permeability of the poorly sorted soils.

As noted above, for poorly sorted soils such as glacial till, the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability.

Minor Component(s). The minor component(s) are the size fraction(s) containing less than 50% volume. Example: the identified components are estimated to be 60% medium sand to granules, 20% silt and 20% clay – there are two identified minor components: silt and clay.

Include a standard modifier to indicate percentage of minor components (see particle size table) and the same descriptors that would be used for a principal component. An example of minor constituents with modifiers include: some silt and clay, low plasticity; little medium to large pebbles, sub-round.

8.2.1 Secondary Descriptors

The following are the descriptors used outside of the principal and minor components. Note that plasticity should be provided as a descriptor for clay and clay mixtures. Dilatancy should be provided for silt and silt mixtures. Angularity should be provided as a descriptor for pebbles and coarse sand.

Angularity. Describe the angularity for coarse sand and larger particles in accordance with the table below (ASTM D-2488-17). Figures showing examples of angularity are available in ASTM D2488-17 and the Arcadis Soil Description Field Guide (**Appendix A**).

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Sub-Angular	Particles are like angular description but have rounded edges
Sub-Rounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges.

Plasticity. Describe the plasticity for silt and clay based on observations made during the following test method (ASTM D-2488-17).

- As in the dilatancy test (described below), select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material, adding water, if necessary, until it has a soft, but not sticky, consistency.
- Shape the test specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation. Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble when the soil is near the plastic limit.

Description	Criteria
Non-plastic	A 1/8-inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Dilatancy. Describe the dilatancy for silt and silt-sand mixtures using the following field test method (ASTM D-2488-17).

- From the specimen, select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material adding water, if necessary, until it has a soft, but not sticky, consistency.
- Smooth the ball in the palm of one hand with a small spatula.
- Shake horizontally, striking the side of the hand vigorously with the other hand several times.
- Note the reaction of water appearing on the surface of the soil.
- Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the table below. The reaction is the speed with which water appears while shaking and disappears while squeezing.

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

Note that silt and silt-sand mixtures will be non-plastic and display dilatancy. Clay mixtures will have some degree of plasticity but do not typically react to dilatancy testing. Therefore, the tests outlined above can be used to differentiate between silt-dominated and clay-dominated soils.

Sorting. Sorting is the opposite of grading, which is a commonly used term in the USCS or ASTM methods to describe the uniformity of the particle size distribution in a sample. Well-sorted samples are poorly graded and poorly sorted samples are well graded. Arcadis prefers the use of sorting for particle size distributions and grading to describe particle size distribution trends in the vertical profile of a sample or hydrostratigraphic unit because of

the relationship between sorting and the energy of the depositional process. For soils with sand-sized or larger particles, sorting should be determined as follows:

Description	Criteria
Well Sorted	the range of particle sizes is limited (e.g., the sample is comprised of predominantly one or two grain sizes)
Poorly Sorted	A wide range of particle sizes are present

You can also use sieve analysis to estimate sorting from a sedimentological perspective; sorting is the statistical equivalent of standard deviation. Smaller standard deviations correspond to higher degree of sorting (see Remediation Hydraulics, 2008).

Consistency or Density. This can be determined by standard penetration test (SPT) blow counts (ASTM D-1586) obtained when using hollow-stem auger drilling methods and a split spoon sampling device. Otherwise, some field tests are available as outlined below. When drilling with hollow-stem augers and split-spoon sampling, the SPT blow counts and N-value is used to estimate density. The N-value is the blows per foot for the 6" to 18" interval. For example, for a 24-inch split spoon soil core, the recorded blows per 6-inch interval are: 4/6/9/22. Since the second interval is 6" to 12", the third interval is 12" to 18", the N value is 6+9, or 15. Fifty blow counts for less than 6 inches is considered refusal. In recent years, more common drilling methods include rotary-sonic or direct push. When blow counts are not available, density is determined using a thumb test. Note however, the thumb test only applies to fine-grained soils.

Fine-grained soil – Consistency

Description	Criteria	Blow Counts (6-12 to 12-18-inch split spoon interval)
Very soft	Easily penetrated several inches by thumb	N-value < 2
Soft	Easily penetrated one inch by thumb	N-value 2-4
Medium Stiff	Indented about ½ inch with much effort	N-value 5-8
Stiff	Indented with ¼ inch with great effort	N-value 9-15
Very Stiff	Readily indented by thumbnail	N-value 16-30
Hard	Indented by thumbnail with difficulty	N-value > than 30

Coarse-grained soil – Density

Description	Criteria	Blow Counts (6-12 to 12-18-inch split spoon interval)
Very loose	Density classification of coarse-grained soils is only required when blow counts from standard penetration tests are performed during hollow-stem auger drilling	N-value 1- 4
Loose		N-value 5-10
Medium dense		N-value 11-30
Dense		N-value 31- 50
Very dense		N-value >50

Moisture Content. Moisture content should be described for each soil sample in accordance with the table below (percentages should not be used unless determined in the laboratory). *Note that some drilling methods (e.g., sonic) can compress and dry out the sample during drilling. Therefore, it can be difficult to determine if a sample is saturated, or merely moist. In this case, care should be taken to try and determine a static water level within the borehole by measuring depth to water through the drill casing, if possible.*

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty
Moist	Damp but no visible water
Wet	Visibly free water

Color. Color should be described using simple basic terminology and modifiers based on the Munsell system. Munsell alpha-numeric codes are required for all samples. If the sample contains layers or patches of varying colors this should be noted, and all representative colors should be described. The colors should be described for moist samples. If the sample is dry, it should be wetted prior to comparing the sample to the Munsell chart.

Notes. Additional comments should be made where observed and should be presented as notes with reference to a specific depth interval(s) to which they apply. Some of the significant information that may be observed includes the following.

- Odor - You should not make an effort to smell samples by placing near your nose since this can result in unnecessary exposure to hazardous materials. However, odors should be noted if they are detected during the normal sampling procedures. Odors should be based upon descriptors such as those used in NIOSH "Pocket Guide to Chemical Hazards", e.g., "pungent" or "sweet" and should not indicate specific chemicals such as "phenol-like" odor or "BTEX" odor.
- Structure
- Bedding planes (laminated, banded, geologic contacts).
- Presence of roots, root holes, organic material, man-made materials, minerals, etc.
- Mineralogy

- Cementation
- NAPL presence/characteristics, including sheen (based on client-specific guidance).
- Reaction with HCl - typically only used for special soil conditions, such as caliche environments.
- Origin, if known (Lacustrine; Fill; etc.).

8.3 Example of Soil Descriptions

The standard generic description order is presented below.

- Depth
- PRIMARY TEXTURE
 - Principal and Minor Components with Descriptors
 - % Modifiers and grain size fraction
 - Angularity for coarse sand and larger particles
 - Consistency or Density
 - Plasticity for silt and clay
 - Dilatancy for silt and silt-sand mixtures
- Sorting
- Moisture Content
- Color
- Notes



10-15 feet CLAY, trace silt, trace small to very large pebbles, subround to subangular up to 2" diameter; medium to high plasticity, stiff, moist, dark grayish brown (10YR 4/2). NOTE: Lacustrine; laminated 0.1 to 0.2" thick, laminations brownish yellow (10YR 4/3).



10 -15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR5/2).

Unlike the first example where a density of cohesive soils could be estimated, this rotary-sonic sand and pebble sample was disturbed during drilling (due to vibrations in a loose sand and pebble matrix) so no density description could be provided. Neither sample had noticeable odor so odor comments were not included.

9 Waste Management

Project-specific requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

10 Data Recording and Management

10.1 Digital Data Collection Process Overview

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

10.2 Digital Data Collection Tools for Soil Descriptions

Arcadis is transitioning from the use of paper forms to a digital soil description logging process using web-based FieldNow applications accessible on field tablets and smart phones. Company-wide roll out of a FieldNow application for soil descriptions is targeted by the end of 2022.

Paper forms are included in Revision 3 (April 2022) of this Soil Description TGI. Specifically, a blank boring log and completed boring log are provided in **Attachment D** and **Attachment E**. Additional guidance and examples of the digital data collection tools for soil descriptions will be provided in the next revision to this TGI.

10.3 Additional Guidance

The general logging scheme for soil descriptions is described in this document. Depending on project data quality objectives, specific soil description parameters that are not applicable to project goals may be omitted at the project manager's discretion. In any case, use of consistent procedures is required.

Completed logs and/or logbook will be maintained in the task/project field records file. Digital photographs of typical soil types observed at the site and any unusual features should be obtained whenever possible. Photographs should include a ruler or common object for scale. Photo location, depth and orientation must be recorded in the daily log or logbook and a label showing this information in the photo is useful.

For projects involving soil logging and soil sampling, the soil sample should be recorded on the Arcadis boring log form and the field logbook based on Data Quality Objectives for the task/project.

11 Quality Assurance

Soil descriptions should be completed only by appropriately trained personnel. Descriptions should be reviewed by an experienced field geologist for content, format and consistency. Edited boring logs should be reviewed by the original author to assure that content has not changed.

12 References

- ASTM D-1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils.
- ASTM D-2488-17, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
- ASTM D422, 63rd Edition, 1972 - Standard Test Method for Particle-Size Analysis of Soils.
- Devlin, J.F. 2015. HydroGeoSieve XL: an Excel-based tool to estimate hydraulic conductivity from grain-size analysis. Hydrogeology Journal, DOI 10.1007/s10040-015-1255-0.
- Folk, Robert L. 1980. Petrology of Sedimentary Rocks, p. 1-48.
- Payne, F. C., Quinnan, J. A., & Potter, S. T. 2008. Remediation Hydraulics. Boca Raton: FL: CRC Press.
- United States Bureau of Reclamation. Engineering Geology Field Manual. United States Department of Interior, Bureau of Reclamation. <http://www.usbr.gov/pmts/geology/fieldmap.htm>.
- Munsell® Color Chart – available from Forestry Suppliers, Inc.- Item 77341 “Munsell® Color Soil Color Charts.
- Field Gauge Card that Shows Udden-Wentworth scale – available from Forestry Suppliers, Inc. – Item 77332 “Sand Grain Sizing Folder.”
- NIOSH Pocket Guide to Chemical Hazards.

Attachment A

Soil Field Reference Guide

The purpose of this attachment is to present a field reference guide for use during soil logging. Field staff are encouraged to bring a laminated copy of this reference guide into the job site.



FINE-GRAINED SOILS	
Description	Criteria
Descriptor - Plasticity A 1/8-inch (3 mm) thread cannot be rolled at any water content.	
Nonplastic	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Low	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
Medium	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.
High	
Descriptor - Dilatancy	
No Dilatancy	No visible change when shaken or squeezed.
Slow	Water appears slowly on the surface of soil during shaking and does not disappear or disappears slowly when squeezed.
Rapid	Water appears quickly on surface of soil during shaking and disappears quickly when squeezed.
Minor Components with Descriptors	
Moisture	
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
Consistency	
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated 1 inch by thumb.
Medium stiff	N-value 5-8 or indented about 1/2 inch by thumb with great effort.
Stiff	N-value 9-15 or indented about 1/4 inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty.
Color using Munsell	
Geologic Origin (if known)	
Other	

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

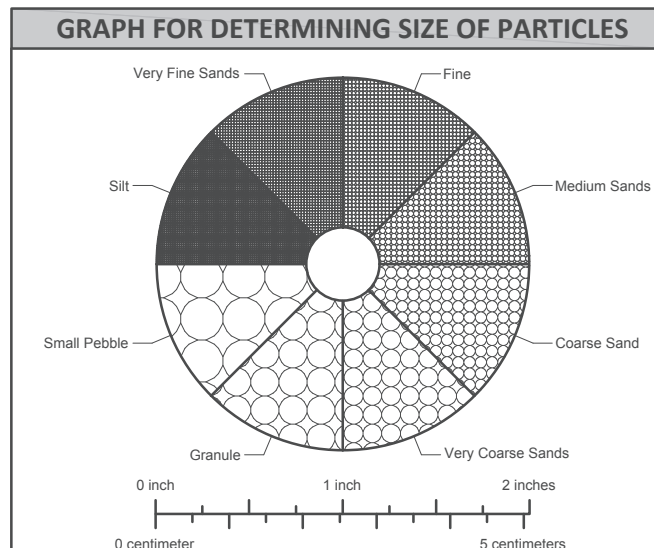
10-15 feet CLAY, trace silt, trace small to very large pebbles, subround to subangular up to 2" diameter; medium to high plasticity, stiff, moist, dark grayish brown (10YR 4/2). NOTE: Lacustrine; laminated 0.1 to 0.2" thick, laminations brownish yellow (10YR 4/3).



DESCRIPTION ORDER
Depth Interval PRIMARY TEXTURE (e.g., SAND) Principal and Minor Components with Descriptors: • % Modifiers and grain size fraction • Angularity coarse sand and larger • Consistency or Density • Plasticity for silt and clay • Dilatancy for silt and silt-sand Sorting for granular sediments Moisture Content Color Other NOTES

UDDEN-WENTWORTH SCALE			
Fraction	Sieve Size	Grain Size	Approximate Scale
Boulder		256 - 4096 mm	Larger than volleyball
Large Cobble		128 - 256 mm	Softball to volleyball
Small Cobble		64 - 128 mm	Pool ball to softball
Very Large Pebble		32 - 64 mm	Pinball to pool ball
Large Pebble		16 - 32 mm	Dime size to pinball
Medium Pebble		8 - 16 mm	Pencil eraser to dime size
Small Pebble	No. 5+	4 - 8 mm	Pea size to pencil eraser
Granule	No. 10 - 5	2 - 4 mm	Rock salt to pea size
Very Coarse Sand	No. 18 - 10	1 - 2 mm	See field gauge card
Coarse Sand	No. 35 - 18	0.5 - 1 mm	See field gauge card
Medium Sand	No. 60 - 35	0.25 - 0.5 mm	See field gauge card
Fine Sand	No. 120 - 60	0.125 - 0.25 mm	See field gauge card
Very Fine Sand	No. 230 - 120	0.0625 - 0.125 mm	See field gauge card
Silt and Clay. See SOP for description of fines	Not Applicable	<0.0625 mm	Analyze by pipette or hydrometer

PARTICLE PERCENT COMPOSITION ESTIMATION					
1%	10%	20%	30%	40%	50%



FOR COARSE-GRAINED SOILS	
Description	Criteria
Descriptor - Angularity	
Angular	Particles have sharp edges and relatively planar sides with unpolished surfaces.
Subangular	Particles are similar to angular but have rounded edges.
Subround	Particles have nearly planar sides but have well-rounded corners and edges.
Round	Particles have smoothly curved sides and no edges.
Minor Components with Descriptors	
Sorting Cu= d60/d10	
Well Sorted	Near uniform grain-size distribution Cu= 1 to 3.
Poorly Sorted	Wide range of grain size Cu= 4 to 6.
Moisture	
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
Density	
Very loose	N-value 1 - 4
Loose	N-value 5 - 10
Medium Dense	N-value 11 - 30
Dense	N-value 31 - 50
Very dense	N-value >50
Color using Munsell	
Geologic Origin (if known)	
Other	
Cementation	
Weak Cementation	Crumbles or breaks with handling or little finger pressure.
Moderate Cementation	Crumbles or breaks with considerable finger pressure.
Strong Cementation	Will not crumble with finger pressure.
Reaction with Dilute HCl Solution (10%)	
No Reaction	No visible reaction.
Weak Reaction	Some reaction, with bubbles forming slowly.
Strong Reaction	Violent reaction, with bubbles forming immediately.

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

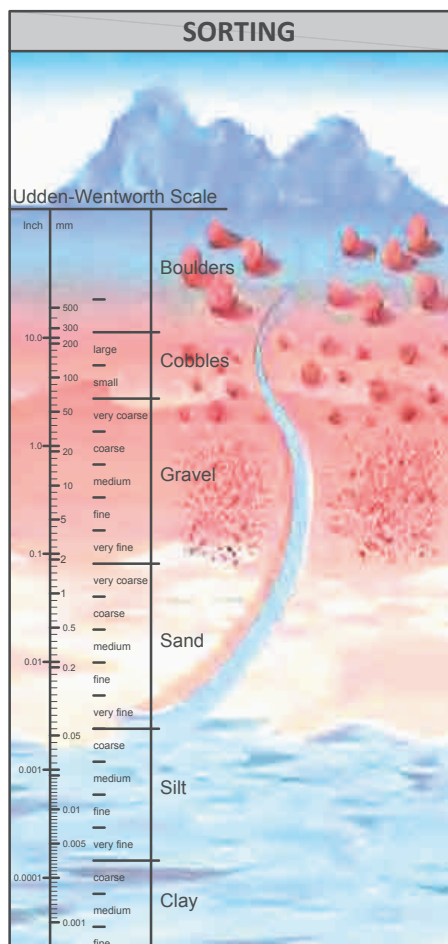
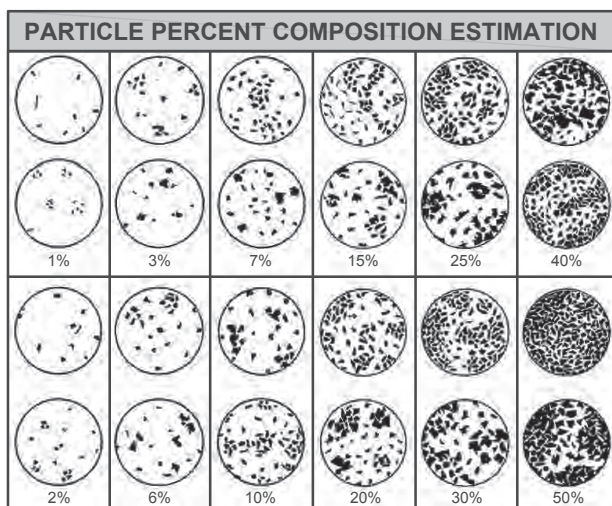
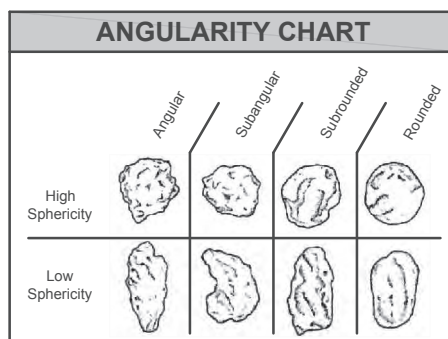
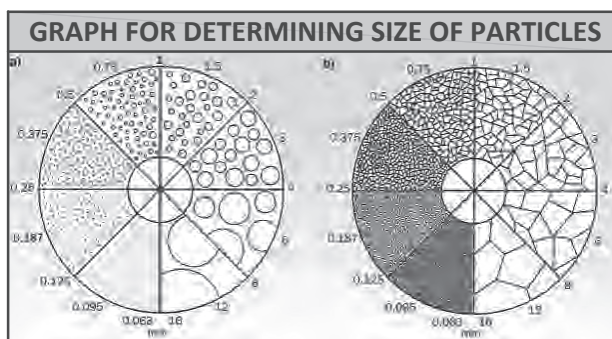
10 - 15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR 5/2).



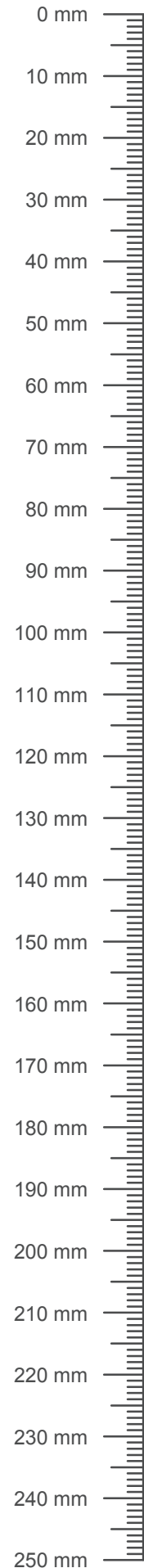
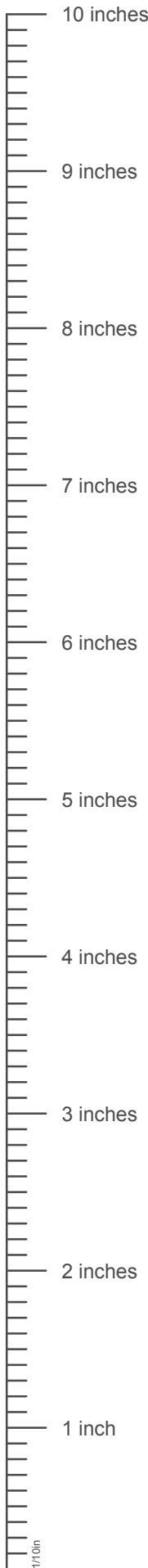


VARIATIONS IN SOIL STRATIGRAPHY	
Term	Thickness of Configuration
Parting	0 - to 1/16-inch thickness.
Seam	1/16 - to 1/2-inch thickness.
Layer	1/2 - to 12-inch thickness.
Stratum	> 12-inch thickness.
Pocket	Small erratic deposit, usually less than 1 foot in size.
Varved Clay	Alternating seams or layers of sand, silt, and clay (laminated).
Occasional	≤ 1 foot thick.
Frequent	> 1 foot thick.

SOIL STRUCTURE DESCRIPTIONS	
Term	Description
Homogeneous	Same color and appearance throughout.
Laminated	Alternating layers < 1/4 inch thick.
Stratified	Alternating layers ≥ 1/4 inch thick.
Lensed	Inclusions of small pockets of different materials, such as lenses of sand scattered through a mass of clay; note thickness.
Blocky	Cohesive soil can be broken down into small angular lumps, which resist further breakdown.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear to be polished or glossy, sometimes striated.



SETTLING TABLE (SILT/CLAY)							
Diameter of Particle (mm)	<0.625	<0.031	<0.016	<0.008	<0.004	<0.002	<0.0005
Depth of Withdrawal (cm)	10	10	10	10	5	5	3
Time of Withdrawal	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec
Temperature (Celsius)							
20	00:00:29	00:01:55	00:07:40	00:30:40	00:61:19	04:05:00	37:21:00
21	00:00:28	00:01:52	00:07:29	00:29:58	00:59:50	04:00:00	
22	00:00:27	00:01:50	00:07:18	00:29:13	00:58:22	03:54:00	
23	00:00:27	00:01:47	00:07:08	00:28:34	00:57:05	03:48:00	
24	00:00:26	00:01:45	00:06:58	00:27:52	00:55:41	03:43:00	33:56:00
25	00:00:25	00:01:42	00:06:48	00:27:14	00:54:25	03:38:00	
26	00:00:25	00:01:40	00:06:39	00:26:38	00:53:12	03:33:00	
27	00:00:24	00:01:38	00:06:31	00:26:02	00:52:02	03:28:00	
28	00:00:24	00:01:35	00:06:22	00:25:28	00:50:52	03:24:00	31:00:00
29	00:00:23	00:01:33	00:06:13	00:24:53	00:49:42	03:10:00	
30	00:00:23	00:01:31	00:06:06	00:24:22	00:48:42	03:05:00	



Attachment B

Particle Size System Comparison

The purpose of this attachment is to illustrate how the Udden-Wentworth particle sizes and descriptive terms compares to other particle size systems.

When in the field, it is a customary practice to compare current soil descriptions to historical soil boring logs for reference purposes. When reviewing boring logs prepared by others, field staff should first note the particle size system used and recognize these particle size systems may differ. This will avoid confusion when cross referencing between historical and new boring logs and when reviewing existing geologic cross-sections.

For example, a well-sorted sand with grain sizes ranging from 1 to 2 mm should be classified as a very coarse sand by the Udden-Wentworth system. As shown in this attachment, the same particle size would be classified as a medium sand by the United Soil Classification System. The later system has fewer particle size grades and in general, is less descriptive than the Udden-Wentworth system.

PARTICLE SIZE SYSTEM COMPARISON

System Name	Used By	Grain size distribution in millimeters (mm)														
Udden-Wentworth	Remediation Geologists and Engineers			V. Fine	Fine	Medium	Coarse	V. Coarse	Granule	Pebbles				Cobbles		
		CLAY	SILT	SAND					GRAVEL							
		0.039	0.065	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	
				1/16	1/8	1/4	1/2									
United Soil Classification System	Geotechnical Engineers			Fine			Medium		Coarse	Fine		Coarse				
		CLAY	SILT	SAND					GRAVEL				COBBLE			
			0.074	0.42			2		4.75	19		75		300		
U.S. Dept. of Agriculture	Soil Scientists			V. Fine	Fine	Medium	Coarse	V. Coarse								
		CLAY	SILT	SAND					GRAVEL							
		0.002	0.05	0.10	0.25	0.5	1	2	75							

Remediation Hydraulics 2008, page 195): The Udden-Wentworth scale is preferred "...because the geometric progression of grain-size diameter also reflects relationships that are important when considering the erosion and deposition of sediments during the depositional process. The correlation between increasing grain size and degree of sorting and permeability is the most important, as permeability structure is responsible for the mobile and immobile porosity within aquifer systems. "

Attachment C

Description of Soil Logging Terms

The purpose of this attachment is to concisely define the soil logging terms used when filling out boring logs. During report preparation, project staff could use this sheet as an index placed in front of the completed boring logs. Also, it can serve as a supplemental reference sheet during field activities.

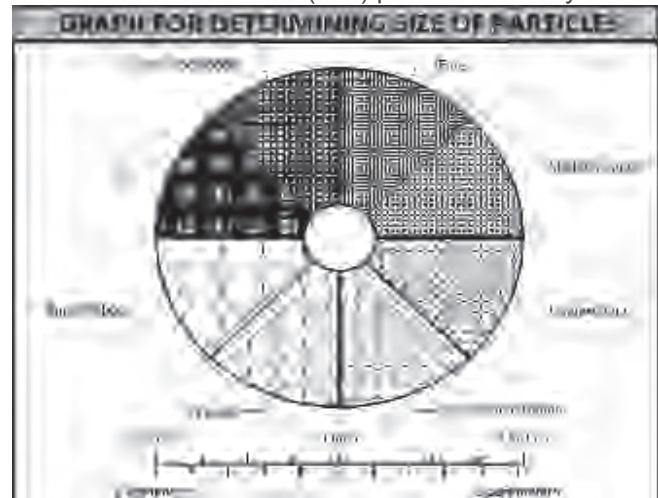
Description of Logging Terms



Note: Soil descriptions based on Arcadis Technical Guidance and Instructions (TGI) procedures. Key terms defined below.

Udden Wentworth Soil Sizes

Boulder	> 256 mm
Large Cobble	128 to 256 mm
Small Cobble	64 to 128 mm
Very Large Pebble	32 to 64 mm
Large Pebble	16 to 32 mm
Medium Pebble	8 to 16 mm
Small Pebble	4 to 8 mm
Granule	2 to 4 mm
Very Coarse Sand	1 to 2 mm
Coarse Sand	0.5 to 1 mm
Medium Sand	0.25 to 0.5 mm
Fine Sand	0.125 to 0.25 mm
Very Fine Sand	0.062 to 0.12 mm
Silt/Clay	<0.065 mm



Primary Texture (e.g. CLAY, SILT, SAND, GRANULE, PEAT, MUCK, FILL, etc.)

List particle size with the highest percentage per sample interval (e.g. SAND)

Always CAPITALIZE the primary texture

Follow primary texture with a comma followed by grain-size descriptors, etc.

Minor Texture

And	(36 to 50%)
Some	(21 to 35%)
Little	(10 to 20%)
Trace	(>10%)

Angularity

Angular	Sharp edges
Sub-Angular	Rounded edges
Sub-Rounded	Well-rounded
Rounded	Smooth curved edges

Sand Density (Blow Counts/ft)

Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	<50

Silt/Clay Consistency (Blow Counts/ft)

Very Soft	0-2,	thumb easily penetrates several inches
Soft	3-4,	thumb easily penetrates one inch
Medium Stiff	5-8,	thumb indents 0.5 in. with much effort
Stiff	9-15,	thumb indents 0.25 in. with great effort
Very Stiff	16-30,	thumbnail is readily intended

Sorting

Well Sorted	1 to 3 Particle Sizes
Poorly Sorted	4+ Particle Sizes

Moisture Content

Dry	Dry to touch
Moist	No visible water
Wet	Visible free water

Plasticity (for silts and clays)

Non-Plastic	3 mm thread can not be rolled
Low Plasticity	3 mm thread can barely be rolled
Medium Plasticity	3 mm thread can easily and quickly rolled, but not rerolled
High Plasticity	3 mm thread can be rolled slowly, but can be rerolled

Dilatancy (for silts and silt-sand mixtures)

None	No visible change in the specimen
Slow	Water appears slowly during shaking / disappears slowly or not at all upon squeezing
Rapid	Water appears quickly during shaking / disappears quickly upon squeezing

Example Description

10 -15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR5/2).

Attachment D

Blank Boring Log

The purpose of this attachment is to present a blank field form for use during soil logging. A digital version (Microsoft Excel) of this field form is available from the authors (upon request). If project specific modifications to this boring log template are warranted, please contact the Site Investigation Community of Practice leader for further assistance.

[illegible]

Boring ID: _____ Project Name: _____ Page: _____ / _____

[illegible]

Attachment E

Completed Boring Log

The purpose of this attachment is to provide an example of a completed boring log for reference purposes to field staff. The example provided is for a soil boring completed outside the waste mass of a closed municipal landfill near Baltimore, Maryland. The objective of the drilling program was to determine the depth to groundwater to determine the appropriate depth interval to install a soil gas monitoring well and groundwater monitoring well across the first water-bearing zone. The site geology consists of unconsolidated sediments of the Mid-Atlantic Coastal Plain, specifically the Upper Patapsco formation. These sediments were deposited in a moderate gradient fluvial environment during the Cretaceous period. The landfill was constructed into a regional clay confining unit.

BORING LOG



Boring ID:	MW-08	Project Name:	Acme Landfill	Page:	1 / 1
Permit ID:	MD-PG-100	Date Started:	7/18/2018	Ground Elevation:	50.5 ft
Site Address:	100 Landfill Road	Date Completed:	7/18/2018	Vertical Datum:	NAVD 88, feet
City, State:	Baltimore, Maryland	Total Depth:	35 ft below ground	Northing:	123456.79
Drilling Co:	Earth Matters	Depth to Water:	19 ft below ground	Easting:	123456.79
Driller:	Rod E. Piper	Hole Diameter:	2-inch	Horizontal Datum:	NAD 83 feet, MD State
Drilling Method:	Direct-push/hollow-stem	Core Device:	5-foot macrocore sampler	Prepared by:	Sandy Pebbles
Boring Status:	completed as well	Drilling Fluid:	none	Reviewed by:	Clay Brown

Drilling Information				Graphical Log for Primary Texture								Soil Description (Udden-Wentworth System)	Field Notes
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	VOC Vapor Reading (ppm)	Fines clay silt	Sand very fine fine medium coarse very coarse	Gravel granule pebble cobble boulder						Depth Interval (ft), PRIMARY TEXTURE, Principal and Minor Components with Descriptors (% modifiers and grain size fraction, angularity for coarse sand and larger, consistency/density, plasticity for silt and clay, dilatancy for silt/silt-sand); Sorting, Moisture Content, Color. NOTES: <i>Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)</i>	Driller's Observations, Geologic Formation, Field Screening Results, Sample Interval etc.
0 to 1	0-5	43.2/60	< 1									0-0.5 ft, topsoil with organics	Grass covered area
1 to 2			< 1		X							0.5-5 ft, SAND, fine, trace silt, trace pebble, round; poorly sorted, moist, yellowish brown (7.5 YR 5/8). NOTE: some cementation, does not react with HCl	continuous macro-core logging
2 to 3			< 1		X								
3 to 4			< 1		X								cemented sand @3.6-4 ft
4 to 5			< 1		X								
5 to 6	5-10	40.8/60	< 1		X	X	X					5-10 ft, SAND, fine to coarse, round to subround; well sorted, moist, light to strong brown (7.5 YR 6/4 to 7.5 YR 5/6).	
6 to 7			< 1		X	X	X						
7 to 8			< 1		X	X	X						
8 to 9			< 1		X	X	X						
9 to 10			< 1		X	X	X						
10 to 11	10-15	36/60	< 1		X	X	X					10-12.5 ft, same as above with trace silt	
11 to 12			< 1		X	X	X						
12 to 13			< 1		X	X	X						
13 to 14			< 1		X	X	X						
14 to 15			< 1		X	X	X						
15 to 16	15-20	55.2/60	< 1				X	X				15-18.9 ft, SAND, coarse to very coarse, round to subround; well sorted, moist, strong brown (7.5YR 5/6) to reddish yellow (7.5YR 6/6)	
16 to 17			< 1				X	X					
17 to 18			< 1				X	X					
18 to 19			< 1	X	X	X							
19 to 20			< 1	X	X	X							water table encountered @ 18.9 ft
20 to 21	20-25	36/60	< 1	X	X	X						18.9-22.7 ft, SAND, very fine to fine, and SILT, coarse to very coarse, poorly sorted, wet, light gray (7.5YR 7/1)	
21 to 22			< 1	X	X	X							
21 to 23			< 1	X	X	X							
23 to 24			< 1	X	X								
24 to 25			< 1	X	X								Middle Patapsco Confining Unit
25 to 26	25-30	30/60	< 1	X	X							22.7-25 ft, CLAY and SILT, high plasticity, soft to stiff at 25 ft, dry to moist, light gray (2/5YR 7/1) w/ red mottling (2.5YR 4/6)	
26 to 27			< 1	X	X								
27 to 28			< 1	X	X								
28 to 29			< 1	X	X								
29 to 30			< 1	X	X								
30 to 31	30-35 ft	60/60	< 1	X	X							25-31.1 ft, CLAY and SILT, high plasticity, stiff; dry to moist, light gray (2/5YR 7/1) with red mottling (2.5YR 4/6)	
31 to 32			< 1	X									
32 to 33			< 1	X									
33 to 34			< 1	X									
34 to 35			< 1	X									End of direct-push boring @ 35 ft

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TGI – Soil Drilling and Sample Collection

Rev: #2

Rev Date: April 8, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 11, 2018	All	Updated and re-written as a TGI	Marc Killingstad
	1	May 12, 2020	None	Review – no changes necessary	Marc Killingstad
	2	April 8, 2022	All	Updated to new format and minor content (e.g., PFAS)	Chris Shepherd/Marc Killingstad

Approval Signatures

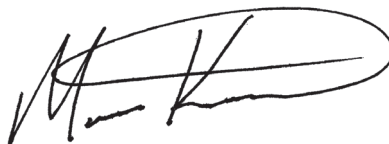
Prepared by:

4/8/2022

Chris Shepherd (Preparer)

Date

Reviewed by:



4/8/2022

Marc Killingstad (Subject Matter Expert)

Date

1 Introduction

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM. All deviations or omissions should be documented.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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3 Scope and Application

This Technical Guidance Instruction (TGI) describes general drilling procedures and the methods to be used to field screen and collect soil samples for laboratory analysis in unconsolidated or weakly consolidated sediments. For soil description procedures, please refer to the *TGI - Soil Description*. For monitoring well installation in granular aquifers, please refer to the *TGI - Monitoring Well Installation*. For per- and polyfluoroalkyl substances (PFASs) drilling and soil sampling procedures, please refer to: *TGI – PFAS-Specific Drilling and Monitoring Well Installation*, *TGI – Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide*, and *TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis*.

Overburden (unconsolidated sediments) drilling is commonly performed using the hollow-stem auger drilling method. Other drilling methods suitable for overburden drilling, which are sometimes necessary due to site-specific geologic conditions, include: direct-push, drive-and-wash, spun casing, rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and hand tools may also be used. Drilling within consolidated materials such as fractured rock is commonly performed using water-rotary (coring or tri-cone roller bit), air rotary or rotasonic methods. For guidance when drilling in consolidated materials (i.e., bedrock), please refer to the *TGI – Bedrock Core Collection and Description*.

The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, targeted chemicals, site or regional geologic knowledge, types of sampling to be conducted, required sample quality and volume, and cost.

Field screening of soil samples is commonly performed using a photoionization detector (PID) and/or a flame ionization detector (FID). These instruments are used to measure relative concentrations of volatile organic compounds (VOCs) for the selection of samples for further laboratory or field analysis. Field screening for dense non-aqueous phase liquids (DNAPL) may be performed using hydrophobic dye (Oil Red O or Sudan IV), which is pertinent at chlorinated solvent sites.

Collection of soil samples for laboratory analysis may be performed using a variety of techniques including grab samples, undisturbed cores, and composite or homogenized samples. Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample. Samples for VOC analysis will not be homogenized or composited and are collected as discrete grab samples.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). Some lubricants (e.g., vegetable oil-based lubricants) may be acceptable, if the constituents won't interfere with the analyses.

4 Personnel Qualifications

Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or state/federal regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid,

cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, Arcadis field personnel will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP), Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Personnel responsible for overseeing drilling operations will have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

Arcadis personnel directing, supervising, or leading soil sampling activities will have a minimum of 1 year of previous environmental soil sampling experience. Field employees with less than 6 months of experience will be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

Additionally, the Arcadis field team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

The following materials will be available, as required, during soil boring drilling, field screening, and sampling activities:

- Site-specific HASP and health and safety documents identified in the HASP
- FIP/work plan that includes site map with proposed boring locations, field sampling plan (with corresponding depths, sample analyses, sample volume required, and sample holding time), and previous boring logs (as available)
- Appropriate personal protective equipment (PPE), as specified in the HASP
- Including but not limited to disposable chemical resistant gloves and Level D PPE
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified in the Traffic Safety Plan (TSP)
- Photoionization detector (PID), flame ionization detector (FID) or other air/soil screening equipment, as needed, in accordance with the HASP or workplan
- Sampling equipment:
 - Drilling equipment required by *ASTM D1586*, when performing split-spoon sampling including clean sample sleeves
 - Disposable plastic liners, when drilling with direct-push equipment
 - Stainless steel hand auger and stainless-steel spade if using manual methods
 - Appropriate soil sampling equipment (e.g., stainless steel spatulas/spoons/bowls, knife)
 - Sealable plastic bags (e.g., Ziploc®)

- Air-tight sample containers and 8-oz. glass Mason jars or driller's jars
- Aluminum foil
- Appropriate sample blanks (trip blank supplied by the laboratory), as specified in the FSP
- Soil sample containers and labels (supplied by the laboratory) appropriate for the analytical method(s) with preservative, as needed (parameter-specific)
- Sample labels
- Indelible ink pens
- Engineer's ruler or survey rod
- Plastic sheeting (e.g., Weatherall Visqueen)
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials
- Decontamination equipment (buckets, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels) in accordance with the *TGI for Groundwater and Soil Sampling Equipment Decontamination*
- Forms/notes:
 - Tablet with digital forms, etc., if appropriate
 - Appropriate soil boring log (**Attachment 1**)
 - Chain-of-custody forms
 - Field notebook
 - Digital camera (or smart phone with camera)
- Drums or other containers appropriate for soil and decontamination water, as specified by the site investigation-derived waste (IDW) management plan, and appropriate drum labels

6 Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service in accordance with the work plan, client requirements, and Arcadis guidance. See appropriate guidance for proper utility clearance protocol. Work will be performed in accordance with the Arcadis *Utility Location and Clearance Health and Safety Standard* and the *Utilities and Structures Checklist* will be completed before beginning any intrusive work.

Prior to beginning field work, the project technical team will ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members. An internal call with the project technical team to review the FIP/work plan scope and objectives is strongly recommended prior to mobilization to ensure that the field work will be effectively and efficiently executed.

Some regulatory agencies have specific requirements regarding borehole abandonment and grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the

drilling plan.

If DNAPL is known or expected to exist at the site, refer to the project specific documents (e.g., DNAPL Contingency Plan) for additional details regarding drilling to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquid (LNAPL) is known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions. Water used for drilling, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply will be considered.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPL is likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

Store and/or stage empty and full sample containers and coolers out of direct sunlight. Sample container threads should be wiped down with a clean, nonabrasive material (e.g., paper towels) to better ensure the sample container is properly sealed. Be careful not to over-tighten lids with Teflon® liners or septa. Over-tightening can impair the integrity of the seal and can cause the glass to shatter and create a risk for hand injuries.

NOTE: Field logs and some forms are considered to be legal documents. All field logs and forms will therefore be filled out in indelible ink. Do not use permanent marker or felt-tipped pens for labels on sample container or sample coolers. Permanent markers could introduce volatile constituents into the samples.

NOTE: An Arcadis employee that is appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel. Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Prior to drilling, utility clearance must be performed (see Section 5). Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Working outside at sites with suspected contamination may expose field personnel to hazardous materials such as contaminated groundwater or NAPL (e.g., oil). Other potential hazards include biological hazards (e.g., stinging insects, ticks in long grass/weeds, etc.), and potentially the use of sharp cutting tools (scissors, knife). Only use non-toxic peppermint oil spray for stinging insect nests. Review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives

and use appropriate hand protection.

If thunder or lightning is present, discontinue drilling and sampling until 30 minutes have passed after the last occurrence of thunder or lightning.

8 Procedure

The procedures for drilling and the methods to be used to field screen and collect soil samples for laboratory analysis are presented below:

8.1 Drilling Procedures

8.1.1 Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area.
 - a. Verify utilities were cleared (see Section 5) and use soft dig technique to clear borehole, if applicable
 - b. Clean sampling equipment in accordance with the FIP/work plan prior to drilling
2. Advance boring to target depth:
 - a. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) using the appropriate tooling (e.g., split-barrel sampler) and sample containers
 - i. Split-barrel or drive-ahead samples are obtained during drilling
 - ii. A common sampling method that produces high-quality soil samples with relatively little soil disturbance is described in *ASTM D1586 – Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils* (ASTM D1586).
 - b. Always change disposable gloves before handling the sampling equipment
 - c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent; see below for additional details on sample collection procedures)
 - d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
 - e. Rotasonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks. The core is retrieved by vibrating the soil/rock into a separate core bag, typically in 5-foot or 10-foot increments. The soil cores may consolidate or expand during retrieval, depending on soils, etc.
 - f. Dual-rotary removes cuttings by compressed air or water/mud and allow only a

- general assessment of geology unless separate coring tools and techniques are used
- g. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
3. Describe each soil sample as outlined in the appropriate project records (refer to the description procedures outlined in the *TGI - Soil Description*)
- a. Record descriptions on the soil boring log (**Attachment 1**) and/or field notebook
 - b. When possible, photo document the samples (e.g., soil cores, split-barrels)
 - c. During soil boring advancement, document all drilling events in field notebook, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments) and work stoppages
 - d. Blow counts will not be available if rotasonic, dual-rotary, or direct-push methods are used; however, if standard penetration testing is required during rotasonic drilling, an automatic drop hammer may be used in conjunction with the method to switch from core barrel advancement to standard penetration testing
 - e. If soils are screened with a PID/FID or another instrument, document the measurement in accordance with the work plan
4. The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising Arcadis geologist of changes in drilling pressure, drilling penetration rates, and keeping a separate general log of soils encountered, including blow counts
- a. The term “samples” means soil materials from particular depth intervals, whether or not portions of these materials are submitted for laboratory analyses
 - b. Records will also be kept of occurrences of premature refusal due to boulders, construction materials that may have been used as fill, etc.
 - c. Where a boring cannot be advanced to the desired depth, the boring will be abandoned, and an additional boring will be advanced at an adjacent location to obtain the required sample in accordance with the work plan
 - d. Where it is desirable to avoid leaving vertical connections between depth intervals (e.g., if DNAPL or perched LNAPL are known or expected to exist at the site), the borehole will be sealed using cement and/or bentonite (see **Section 5** above)
 - e. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location

8.1.2 Direct-Push Method

The direct-push drilling method may also be used to complete soil borings. Examples of this technique include Geoprobe®, Diedrich Environmental Soil Probe (ESP) System, or AMS PowerProbe.

Environmental probe systems typically use a hydraulically operated percussion hammer.

Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual tube liner for sampling soil

(dual tube sampling system).

The outside diameter (OD) of the outer casing ranges from 2.25 to 6 inches and the OD of the inner sampling tube diameter ranges from 1.4 to 4.5 inches. The outer casing isolates overlying soil and permits the unit to continue to probe at depth. The dual tube sampling system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, a single rod system may be used that does not provide a cased boring and which limits tremie-grouting from the bottom up.

Direct-push drilling can generally achieve target depths 100 feet or less depending on the site geology. The known or expected site conditions (e.g., presence of NAPL) will be evaluated when selecting the type of direct-push sampling system to be employed.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
 - a. Verify utilities were cleared (see Section 5) and use soft dig technique to clear borehole, if applicable
 - b. Clean sampling equipment in accordance with the FIP/work plan prior to drilling
2. Advance soil boring to target depth.
 - a. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) using clean/disposable sampling equipment (plastic liners)
 - b. Always change disposable gloves before handling the sampling equipment
 - c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent; see below for additional details on sample collection procedures)
 - d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
3. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
4. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

8.1.3 Manual Methods

Manual methods may also be used to complete shallow soil borings. Examples of this technique include using a spade, spoon, scoop, hand auger, or slide hammer. Manual methods are typically used to collect surface soil samples (0 to 6 inches) or to complete soil borings/collect soil samples from a depth of 5 feet or less.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris
3. Use a spade, spoon, scoop, hand auger, or slide hammer to collect a sample of the required depth interval
4. Use an engineer's ruler or survey rod to verify that the sample is collected to the correct depth and

record the top and bottom depths from the ground surface

5. To collect samples below the surface interval, remove the surface interval first; then collect the deeper interval
 - a. To prevent the hole from collapsing, it may be necessary to remove a wider section from the surface or use cut polyvinyl chloride (PVC) pipe to maintain the opening
 - b. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) and transfer to the appropriate, laboratory-supplied container
 - c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent; see below for additional details on sample collection procedures)
 - d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
6. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
7. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

8.2 Field Screening Procedures

8.2.1 PID and FID Screening

Soils are typically field screened with a PID or FID for a relative measure of the total VOCs at sites where VOCs are known or suspected to exist. PIDs and FIDs require calibration in accordance with the work plan(s) and manufacturer's specifications and PIDs should be calibrated based on the target chemicals. The PID employs an ultraviolet lamp to measure VOCs and the ionization energy (IE) of the site constituents need to be considered when selecting the type of lamp (e.g., 10.6 eV, 11.7 eV) that will be used. In general, any compound with an IE lower than that of the lamp photons can be measured. The FID has a wide linear range and responds to almost all VOCs.

Field screening is performed using one (or both) of the following two methods:

1. Upon opening the sampler, the soil is split open and the PID or FID probe is placed in the opening and covered with a clean, gloved hand. Such readings will be obtained at several locations along the length of the sample.
2. A portion of the collected soil is placed in a jar, which is covered with aluminum foil, sealed, and allowed to warm to room temperature (see below). After warming, the cover is removed, the foil is pierced with the PID or FID probe, and a reading is obtained.

Prior to usage, the PID or FID must be calibrated according to the manufacturer's specifications at a minimum frequency of once per day prior to collecting PID or FID readings. The PID will be calibrated to a benzene-related compound (isobutylene) or other appropriate gas, while the FID will be calibrated to methane. The time, date, and calibration procedure must be clearly documented in the field notebook and/or the calibration form.

If at any time the PID or FID results appear erratic or inconsistent with field observations, then the instrument will be recalibrated.

If calibration is difficult to achieve, then the PID's lamp will be checked for dirt or moisture and cleaned, or technical assistance will be required. Maintenance and calibration records will be kept as part of the field quality assurance program.

Initial PID readings will be recorded on the soil boring log (**Attachment 1**) and/or in the field notes. The soil sample will be separated from the slough material (if any) by using disposable gloves and a pre-cleaned stainless-steel spoon or tool.

For the second method, a representative portion of the sample will be placed in a pre-cleaned air-tight container (as quickly as possible to avoid loss of VOCs), filling the container half full to allow for the accumulation of vapors above the soil. An aluminum foil seal will be placed between the glass and cap and the cap will be screwed on tightly. Unless the screening will be performed immediately after the sample is placed in the container, the sample containers will be stored in a cooler chilled to approximately 4°C until screening can be performed.

The headspace of the container will be measured using a PID or FID as follows:

1. Samples will be taken to a warm workspace and allowed to equilibrate to room temperature for at least one hour.
2. Prior to measuring the soil vapor headspace concentration, the container will be shaken.
3. The headspace of the sample will then be measured directly from the container by piercing the aluminum foil seal with the probe of the PID or FID and measuring the relative concentration of VOCs in the headspace of the soil sample. The initial (peak) reading must be recorded.

8.2.2 NAPL Screening

To screen for the potential presence of non-aqueous phase liquid (NAPL) in soil, drilling procedures must allow for high-quality porous media samples to be taken. Split-barrel samplers or direct-push samplers will be collected continuously ahead of the auger, drill casing/rods, or probe rods. Upon opening each split-barrel sampler or direct-push plastic liner sleeve, the soil will immediately be evaluated for the presence of visible NAPL and odors. If suspected NAPL is immediately visible in the sample, its depth will be noted.

Additionally, the soil will be screened for the presence of organic vapors using a PID or FID, in accordance with the work plan, if applicable. During screening, the soil will be split open using a clean spatula or knife and the PID or FID probe will be placed in the opening and covered with a clean, gloved hand (**Method 1** above). Such readings will be obtained along the entire length of the sample. Alternatively, **Method 2** for PID/FID screening (outlined above) may also be performed. If the PID or FID examination reveals the presence of organic vapors above 100 parts per million (ppm), the sample will undergo further detailed evaluation for visible NAPL.

The assessment for NAPL will include the following tests/observations:

- Evaluation for Visible NAPL Sheen or Free-Phase NAPL in Soil Sampler
 - NAPL sheen will be a colorful iridescent appearance on the soil sample
 - NAPL may also appear as droplets or continuous accumulations of liquid with a color typically ranging from yellow to brown to black, depending on the type of NAPL
 - Creosote DNAPL (associated with wood-treating sites) and coal tar DNAPL (associated with manufactured gas plant [MGP] sites) are typically black and have a characteristic, pungent odor
 - Pure chlorinated solvents may be colorless in the absence of hydrophobic dye. Solvents mixed

with oils may appear brown

- Particular care will be taken to fully describe any sheens observed, staining, discoloration, droplets (blebs), or NAPL saturation
- Soil-Water Pan Test
 - A portion of the selected soil interval with the highest PID or FID reading above 100 ppm will be placed in a disposable polyethylene dish along with a small volume of potable or distilled water
 - The dish will be gently tilted back and forth to mix the soil and water, and the surface of the water will be viewed in natural light to observe the development of a sheen, if any
 - A small quantity of Oil Red O or Sudan IV hydrophobic dye powder should be added in accordance with the work plan, and the soil and dye will be manually mixed for approximately 30 to 60 seconds and smeared in the dish to create a paste-like consistency
 - A positive test result will be indicated by a sheen on the surface of the water and/or a bright red color imparted to the soil following mixing with dye
- Soil-Water Shake Test
 - A small quantity of soil (up to 15 cc) will be placed in a clear, colorless, jar containing an equal volume of potable or distilled water (40-mL vials are well suited to this purpose, but not required)
 - After the soil settles into the water, the surface of the water will be evaluated for a visible sheen under natural light
 - The jar will be closed and gently shaken for approximately 10 to 20 seconds
 - Again, the surface of the water will be evaluated for a visible sheen or a temporary layer of foam
 - A small quantity (approximately 0.5 to 1 cc) of Oil Red O or Sudan IV powder will be placed in the jar in accordance with the work plan
 - The sheen layer, if present, will be evaluated for a reaction to the dye (change to bright red color)
 - The jar will be closed and gently shaken for approximately 10 to 20 seconds
 - The contents in the closed jar will be examined under natural light for visible bright red dyed liquid inside the jar

- A positive test result will be indicated by the presence of a visible sheen or foam on the surface of water, a reaction between the dye and the sheen layer upon first addition of the dye powder, a bright red coating on the inside of the vial (particularly above the water line), or red-dyed droplets within the soil

NOTE: *If NAPL is obviously present upon opening the soil sampler or evaluating the soil sample within the split-spoon sampler or direct-push liner sleeve, it is not necessary to perform a soil-water pan test or soil-water shake test. In addition, it is not necessary to perform both a soil-water pan test and a soil-water shake test; either test method is acceptable. The pan test may be preferred in some circumstances because the presence of a sheen may be easier to see on a wider surface. Further, these tests will only be performed if specified in the work plan(s).*

NOTE: *When using hydrophobic dye in the tests above, color will be assessed outdoors under natural light during the period between sunrise and sunset, regardless of the degree of cloud cover. The hydrophobic dye Safety Data Sheets (SDS) will be incorporated into the HASP and reviewed prior to use and the dyes will be carefully handled and disposed in accordance with regulations, if applicable.*

8.3 Soil Sample Collection for Laboratory Procedures

If not specifically identified in the FIP/work plan, soil samples will be selected for laboratory analysis based on:

1. Their position in relation to identified source areas
2. The visual presence of source residues (e.g., NAPL or staining)
3. The relative levels of total VOCs based on field screening measurements
4. The judgment of the field coordinator
5. Moisture content or relative position with regard to apparent groundwater table/saturation

Samples designated for laboratory analysis will be placed in the appropriate containers.

Sample containers for VOC analysis will be filled first immediately following soil core retrieval to reduce loss of VOCs.

If samples will be collected for other analyses, a sufficient amount of the remaining soil will then be homogenized as described below and sample containers will be filled for other parameters.

VOC samples will be collected as discrete samples using a small diameter core sampler (e.g., En Core® Sampler, Terra Core™ Sampler).

The En Core® Sampler is a disposable volumetric sampling device that collects, stores and delivers soil samples without in-field chemical preservation. The En Core® Sampler requires the use of a reusable T-handle.

The Terra Core™ Sampler is a one-time use transfer tool, designed to collect soil samples and transfer them to the appropriate containers for in-field chemical preservation (e.g., methanol).

The small diameter core samplers will be used according to the manufacturer's instructions (e.g., Ennovative Technologies). Some regulatory agencies have specific requirements regarding VOC sample

collection. Determine whether the oversight agency has specific requirements prior to commencing sampling and collect samples at appropriate interval as specified in the FIP/work plan (or equivalent). Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample.

NOTE: *Samples for VOC and PFAS analysis will NOT be homogenized or composited and will be collected as discrete samples as described above.*

The procedure for mixing samples is provided below.

1. Mix the materials in a stainless steel (or appropriate non-reactive material) bowl using a stainless-steel spoon (or disposable equivalents)
 - a. When dealing with large sample quantities, use disposable plastic sheeting and a shovel or trowel
 - b. **NOTE:** *When preparing samples for metals analyses, do not use disposable aluminum (or metal tools or trays other than stainless steel), as it may influence the analytical results*
2. Flatten the pile by pressing the top without further mixing
3. Divide the circular pile by into four equal quarters by dividing out two diameters at right angles
4. Mix each quarter individually using appropriate non-reactive bowls, spoons and/or sheeting
5. Mix two quarters (as described above) to form halves, then mix the two halves to form a composite or homogenized sample
6. Place composite or homogenized sample into specified containers
7. Remaining material will be disposed of in accordance with project requirements and applicable regulations
8. Sample containers will be labeled with sample identification number, date, and time of collection and placed on ice in a cooler (target 4° Celsius)
9. Samples selected for laboratory analysis will be documented (chain-of-custody forms), handled, packed, and shipped in accordance with the procedures outlined in the FIP/work plan (or equivalent).

8.4 Soil Boring Abandonment

All soil borings need to be abandoned in accordance with ***TGI for Monitoring Well and Soil Boring Decommissioning***. See Attachment E of the TGI for specifics.

9 Waste Management

Investigative-Derived Waste (IDW) generated during drilling activities, including soil and excess drilling fluids (if used), and decontamination liquids, will be stored on site in appropriately labeled containers and disposed of properly. Disposable materials will be stored and disposed of separately. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, PPE). Waste will be managed in accordance with the ***TGI – Investigation-Derived Waste Handling and Storage***, the procedures identified in the FIP/work plan or QAPP as well as

state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP.

In general, drilling activities will be documented on appropriate field/log forms as well as in a proper field notebook. All field data will be recorded digitally or with indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead. Any deviations or omissions from this TGI should be documented.

Initial field logs and chain-of-custody records will be transmitted to the Arcadis CPM and Technical Lead at the end of each day unless otherwise directed by the CPM. The field teamleader retains copies of the field documentation.

Additionally, all documents (and photographs) will be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of drilling activities, soil descriptions, soil boring information, and quantities of materials used.

In addition, the locations of soil borings will be documented photographically and in a site sketch. If appropriate, a measuring wheel or engineer's tape will be used to determine approximate distances between important site features.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

11 Quality Assurance

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate TGI.

Field-derived quality assurance blanks will be collected as specified in the FIP/work plan and/or site- specific QAPP, depending on the project quality objectives. Typically, field rinse blanks (equipment blanks) will be collected when non-dedicated equipment (e.g., split-spoon sampler, stainless steel spoon) is used during soil sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities and during transport to the laboratory.

Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.

12 References

ASTM D1586 - *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. ASTM International. West Conshohocken, Pennsylvania.

13 Attachments

Attachment 1. Soil Boring Log Form

Attachment 1

Soil Boring Log Form

[illegible]

Boring ID: _____ Project Name: _____ Page: _____ / _____

[illegible]

Boring ID: _____ Project Name: _____ Page: _____ / _____

[illegible]

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TGI – Surface Sediment Sampling with Grab Samplers

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 12, 2018	All	Initial conversion to TGI format	Shannon Dunn
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Approval Signatures

Prepared by:



6/13/2022

Elizabeth Hover (Preparer)

Date

Reviewed by:



6/13/2022

Shannon Dunn (Subject Matter Expert)

Date

1 Introduction

This Technical Guidance Instruction (TGI) describes the procedure for collection of surface sediment samples from surface water bodies.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI describes the procedure for collection of surface sediment samples from surface water bodies using push cores and grab sampler. The methods described in this TGI are applicable to any kind of surface water body. The data may be used to evaluate sediment quality.

4 Personnel Qualifications

Arcadis field personnel will be versed in the relevant TGIs and SOPs and will possess the skills and experience necessary to successfully complete the desired field work.

5 Equipment List

The following materials will be available, as required, during sediment sampling:

- Personal protective equipment (PPE), as required by the site Health and Safety Plan (HASP)
- Sampling vessel equipped with health and safety equipment specified in the HASP; that has been inspected; is capable of supporting the work to be performed; and accommodates all workers, equipment, and samples. If the grab sampler is a full size ponar, or equivalent, the sampling vessel will have a davit, or equivalent, and winch from which to operate the grab sampler
- High-precision differential global positioning system (DGPS) with sub-meter accuracy pre-loaded with sample location target coordinates
- Navigation chart(s) for on-water activities (if available and as applicable);
- Grab sampler such as Power grab, Van Veen, or Ponar sampler mounted on boat
- Lexan tubes (4-inch diameter) and plastic caps;
- Weighted lead-line with accuracy of ± 0.01 foot
- Tape measure with accuracy of ± 0.01 foot
- One-foot-long ruler with accuracy of ± 0.01 foot
- Siphon tubing, peristaltic pump, and/or turkey baster
- Stainless-steel bowl or disposable aluminum pans;
- Stainless-steel spoons and/or spatulas;
- Steel core driver (i.e., slide hammer);
- calibrated rod for sediment depth measurement
- Polypropylene twine/rope
- Hacksaw, sawzall, or other cutting tool to cut core barrels into smaller sections, if needed
- Rubber mallet
- Calibrated photoionization detector (PID) and calibration gas
- Zip-top plastic bags
- Appropriate sample containers, labels, and forms
- Camera
- Dry erase board with marker
- Indelible ink/rite in the rain pens
- Decontamination supplies (see the TGI for Field Equipment Decontamination) including bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels
- Field notebook, logging tools (see the TGI for Soil Description), field logs, and black ball point pen, and/or electronic data gathering environment (EDGE) tool
- Sample packing and shipping materials (see the TGI for Chain-of-Custody and DOT HazMat sample handling, packing, and shipping handbook)

6 Cautions

Cores will be maintained vertically to minimize the potential for migration of porewater contaminants within the core when the core is horizontal.

Decanting of overlying water in the core or grab sampler can result in suspension of surface sediment and the loss of that sediment. Suspended sediment will not be decanted.

7 Health and Safety Considerations

Health and safety hazards are discussed in the HASP.

8 Procedure

Grab Sampler Procedure

The following procedure will be used to collect surface sediment with a grab sampler:

1. If publicly available data on surface water elevation are available, record these data at time of sampling. If publicly available data are not available, and the elevation of the sediment surface is needed, measure and record the surface water elevation at a surveyed reference location of known elevation where surface water conditions are equivalent to surface water at the sample location at 30-minute intervals throughout all on-water sampling activities.
2. Maneuver the sampling vessel to the target sample location and secure the vessel in place.
3. Decontaminate the grab sampler in accordance with the TGI for Field Equipment Decontamination.
4. Measure and record the sample location coordinates using the DGPS.
5. Measure and record the water depth at the sample location, using the lead line, immediately prior to each deployment of the sampler. Record the date, time, water depth, and wave/water conditions at the sample location at the time of each deployment of the sampler.
6. Inspect the grab sampler to confirm that the bucket is able to fully close and seal and that the top panels are unlocked. With the sampler resting on either the deck of the vessel or on the sampler holding frame, cock the sampler open by lifting the cable connected to the sampler. Using the winch, lift the cable until the sampler opens but does not lift on the deck or frame.
7. Place the locking pin in the sampler. The locking pin holds the sampler open.
8. Using the winch, raise the sampler from the deck or frame. Using the davit, swing the sampler over the side of the vessel.
9. Remove the locking pin from the sampler. The sampler is now primed to spring shut upon impact.
10. Using the winch, lower the sampler through the water column at a slow constant rate. Do not allow the sampler to free fall or lower the sampler at a high rate of speed. This will cause a pressure wave in advance of the sampler that will erode the surface sediment that is intended to be sampled.
11. Once the sampler impacts the sediment, stop spooling out cable with the winch. Close the sampler jaws by reversing the winch and pulling up cable. This will cause the arms of the sampler to raise, which will close the sampler jaws.

12. Using the winch, pull the sampler upward out of the sediment.
13. Using the winch, lift the sampler to above the surface of the water. Observe and record the water surface during grab deployment for evidence of sheen. Observe and document the acceptability of the sampler for the jaws of the sampler are completely closed and the sampler did not over penetrate. Over penetration is indicated by sediment on the top of the sampler.
14. Using the davit, swing the sampler onboard the vessel.
15. Using the winch, lower the sampler to either the sampler holding frame or the deck of the vessel.
16. Open the sampler top panels. Assess and document the acceptability of the sample:
 - a. Jaws are completely closed
 - b. Sampler achieved target penetration depth and did not over penetrate. Over penetration is indicated by sediment pressed against the top panels or sediment on top of the sampler.
 - c. Sampler sealed and retained standing surface water over the recovered sediment

If the sample is determined to meet the acceptability criteria, keep the sample and continue with Section Processing Surface Sediment Samples, described below. If these acceptability criteria are not achieved, remove the sediment from the sampler and return to step 3.

Push Core Procedure

The following procedure will be used to collect surface sediment with a push core:

1. If publicly available data on surface water elevation are available, record these data at time of sampling. If publicly available data are not available, and the elevation of the sediment surface is needed, measure and record the surface water elevation at a surveyed reference location of known elevation where surface water conditions are equivalent to surface water at the sample location at 30-minute intervals throughout all on-water sampling activities.
2. Maneuver the sampling vessel to the target sample location and secure the vessel in place.
3. Decontaminate the grab sampler in accordance with the TGI for Field Equipment Decontamination.
4. Measure and record the sample location coordinates using the DGPS.
5. Measure and record the water depth at the sample location, using the lead line, immediately prior to each deployment of the sampler. Record the date, time, water depth, and wave/water conditions at the sample location at the time of each deployment of the sampler.
6. Lower the Lexan tube until it reaches the top of sediment.
7. Push the Lexan tube by hand 6 inches into the sediment or until refusal is encountered. Record the penetration depth.
8. Seal the top of the core tube with a cap to retain capillary pressure within barrel.
9. Slowly pull the tube from the sediment. Before the bottom of the coring tube breaks the water surface, place a cap over the bottom to prevent the loss of material from the core tube. Place the cap on the core tube by reaching down into the water. Keep the core tube vertical at all times.
10. Document the appearance of sediment and recovery length of the sample (i.e., linear measurement of sediment sample in Lexan tube) to confirm acceptability of the sample. Acceptability will be based on project specific definition of surface sediment depth.

If the sample is determined to meet the acceptability criteria, keep the sample and continue with Section Processing Surface Sediment Samples, described below. If these acceptability criteria are not achieved, remove the sediment from the sampler and return to step 3.

Processing Surface Sediment Samples

The following procedure will be used to process surface sediment samples from grab samplers:

1. Siphon the standing surface water off using tubing primed with site surface water, a turkey baster, or a peristaltic pump. Be careful not to disturb the sediment-water interface.
2. Place a decontaminated ruler into the deepest part of the grab sampler, to measure sampling depth. Place the ruler between the sampler and the sediment. Place the ruler with the 0-length measurement into the sampler (0 mark down).
3. Photo-document the sediment surface to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Include in the photo a view of a dry-erase board marked with the grab sample ID, date, and time. The photo will also include a view of the ruler for scale.
4. Using a decontaminated stainless-steel spoon, scoop sediment from the sampler into a decontaminated stainless-steel bowl. Do not collect sediment that is in contact with the sampler. Use the ruler to measure the project specific sample depth for collection.
5. Log sediment samples according to the amended procedure described in the TGI for Soil Description.
6. Homogenize the sediment by mixing with the spoon until the sediment is of uniform color and texture.
7. Photo-document the sediment sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Include in the photo a view of a dry-erase board marked with the grab sample ID, date, and time. The photo will also include a view of a tape measure for scale.

The following procedure will be used to process surface sediment samples from push cores:

1. Photo-document the sediment to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Include in the photo a view of a dry-erase board marked with the grab sample ID, date, and time. The photo will also include a view of tape measure for scale.
2. Remove the core cap at the top of the core. Siphon the standing surface water off using a peristaltic pump or by slowly decanting the surface water. Be careful not to decant any fine sediment suspended in the water above the sediment.
3. Holding the core tube over a decontaminated stainless-steel bowl, remove the core cap at the bottom of the core. The sediment may slide out of the core tube into the bowl. If the sediment does not come out of the core tube, gently tap the core tube with the rubber mallet to cause the sediment to slide out.
4. Log sediment samples according to the amended procedure described in the TGI for Soil Description.
5. Homogenize the sediment by mixing with a decontaminated spoon until the sediment is of uniform color and texture.

6. Photo-document the sediment sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Include in the photo a view of a dry-erase board marked with the grab sample ID, date, and time. The photo will also include a view of a tape measure for scale.

Fill pre-cleaned laboratory-supplied sample jars with sediment sample, as specified in the QAPP for the analytical suite. Place the sample jars in a cooler with ice.

Handle samples as described in the Chain-of-Custody TGI.

9 Waste Management

Solid investigation-derived wastes (IDWs), such as excess sediment generated through sampling activities, will be collected into 55-gallon drums and stored on site pending disposal. Liquid IDWs, such as decant water from grab samplers and decontamination liquids, will be collected into 55-gallon drums pending treatment and/or disposal. Non-aqueous liquid wastes, if generated (e.g., hexane, non-aqueous phase liquid [NAPL]), will be segregated and stored in appropriately sized buckets pending disposal.

PPE, soiled disposable items, and other trash will be stored in 55-gallon drums on site pending disposal.

IDW will be sampled as needed for disposal characterization. IDW will be stored on site pending treatment and/or disposal. IDW may be managed in conjunction with remedial activities. All IDW will be stored in a secure onsite location pending disposal. Follow the procedures in the IDW TGI.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

11 Quality Assurance

Sample quality will be achieved by complying with the procedures outlined in this TGI. Cross- contamination will be prevented by following the protocols described in the TGI for Field Equipment Decontamination. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific QAPP

12 References

Not Applicable.

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TGI – Water-Level Monitoring Using Data Logging Instruments

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Prepared by:



3/16/2022

Christian Seidel (Preparer)

Date

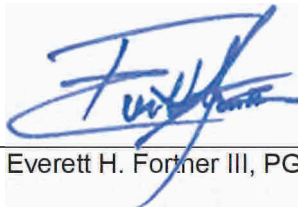


3/16/2022

Colleen Barton, PG (Preparer)

Date

Reviewed by:



3/16/2022

Everett H. Fortner III, PG

Date

1 Introduction

Water-level monitoring is essential information for many environmental to engineering projects. The use of data-logging instruments increases the frequency of recording and understanding with time-series analysis.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI describes procedures to measure and record groundwater and surface-water levels with data logging instruments such as pressure transducers that are used for several different applications and durations. The high-resolution data acquisition applications include:

- Hydraulic testing and characterization
- Horizontal and vertical hydraulic gradients
- Groundwater/surface-water interaction
- Surface-water, ocean tides, and earth tides
- Remediation, mining, or water supply system performance/operations and maintenance.

Thoughtful planning and proper design combine to form the backbone of high-resolution water-level monitoring via data logging instruments because it is important to ensure that data are acquired to meet the project and data quality objectives. A detailed FIP is essential for execution of the work described in this TGI. Therefore, it is strongly recommended that the project hydrogeologist develop a detailed field implementation plan (FIP) that clearly outlines the objectives, design of the monitoring to be performed, specific steps/procedures to be followed, communication expectations and protocol, and health and safety requirements. This plan will be reviewed with field personnel prior to mobilization to the field.

Design considerations include adequate spatial coverage both laterally (spacing and number of wells or surface points) and vertically (shallow to deep groundwater zones), presence and nature of surface-water and surface-water body sediment point, and collection of background data. The conceptual site model (CSM) drives the design decisions through consideration of key components such as surface topography, changes in geology (i.e., heterogeneity), groundwater zone characteristics (e.g., confined/unconfined, depth, extent, sources of recharge, discharge points, vertical leakage between hydrostratigraphic units, groundwater flow direction), groundwater to surface water interaction zones, and presence of pumping wells and/or injection wells.

Manual water-level measurements, following the *TGI – Manual Water-Level Monitoring*, involves taking an instantaneous measurement of the water level in a well or surface-water body to a known survey point. Knowledge of the vertical datum of the survey is needed to ensure accuracy and consistency. Manual readings are used initially to understand the water column of the system; if historical measurements are available, the historical fluctuation of water levels will be used to determine pressure transducer installation depths. Or, if the monitoring is for a pumping or injection test, the estimated drawdown or mounding will also be considered. Manual water-level measurements are also used to adjust the pressure transducer measurements to an elevation datum either during post-processing or during programming of the pressure transducer with an offset using the instrument software. Additionally, manual water-levels are used to monitor accuracy and potential drift of the instrument readings.

Understanding the instrument type is also critical when planning and designing a water-level monitoring program. Many brands of data logging instruments are available that have different accuracies, sizes, memory capacity, acquisition rates, depth restrictions, warranties, and life spans. All new instruments come with laboratory calibration certificates or are available upon request. If renting an instrument, the rental company must provide the calibration and age to confirm it is within calibration recommendations per the manufacturer. Standard pressure transducers can also record temperature and specific conductance/conductivity depending on the model. More advanced instruments, such as multiparameter probes (sondes), can be customized to provide multiple data types as well (e.g., pH, dissolved oxygen, fluorescence) and requires multi-point calibration.

Other important considerations when planning/designing for a project include:

- Depth required to account for fluctuations and accuracy;
- Density variation;
- Nonaqueous phase liquid (NAPL) monitoring;
- Matching depth with instrument model;
- Choosing absolute (sealed) or vented (gauge);
- Direct read cable or cord requirements;
- Wellhead or surface-water structure connection;

- Acquisition rate needed;
- Available/required memory (acquisition rate and duration); and
- Communication equipment (e.g., direct read cable with laptop, wireless communication).

In general, with most instrument brands, the accuracy of a pressure transducer decreases with increasing head.

Absolute pressure transducers (i.e., non-vented or sealed) do not require a vented tube within the cable or a cable and are cheaper to install; however, a sealed transducer must be coupled with barometric pressure measurements so that compensation of the atmospheric pressure can be subtracted and/or evaluated for characterization (correction, barometric efficiency, or barometric response function). Data-logging barometric pressure transducers are available from most manufacturers.

Gauged pressure transducers (i.e., vented) must have a vented tube within the cable to vent the instrument to the atmosphere, are generally more expensive, and can have complications with the vent tube twisting/bending or collecting moisture. Although vented pressure transducers do not need barometric compensation, barometric pressure measurements are still needed, particularly if aquifer characterization is required for the evaluation (i.e., calculating barometric efficiency). Vented pressure transducers are more frequently used for field programs that require short-term, real-time measurements and evaluation (e.g., slug tests).

Collection and evaluation of weather station data, including rainfall and barometric pressure, will be incorporated into the test design. Precipitation data is necessary to understand and account for recharge response for both surface water and groundwater applications. Site-specific weather station data is preferred; however, the data can also be obtained from local weather stations maintained by third parties (e.g., National Oceanic and Atmospheric Administration or local airport). These third-party datasets, though, should be used with caution; always confirm availability of the data, data resolution, and that the distance from the site is adequate as the distribution of precipitation can be highly variable.

Different brands of pressure transducers may offer different acquisition programming functions and interfaces (e.g., differential, linear, and logarithmic logging of data) and overwriting of memory or slate (i.e., once memory is full, pressure transducers typically stop recording). Additional programming beyond the pressure head of the overlying water column includes setting reference points to measure water level elevation or depth to water. Software is available from the manufacturer (typically free of charge) that provides an interface between a laptop/tablet/mobile device and the particular brand of transducer. Note that the interfacing software is compatible with most laptops and most manufacturers have recently adapted their programs for mobile applications with some brands for use on tablets or smart phones. There are also remote considerations for radio (WiFi or Bluetooth or cellular) telemetry to have direct data feeds to servers or databases. Communication equipment, specific to the brand, are available (e.g., direct connection via cable or by Bluetooth).

Over the last several years, data acquisition rates and memory have been significantly improved by manufacturers with acquisition rates as low as 10 measurements per second and may record in memory more than 350,000 total data points. The selection of a specific brand or model to meet data acquisition needs and data quality objectives (accuracy) is based on the overall project objectives. Compatibility with the geochemistry or contaminant chemistry is also a consideration when selecting an instrument.

4 Personnel Qualifications

Field personnel performing the extraction constant rate tests will have the following qualifications:

- Familiarity and competency with:
 - quantitative hydrogeology,
 - understanding of the Project Site,
 - this TGI, and
 - the scope of work and objectives (i.e., reviewed the FIP with project hydrogeologist).
- Sufficient “hands-on” experience necessary to successfully complete the field work.
- Demonstrated familiarity with equipment required for this testing. Project personnel involved must understand the use, installation, and software required, which will be loaded on the communication device and tested before the event.
- Completed current health and safety training in accordance with the project health and safety plan (HASP) (e.g., 40-hour Hazardous Waste Operations and Emergency Response [HAZWOPER] training and/or Occupational Safety and Health Administration HAZWOPER site supervisor training and/or site-specific training, as appropriate).

5 Equipment List

The following items are required for water level measurements:

- HASP
- Personal protective equipment (PPE) as specified in the HASP
- Decontamination equipment
 - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean five-gallon buckets or clean wash tubs
 - Distilled or de-ionized (required for sites with metals) water for equipment decontamination
 - Solvent (methanol/acetone) rinse – optional
 - Optional plastic drop cloth (e.g., Weatherall Visqueen) to place beneath the buckets or tubs to reduce potential for contamination of the tape or probe
- Photoionization detector (PID) and/or organic vapor analyzer (optional)
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Tools and/or keys required for opening wells
- Well construction summary table and/or well construction logs
- Summary table of previous water-level measurements
- Field notebook and appropriate field forms (Attachment A); a pressure transducer field form is also available using FieldNow®
- Indelible ink pen
- Digital camera or camera on smart device if photo documentation is necessary

- Electronic water-level indicator, or oil-water level indicator, that is calibrated and graduated in 0.01-foot increments
- Electrical tape
- Pressure transducers, direct-read cables (if applicable), specialized well caps (if necessary), and wire/Kevlar cord to deploy/hang transducers (In-Situ or Solinst® brand equipment is preferred)
- Pressure transducer communication equipment—laptop/tablet/mobile device (smart phone) with associated chargers and loaded with appropriate pressure transducer software
- Barometric pressure transducer, rain logger, tipping bucket, or weather station (if applicable)
- Flash USB memory stick
- Site-specific details regarding the equipment required and its use will be described in the FIP and discussed during a kick-off meeting prior to the field work. Photographs of common examples of transducers, specialized well caps, and related equipment is included in Attachment B.

6 Cautions

The notes listed below are intended to provide reminders and information for potential issues, particular application notes, or key points:

- Test all equipment with the interface/communication device (laptop/tablet/mobile device) to be used in the field prior to mobilization to ensure functionality.
- Decontaminate each piece of equipment that will be placed into the well, including the pressure transducer, cable/cord, and electronic water-level indicator.
- Instrument equilibration takes time, especially when temperature changes are highly variable during deployment. Allow at least 5 to 10 minutes for equilibration and verify stability with real time data review.
- Direct-read cables may require time to stretch once transducers are deployed especially if they were shipped in tight coils. Allow 10 to 20 minutes following transducer deployment for the cables to equilibrate as well.
- For manual water-level measurements, please refer to TGI – Manual Water-Level Monitoring.
- When taking manual water-level measurements, at least three measurements of the depth to water will be performed to ensure accuracy of measurements and that the pressure transducer will be installed at an appropriate depth.
- When taking total depth measurements, compare the measurements to the well construction log to verify total depth and determine the amount of material accumulation in the well (if any). Evaluate the available water column and depth at which the pressure transducer will be set. This deployment depth will be established in the FIP to understand the fluctuations induced naturally or by hydraulic testing. The depth of deployment will ensure that the water level does not fall below the pressure transducer sensor (dry conditions) or does not rise to a level that exceeds the specified pressure tolerance of the transducer.
- If the presence of a non-aqueous phase liquid (NAPL) is known or suspected at the site or within specific wells, do not use an electronic water-level indicator. Use an oil-water interface meter instead.
- Special considerations are also required for installation of pressure transducers if NAPL or other density-driven situations exist (e.g., zones of increased groundwater density due to reagent injections) and if there are concerns regarding the presence of explosive conditions down-well. Density corrections can be made during

post-processing or directly programmed into the pressure transducer. Pressure transducers may be installed below or within light NAPL (LNAPL) or dense NAPL (DNAPL) for specialized testing or monitoring.

- The head space in the well requires venting to the atmosphere for all types of pressure transducers for (1) proper equilibration and (2) so that pressure does not build up in the head space that could affect the instrument readings.
- When using specialized well caps, ensure a measuring point (survey) point offset is recorded by taking a manual depth to water measurement prior to installation and after installation to the known measurement point. The pressure transducer accuracy is reduced when correlating to a known survey point for the elevation calibration (at the accuracy of the manual water-level meter). However, the actual fluctuations evaluated are at the accuracy of the pressure transducer model.
- Special applications may exist that require sealing of the wellhead space. If this is the case, proper planning and an additional pressure transducer may be needed for the sealed head space.
- Understanding instrument drift (vertical movement of transducer due to a variety of reasons) is primarily required for long-term projects (monitoring over a period of months to years). Drift can be evaluated post-processing and by recording the differences between pressure transducer readings and manual measurements (offsets) through time. If drift is excessive (determined by senior technical staff/project hydrogeologist) by the accuracy or continual increasing/decreasing differences of the water-levels, then instrument recalibration by the manufacturer or replacement may be necessary.
- During installation, data download, or operation verification, a manual depth to water measurement is required (see the TGI – Manual Water-Level Monitoring). Manual water levels can be recorded on the form provided in Attachment A or by using FieldNow® electronic data collection.
- Limit handling of the pressure transducers to prevent the need for post-processing shift adjustments.
- If freezing conditions may be encountered, refer to manufacturer guidelines that may include installation with a balloon filled with a nontoxic antifreeze solution.
- If multiple water-level meters will be used, calibrate prior to performing field activities by taking a water-level measurement from one well using all water-level meters to be used on site. Record the well ID, water-level meter ID (e.g., A, B), depth to water, and time measured (see form provided in Attachment A or use FieldNow). Water level meters and transducers will be decontaminated as described in the TGI – Manual Water-Level Monitoring.
- Ensure that pressure transducer wellhead connections are secured according to manufacturer guidelines and using proper equipment. If the pressure transducers need to be redeployed, do so in such a manner to discourage movement/slippage of the line/cable or pressure transducer.
- Barometric pressure transducers require specific conditions for proper operation. Place the barometric pressure transducer in a cool/shaded location that is protected from precipitation and condensation. Desiccants can be used to help with condensation. Often, barometric pressure transducers are placed in a well casing stickup, between the inner and outer casings.
- Pressure transducers (including barometric loggers) require clock synchronization by one device. Most pressure transducer software does not account for daylight savings time.
- Pressure transducer details (serial number, model, programming, deployment, and retrieval information) must be recorded (see Attachment A or use FieldNow®). Also record the date and time of all manual water-level measurements.

- The barometric pressure transducer will always be the first to be deployed. The barometric pressure, rain, or weather station logger/equipment are always last to be downloaded (after all other transducers), following the same protocol as the pressure transducers.
- All time will be recorded in 24-hour format with the time zone indicated. Programming will be required for future start at equal intervals on an even interval (e.g., 14:05:00 start) to facilitate post-processing.
- All data (pressure transducer, barometric pressure, rain, and weather station logger/equipment) will be downloaded and saved as the software raw data file and exported as .csv (comma-separated values) or .xlsx (Excel spreadsheet) file upon download. Filenames will follow the form specified in the FIP. For example, the format may be Well ID_YYYYMMDD (e.g., GW1_20190405) with an additional numeral if multiple daily downloads occur at one well. In addition, cloud services or other networking can be used to transmit data, and remote telemetry systems can be set up to record data in a specified database.
- Communication protocols will be outlined in the FIP. In general, field staff should communicate with the rest of the project team prior to and at the completion of each field visit/monitoring event (before demobilizing from the site). Communication with the project team is critical so informed decisions can be made to address any complications that arise.
- There is a potential for pressure transducer drift or induced error by the instrument or cable if exposed to high/low temperatures or solar radiation. For both these cases, refer to the instrument documentation to ensure that the conditions are met for the expected environment or type of instrument installation.

7 Health and Safety Considerations

Field work will be performed in accordance with the HASP, which includes related Job Safety Analyses (JSA) and safety data sheets (SDS) for site hazards and risks. Arcadis field personnel must review and understand the HASP and sign the appropriate acknowledgement page of the HASP prior to the start of work.

Appropriate PPE, as specified in the HASP, will be worn during these activities. At a minimum, Level D PPE, including hard hat, safety glasses, steel-toe boots, and nitrile gloves, is generally required.

Health and safety tailgate meetings will be conducted at least once daily (in the morning) and at the start of each task to discuss the scope of work, hazards associated with the work, and each person's responsibilities.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or oil. Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g., ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife). Open well caps slowly and keep face and body away to allow to vent any built-up pressure.

Field personnel will thoroughly review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives.

8 Procedure

The following procedure will be performed at each wellhead or surface-water point during deployment, download, reset, or retrieval of the pressure transducers.

8.1 Pressure Transducer Setup and Deployment

1. Prior to mobilization, pressure transducers and related equipment will be checked and tested to verify working condition. Each pressure transducer will be accessed with the manufacturer software to ensure proper connection capabilities with laptop/tablet/smart or Bluetooth device. Pressure transducers will be submerged in a bucket of water at a known depth to verify accuracy and proper operation.
2. Don appropriate PPE (as required by the HASP).
3. Inspect wellhead for damage. Open the well/remove well cap and allow for atmospheric equilibration. If required in the HASP, measure headspace with PID. **Measure the depth to water three times**, and record final measurement, well ID, and date and time on the field form (Attachment A) or using FieldNow®. Measure total depth of well and confirm well construction against well construction log or summary table. Use appropriate length cable or cord to install the pressure transducer. If surface water monitoring is being completed, follow the same procedures for the stilling well or stream gauge.
4. Deploy pressure transducers:
 - a. The barometric pressure transducer will be programmed and installed first. The barometric transducer will be installed in an open atmosphere setting protected from weather (sun or rain), such as inside an outer well casing which does not pose a risk of flooding. Use desiccants if excessive condensation is expected.
 - b. Prior to deployment, program the pressure transducer following the manufacturer's instructions and as outlined in the field implementation plan. Information programmed into the transducer will include well identification, parameter to be measured (select Level/Depth, Top-of-Casing, or Elevation, and use appropriate reference elevation, if applicable), recording interval, units, and recording type (e.g., linear, differential, event, logarithmic). Determine start time (following the recommendations stated below) and other options:
 - c. All pressure transducers will be synchronized to start after instrumentation is completed at monitoring wells or surface water points. Note that each time a pressure transducer is accessed an option for synchronization to a device can be done. Ensure a consistent device is used or the previous pressure transducer time and new synchronized device differences are recorded.
 - d. Pressure transducers will be programmed for a future start date that is consistent with the time interval selected (start time is at even increments using the future start option, with 00 seconds and recording interval, as applicable [e.g., 08:00:00]).
 - e. Cables or cords will be pre-measured to match the deployment depth as specified in the field implementation plan. Ensure connections are not cross-threaded and sealed. If using a cord, use of a small-diameter Kevlar cord with a bowline knot for connections is recommended. Vented pressure transducers have a top cable connection that will likely have a desiccant connection to inhibit moisture concerns in the vent tube.
 - f. Slowly lower the pressure transducer to avoid any sudden disturbance of the water surface. Set to the appropriate depth for the project and data quality objectives as specified in the field plan. If setting the transducer at the base of a well or in a shallow stream, ensure there is at least 6 inches of vertical water column below the transducer to prevent the instrument from coming into contact with sediment. Attach the transducer cable or cord to the well cap and ensure that it is secured to prevent potential movement.
 - g. Record all pressure transducer settings on the field form (Attachment A) or using FieldNow®.
 - h. Check and record the manual depth to water measurement and initial transducer readings to confirm accuracy of test setup and if anomalies are observed (e.g., depth to water measurement does not match

the initial reading and/or transducer readings don't match manual measurements), consult with Project Hydrogeologist and/or Project Technical Lead.

- i. If required, coil excess pressure transducer cable without damaging it and leave inside the protective well casing.
- j. Close wellhead and confirm it is vented (do not fully tighten j-plugs or caps) to the atmosphere and not sealed (use specific manufacturer well cap assembly, as necessary).
- k. Scan/photograph all paper notes and forms, back up to an external flash memory stick, and upload to project folder/SharePoint as specified in the field implementation plan.

8.2 Transducer Retrieval/Download/Reset of Pressure Transducer or Barometric Pressure Logger

5. Follow Steps 1 and 2 in Section 8.1.
6. Retrieve, if applicable, and/or connect to the pressure transducer using appropriate communication equipment and device.
7. Download data following the manufacturer's instructions. Perform an initial qualitative review of the data to identify anomalies and dataset completeness and record the date and time interval.
8. Save data (raw data file and exported .csv or .xls) on communication device (laptop/tablet/mobile device) or using the cloud. Duplicate data on an external flash memory stick. If copied to the cloud, have support staff check for data completeness. Preview saved information to ensure data were saved accurately. Check available memory of the pressure transducer and leave recording or follow the field plan for resetting.
9. Make relevant notes on field form (Attachment A) or FieldNow®.
10. Check and assess remaining memory relative to the recording frequency and recording frequency and clear/reset as necessary to avoid data loss. To reset the transducer, follow programming guidelines presented in Section 8.1.
11. Scan/photograph all paper notes and forms back up to an external flash memory stick, and upload to project folder/SharePoint as specified in the field implementation plan.
12. If the retrieval of a transducer was necessary, reinstall following guidelines outlined in Section 8.1.

Before leaving the site (if possible), confirm that the data are saved on the cloud or server, and communicate the location to the project team.

Additional data download/management is necessary if other site instruments have been deployed (e.g., rain logger, weather station). Follow the same protocol as described above for retrieval/download/reset as needed.

Following final downloading and transducer pull event, decontaminate all transducers and cables as described in the *TGI – Manual Water-Level Monitoring*.

9 Waste Management

Decontamination fluids, PPE, and other disposable equipment will be properly stored on site in labeled containers and disposed of properly. Waste containers must be properly labeled and documented in the field log book. Review the TGI – Investigation-Derived Waste Handling and Storage for additional information and state- or client-specific requirements.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

In general, data recording and management will follow the steps outlined above in Section 7.2. Specific data management protocols will be outlined in the field implementation plan.

Data/information uploaded to the Arcadis server or the cloud after each field visit/monitoring event at a minimum will include:

- Pressure transducer and other instrument data which should include:
 - Well IDs/locations
 - Measurement times
 - Depth to water/pressure head readings
 - Additional measurements, as necessary (e.g., temperature)
 - Total well depths
- Field notes
- Calibration information (water-level meters and pressure transducers)
- Photographs of the activities performed (if necessary)
- Any discrepancies or interesting findings/observations.

Once all data/information are collected and recorded, all notes/forms/data will be uploaded to the appropriate project folder/SharePoint. Project field personnel will send an email to the project Task Manager, Technical Expert, and Data Manager for notification. The work completed that day, significant observations, and copies of the data listed above will be summarized in the email. The appropriate team members will review the data for accuracy and provide feedback.

11 Quality Assurance

The quality items listed below are intended to provide information to ensure that data are collected at highest quality possible based on the field conditions:

- Calibrate the electronic water-level meter prior to use, instead of using an engineer's ruler, to ensure accurate length demarcations on the tape or cable. Record the results.
- Measurements will be conducted three times and the final measurement will be recorded.
- Review the field notes once the field data are delivered.
- Ensure all rental instruments are within calibration warranty dates.

- Do not install the transducer closer than 6 inches from the base of the well to eliminate the possibility of fouling the transducer with sediment accumulated at the bottom of the well or surface-water point.
- To prevent pressure transducer malfunction or damage, do not submerge pressure transducers in excess of the operating range and do not insert objects in the sensor opening unless directed by the manufacturer.
- Test functionality using a bucket or barrel filled with water. Submerge the pressure transducer, measure and estimate the water head above the pressure transducer, and compare the measurement to the reading (recall that absolute [sealed] pressure transducers will have compounded barometric pressure).
- Additional testing of the pressure transducers includes checking the pressure transducer response to changing heads by raising the pressure transducer a known distance, observing the change in head, and measuring the distance manually.
- Check and assess memory prior to deployment and after each download to avoid data loss. Use time interval between download events, sampling frequency, and remaining memory capacity of the transducer to determine if sufficient memory is available or the transducer requires resetting. Alternatively, remaining memory and sampling frequency can be used to schedule future downloading events.

12 References

- Cunningham, W.L., and Schalk, C.W., comps., 2011. Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p.
- Freeman, L.A., Carpenter, M.C., Rosenberry, D.O., Rousseau, J.P., Unger, R. and McLean, J.S., 2004. Use of submersible pressure transducers in water-resources investigations: US Geological Survey Techniques of Water-Resources Investigations, book 8, chap. A3.
- USEPA 2013. SESD Operating Procedure, Groundwater level and Well Depth Measurement. January 29.

Attachment A

Pressure Transducer Log

[illegible]

NOTES:
ft bTOC - feet below top of casing.
DTW and DTB - depth-to-water and depth-to-bottom

Attachment B

Photographs of Common Examples of Transducers



Solinst Levellogger connected to a PC using an optical reader



Solinst Levellogger and direct read cable connected to a PC using a PC interface cable



In-Situ LevelTrolls and BaroTroll



In-Situ vented cable and desiccant pack



Well cap assemblies for transducer deployment



Deployed transducers to measure barometric pressure and water level



Wireless communication equipment

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TGI – Sample Chain of Custody

Rev: 3

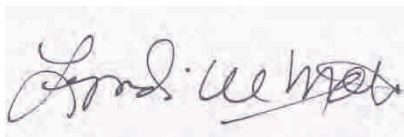
Rev Date: March 28, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	April 19, 2017	All	Re-write to COC only	Richard Murphy
	1	May 23, 2017	4,7,9	Add: Guidance on use of previous version of TGI. Add: Info on COCs for multiple shipping containers Modify: Move letter i. to letter m. and change to “when appropriate”	Peter Frederick
	2	April 29, 2020	4, 11	Remove obsolete link	Lyndi Mott
	3	December 28, 2022	All	Updated Arcadis format Added to 6c. Collection time between COC and container must match. Added to 6o. Add name of overnight courier when relinquishing samples. Updated reference documents and added internet links.	Lyndi Mott

Approval Signatures

Prepared by:

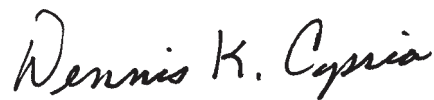


3/28/2022

Lyndi Mott (Preparer)

Date

Reviewed by:

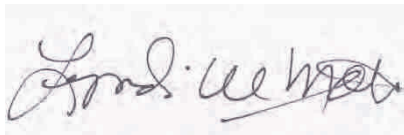


3/28/2022

Dennis Capria (Chain of Custody Reviewer)

Date

Reviewed by:



12/22/2021

Lyndi Mott (Subject Matter Expert)

Date

1 Introduction

This Technical Guidance Instruction (TGI) provides the procedure for Arcadis field personnel for required documentation during the collection of environmental field samples and transfer of custody to a laboratory. It provides direction for completion of the Chain of Custody form that must accompany collected field samples for analysis by a laboratory.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI describes the general Chain of Custody (COC) procedures and guidance instructions for samples collected from project sites that are relinquished from Arcadis' possession.

COC is defined as the maintenance of an unbroken record of possession of an item from the time of its collection through some analytical or testing procedure. COC is typically documented by a written record of the collection, possession, and handling of samples collected from a project location. Each sample will be tracked by a documented record that efficiently documents the individuals who were responsible for the sample during each successive transfer of that sample to various recipients beyond Arcadis' possession. This information can be used to legally establish the integrity of the samples and therefore the analytical results derived from the samples. This

information can be used in addition to other records and documentation regarding the samples, such as field forms, field logs, and photographs.

A sample is considered under custody if:

- It is in your possession; or
- It is in your view, after being in your possession; or
- It was in your possession and then you then locked it up to prevent tampering; or
- It is in a designated secure area.

Continued use of previous version of TGI:

Although not recommended, Arcadis program-, project-, and client-teams may be able to use the previous version of this TGI provided that it meets all of the quality expectations of Arcadis and client and meets applicable regulatory requirements. It is up to the program, project, and/or client-team leader to determine whether it is appropriate to adopt the current TGI or to continue using the previous version.

However, all new work not associated with the previous version of this TGI must be performed with the current version of the TGI.

When adopting this new TGI, users of the previous versions must be aware that specific handling, packing, and shipping procedures and guidance has been removed and that those should be addressed within program or project plans (e.g., Quality Assurance Project Plans (QAPP), Work Plans, Sampling and Analysis Plans (SAPs), etc.) or in a more detailed TGI specific to that sampling activity, whether related to media, constituent/analyte, client, state, etc.

In addition, adopting this new TGI will require users to refer to the Arcadis Department of Transportation (DOT) Safety Program for procedures and guidance on the determination and handling, packing, and shipping of samples that are or may be considered hazardous materials.

4 Personnel Qualifications

Arcadis personnel performing work under the purview of this TGI will have received appropriate training and have field experience regarding the collection of samples from project locations. Arcadis personnel will have all other applicable and appropriate training relevant to the sampling work and project site.

5 Equipment List

The following list provides materials that may be required for each COC. Project reporting and documentation requirements must be reviewed with the CPM prior to execution of work. Additional materials, tools, equipment, etc. may be required, and project staff are required to verify with the CPM and/or Technical Expert what specific equipment is required to complete the COC.

- Indelible ink pen (preferably either black or blue ink);
- COC form (**Appendix A**) from either Arcadis, laboratory receiving and analyzing the samples, or other applicable and appropriate entity for the work performed;
- When appropriate, such as for litigation or expert testimony work, custody seals or tape.

6 Cautions

One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

A proper chain of custody requires three types of affirmations: (1) affirmation that a sample is what it purports to be (for example, soil collected from a specified location and depth); (2) affirmation of continuous possession by each individual who has had possession of the sample from the time it is collected until the time it is analyzed or held by a laboratory; and (3) affirmation by each person who has had possession that sample remained in substantially the same condition and not contaminated or affected by outside influences from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, affirmation that the sample was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the samples in question, by showing the absence of alteration, substitution, or change of condition.

Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material are planned for and provided at the site at the time of sample collection.

Understand the offsite transfer requirements of the samples for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation.

An Arcadis employee appropriately trained at the correct level of internal hazardous materials/DOT)shipping must complete an Arcadis shipping determination to address applicable DOT and International Air Transport Association (IATA) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging, and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

7 Health and Safety Considerations

Follow the health and safety procedures outlined in the project/site Health and Safety Plan (HASP) as well as other applicable H&S requirements, such as:

- Arcadis Hazardous Material/DOT handling, packaging, and shipping training
- Project site-specific H&S training
- Client-specific H&S training
- Constituent-specific H&S training
- Media-specific H&S training

8 Procedure

Collected samples must be uniquely identified, and properly documented, containerized, labeled with unique identifier, possessed in a secure manner during remainder of sampling event, packaged, and shipped to recipient laboratory.

Sample Identification

The method of sample identification depends on the type of measurement or analyses performed. In some cases, in-situ measurements of existing conditions and/or sample location must be made during sample collection.

These data will be recorded directly on field forms, logbooks, or other project record data sheets used to permanently retain this information for the project file. Examples of location identification information includes: latitude/longitudinal measurements, compass directions, well number, building number, floor number, room name, or proximity to a site feature unique to the site. Examples of in-situ measurements are pH, temperature, conductivity, flow measurement, or physical condition of the media being sampled. Physical samples collected are identified by a unique identifying number or code on a sample tag or label. These physical samples are removed from the sample location and transported to a laboratory for analyses.

In some cases, before samples are placed into individual containers and labeled as individual samples, samples may be separated into portions depending upon the analytical methods and required duplicate or triplicate analyses to be performed.

When completing a COC for samples, personnel must complete the following:

1. Written COCs must be completed with indelible ink (preferably either black or blue colored ink).
2. Written COCs must be completed using legible printed writing, and not cursive writing.
3. All entry fields on the COC form must be completed. If information is not applicable for a specific entry field, personnel will either put "N/A" or use a strike-out line or dash like "-----" to indicate no applicable information is needed for that field.
4. Use of quotation marks or lines/down arrows to represent repetitive/duplicative text in similar fields.
5. Regardless of the type or specific COC form, the following pertinent information must be provided on the COC form:
 - a. Arcadis project number
 - b. Arcadis project name
 - c. Project location, including street address, city, state, building number, providing as much detail as appropriate
 - d. Recipient laboratory contact and sample receiving shipping location information
 - e. Entities'/persons' contact information for who will be receiving analytical results
 - f. Name of sampler, i.e., person collecting sample and relinquishing possession of samples to the next entity in the chain of custody
 - g. Date of sample collection
 - h. If appropriate for the sample media, contaminant/constituent of concern, or analytical method, document time of sample collection using standard military time
 - i. Sample analytical method(s)

- j. Turnaround time required for analyses and/or reporting
- k. Instructions to laboratory regarding handling, timing, analyses, etc. as applicable and appropriate.
- l. Printed name and signature of the individual person who collected the samples and relinquishing possession of the samples
- m. If appropriate or when documentation of the specific sample collection method will influence how the laboratory handles, prepares, or analyzes the samples, document the sample collection methodology used for collecting the samples (e.g., ASTM D5755)

6. The following additional specific information will be entered on the COC form, regardless of what type of COC is being used:

- a. Unique Sample Identifier – The sample identifier (ID) must be unique to the individual sample it is applied to. The information in which the sample ID conveys is determined by the CPM, Technical Expert, and/or other project team members in advance of sample collection so that sample identification is consistently applied for the project. The sample nomenclature may be dictated by a specific client, program, or project database and require unique identification for each sample collected for the project. Consult with the CPM and/or Technical Expert for additional information regarding sample identification.

The sample ID could convey specific information regarding the sample to aid personnel in recognizing what the sample represents, or they may be arbitrary so as to facilitate the anonymity of the sample location, media, constituent of concern, project site, etc.

Examples of unique identifiers include:

- 1. Well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. DO NOT use the apostrophe or quotes in the sample ID.
 - 2. Sample names may also use the abbreviations “FB,” “TB,” “FD” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively.
- b. List the date of sample collection. All indicated dates must be formatted using either mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g., 03/07/2009).
 - c. List the local time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15. The time listed on the COC form must match the sample collection time on the sample container(s).
 - d. Samples should be indicated to be either “Grab” or “Composite”. Grab samples are collected from only one unique location at one specific point in time.
 - e. Composite samples are a group of individual samples that are combined for analysis in their totality. Composite samples need to be documented if they are either collected from a number of different locations over a broader area to be representative of the entire area being sampled, or if they are representative of a single location over an extended period of time.

- f. If used, preservatives for the individual sample will be noted.
 - g. The requested analytical method(s) that the samples are being analyzed for must be indicated. As much detail, as necessary, should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering “EPA Method 8082 – PCBs” or “EPA PLM 600-R93-116.” In cases where multiple analytical methods and/or analytical parameters are required for an individual sample, each method should be indicated for the sample (e.g., EPA 8082/8260/8270 or EPA PLM/400-point count).
 - h. If there are project-specific sample analytes to be reported, they should be specifically listed for each individual sample (e.g., 40 CFR 264 Appendix IX).
 - i. The total number of containers for each analytical method requested should be documented. This information may be included under the parameter or as a total for the sample.
 - j. When necessary, note which samples should be used for site specific matrix spikes in the Remarks or Comments field.
 - k. Indicate special project-specific requirements pertinent to the handling, shipping, or analyses. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG).
 - l. Indicate turnaround time (TAT) required for samples on COC. If individual samples have differing TATs, the different TATs for each sample or groups of samples must be clearly indicated.
 - m. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory. The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.
 - n. If available, attach the Laboratory Task Order or Work Authorization forms.
 - o. The “Relinquished By” field must contain the signature of the Arcadis person who relinquished custody of the samples to the next entity in the chain of custody, which may be another person, the shipping courier, or the analytical laboratory. If a courier, enter the shipping courier in the “Received by” such as FedEx. The date/time relinquished should be when the person signs the COC and seals the cooler or shipping container for pick-up by the shipping courier.
 - p. Dates and times must be indicated using the following format:
 - 1) Date: either mm/dd/yy e.g., 01/01/17 OR mm/dd/yyyy e.g., 01/01/2017
 - 2) Time: use military format, e.g., 9:30 a.m. is 0930 and 9:30 p.m. is 2130
 - q. The “Received By” section is signed by sample courier or laboratory representative who received the samples from the sampler. The laboratory will sign upon laboratory receipt from the overnight courier service.
7. When more than one page of the COC form is required to complete the total number of samples, use as many sheets as necessary to accurately and clearly, document the samples and information. Some COCs may have a standard first page/cover page, and subsequent pages may not contain all the detailed fields as

the first page/cover page. Ensure that any subsequent pages convey all of the necessary and pertinent information for each individual sample as required in this procedure document.

8. Pages of the COC must retain a page count of the total number of pages; e.g., Page 1 of 3, Page 2 of 3, Page 3 of 3.
9. Upon completing the COC forms, forward the original signed COC with the sample package. Ensure that the original COC form is secured with the sample package so that it remains with the physical samples for the duration of transport and handling to its final destination and ensure that the COC form will not be become damaged or rendered unreadable due to sample breakage/leakage if stored inside the sample shipping container or outside influences if COC is stored in an outside plastic pouch to the container.
10. If you've collected enough samples that would require more than one container to ship them all to the same laboratory or location, then each separate/individual container that contains any number of samples must have a separate COC representing only those samples contained within that specific container. For example, if you have 3 total shipping containers for all of your samples, you must have a total of 3 separate, individual COCs for each of the 3 containers representing only those samples in their representative container. Thus, every container holding samples must have its own, individual COC.
11. If electronic chain of custody (eCOC) forms are utilized, ensure that the requirements of this procedure and guidance instructions are followed to the extent possible. Verify that proper signature and COC procedures are maintained with the CPM and/or Technical Expert when using eCOC.

9 Waste Management

Not Applicable.

10 Data Recording and Management

The original signed COC shall be submitted with the samples. Copies of COC records will be transmitted to the CPM or designee at the end of each day unless otherwise directed by the CPM. The sampling team leader retains copies of the chain of custody forms for filing in the project file. Record retention shall be in accordance with client- and project-specific requirements and Arcadis policies, the most stringent will apply.

The option to use the Electronic Chain of Custody (eCOC) form in conjunction with the appropriate sample application(s) may be available through the FieldNow® program but is currently limited to a select list of approved analytical laboratories. Use of the eCOC application is intended to reduce common transcription errors both by field staff and laboratory staff on a conventional handwritten paper COC. Once the eCOC form is completed and approved on the field tablet by field staff, a PDF version of the form is automatically emailed to each assigned team member. In addition, a dedicated or mobile printer is recommended for printing a hard copy of the completed eCOC to be included in each sample cooler to meet laboratory requirements.

11 Quality Assurance

COC forms will be legibly completed in accordance with this procedure and guidance instruction document, as well as other applicable and appropriate project documents such as SAP, Quality QAPP, Work Plan, or other project guidance documents.

COC records will be reviewed by the CPM or their appropriate designee for completeness and accuracy to the applicable requirements. Non-conformances will be noted and corrected in a timely manner on the copies retained by Arcadis as well as contacting the ultimate receiving entity for correction to the originally signed COC in their possession.

12 References

Arcadis Transportation Safety Program requirements, procedures, and guidance instructions.

EPA Samplers' Guide – Contract Laboratory Program Guidance for Field Samplers, EPA document EPA-540-R014-013 October 2014 https://www.epa.gov/sites/default/files/2015-03/documents/samplers_guide.pdf.

EPA Region III – Sample Submission Procedures for the Office of Analytical Services and Quality Assurance (OASQA) Laboratory Branch revision 14.0 October 18, 2018, <https://www.epa.gov/sites/default/files/2018-12/documents/sample-submission-procedures-rev14.pdf>.

EPA Region IV Science and Ecosystem Support Division Operating Procedure for Sample and Evidence Management May 25, 2016, <https://www.epa.gov/sites/default/files/2015-06/documents/Sample-and-Evidence-Management.pdf>.

Attachment A

Chain of Custody and Laboratory Analysis Request Form



		CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM	ID# 	Page ____ of ____	Lab Work Order # 						
Send Results to:	Contact & Company Name:		Telephone:		Preservative	Filtered (✓)	# of Containers	Container Information	Matrix Key:	Keys	Containment Information Key
	Address:		Fax:								
	City State Zip		E-mail Address:								
	Project Name/Location (City, State):		Project #:								
Sampler's Printed Name:		Sampler's Signature		PARAMETER ANALYSIS & METHOD							
SAMPLE ID		Collection Date Time		Type (✓) Comp Grab		Matrix		REMARKS			
Special Instructions/Comments ☐ Special QA/QC Instructions (✓)											
Laboratory Information and Receipt		Relinquished By		Received By		Relinquished By		Laboratory Received By			
Last Name:		Cooler Custody Seal (✓) ☐ Intact ☐ Not Intact		Printed Name:		Printed Name:		Printed Name:		Printed Name:	
☐ Cooler packed with ice (✓)				Signature:		Signature:		Signature:		Signature:	
Specify Turnaround Requirements:		Sample Receipt		Firm:		Firm:		Firm:		Firm:	
Shipping Tracking #:		Condition/Cooler Temp: _____		Date/Time:		Date/Time:		Date/Time:		Date/Time:	

SOP – Sample Chain of Custody Rev1_May 23, 2017

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TGI - Surface Water Sample Collection

Rev: 2

Rev Date: June 13, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	April 9, 2019	All	Original approved document	Jessica Geurts / Shannon Dunn
	1	May 8, 2020	None	Periodic review – no changes	Shannon Dunn
	2	April 5, 2022	All	Clarified procedure	Shannon Dunn

Approval Signatures

Prepared by:



Elizabeth Hover (Preparer)

6/13/2022

Date

Reviewed by:



Sharon Dunn (Subject Matter Expert)

6/13/2022

Date

1 Introduction

This Technical Guideline Instruction (TGI) describes the procedure for collection of discrete flow and time surface water samples using a dipper sampler, discrete depth sampler or peristaltic pump.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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3 Scope and Application

This TGI describes the procedure for collection of discrete flow and time surface water samples using a dipper sampler, discrete depth sampler or peristaltic pump. The methods described in this TGI are applicable to any kind of surface water body. The data may be used to evaluate surface water quality.

4 Personnel Qualifications

Arcadis field personnel will be versed in the relevant TGIs and SOPs and will possess the skills and experience necessary to successfully complete the desired field work.

5 Equipment List

The following equipment list contains materials that may be needed in carrying out the procedures contained in this TGI. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- personal protective equipment (PPE) and other safety equipment, as required in the project Health and Safety Plan (HASP)
- high-precision differential global positioning system (DGPS) with sub-meter accuracy pre-loaded with sample location target coordinates
- for dipper sampling method: pole with polyethylene and/or stainless-steel dipper (e.g., cup or bottle with cap removed)
- for discrete depth sampling method: discrete depth samplers (e.g., Kemmerer, Van Dorn) and rope marked at depth intervals
- for peristaltic pump sampling method: peristaltic pump with power source, tubing of length needed for sample depth and diameter based on pump (tubing material is typically Teflon® tubing or Teflon®-lined polyethylene tubing unless per- and polyfluoroalkyl substances are the compound of interest in which case see the PFAS water sampling TGI) Tygon® tubing (or other type as specified by the manufacturer), metal rod or plastic pipe marked at depth intervals, and zip ties
- water-quality meter and flow- through measurement cell or wide mouth container. The water quality probes will be project specific and may include temperature, pH, specific conductivity, oxygen reduction potential, turbidity, and/or dissolved oxygen. Several water quality meter brands may be used, including:
 - YSI 6-Series Multi-Parameter Instrument
 - Hydrolab Series 3 or Series 4a Multiprobe and Display
 - Horiba U-10 or U-22 Water Quality Monitoring System
- indelible ink pens
- appropriate sample containers, labels, and forms
- decontamination supplies (see the TGI for Field Equipment Decontamination) including bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels.
- sample packing and shipping materials (see the TGI for Chain-of-Custody and DOT HazMat sample handling, packing, and shipping handbook)

6 Cautions

If surface water and sediment sampling is performed during the same field event, the surface water samples will be collected prior to the sediment samples. Sediment sampling will suspend particulates, which may become entrained in the surface water samples. The particulates may affect the surface water sample results.

Surface water samples will be collected from sampling locations sequentially from downstream to upstream to prevent cross-contamination associated with potential sediment disturbance.

Field personnel will handle only the portions of the sample containers that do not come in contact with the sample, to avoid contamination. Care will be taken to avoid exposing samples and sample containers to atmospheric

inputs such as dirt or dust. Avoid overfilling sample containers to prevent preservatives, if present, in sample container from being lost.

If heavy precipitation occurs and no cover over the sampling area can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate surface water samples.

Do not use permanent marker or felt-tip pens for labels on sample container or sample coolers – use indelible ink. The permanent markers could introduce volatile constituents into the samples.

It may be necessary to field-filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives.

Store and/or stage empty and full sample containers and coolers out of direct sunlight. Direct sunlight may result in biological activity in the water sample, which may affect chemical concentrations.

7 Health and Safety Considerations

Health and safety hazards are discussed in the HASP.

8 Procedure

Sampling Method

Dipper Sample Collection

The dipper sample collection techniques are as follows:

1. If surface water elevation data are required per the Sampling and Analysis Plan, follow this step. If publicly available data on surface water elevation are available, record these data at time of sampling. If publicly available data are not available, measure and record the surface water elevation at a surveyed reference location of known elevation where surface water conditions are equivalent to surface water at the sample location at 30-minute intervals throughout all on-water sampling activities.
2. Mobilize to surface water sampling location. If sampling from a vessel, secure the vessel in place.
3. Measure and record the sample location coordinates using the DGPS.
4. Attach the decontaminated dipper to the sampling pole. If the laboratory supplied sample bottle does not contain preservative, the sample bottle may be attached to the sampling pole rather than the dipper.
5. Facing upstream, lower the dipper into the surface water upstream of the vessel or where the sampler is standing. Sampling upstream will minimize the entrainment of sediment that is suspended from the vessel wake and anchor or from field staff wading. Collect sample by lowering the dipper so that the mouth of the dipper is just below the water surface. Allow the dipper to fill with water.
6. Pour the water from the dipper into the laboratory supplied sample containers.
7. Label the sample containers.
8. Pour water into a wide mouth container to measure water quality parameters.
9. Measure and record water quality parameters.
10. Place the sample jars in a cooler with ice.
11. Handle samples as described in the Chain-of-Custody TGI.

Sample Collection Using a Discrete Depth Sampler

The discrete depth sample collection techniques are as follows:

1. If surface water elevation data are required per the Sampling and Analysis Plan, follow this step. If publicly available data on surface water elevation are available, record these data at time of sampling. If publicly available data are not available, measure and record the surface water elevation at a surveyed reference location of known elevation where surface water conditions are equivalent to surface water at the sample location at 30-minute intervals throughout all on-water sampling activities.
2. Mobilize to surface water sampling location. If sampling from a vessel, secure the vessel in place.
3. Close the sampling port on the sampler. The sampling port is tubing extending from the lower part of the sampler. The sampling port is closed by a clamp that pinches the tubing shut.
4. Cock the sampler open by pulling back the top and bottom lids on the sampler tube. Cock the sampler open so that water is allowed to pass through the tube.
5. Move the messenger (a weighted bead on the rope attached to the sampler) to the top of the rope (the end of the rope not attached to the sampler).
6. Facing upstream, lower the sampler into the surface water upstream of the vessel or where the sampler is standing. Sampling upstream will minimize the entrainment of sediment that is suspended from the vessel wake and anchor or from field staff wading. Lower the sampler to the predetermined depth by spooling out the rope attached to the sampler. Measure the sampler depth using the marked rope attached to the sampler.
7. Keeping the rope that is attached the sampler taught, send down the messenger. The messenger causes the sampler to close, capturing water at the sampler depth.
8. Retrieve sampler.
9. Open the sampling port by opening the clamp and discharge the first 10-20 mL of water to clear any potential cross-contamination.
10. Release water into the laboratory supplied sample containers.
11. Label the sample containers.
12. Release water into a wide mouth container to measure water quality parameters.
13. Measure and record water quality parameters.
14. Place the sample jars in a cooler with ice.
15. Handle samples as described in the Chain-of-Custody TGI.

Sample Collection Using Peristaltic Pump

Surface water will be collected using a peristaltic pump if flow is slow and conventional sampling procedures are impossible without collecting excess suspended sediment in the sample. Contact with peristaltic pump apparatus (e.g., control knobs) can serve as a source of metals contamination in dissolved metals analyses. Operation of pump controls should be conducted with gloves that do not come into contact with the sample or with materials that contact the sample.

The peristaltic pump sample collection techniques are as follows:

1. If surface water elevation data are required per the Sampling and Analysis Plan, follow this step. If publicly available data on surface water elevation are available, record these data at time of sampling. If publicly

available data are not available, measure and record the surface water elevation at a surveyed reference location of known elevation where surface water conditions are equivalent to surface water at the sample location at 30-minute intervals throughout all on-water sampling activities.

2. Mobilize to surface water sampling location. If sampling from a vessel, secure the vessel in place.
3. Attach tubing to pump.
4. Attach intake of tubing to PVC pipe and configure tubing such that intake is positioned at the desired sample depth within the water column.
5. Place discharge of tubing in laboratory supplied sample container.
6. Turn the pump on and adjust the flow rate as necessary to avoid splashing or overfilling. Fill the sample containers.
7. Label the sample containers.
8. Release water into a wide mouth container to measure water quality parameters.
9. Measure and record water quality parameters.
10. Place the sample jars in a cooler with ice.
11. Handle samples as described in the Chain-of-Custody TGI.

9 Waste Management

Liquid investigation-derived wastes (IDWs), such decontamination liquids or excess surface water, will be collected into 55-gallon drums and may be transferred into large-volume polyethylene tanks with secondary containment pending treatment and/or disposal.

Non-aqueous liquid wastes, if generated (e.g., hexane, non-aqueous phase liquid [NAPL]), will be segregated and stored in appropriately sized buckets with secondary containment pending disposal.

PPE, soiled disposable items, and other trash will be stored in 55-gallon drums and stored on site pending disposal.

IDWs will be collected and stored on site in United States Department of Transportation (DOT)-compliant 55-gallon drums and/or large-volume tanks with secondary containment. Fifty-five-gallon drums and tanks will be labeled with DOT-compliant labels with the following information: drum contents, generator contact information, and date container was filled. IDWs known to be hazardous will be segregated and stored separately from non-hazardous IDWs. Solid IDWs will be segregated and stored separately from liquid IDWs.

IDWs will be sampled as needed for disposal characterization and stored on site pending treatment and/or disposal. IDWs may be managed in conjunction with remedial activities.

All IDWs will be stored in a secure onsite location pending treatment and disposal and/or discharge.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and

are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

11 Quality Assurance

Sample quality will be achieved by complying with the procedures outlined in this TGI. Cross- contamination will be prevented by following standard decontamination protocols. Field activities will be supervised by appropriate experienced field supervisors. Additional quality assurance information is presented in the project-specific Quality Assurance Project Plan.

12 References

Not Applicable

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SOP – HAZARDOUS WEATHER PROCEDURES

Rev: 3

Rev Date: February 4, 2019



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
01				
02	June 11, 2014			Andrew Korik and Mark Modrak
03	February 4, 2019		Template update; added appropriate H&S Standard references in Sections 2, 3, 6 and 7; updated lightning procedures and made additions to flash flooding, winter weather and heat in Section 7.	Julie Santaniello

APPROVAL SIGNATURES

Prepared by:



Andrew Korik

February 4, 2019

Date:

Technical Expert Reviewed by:



July Santaniello

February 4, 2019

Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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2 SCOPE AND APPLICATION

This document describes procedures for recognizing and avoiding hazardous weather and outlines appropriate actions to take if caught in hazardous weather. For the purposes of this SOP, hazardous weather will be categorized into the following: 1) Thunderstorms (to include lightning, tornadoes, and hail), 2) Flash Flooding, 3) High Winds, 4) Winter Weather, and 5) Heat. This SOP is designed as a supplement to policies and procedures outlined in the Arcadis Health & Safety Standards, Arcadis Employee Field Health and Safety Handbook and the site-specific Health and Safety Plan.

3 PERSONNEL QUALIFICATIONS

No special training in meteorology is required to implement these procedures. A variety of tools are available that when properly applied and combined with common sense can prevent loss/injury and save lives. This SOP assumes that Arcadis field personnel will be versed in the relevant QPs, SOPs, TGIs, Health & Safety Standards and be familiar with the applicable site Health and Safety Plan.

4 EQUIPMENT LIST

The following list of materials and devices are appropriate for monitoring the occurrence and/or approach of hazardous weather:

- NOAA weather radio
- AM radio
- Cellular smartphone or cellular phone
- Laptop computer with internet access
- Hand-held lightning detector (optional)

5 CAUTIONS

Avoidance is the best approach to dealing with hazardous weather. As such, field crews and project managers will use TRACK prior to initiating field work. In addition, they will obtain an updated weather forecast for their respective projects each day prior to beginning work. The local television station website is a good source for local/area forecasts. Alternatively, you can go to the Accuweather website at <http://www.accuweather.com/> and enter the town and state in the box at the upper left of the page, or access any reliable weather app on their smartphone or tablet.

Be familiar with the terms “**Watch**” and “**Warning**”.

- A **Watch** means that conditions are favorable for the formation of severe weather.
- A **Warning** means that the severe condition is either verified as occurring or is believed to be occurring. **A Warning is cause for immediate action to protect life and property.**

6 HEALTH AND SAFETY CONSIDERATIONS

Refer to the project Health and Safety Plan for site-specific procedures or instructions for responding to hazardous weather conditions. Generalized procedures can be found in the Arcadis Employee Field Health and Safety Handbook. Specific procedures for working in hot or cold weather can be found in Arcadis Health & Safety Standards (Heat Stress Prevention HSS and Cold Stress Prevention HSS, respectively).

7 PROCEDURE

Project Managers and all field staff will monitor weather conditions for their respective project sites to determine if the potential exists for hazardous conditions. The local television station's weather page is an excellent source for weather radar and up to date local forecasts, or a reliable weather app on a smartphone or tablet. The following steps will be followed as outlined for each respective scenario:

THUNDERSTORMS

The hazards associated with thunderstorms include lightning, tornadoes, high winds, flash flooding, and hail. A thorough discussion of thunderstorm safety can be found at

<https://www.weather.gov/media/owlie/ttl6-10.pdf>. Although high winds and flash flooding can occur during thunderstorms, these phenomena are discussed separately. Additionally, cloud-to-ground lightning strikes can start brush/forest fires. Fires are not discussed in this SOP, but field crews should be mindful of this potential when working at remote locations during dry periods.

Lightning

Thunderstorms can form very quickly and begin producing lightning. Lightning is unpredictable and can strike outside rainfall areas from as far as 10 miles away. The hazards associated with lightning include the electric charge and extreme heat. The air near a lightning strike is heated to 50,000 °F.

Check NOAA (or similar) weather reports (including radar), including weather apps or websites on smartphones or tablets prior to beginning field work, and frequently during work if hazardous weather is forecasted. Bursts of static or crackling on an AM radio can alert you that lightning is near. Watch for towering clouds that may begin to flatten out on top (will look like an anvil). If you can see lightning or hear thunder, fieldwork must be suspended. An exception to this rule would be if weather radar indicates thunderstorms ten miles or more away. Fieldwork can be resumed only after 30 minutes have elapsed since thunder was last heard and/or weather radar indicates there is no hazardous weather within 10 miles of the work area. Field crews working on bodies of water (lakes, rivers, ponds, etc.) or at remote locations must consider the additional time necessary to reach shore/shelter if thunderstorms approach.

Prior to work, identify and communicate to field crews the location of safe shelters for hazardous weather. Shelter should be sought in a sturdy building during a thunderstorm. Avoid open, pavilion type structures. Automobiles with a solid top and the windows rolled up offer significant protection from lightning. Avoid touching metal while inside the vehicle.

If caught in the open and unable to reach shelter:

- Lightning is likely to strike the tallest objects in a given area—do not be the tallest object.
- Avoid isolated tall trees, hilltops, utility poles, cell phone towers, cranes, large equipment, ladders, scaffolding, or rooftops.
- Avoid open areas, such as fields. Never lie flat on the ground.
- Retreat to dense areas of smaller trees that are surrounded by larger trees, or retreat to low-lying areas (e.g., valleys, ditches) but watch for flooding.
- Avoid water, and immediately get out of and away from bodies of water (e.g., pools, lakes). Water does not attract lightning, but it is an excellent conductor of electricity.
- Avoid wiring, plumbing, and fencing. Lightning can travel long distances through metal, which is an excellent conductor of electricity. Stay away from all metal objects, equipment, and surfaces that can conduct electricity.
- Do not shelter in sheds, pavilions, tents, or covered porches as they do not provide adequate protection from lightning.
- If you feel your skin tingle or your hair stands on end, squat low to the ground on the balls of your feet. Place your hands on your knees with your head between them. Make yourself the smallest target possible and minimize contact with the ground.
- If in a boat, get to land and find shelter.

- If in a boat and unable to get to shore, take shelter below deck, or if in an open boat, crouch low as described above.

Tornados

Tornadoes are commonly associated with severe thunderstorms. A tornado is a violently rotating column of air that can rotate at speeds in excess of 250 miles per hour. Tornadoes may remain stationary over a given location, but generally travel along the ground at 30 to 70 mph.

If you see a tornado or hear a Tornado Warning is issued, immediately seek shelter in a reinforced building. If the building has a basement take shelter there, otherwise seek shelter in an interior room on the lowest floor of the building. If you are driving during a tornado you should consider abandoning your vehicle if you can quickly take shelter in a strong building. If you are being overtaken by a tornado while driving and there is not time to get to a strong building, abandon your vehicle and lie flat in the lowest place you can find (such as a culvert or ditch that is not flooded) and cover your head. If no shelter or low-lying area in which to take cover can be found, then consider staying in your vehicle with your seat-belt fastened, the windows rolled up and with your head lower than the level of the windows. Keep the engine running, so that the car's airbags will deploy, if necessary. Likewise, if caught outside with no nearby shelter, lie flat in a low area and cover your head.

Hail

Hail is produced by strong updrafts in thunderstorms wherein water droplets are carried upward, freeze and begin to descend. As the small frozen droplets descend they are coated with liquid water, re-entrained into the updrafts and lifted above the freezing level. In strong thunderstorms this cycle can repeat many times resulting in a progressively larger hailstone. Eventually the hailstone is too heavy to be supported by the updraft and falls to earth.

Small, pea-sized hail is not uncommon and has little potential to cause damage or personal injury. Large hailstones the size of golf balls up to softball size can occur in severe thunderstorms. Hailstones of this size can fall at a rate of up to 100 mph and will be treated as an immediate threat to life and property. Work should already have been suspended due to thunderstorms, but if caught unaware by a sudden hailstorm, immediately seek shelter in a sturdy building. If no buildings are nearby, seek shelter in a vehicle and cover your head with your arms.

Flash Flooding

A Flash Flood is a rapid rise of water along a stream or low-lying area. Flash floods are the number one cause of death associated with thunderstorms, but can occur during short-duration, heavy rain events without lightning and thunder. Roadways/escape routes may become rapidly inundated during flash floods. Most flash flood fatalities occur at night and most victims are people who become trapped in automobiles. As little as two feet of standing water can float a vehicle. Six inches of fast-moving water can

knock you off your feet. Additional information on flood safety can be found at http://www.weather.gov/floodsafety/resources/FloodsTheAwesomePower_NSC.pdf.

If you are working at site that has experienced heavy rain, whether thunderstorm related or not, be mindful of rising waters in streams or low-lying areas. Be careful not to stage equipment or Investigation Derived Waste in locations that may become flooded. In general, the following rules apply:

- Immediately evacuate to higher ground if a Flood Warning is issued for the area.
- Do not attempt to cross streams or flowing water over ankle deep.
- Do not attempt to drive over flooded roads where water depth or road stability is not known. Water may be deeper than it appears and can hide hazards such as sharp objects, washed out road surfaces, electrical wires, chemicals, etc.
- Immediately evacuate a vehicle stalled by water and seek higher ground.

High Winds

High winds can occur under a variety of weather conditions. Severe, straight-line winds in excess of 100 mph can occur during severe thunderstorms. Alternatively, strong wind gusts or sustained damaging winds can occur during periods of otherwise “good” weather. Hazards associated with high winds include (but are not limited to): downed trees and power lines, flying projectiles, and damage to equipment and structures. The Site Safety Officer must evaluate conditions and decide whether to suspend work and/or evacuate the site due to high winds. Shelter from high winds should be sought in a sturdy building. Vehicles can provide shelter; however, falling trees can crush a vehicle. If you must take refuge in a vehicle attempt to position the vehicle away from trees and power lines. If power lines fall on your vehicle DO NOT attempt to get out and DO NOT touch any metal. Stay inside the vehicle until appropriate rescue/utility crews arrive.

WINTER WEATHER

The major hazards associated with winter weather are heavy snow, ice, cold, and flooding. Winter flooding is typically caused by heavy rains in combination with sudden snowmelt and/or ice jams. Flooding will not be discussed in this section as the same cautions and procedures as previously described apply. More information on winter weather issues can be found at <https://www.weather.gov/safety/winter>.

Heavy Snow

Heavy snow can immobilize a region, block highways and disrupt emergency services. The weight of snow can damage structures and bring down trees and power lines. Even relatively light to moderate snowfall can make driving hazardous and this fact must be considered during commutes to and from the office and project sites.

The project Site Safety Officer may decide to suspend work because of snow. As a general rule, if local highway patrol or police recommend keeping off roads due to snow or ice, work will be suspended or postponed until roadways are clear for safe driving. Be mindful of road conditions and reduce speed accordingly. If your vehicle becomes trapped in the snow and you are in a populated area, you should

cautiously abandon your vehicle and seek shelter. If your vehicle becomes immobilized in a rural, unfamiliar area, do not attempt to abandon the vehicle during the storm as you can easily become disoriented in heavy snow.

Ice

Sleet and freezing rain are common winter phenomena. Sleet is a small frozen ice pellet (not to be confused with hail). Freezing rain falls as a liquid until it contacts the ground or other surface and freezes on impact. Although sleet can cause slippery driving conditions, freezing rain presents the more serious hazard. Freezing rain can turn roads into a sheet of ice. The weight of accumulated ice can bring down trees and power lines. Project managers should not schedule work if freezing rain is forecast and field work should be suspended if freezing rain occurs. Extreme caution will be exercised if you must drive in freezing rain.

Cold

Cold temperatures present the risk of frostbite and hypothermia. Project management will work with field crews to ensure a plan is in place to prevent cold related illness and injuries, or delay outdoor project work, if appropriate. Field crews should be mindful of forecast temperatures and wind chills prior to beginning work. Refer to the site-specific Health and Safety Plan, Arcadis Cold Stress Prevention HSS and the Arcadis Employee Field Health & Safety Handbook for detailed guidance for cold related issues.

Heat

Heat-related hazards are addressed in depth in the site-specific Health and Safety Plans, the Arcadis Heat Stress Prevention HSS and the Arcadis Employee Field Health & Safety Handbook and will not be repeated here. Heat related illness/injury is a significant threat to Arcadis field crews. The body's susceptibility to heat-related issues is a function of a variety of meteorological parameters including temperature, humidity, wind speed, and the presence/absence of direct sunlight. In addition, poor air quality is often associated with high heat conditions and can exacerbate respiratory distress.

Field crews will review forecast temperature and humidity conditions prior to beginning work. Local air quality parameters should also be ascertained. Current air quality conditions can be viewed at <http://cfpub.epa.gov/airnow/index.cfm?action=airnow.main>.

8 WASTE MANAGEMENT

Not applicable for this SOP.

9 DATA RECORDING AND MANAGEMENT

Weather conditions that result in a suspension of work, near loss, personal injury or other loss will be documented to the best of your ability AFTER all other health and safety considerations have been dealt with. Do not linger in a hazardous situation simply to take notes. Record your observations after the situation becomes safe.

10 QUALITY ASSURANCE

Not applicable for this SOP.

11 REFERENCES

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Thunderstorms, Tornadoes and Lightning, A Preparedness Guide, undated.

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Winter Storms, the Deceptive Killers, a Preparedness Guide. December 2001.

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Floods, the Awesome Power. March 2005.

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Heat Wave: a Major Summer Killer. Informational Pamphlet, undated.

United States Department of Labor, Occupational Safety and Health Administration (OSHA). Fact Sheet: Lightning Safety When Working Outdoors. May 2016.

Arcadis Employee Field Health and Safety Handbook. 2014.



TGI - In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater

Rev: 1

Rev Date: April 15, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 16, 2018	All	Updated and re-written as TGI (in-situ and ex-situ adaptation)	Marc Killingstad
	1	April 15, 2022	All	Review and update to include surface water turbidity sensors	Shannon Dunn / Marc Killingstad

Approval Signatures

Prepared by:

4/15/2022



Chris Shepherd, PG

Date

Reviewed by:



Marc Killingstad (Subject Matter Expert)

4/15/2022

Date

1 Introduction

This Technical Guidance Instruction (TGI) describes methods used to measure water quality parameters in surface water as well as groundwater both in-situ and ex-situ.

2 Intended Use and Responsibilities

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3 Scope and Application

Water quality parameters (e.g., turbidity, specific conductivity, pH, and temperature) of natural waters are usually measured in the field. The temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP) and turbidity of water will be measured in-situ or ex-situ with a multiparameter water quality meter (i.e., multimeter).

Conductivity is the ability of a solution to pass an electric current. This current is carried by inorganic dissolved solids. The measurement is useful to quantify the chemical purity of the water relative to the amount of dissolved solids in a solution. Generally, temperature-compensated conductivity, termed specific conductivity, is measured by a water quality meter. Specific conductivity can also be used to estimate total dissolved solids (TDS) in solution

(grams per liter or g/L) by multiplying the specific conductivity (measured in milli-siemens per centimeter or mS/cm) by 0.65 or a matrix specific factor, which assumes that sodium chloride is a reasonable surrogate for the dissolved solids in solution.

Measuring the concentration of DO in water is an important component in evaluating the quality of natural as well as contaminated waters. The effects of wastes on rivers/streams, the suitability of water for fish and other organisms, as well as the effects of remediation efforts, can often be ascertained from the DO content. Dissolved oxygen levels generally range from 5 to 9 milligrams per liter (mg/L) when measured in water that is in equilibrium with air, depending on the temperature and barometric pressure; however, levels may be lower in a 'reducing' environment where anoxic conditions exist in water (e.g., gasoline plume undergoing bioremediation). DO is measured in both mg/L and percent.

The measurement from an ORP sensor represents the net status of all the oxidation and reduction reactions in the sample being measured. Positive results indicate an oxidizing environment while negative results indicate a reducing environment. ORP is determined by measuring the potential of a chemically-inert electrode which is immersed in the solution. The sensing electrode potential is read relative to the reference electrode of the pH probe and the value is presented in millivolts (mV).

ORP meter results can indicate possible contamination and can be particularly useful if it is known that one component of the sample is primarily responsible for the observed value. For example, excess chlorine in a sample will result in a large positive ORP value while the presence of hydrogen sulfide will result in a large negative ORP value. Together with pH, temperature, and knowledge of the dominant species in a sample, ORP results help predict the oxidation state of ions in solution and whether certain reactions may take place.

Temperature readings will be taken at each water sampling location to assist understanding the water quality as well as compensating measurements. A thermometer is typically part of the multimeter. If not, a temperature probe or thermometer will be used.

Turbidity is a measure of the relative clarity of water. It is an optical measurement of the amount of light scattered in the water. Turbidity is often used as a proxy for the amount of suspended particles in the water. Turbidity is typically reported in nephelometric turbidity units (NTUs) or Formazin Nephelometric Units (FNUs).

Refer to the appropriate TGI(s) for surface water sampling and/or groundwater sampling, if applicable. In addition, the water quality instruments should be cleaned in accordance with the manufacturers specifications and the *TGI for Groundwater and Soil Sampling Equipment Decontamination* and all investigative derived wastes (IDW) should be managed in accordance with project plans.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP), Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the field sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

The following materials, as required, will be available during field measurement of water quality parameters:

- Site-specific HASP and health and safety documents identified in the HASP (e.g., job safety assessments [JSAs])
- Field Implementation Plan (FIP) that includes site map with sampling locations, well construction records (table or logs), sampling plan, and prior sampling records (if available)
- Field notebook, pen(s) (indelible ink) and/or smart device (smart phone or tablet, see Section 10)
- Field laptop / smart device / data manager, as appropriate
- Water Quality Measurement Log (**Attachment 1**) or smart device with a digital form; alternatively, the surface water sampling or groundwater sampling form may be used, if appropriate.
- Water Quality Meter Calibration Log (**Attachment 2**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified in the Traffic Safety Plan (TSP)
- Well key(s), as needed
- Photoionization detector (PID), flame ionization detector (FID) or other air monitoring equipment, as needed, in accordance with the HASP
- Plastic sheeting (e.g., Weatherall Visqueen) or other clean surface to prevent sampling equipment from coming in contact with potentially contaminated surfaces, as needed
- Multiparameter (temperature/pH/specific conductivity/ORP/turbidity/DO) water quality meter or sonde with flow-through cell (as appropriate) plus reader and protective housing, for example:
 - YSI Professional Plus Multiparameter Instrument
 - YSI EX01 or EX02 Multiparameter Sonde
 - Horiba W-22 XD Multiparameter Instrument
 - Hydrolab DS5 Multiprobe and Display

- Turbidity meter (e.g., Lamotte 1974) and sample vessels, as required by FIP or QAPP.
 - Some multiparameter meters have a turbidity sensor; however, the team must verify the sensor will meet the data quality objectives in the FIP or QAPP.
- Operation manual(s) for meter(s)
- Water quality meter extension cable (as needed for in-situ readings of wells)
- Standard solutions for calibration, check expiration dates
- Multimeter maintenance kit and extra DO membranes if using amperometric DO probe
- Extra batteries for the various instruments and/or charging cables
- Electronic water-level indicator (e.g., Solinst Model 101) or oil/water interface probe with 0.01-foot accuracy), as needed
- Tape measure, as needed
- Cleaning equipment (buckets, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels), as needed.

6 Cautions

NOTE: Proper operation and maintenance are very important for a functioning meter and accurate readings. Carefully follow manufacturer's instructions for operation (including down-hole use), maintenance, and calibration as each manufacturer's instructions will vary. Some meters require periodic manufacturer calibration.

Verify the meters meet the project data quality objectives in the FIP and QAPP. In some cases, it may be necessary to use a separate turbidity meter (nephelometer) or higher accuracy and precision meter(s) if the measurements are intended to be used for compliance purposes.

Verify the meter is intended for in-situ measurements (i.e., can be fully submerged in water) and that all necessary parts are available prior to field mobilization. Check and record the expiration dates of calibration fluids. Verify that calibration readings are reasonable and correspond to previous calibration readings when available. Expired or contaminated calibration fluids may result in erroneous results. If accurate measurements of TDS are required, site-specific calibration will be necessary in accordance with the manufacturer's specifications.

When taking measurements in the field, verify that readings make sense and compare to historical readings when possible. See Section 3.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal PPE will be worn at all times in line with the task and the site-specific HASP. Also, at a minimum, wear latex gloves and safety glasses when working with calibration solutions.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells and some surface water bodies may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around wellhead), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

If working near surface water bodies, it may be necessary to use personal flotation devices and/or use additional safety measures. Consult with the HASP and JSA for site- and task-specific health and procedures.

If working at a site with hazardous levels of volatile organic compounds, headspace and/or breathing zone readings will be measured prior to working at/in the well, in accordance with the HASP.

8 Procedures

This Procedures Section is divided into:

- General Procedures – calibration, operation, and maintenance procedures that apply to all methods and meters
- Calibration – general calibration procedures for:
 - Multimeter
 - Separate turbidity meter, if required
- Operation – general measurement operations for:
 - Ex-situ measurements
 - Multimeter
 - Separate turbidity meter, if required
 - In-situ measurements (downhole/well or submerged applications)
- Maintenance
 - Multimeter
 - Turbidity meter

8.1 General Procedures

The following, general procedures apply to most instruments regardless of whether measuring in-situ or ex-situ. For groundwater, most measurement are conducted ex-situ (i.e., not within the groundwater well/aquifer). It is also possible to use in-situ measurements for some parameters and ex-situ measurements for other parameters. If in-situ measurements are carried out, a special probe and/or cables are required.

- Read through all relevant procedures before field implementation and familiarize yourself with the equipment
- Verify all equipment is present and the instrument is fully functioning prior to field mobilization, if possible
 - Check batteries/power levels
- The meter(s) should be cleaned prior to each use in accordance with cleaning and decontamination procedures as specified in the FIP or QAPP and in accordance with the instruction manual.
 - Most meters can only handle light washing with a mild soap and warm water.
 - After cleaning the sensors should be soaked in distilled/deionized water and then rinsed in distilled/deionized water. The recommended soaking periods vary depending on the sensor (see Section 8.2)
 - It is recommended that you temporarily store the probes in distilled/deionized water uses between measurements as some probes like conductivity require long soaking periods (see Section 8.2).
- The meter will be calibrated following the manufacturer's instructions as calibration steps vary by manufacturer
 - Probes should be rinsed with a small amount of the calibration solution and then discard that used solution prior to calibration, if applicable. This will reduce cross-contamination of the calibration solution during calibration
 - Two or three-point calibrations are preferred over single point calibrations, where applicable. See Section 8.2 and should be selected based on expected water quality
 - Verify calibration solutions, if applicable, are not expired
 - Caution: calibration solutions should not be reused as it can cross-contaminate the solution unless authorized by the QA/QC manager
 - Ensure the sensor is completely submerged in the calibration solution, if applicable
 - Calibration information will be recorded in the calibration log (Attachment 2) and the field notebook
 - More frequent calibration may be necessary in harsh conditions or per project plans
 - Barometric verification or calibration may be required for some instruments
- The meter will be operated following the manufacturer's instructions
- Multimeters can be operated in-situ (down-hole, in water, etc.) or ex-situ (water is transferred to container for measurement)
 - Ex situ operation is described in Section 8.3.1
 - In situ operation is described in Section 8.3.2
- The meter will be maintained according to the manufacturer's instructions
 - Maintenance information will be recorded in the field notebook or instrument log
 - Manufacturer recalibration or replacement probes may be required on a routine basis
 - Additional details for pH, conductivity, temperature, dissolved oxygen, and turbidity maintenance

are presented in section 8.4 Maintenance below

- More frequent maintenance (probe replacement, sensor reconditioning, etc.) may be necessary in harsh conditions or per project plans
- A replacement meter and probes will be available onsite or ready for overnight shipment, as necessary
- Store the meters in accordance with manufacturer's specifications
 - Most multi-meter sensors should be stored with a small amount of water in the cap to keep it moist but not saturated/submerged.

The complete procedures are described in Section 8.2 through 8.4.

8.2 Calibration

8.2.1 Multimeter Calibration

- 1) Connect cables from meter to reader
- 2) Check probes and ensure they are clean
- 3) Switch on instrument and allow to warm-up, warm up may take from 5 to 15 minutes depending on the instrument and sensors used
- 4) Check battery life and replace, if needed
- 5) Adjust date/time, if needed
- 6) Soak all probes in distilled or de-ionized water for at least 5 minutes (some probes may require longer soak times, see below and manufacturer instructions) and then shake off excess liquid
 - i. NOTE: *If the probes are recently reconditioned or have slight build-up, allow for longer soaking period*
- 7) Navigate to calibration display/mode; enable auto stabilization feature, if appropriate
- 8) **pH Calibration** – when in use, the pH meter will be calibrated daily, at a minimum.
 - a. Connect electrode (if applicable) or remove protective cap from electrode
 - b. Rinse end of electrode in distilled/deionized water and shake off excess water
 - c. Measure and record temperature of buffer solutions
 - d. Immerse pH electrode in pH buffer 7.00, set the temperature to that of the buffer 7.00, and allow sufficient time for the electrode to stabilize
 - e. Adjust the calibration for the correct readout and temperature
 - f. Confirm/press the calibration button
 - g. Remove electrode from buffer and rinse with distilled/deionized water
 - h. Immerse pH electrode in buffer 4.00, set the temperature control to that of the buffer 4.00, and allow sufficient time for the electrode to stabilize

- i. Adjust the calibration for the correct readout and temperature
 - j. Confirm/press the calibration button
 - k. Rinse electrode with distilled/deionized water
 - l. A pH 10 calibration will also be performed if high pH (>9) is anticipated, following manufacturers procedures
 - m. The pH meter is calibrated
- 9) **Conductivity Calibration** – when in use, the conductivity meter will be calibrated daily, at a minimum.
- a. Conductivity is generally measured in specific conductivity (temperature compensated), verify with the FIP/work plan
 - b. Soak the probe in distilled/deionized water for at least 30 minutes
 - c. Remove the probe from the water and fling out drops clinging inside
 - d. Immerse the probe to or beyond the vent holes in a beaker containing 1.413 mS/cm standard solution for freshwater measurements or a standard with a higher concentration for marine water, and gently agitate vertically to remove entrapped air
 - e. Repeat Steps 3 and 4 at least once more
 - f. Press calibration button
- 10) **Temperature calibration** – temperature will be verified according to FIP/work plan, if applicable.
- 11) **Dissolved Oxygen (DO) calibration** – when in use, the DO meter will be calibrated daily using the air calibration method or less frequently if using an optical sensor (see below).
- a. Preparation
 - i. Polarographic sensor – periodically recondition sensor, replace fluids, and Teflon® membrane, per manufacturer, and air bubbles should not be present
 - ii. Galvanic sensor – Periodically recondition sensor, replace fluids, and membrane, per manufacturer, and air bubbles should not be present
 - iii. Optical sensor – Per manufacturer, most will only require field checks and maintenance, however, weekly checks are recommended to verify the accuracy, at a minimum
 - b. Obtain a barometric pressure reading from a daily weather report or from the instrument, as required by instrument
 - c. Keep instrument upright and vent cap/cover while retaining a small amount of clean water (do not cover probes) for non-optical sensors only
 - d. Allow 5 to 15 minutes for optimum probe stabilization and polarization, for non-optical sensors (reading will range between 5 to 9 mg/L depending on temperature and barometric pressure)
 - e. Press calibration button if reading is more than 2% from the standard

- 12) **Oxidation reduction potential (ORP) calibration** – when in use, the ORP meter will be calibrated daily, if required.
 - a. Rinse the probe in distilled/deionized water
 - b. Remove the probe from the water and fling out drops clinging inside
 - c. Immerse the probe in the ORP solution. Gently agitate vertically to remove entrapped air.
 - d. Adjust calibration target based on temperature in accordance with manufacturer and calibration solution guide
 - e. Allow the sensor to equilibrate to solution
 - f. Press calibration button if reading is more than 2% from the standard
- 13) **Turbidity, if used** – when in use, turbidity sensor will be checked daily and calibrated weekly, at a minimum
 - a. Verify with the FIP/work plan if the turbidity sensor will be used and the proper units (NTU, FNU, etc.)
 - b. Gently clean the sensor to remove sediments or buildup and then rinse the sensor with distilled/deionized water one to two times
 - c. Remove the probe from the water and fling out drops clinging inside
 - d. Next do a final rinse with the calibration solution starting with lower calibration solution and dispose of the used solution.
 - e. Immerse the probe in the calibration cup with the guard. It is important to calibrate with the guard on or verify the cup is designed to match the guard as turbidity measurements are affected by the dimensions and reflectivity of the guard. Verify there are no air bubbles.
 - f. Repeat Steps c, d, and e at least once more with higher turbidity calibration solutions
 - g. Press calibration button
- 14) Adjust the instrument to READ or LOGGING mode, per instruction manual and project plans; the instrument is now ready for use
- 15) Record the calibration on the field form or smart device.

8.2.2 Turbidity Meter Calibration (if required)

When in use, the turbidity meter will be checked daily and calibrated weekly. The turbidity meter will be calibrated per steps below:

- 1) Switch on instrument and allow time to warm-up
- 2) Check battery life and replace, if needed
- 3) Turbidity sample tubes will always be washed prior to use, but not the calibration standard tubes, using a mild detergent to remove any dirt or fingerprints that could bias the results
- 4) Dry the outside of the sample turbidity tubes with a clean, lint-free cloth or disposable wipe (non-scratch)

and allow the turbidity tubes to air-dry in an inverted position to prevent dust from entering the tube, as allowable (but, not the calibration standard tubes)—dirt or fingerprints can lead to inaccurate results.

- 5) Wipe the 1 NTU standard and place in the chamber after aligning the arrows (manufacturer dependent)
- 6) Place the light shield over the turbidity standard and allow the meter to stabilize
- 7) Press the read and/or CAL button, per instructions
- 8) Repeat steps 3 thru 5 above
- 9) Adjust to READ mode and the instrument is now ready for use
- 10) Record the calibration and/or verification in the calibration log.

8.3 Operation

Water quality parameters can be measured ex-situ or in-situ in accordance with the FIP/work plan. The operating procedures for each method are described below. It is also possible to collect a depth-specific water sample from a well or water body for ex-situ measurement.

8.3.1 Ex-situ Operation

For ex-situ operation one or two representative water samples will be collected from the well or surface water body for measurement using the required meters. If two representative samples are collected, both values for each parameter should be reported, however, the average of the two results should be used as the final value.

8.3.1.1 Multimeter

- 1) Fill two 100-mL plastic clean, disposable containers or cleaned beakers with water from the sample
- 2) Insert the probe into the first beaker immersing all sensors and allow to stabilize (2 minutes at minimum)
- 3) Record readings
 - a. Temperature – in degrees Celsius or Fahrenheit
 - b. pH – in standard units between 0 and 14, in 0.01 increments
 - c. Specific conductivity – in mS/cm or micro siemens per centimeter (uS/cm)
 - d. DO – in mg/L and percent (will typically read between 0 and 15 mg/L)
 - e. ORP – in millivolts (mV; will typically read between -1,400 mV and + 1,400 mV), if required
 - f. Turbidity, if used – in NTU or NFU
- 4) Rinse probe off with distilled/deionized water
- 5) Repeat Steps 2 thru 4 for the other beaker, if applicable
- 6) Record results on the water quality measurement log and/or in field notebook - the average will be the actual result, after stabilization if two samples are used

- 7) Rinse probe off with distilled/deionized water

NOTE: If a flow through cell is used during sampling, a single reading can be obtained from the multimeter during each step of the wells purging in accordance with TGI - Low Flow Groundwater Purging and Sampling.

8.3.1.2 Turbidity Meter, if needed

- 1) Fill the two cleaned, manufacturer provided sample tubes with water from the sample
 - a. If using a flow through cell, it is recommended to collect the turbidity samples before the flow through cell
- 2) Wipe off and dry the outside of the sample turbidity tubes with a clean, lint-free cloth or disposable wipe
- 3) Insert the first sample tube and close the cover
- 4) Push the READ button
- 5) Record turbidity reading in NTUs (0 to 1,100 NTUs)
 - a. If readings are over the instrument limit, a single 2X dilution can be run by mixing the sample with equal parts distilled or de-ionized water and gently mixing
 - b. The resulting value will need to be doubled (for example, if the diluted reading is 750 NTUs, the estimated turbidity would be $750 \times 2 = 1,500$ NTUs. Diluted samples will be qualified as estimated)
- 6) Repeat steps 2 thru 5 with the second sample tube
- 7) Log the results on the water quality measurement log and/or in field notebook - the average will be the actual result
- 8) Rinse sample tubes with distilled/deionized water.

NOTE: If a flow through cell is used during low flow groundwater sampling, a single reading can be obtained from the multimeter during each step of the wells purging in accordance with TGI - Low Flow Groundwater Purging and Sampling. The turbidity sample is recommended to be collected prior to passing through the flow through cell.

8.3.2 In-situ Operation

- 1) Connect extension cable and protective housing to meter
- 2) Measure water level from reference point
- 3) Lay out plastic sheeting as needed to keep the multimeter clean
- 4) Clean multimeter and cable per decontamination procedures and instruction manual and rinse with distilled/deionized water using caution, as most meters can only handle light washing with a mild soap and warm water
- 5) Organize work area to prevent dirt or objects from falling in the well
- 6) Measure and mark extension cable at planned measurement intervals in accordance with the FIP
- 7) Slowly lower the probe into the well or water body to the desired measurement interval using caution to prevent rubbing of cable on the well and minimize water and sediment disturbance

- 8) Allow readings to stabilize (typically 1 to 3 minutes)
 - a. For many instruments, the instrument may need to be slowly oscillated up and down a few inches to circulate water around the probes
- 9) Record readings
 - a. Temperature – in degrees Celsius or Fahrenheit
 - b. pH – in standard units between 0 and 14, in 0.01 increments
 - c. Specific conductivity – in mS/cm or uS/cm
 - d. DO – in mg/L and percent (will typically read between 0 and 15 mg/L)
 - e. ORP – in mV (will typically read between -1,400 mV and +1,400 mV), if required
 - f. Turbidity, if used – in NTU or NFU
- 10) Repeat steps 4 through 9 to complete targeted in-situ measurements
- 11) Record results on the water quality measurement log or smart device
- 12) Slowly retrieve the multimeter
- 13) Clean multimeter and cable per decontamination procedures and instruction manual and rinse with distilled/deionized water using caution, as most meters can only handle light washing with a mild soap and warm water

8.4 Maintenance

8.4.1 Multimeter

- 1) After use, the meter will be inspected and maintained according to the manufacturer's specifications and the inspection/maintenance activities will be recorded in the field notebook
- 2) Keep records of usage, maintenance, calibration, problems, and repairs
- 3) Recharge/replace batteries on a regular basis
- 4) Store meters or electrodes in protective casing when not in use
- 5) DO membranes will be stored moist, unless specified otherwise by manufacturer
- 6) Focused probe cleaning may be necessary in accordance with the operation manual and may be needed more frequently in harsh conditions
- 7) A replacement meter will be available onsite or ready for rapid delivery/shipment
- 8) Periodic manufacturer calibration may be necessary per operation manual and/or field plans.

8.4.2 Turbidity Meter, if used

- 1) Recharge battery on a regular basis

- 2) Store in protective casing when not in use
- 3) Keep records of usage, maintenance, calibration, problems, and repairs
- 4) After use, the meter will be inspected with results recorded in the field notebook
- 5) Keep sample tubes clean inside and out replacing them when they become scratched or etched and avoid handling the tubes in the region where the light beam enters them.
- 6) Clean lens periodically per instruction manual
- 7) Turbidity meter will be sent back to the manufacturer for service when needed

9 Waste Management

IDW, including decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), FSP, and/or IDW management guidance document.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The FieldNow® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site-specific QAPP. Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

In general, documentation of the following information is required:

- Calibration – calibration information will be recorded on a calibration form, field log, or electronic device per project plans
 - Meter manufacturer and model
 - Serial number
 - Calibration personnel
 - Calibration date/time
 - Standard value, initial and final reading
 - Observations, if applicable

- Readings - data will be recorded on a field log, sampling form, or electronic device per project plans
 - Instrument model
 - Measurement date/time
 - Field personnel
 - Weather
 - Measurement location and depth, if applicable
 - Source of water (surface water, groundwater, etc.)
 - In-situ vs ex-situ measurement method
 - Value of readings and average reading, if applicable
 - Units of readings
 - Key observations

All records will be provided to the project manager and retained in the project files. Any maintenance needs will be communicated to the project manager promptly.

11 Quality Assurance

Quality assurance procedures will be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP. Refer to the QAPP or FIP/sampling plan/work plan for the frequency of calibrations.

12 References

Not applicable.

13 Attachments

Attachment A - Water Quality Measurement Log

Attachment B - Water Quality Meter Calibration Log

Attachment A

Water Quality Measurement Log

WATER QUALITY MEASUREMENT LOG

Page _____ of _____

GENERAL INFORMATION

Date	_____	Weather	_____
Project No	_____	Sample Personnel	_____
Site Name	_____	Sample ID	_____
Site Location	_____	Start reading time	_____
Site/Well No.	_____	End reading time	_____

MEASUREMENT DATA

Measuring Point (MP) description	_____	☐ Surface Water or ☐ Groundwater
Depth to Water (ft)/Time	_____	Instrument model/serial no. _____
Well Screen Interval (ft)	_____	Instrument model /serial no. 2 _____
Casing Diameter (in)	_____	☐ In-situ ☐ Ex-situ reading
Meters calibrated (Y/N)	_____	(see calibration log, if applicable)

Water Quality Parameters

Time	Depth (ft)	pH (S.U.)	Spec. Cond. (mS/cm or uS/cm)	Temp (°C or °F)	DO (mg/L) (%)		ORP (mV)	Turbidity (NTU)	Observations (Odor, clarity, etc., if applicable)

REMARKS

Attachment B

Water Quality Meter Calibration Log

WATER QUALITY METER CALIBRATION LOG

PROJECT NAME	
PROJECT NO.	
MODEL(s)	
SERIAL #(s)	
SAMPLER	
DATE	

TURBIDITY CALIBRATION					
CAL. READING		CAL. READING		CAL. RANGE	TIME
(LOT #)		(LOT #)			
(EXP. DATE)		(EXP. DATE)			
PRE-CAL. / POST-CAL		PRE-CAL. / POST-CAL			
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	

MULTIMETER CALIBRATION							
AUTOCAL SOLUTION (Y / N)			CAL. READING	CAL. RANGE	TIME	CALIBRATION RANGES ⁽¹⁾	
(LOT #)							
(EXP. DATE)							
PARAMETER		LOT / EXP. DATE	PRE-CAL. / POST-CAL				
☐	pH		/	☐ WITHIN RANGE		pH	± 0.2 S.U.
☐	CONDUCTIVITY		/	☐ WITHIN RANGE		COND	± 1% OF CAL. STANDARD
☐	ORP		/	☐ WITHIN RANGE		ORP	± 25 mV
☐	DO		/	☐ WITHIN RANGE		DO	Atmospheric
☐	TURBIDITY		/	☐ WITHIN RANGE		TURB	± 5% OF CAL. STANDARD
☐			/	☐ WITHIN RANGE			
☐			/	☐ WITHIN RANGE			

(1) CALIBRATION RANGES ARE SPECIFIC TO THE MODEL OF THE WATER QUALITY METER

NOTES:

SIGNED

DATE

CHECKED BY

DATE

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TGI - INVESTIGATION-DERIVED WASTE HANDLING AND STORAGE

Rev #: 1

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VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Ryan Mattson / Peter Frederick
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APPROVAL SIGNATURES

Prepared by:


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02/23/2017

Date:

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Ryan Mattson (Technical Expert)

05/15/2020

Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The objective of this Technical Guidance Instruction (TGI) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and nonhazardous, generated during site activities, which may include, but are not limited to: drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. For the purposes of this TGI, IDW is considered to be discarded materials which are defined as solid waste by United States Environmental Protection Agency (EPA) standard 40 CFR § 261.2 (which may include liquids, solids, or sludges). IDW may include soil, groundwater, drilling fluids, decontamination liquids, as well as contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Hazardous or uncharacterized IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary onsite storage area (discussed in further detail under Drum Storage) pending characterization and disposal. IDW materials will be characterized using process knowledge and appropriate laboratory analyses to determine the waste classification and evaluate proper safe handling and disposal methods.

This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly transported from the project site and disposed. The procedures included in this TGI for handling and temporary storage of IDW are based on the EPA's guidance document *Guide to Management of Investigation Derived Wastes* (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). Although not comprehensive, the following laws and regulations on Hazardous Waste Management should be considered as potential ARAR. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987.
- Federal Hazardous Waste Regulations 40 CFR § 260-265

Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Regional, County, Municipal, and Local Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Initial Storage

Pending characterization, IDW will be temporarily stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Uncharacterized wastes are considered potentially hazardous wastes and must be stored in DOT approved packaging. Liquid wastes must be stored in DOT approved closed head drums or other approved containers (e.g., portable tank containers) that are compatible with the type of material stored therein. Solid materials must be stored in DOT approved open head drums where practicable. Larger quantities of solid IDW can be containerized in bulk containers (such as in a roll-off box). Soil from large excavation projects may be managed in stockpiles within the AOC and does not need to be containerized until exiting the AOC.

Characterization

Waste characterization can either be based on generator knowledge, such as using historical process knowledge and safety data sheets (SDS), or can be based upon characterization sampling analytical results. IDW typically is not characterized using SDS as it is a mixture of aged chemicals and environmental media. Historical process knowledge should be used to determine if the IDW is a listed hazardous waste (40 CFR § 261.31-33). If the IDW is not a listed hazardous waste, waste

characterization can be completed by laboratory analysis of representative samples of the IDW. The laboratory used for waste characterization analysis must have the appropriate state and federal accreditations and may be required to be pre-approved by the Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization determination.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Waste material classified as RCRA nonhazardous may be handled and disposed of as nonhazardous waste in accordance with applicable federal, state, and local regulations.

Storage Time Limitations

Containerized hazardous wastes can be temporarily stored for a maximum of 90 calendar days from the accumulation start date for a large quantity generator or a maximum of 180 calendar days from the accumulation start date for a small quantity generator. Wastes classified as nonhazardous may be handled and disposed of as nonhazardous waste and are not subject to storage time limitations.

This TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling and packaging hazardous waste and performing hazardous waste characterizations must have RCRA hazardous waste management training per 40 CFR § 264.16. Additional state-specific hazardous waste management training is required in certain states (i.e., California).

Although not common practice, in certain situations Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator. Arcadis personnel who sign waste profiles and/or waste manifests will have both current RCRA hazardous waste management training per 40 CFR § 264.16 and current DOT hazardous materials transportation training per 49 CFR § 172.704. Arcadis field personnel will also comply with client-specific training. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

4 EQUIPMENT LIST

The Following Materials, as required, will be available for IDW handling and Storage:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan (HASP)
- DOT approved containers
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Portable tank container
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook

5 CAUTIONS

Filled drums can be very heavy, become unbalanced, or spill its contents. Therefore, use appropriate moving techniques and equipment for safe handling. Similar media (e.g. soils with other soils; or liquids with other liquids) will be stored in the same drums to aid in sample analysis and disposal. Drum lids must be secured to prevent rainwater from entering the drums and leakage during movement. Drums containing solid material may not contain any free liquids. Waste containers stored for extended periods of time may be subject to deterioration. Drum Over Packs may be used as secondary containment. All drums must be visually inspected for condition to ensure that they are in good condition without visible evidence of rusting, holes, breakage, etc., to prevent potential leakage and facilitate subsequent disposal. All drum lids must be verified as having a properly functioning secured lid prior to use.

6 HEALTH AND SAFETY CONSIDERATIONS

As determined by the site's known and suspected hazards, appropriate PPE must be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as required in the Site Health and Safety Plan. If soil excavation in areas with potentially hazardous contaminants is possible, contingency plans will be developed to address the potential for encountering gross contamination or non-aqueous phase liquids. All excavation activities shall be in compliance with OSHA standard 29 CFR 1926.651 Excavations, and any other applicable regulations.

Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

7 PROCEDURE

Specific waste temporary storage and handling procedures to be used are dependent upon the type of generated waste, including type of media (e.g. soils or free liquids) and constituents of concern. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, where solids can be stockpiled onsite (if nonhazardous) and purge water may be stored in portable tank containers. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the project team during all phases of the project. Site managers may want to consider techniques such as replacing solvent based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be properly decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that minimize the generation of waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring.

Drum Storage

Drums containing hazardous waste will be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized onsite location that is readily accessible for vehicular pick-up. Drums confirmed as, or assumed to contain hazardous waste will be stored over an impervious surface provided with secondary spill containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific or local-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Very small quantity generators (VSQG) are generators who generate less than 100 kilograms of hazardous

waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator's state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 calendar days or less without a permit and without having interim status, provided that such accumulation is in compliance with requirements in 40 CFR § 262.17. A SQG may accumulate hazardous waste on site for 180 calendar days or less without a permit or without having interim status, subject to the requirements of 40 CFR § 262.16. VSQG requirements are found in 40 CFR § 262.14. NOTE: The federal VSQG and SQG provisions may not be recognized by some states (e.g., California and Rhode Island). State-specific and local-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste Satellite accumulation (SAA) will mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.15 and without any storage time limit, provided that the generator complies with 40 CFR § 262.15.

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable or reactive hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste should be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste).
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (e.g., polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or "Testing in Progress" label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Pending Analysis, Hazardous, or Nonhazardous)
- Waste generator's name (e.g., client name)
- Project Name
- Name and telephone number of Arcadis project manager
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date

- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a "Waste Container" or "Pending Analysis" label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied.

- Containers with waste determined to be non-hazardous will be labeled with a green and white "Nonhazardous Waste" label over the "Waste Container" label.
- Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label.

The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition, a DOT proper shipping name will be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g., Boring-1, Test Pit 3, etc.) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health outside of the site or when Client or Arcadis has knowledge of a spill that has reached surface water, Client or Arcadis must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.265. Other notifications to state and/or other local regulatory agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

Excavated Solids

Excavated solids may include, but are not limited to: soil, fill, and construction and demolition debris. Prior to permitted treatment or offsite disposal, potentially hazardous excavated solids may be temporarily stockpiled onsite as long as the stockpile remains in the same AOC from where it was excavated. Potentially hazardous excavated solids removed from the AOC must be immediately containerized in labeled drums or closable top roll-offs lined with 9-mil polyvinyl chloride (PVC) sheeting and are subject to LQG storage time limits. Nonhazardous excavated solids can be stockpiled either inside or outside of the AOC, do not have to be containerized and are not subject to hazardous waste regulations. Potentially hazardous excavated solids must not be mixed with nonhazardous excavated solids. All classes of excavated solid stockpiles should be maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (USEPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner or sprayed dust control product. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in closed head drums compatible with the decontamination solution. Decontamination procedures, including personnel and field sampling equipment, must comply with applicable Arcadis procedural documents.

Disposable Equipment

Disposable equipment includes personal protective equipment (e.g., tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, contaminated disposable equipment will also be disposed of as a hazardous waste. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If these materials are not compatible (i.e., the IDW is a liquid and the disposal equipment is a solid), the disposable equipment will be stored onsite in separate labeled 55-gallon drums. Uncontaminated or decontaminated disposable equipment can be considered nonhazardous waste.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring

well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert plastic materials. The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are described in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any visible sediment and water before returning, a professional cleaning service may be required. Each specific vendor should be consulted concerning specific requirements for returning tanks.
- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

8 WASTE MANAGEMENT

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and local/state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific applicable regulatory agency thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered “listed” hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 250 cubic yard basis for stockpiled soil or one per 55-gallon drum per different waste stream for containerized. A four-point composite sample will be collected per 250 cubic yards of stockpiled material and for each drum waste stream. Sample and composite frequencies may be adjusted in accordance with the waste handling facility’s requirements and may be reduced for large volumes of waste with consistent properties. Waste characterization samples will be considered valid for consistent waste streams for a period of 1 year. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls (PCBs), as well as reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches.

Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and local/state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility. Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- and/or local-specific regulations may require different or additional sampling approaches.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with current Arcadis sample chain of custody, handling, packing, and shipping procedures and guidance instructions.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

Preparing Waste Shipment Documentation (Hazardous and Nonhazardous)

Waste profiles will be prepared by the Arcadis CPM and forwarded, along with laboratory analytical data to the Client for approval/signature. The Client will then return the profile to Arcadis who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by Arcadis prior to forwarding to the Client for approval. Upon approval of the manifest, the Client will return the original signed manifest directly to the waste contractor or to the Arcadis CPM for forwarding to the waste contractor. Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator.

Final drum labeling and pickup will be supervised by an Arcadis representative who is trained and experienced with applicable waste labeling procedures. The Arcadis representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums. A copy of the Arcadis drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

9 DATA RECORDING AND MANAGEMENT

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan or Sampling and Analysis Plan. Copies of the chain-of-custody forms will be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

10 QUALITY ASSURANCE

The CPM or APM will review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to: the proposal/scope of work, QAPP, SAP, HASP, etc. Deficiencies will be noted, tracked, and resolved. Upon correction, they will be noted for project documentation.

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.



TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells

Rev: 2

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
	1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad
	2	April 5, 2022	All	Updated to new branding template and minor edits	Marc Killingstad

Approval Signatures

Prepared by:

4/5/2022



Xuan Xu (Preparer)

Date

Reviewed by:

4/5/2022



Marc Killingstad (Subject Matter Expert)

Date

1 Introduction

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well

construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16" socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinst Model 101) or oil/water interface probe with 0.01- foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

- YSI 6-Series Multi-Parameter Instrument
- Horiba U-22 Multi-Parameter Instrument.
- Hydrolab Series 3 or Series 4a Multiprobe and Display.

NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
 - Non-phosphate laboratory soap (Alconox or equivalent), brushes, and clean buckets, and/or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
 - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
 - Submersible pump (e.g., Grundfos Redi-Flo 2)
 - Peristaltic pump (e.g., ISCO Model 150)
 - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
 - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
 - Submersible pumps such as Grundfos require a pump controller to run the pump
 - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N₂ or CO₂ gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
 - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
 - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stopwatch or other device to measure time to determine pumping rate
- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)

- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
 - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.

6 Cautions

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rainwater could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
 - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible and avoid the hottest times of the day.
 - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient to source area locations.
- Note that permanent markers could introduce volatile constituents into the samples; *therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e., Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS.*

- When using a bladder pump for collecting VOCs and dissolved gases, “best practice” is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use of a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethylene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be always worn in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

8 Procedure

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination*) prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
 - a. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
 - b. Record well construction and conditions on the Low-Flow Sampling Field Form (**Attachment A**).
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g., on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.
8. Prepare and install the pump in the well.

NOTE: Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.

- a. For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting

and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

- b. If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.
 - c. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.
 - d. If using an in-line 'T' and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.
9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).
10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).
11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.
12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.
13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.
14. Record pumping rate adjustments and depths to water.

If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

For wells screened across the water table, the well may be pumped dry, and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be

maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.

15. After water levels have stabilized and a sufficient volume has been purged (see note below), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

NOTE: The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.
17. Record field indicator parameters on the groundwater sampling log.
18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:
 - **Turbidity** within $\pm 10\%$ for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
 - **Dissolved Oxygen (DO)** within $\pm 10\%$ for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
 - **Specific Conductance** within $\pm 3\%$
 - **Temperature** within $\pm 3\%$
 - **pH** within ± 0.1 unit
 - **Oxidation/Reduction Potential (ORP)** within ± 10 millivolts (mV)

NOTE: Alternate stabilization goals may exist in different geographic regions, consult the site-specific FIP/work plan for stabilization criteria).

NOTE: While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within $\pm 10\%$) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.
20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

In general, three potential options are available if stabilization criteria are not met:

 - a. Continue purging until stabilization is achieved.
 - b. Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

- c. Discontinue purging, collect samples, and provide full explanation of attempts to achieve stabilization. There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.

NOTE: DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.

NOTE: During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.

NOTE: If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.

Oxygen Solubility in Fresh Water	
Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., Introduction to Environmental Engineering, PWS Publishing Company, Boston, 468 pages (1996)

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.
 - a. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.
 - b. Under no circumstances will analytical samples be collected from the discharge of the flow- through cell.
 - c. If an in-line 'T' and valve are used, the valve needs to be removed as well.

- d. Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).
 - e. When the container is full, tightly screw on the cap.
23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.
- a. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.
 - b. Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL).
 - c. Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.
 - d. When the container is full, tightly screw on the cap.
24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.
25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (**see Attachment A**).
26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.
27. Slowly remove the pump, tubing, lines, and safety cable from the well.
- a. If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
 - b. If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.
 - c. Use a length of rope or string to tie the tubing to the well cap.
 - d. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.
28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.
29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of-Custody.
30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*).
31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

9 Waste Management

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage*, the procedures identified in the

FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

11 Quality Assurance

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples
- One laboratory matrix/matrix spike sample for every 20 samples
- In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:
- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled

- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

12 References

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

13 Attachments

Attachment A – Low Flow Sampling Field Form

Attachment A

Low-Flow Sampling Field Form

Well Location:		Well Locked at Arrival:	Yes	/	No
Condition of Well:		Well Locked at Departure:	Yes	/	No
Well Completion:	Flush Mount / Stick Up	Key Number To Well:			GW Samp Form

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TGI – Resource Conservation and Recovery Act (RCRA) Waste Characterization Sampling

Rev: 0

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
1	0	May 20, 2021	All	New TGI	Ryan Mattson

Approval Signatures

Prepared by:



05/20/2021

Ryan Mattson

Date:

Technical Expert Reviewed by:



05/21/2021

Michelle Clayton

Date:

1 Introduction

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 Scope and Application

The objective of this Technical Guidance Instruction (TGI) is to provide field sampling personnel procedures for collecting waste characterization samples from materials which are subject to the Resource Conservation and Recovery Act (RCRA) definition of solid waste at 40 CFR §261.2. Solid wastes, which include liquid, solid, or sludge – phase wastes, typically encountered by Arcadis are contaminated environmental media (soil and groundwater), contaminated building materials, drilling fluids, decontamination liquids, contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Arcadis may also be hired to sample client industrial or manufacturing wastes.

This TGI specifically excludes the following sampling which should be covered by more specific TGIs: polychlorinated biphenyl waste sampling under the Toxic Substances Control Act, radioactive waste sampling under the Atomic Energy Act, naturally occurring radioactive material or technologically enhanced naturally occurring radioactive material waste sampling, asbestos sampling, lead paint sampling, medical waste sampling, National Pollution Elimination Discharge permit sampling and publicly owned treatment works discharge sampling.

Personnel utilizing this TGI should have a sampling plan, waste analysis plan or request that has been reviewed by a client or Arcadis hazardous waste Technical Expert and the sampler should understand location, scope, analytical testing laboratory, results timing, and data quality objectives for the particular sampling event prior to work. If this is not the case, stop work and contact the CPM for scope related questions or the hazardous waste Technical Expert for waste compliance questions. Arcadis hazardous waste Technical Expert advice is available by emailing regulatedwaste@arcadis.com.

This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures for waste characterization sampling. The procedures included in this TGI for waste characterizations sampling are based on the EPA's guidance document RCRA Waste Sampling Draft Technical Guidance (USEPA 2002). Waste characterization sampling provides data to help ensure the wastes are managed, transported and disposed in accordance with applicable federal, state, and local regulations. Although not comprehensive, the following laws and regulations pertaining to Hazardous Waste Management should be considered applicable. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC §6901-6987 (1976).
- Federal Hazardous Waste Regulations 40 CFR §260-261, Appendix I to §261, §264
- Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR §171-173
- Occupational Safety and Health Administration (OSHA) Regulations 29 CFR §1910 and §1926

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.
- Regional, County, Municipal, and Local Regulations

This TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work should be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes should be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 Personnel Qualifications

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour OSHA hazardous waste operations and emergency response (HAZWOPER) training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling hazardous waste, including sampling, should have RCRA hazardous waste management training per 40 CFR §264.16. Additional state-specific hazardous waste management training may be required in certain states (i.e., California).

Arcadis personnel who ship samples that are subject to the definition of a DOT hazardous material (49 CFR 171.8) should have biennial DOT hazardous materials transportation training per 49 CFR § 172.704 (Arcadis

requires every 2 years, DOT requires every 3 years). Arcadis field personnel should also comply with client-specific training. In addition, Arcadis field sampling personnel should be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents may identify other training requirements or access control requirements.

4 Equipment List

The following equipment and materials, as required, should be available for waste characterization sampling:

All sampling events:

- Appropriate personal protective equipment as specified in the HASP
- Leather gloves
- Nitrile gloves
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Decontamination equipment/tools including Alconox®/Liquinox®-band detergent spray bottle, deionized or distilled water spray bottle, brushes, buckets.
- Indelible ink and/or permanent marking pens
- Appropriate sample containers, labels, and forms
- Digital camera
- Field logbook

Additional equipment/materials for Container Sampling – Solid Phase Waste

- Hammer
- 5/8" drum wrench/socket
- Stainless steel or disposable plastic hand spade
- Stainless steel scoop
- Stainless steel bucket auger

Additional equipment/materials for Container Sampling – Liquid Phase Waste

- Hammer
- 5/8" drum wrench/socket
- Step stool or ladder
- Disposable bailer, coliwasa sampler, or dipper

Additional equipment/materials for Process Waste Streams

- Process diagram
- Lockout/tagout information
- Step stool or ladder
- Stainless steel or disposable plastic hand spade
- Stainless steel scoop
- Disposable bailer, coliwasa sampler, or dipper

Additional equipment/materials for Uncontained Release Area

- Air monitoring equipment
- Underground utilities clearance checklist
- Long measuring tape or wheel
- Pin flags
- Stainless steel or disposable plastic hand spade
- Stainless steel scoop
- Stainless steel bucket auger

Additional equipment/materials for Destructive Building Material Sampling

- Plastic sheeting
- Hammer drill with appropriate bits
- Hammer
- Flathead screwdriver
- Chisel
- Putty knife
- Generator or other power source
- Zip seal plastic bags
- Paper plates

5 Cautions

This TGI does not provide procedures for sampling waste streams where there is no knowledge of waste origin or potential hazards. If such a situation arises, the sampler should stop work and consult the CPM and a Technical Expert.

6 Health and Safety Considerations

As determined by the site's known and suspected hazards, appropriate PPE should be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as stated in the Site HASP.

Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

Filled waste containers can be very heavy, become unbalanced, and/or spill contents. Waste containers stored for extended periods of time may be subject to deterioration. Personnel should attempt to sample waste containers without moving them and, if necessary, use appropriate moving techniques and equipment for safe handling. Container lids must be replaced after sampling to maintain RCRA compliance. Large containers such as rolloff bins and frac tanks may require climbing to access sampling ports. A second sampler is recommended as a spotter for such sampling events. Sampling wastes from active processes can involve opening valves or accessing confined spaces. Stop work and communicate with the CPM and process operator if there is any misunderstanding or change in scope of sampling. Destructive bulk sampling can generate projectiles, please make sure the area is clear of ancillary personnel and upgrade PPE as appropriate. Destructive sampling can

also encounter hidden utilities. Sampling of uncontained wastes may result in exposure to airborne contamination or if the waste is in stockpiles may involve gravity hazards. Upgrade monitoring equipment and plan work in advance to minimize these hazards.

7 Procedure

Sampling Methodology

RCRA requires that waste characterization samples be representative of the waste stream. A representative sample is defined in 40 CFR 260.10 as a sample of a universe or a whole that can be expected to exhibit the average properties of the universe or whole. Arcadis personnel should work with the client, waste Technical Expert and disposal facility on an approach to collect representative waste characterization samples and prepare them for shipment for laboratory analysis. The laboratory used for waste characterization analysis should have the appropriate federal and state accreditations and may be required to be pre-approved by the Client.

Sampling Containerized Solid Wastes

1. Assess the integrity of the container for labels, bulging, leaks. If the container appears compromised or unlabeled, stop work and contact the CPM.
2. Open the container using appropriate tools.
3. Record visual appearance and volume of waste in field logbook.
4. Collect volatile constituent samples (volatile organic compounds, total petroleum hydrocarbons – gasoline range, etc.) as grab samples at a random location using a method to minimize the loss of volatiles, typically directly into laboratory provided sampling devices/containers.
5. Collect semi and nonvolatile constituent samples (semi-volatile organic compounds, etc.) as grab samples for 4-point composites from random locations in the accessible waste layer. The nonvolatile sample compositing should be performed by the laboratory. A disposable or stainless-steel sampling tool or bucket auger may be used if deep container sampling is requested. Decontaminate any tool used between sampling different locations.
6. Place samples in laboratory provided sample containers.
7. Close the container by replacing all components disassembled to open it.
8. Take a photograph of the container.
9. Note the container sampled, photo number and sample ID in the field logbook.

Sampling Containerized Liquid Wastes

1. Assess the integrity of the container for labels, bulging, leaks. If the container appears compromised or unlabeled, stop work and contact the CPM.
2. If the container is a tank, sampling from a hatch or opening at the top is preferred over a valve at the bottom because of potential waste stratification.
3. Open the container using appropriate tools.
4. Record visual appearance and volume of waste in field logbook and assess the waste for separate phases (non-aqueous phase liquid [napl], liquid, sediment) and record percentages by volume of each in field logbook. If there are separate phases, contact CPM to advise if discrete sampling of each phase is required.
5. Open an unused disposable liquid sampling tool (such as a bailer, coliwasa or dipper). If discrete phase sampling is required, choose a sampling tool that is capable of collecting the desired phase only and

insert the sampling end of the tool in the phase to be sampled. If discrete phase sampling is not required, choose a sampling tool, and stir the waste.

6. Collect a representative sample of the waste using the tool into laboratory provided sample containers.
7. If pH is requested by field test, apply some waste from the liquid sampler to pH paper/pH meter and photograph the paper result or equipment display screen showing the pH value for project records. Note if using pH paper, it must be capable of reading pH in the range of at least 1 to 13 pH units, with a larger range acceptable.
8. Close the container by replacing all components disassembled to open it.
9. Take a photograph of the container.
10. Note the container sampled, photo number and sample ID in the field logbook.

Sampling Process Waste Streams

Process waste streams typically have designated sample collection locations (built in sampling ports, covered pits, sumps etc.) to allow collection of waste characterization samples. The sampler should consult the process operator and receive authorization before collecting any samples from an active process.

1. Record the name of the sampling location in field notes and on sample labels.
2. Collect a sample directly from the sampling location into the laboratory-provided container, if possible. Some liquid processes may need to be sampled using a dipper which should be passed through the process waste in one continuous motion to collect the sample and transfer to laboratory-provided containers. A disposable flat scoop sampling tool can be used to collect solid process wastes off conveyors, etc. prior to transferring to laboratory-provided containers.
3. Take a photograph of the sample location.
4. Note the sample location, photo number and sample ID in the field logbook.

Sampling Uncontained Release Areas

Sampling of an uncontained release or spill area can be performed as follows:

New Releases:

1. Visually assess the horizontal boundaries of the spill. The first round of waste characterization is typically biased by collecting waste characterization samples that are most likely to be “worst case”, i.e., visually impacted and near the center of the spill. The samples should be collected as grab samples with ideally a minimum of four (4) grab samples to characterize a new waste stream to statistical significance.
2. Collect volatile constituent samples (volatile organic compounds, total petroleum hydrocarbons – gasoline range, etc.) semi and nonvolatile constituent samples (semi-volatile organic compounds, etc.) as grab samples centered on the release location. A disposable or stainless-steel sampling tool may be used or a bucket auger if deep sampling is requested. Volatile constituent samples should be collected using a method to minimize the loss of volatiles, typically directly into laboratory provided sampling devices/containers. Decontaminate any tool used between sampling different locations.
3. Place samples in laboratory provided sample containers.
4. Take a photograph of the sampling location.
5. Note the sampling location, photo number and sample ID in the field logbook.

Stockpiles:

1. Assess the size of the stockpile and work with the client, waste Technical Expert and disposal facility on an approach to collect an appropriate number of representative samples.

2. Collect volatile constituent samples (volatile organic compounds, total petroleum hydrocarbons – gasoline range, etc.) semi and nonvolatile constituent samples (semi-volatile organic compounds, etc.) as grab samples from randomly selected places in the stockpile. A disposable or stainless-steel sampling tool may be used for samples near the outer edge of the stockpile and a bucket auger can be used for sampling deeper into the stockpile. Volatile constituent samples should be collected from stockpile material inside the outer “shell” of the stockpile that has had less exposure to air for using a method to minimize the loss of volatiles, typically directly into laboratory provided sampling devices/containers. Decontaminate any tool used between sampling different locations.
3. Collect semi and nonvolatile constituent samples (semi-volatile organic compounds, etc.) as either grab samples from randomly selected places in the stockpile, if characterization samples will be used to separate the stockpile into different waste streams, or as grab samples for 4-point composites from random locations, if the stockpile will be disposed collectively as one waste stream. Nonvolatile sample compositing should be performed by the laboratory. A disposable or stainless-steel sampling tool may be used for samples near the outer edge of the stockpile and a bucket auger can be used for sampling deeper into the stockpile. Decontaminate any tool used between sampling different locations.
4. Place samples in laboratory provided sample containers.
5. Take a photograph of the sampling location.
6. Note the sampling location, photo number and sample ID in the field logbook.

Historical Releases:

Waste characterization for historical release areas subject to future remediation is typically performed in accordance with a site investigation work plan and is out of scope for this TGI.

Destructive Sampling Building Materials

1. Assess the building material and area to be sampled. Surface coatings and softer material such as sheet rock can be sampled with hand tools (hammer, chisel, putty knife, etc.). Harder materials such as wood, masonry and concrete may require a hammer drill with an appropriate bit. Confirm the volume/mass requirements for the sample with the analytical lab to collect a sufficient amount of sample for analysis while minimizing damage to the sample area.
2. Sampling Vertical Surfaces:
 - Place plastic sheeting under the sampling area.
 - If directed to collect a surface coating sample, scrape material into a labeled laboratory provided sampling container or, if necessary, a new plastic bag beneath the sampling area.
 - If directed to collect a representative sample of the entire building material, drill into the full thickness of the material to be disposed, collecting shavings on a labeled new paper plate beneath the sampling area. Move to an adjacent area and drill another full thickness hole if additional sampling volume/mass is needed.
3. Sampling Vertical Surfaces:
 - Place plastic sheeting around the sampling area.
 - If directed to collect a surface coating sample, scrape material, and transfer it to a labeled laboratory provided sampling container.
 - If directed to collect a representative sample of the entire building material, place a labeled new paper plate directly over the sampling area and drill through the plate into the full thickness of the material to be disposed. Shavings should collect on the paper plate. Move to an adjacent area

and drill another full thickness hole using a new paper plate each time if additional sampling volume/mass is needed.

4. Record visual appearance and volume of waste in field logbook.
5. Transfer samples from bags or plates to laboratory provided sample containers.
6. Take a photograph of the sampling location.
7. Note the sampling location, photo number and sample ID in the field logbook.

Sampling Frequency

The sampler should work with the client, waste Technical Expert and disposal facility on an approach to collect an appropriate number of representative samples. In the absence of any other frequency directive, waste characterization samples should be collected at the following frequencies:

- Large Volume Soil/Sludge Waste Streams (Uncontained, Stockpiles, Rolloff Bins, etc.): minimum one representative sample per 200 cubic yards.
- Large Volume Liquid Waste Streams (Tanks, Ponds, etc.): minimum one representative sample per waste stream.
- Small Volume Soil/Sludge Waste Streams (Drums, Totes, etc.):
 - 1-4 containers: one grab sample from one randomly selected container for volatile constituents; grab samples from each container to be combined by laboratory into 4-point composite for nonvolatile constituents.
 - More than 4 containers: grab samples for volatile constituents from randomly selected containers representing 20% of total number of containers; grab samples for nonvolatile constituents from the same 20% of total number of containers to be combined by laboratory into 4-point (or less) composites.
- Small Volume Liquid Waste Streams (Drums, Totes, etc.): minimum one representative sample from randomly selected containers representing 20% of total number of containers.

Waste Characterization Sample Analytical Parameters

Waste characterization should be conducted in accordance with the requirements of the client, waste handling facility, and local/state/federal governments. In general, wastewater should be analyzed by methods appropriate for the known or suspected contaminants in the waste stream. Solid phase waste characterization samples may be analyzed for toxicity characteristic leaching procedure (TCLP) VOCs, TCLP SVOCs, TCLP RCRA metals, and PCBs, as well as reactivity. Liquid and sludge phase waste characterization samples may be analyzed for TCLP VOCs, TCLP SVOCs, TCLP RCRA metals, and PCBs, as well as corrosivity (pH), reactivity and flammability (flashpoint). Project-specific constituents of concern including PCBs, herbicides and pesticides may require additional sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches such as total petroleum hydrocarbon sampling, fish bioassay sampling, etc.

Sample Handling and Shipping

All samples should be appropriately labeled, packed, and shipped in accordance with Arcadis sample cooler packing procedure/video available at the Arcadis Transportation Safety SharePoint site. The chain-of-custody should be filled out in accordance with current Arcadis sample chain of custody standard operating procedure (SOP) available from the Arcadis Virtual Library. Any sample compositing instructions for the laboratory should be included on the chain of custody. The Arcadis shipping determination form (Arcadis Transportation Safety SharePoint) should be completed prior to the first shipment of samples from a project site.

As noted under the qualifications section above, biennial training is required by Arcadis for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

8 Data Recording and Management

Waste characterization sample handling, packing, and shipping procedures should be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan, Sampling and Analysis Plan, or Waste Analysis Plan. Copies of the chain-of-custody forms should be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

9 Quality Assurance

The CPM should review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to the proposal/scope of work, QAPP, SAP, WAP, HASP, etc. Deficiencies should be noted, tracked, and resolved. Upon correction, they should be noted for project documentation.

10 References

United States Environmental Protection Agency (USEPA). 2002. RCRA Waste Sampling Draft Technical Guidance. Office of Solid Waste. August.

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Imagine the result

Test Pit Excavation (NON-ENTRY)

Rev. #: 2

Rev Date: May 28, 2008

Approval Signatures

Prepared by: Andrew Kanik Date: 5/28/2008

Reviewed by: Michael J. Gephell Date: 5/28/2008
(Technical Expert)

I. Scope and Application

This SOP outlines policies and procedures for the advancement of test-pits using rubber-tire or track-mounted backhoes. For all work activities conducted by ARCADIS involving test pits or other excavations, ARCADIS staff will refer to and comply with ARCADIS HS Procedure No. ARC HSCS005, Excavation and Trenching. Test pits will be excavated using a decontaminated, rubber-tired backhoe or track-hoe as appropriate. Test pits may be performed based on the need to identify subsurface structures, facilitate the collection of soil samples and provide larger-scale subsurface characterization than allowed using soil borings. Personnel should stand upwind of the excavation area to the extent possible. Continuous air monitoring may be conducted as indicated in the site Health and Safety Plan (HASP). Excavating will be conducted at the selected locations that have been cleared for utilities until significant source materials, groundwater, or bedrock is encountered, or the purpose of the test pit has been met, or the physical limits of the backhoe have been reached. Test pit materials will be visually observed and described with respect to depth. Samples may be collected for laboratory or geotechnical analyses. Photographs of the test pits and excavated materials should be taken for future reference.

II. Personnel Qualifications

ARCADIS personnel overseeing, directing, or supervising the sampling portion of the test pit activities will have a minimum of 6 months of previous related experience under the supervision of an experienced (2 years) oversight person and at a minimum a 4-year degree (Bachelors) in environmental sciences, engineering, hydrogeology, or geology, and have completed health and safety training as required by OSHA Regulation 29 CFR 1910.120 (HAZWOPER). Personnel will also have completed any client-specific training as may be required. If the test pit is excavated by ARCADIS personnel, a competent person as defined by ARC HSCS005 will be on-site at all times.

If the test pit is excavated by a subcontractor, the subcontractor will provide the competent person per OSHA 1926.32(f). The excavation subcontractor will maintain all appropriate licenses and/or certifications as required by the State and Municipality. The equipment operator and any assistants working on site will, prior to beginning work, have completed all health and safety and other training as may be required by ARCADIS and the client.

III. Equipment List

The following equipment will be available, as required, during test pitting:

- rubber-tired (or track-mounted) backhoe in good working order;
- flame ionization detector (FID) and/or photoionization detector (PID), and/or other colorimetric;
- sample containers and forms;
- daily field log and/or field notebook;
- supplies and equipment to comply with site- and client-specific health and safety procedures;
- stainless steel shovel, scoop, hand auger, or trowel;
- digital camera;
- polyethylene sheeting; and
- ground stakes.

IV. Cautions

Water used for decontamination of excavation equipment will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Work may be conducted on or in proximity to steep terrain. Site-specific health and safety issues will be thoroughly reviewed by all site personnel prior to beginning work.

V. Health and Safety Considerations

A site-specific Health and Safety Plan (HASP) meeting client requirements will be prepared along with Job Safety Analyses (JSAs) that outline the H&S hazards and controls for conducting the test pit activities. Project staff will review and be familiar with these plans and JSAs prior to work. These documents will detail the excavation safety requirements per ARC HSCS005. In addition, underground and above ground utilities will be located and cleared per ARCADIS H&S Procedure ARC HSFS019 – Utility Location.

VI. Procedures

Where necessary to characterize soil conditions, soil samples will be collected from the backhoe bucket, either directly or with a decontaminated stainless steel scoop or trowel.

Samples should be homogenized, if appropriate.

Material removed from the test pits during excavation will be placed on polyethylene sheeting. Visually clean soils will be segregated from soils that may contain source materials. Soils meeting field screening or laboratory analytical criteria may be placed back into the excavation. Soils not meeting screening or laboratory analytical criteria will be managed on site as described in the *Waste Management* section below. For sites that cannot be fully secured, clean fill will be available to backfill excavations immediately upon completion of test pits. To facilitate surveying, the location of the test pits will be marked with stakes after they have been backfilled. Stakes should be placed at the ends of the test pit and at any significant bend or corner, as appropriate.

VII. Waste Management

All water generated during decontamination procedures will be collected and contained onsite in 55-gallon drums or a temporary frac-tank pending laboratory analysis and appropriate disposal.

Personal protective equipment (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums for appropriate disposal.

Depending on volume generated, soil materials will be placed in sealed 55-gallon steel drums or stockpiled on site (placed on and covered by plastic sheeting). The material will be analyzed to determine the appropriate disposal method.

VIII. Data Recording and Management

The supervising geologist/engineer/scientist will be responsible for documenting activities using a daily field log to record all relevant information in a clear and concise format. As an alternative, a bound field notebook may be used at the discretion of field personnel to document field activities. Where appropriate, photographs will be taken to supplement written notes. The record of test pitting will include:

- start and finish dates of excavating;

- name and location of project;
- project number, client, and site location;
- sample number and depths;
- depth to water;
- observations of soil type/characteristics and lithology;
- documentation of any elevated organic vapor emissions;
- names of Contractor's personnel, inspectors, or other people onsite; and
- weather conditions.

IX. Quality Assurance

Equipment will be cleaned prior to use onsite. At the discretion of the ARCADIS Project Manager or field geologist/engineer/scientist, equipment may be decontaminated between each test pit location, and prior to leaving the site. All equipment and associated tools that may have come in contact with contaminated soils and/or waste materials will be cleaned with high-pressure steam cleaning equipment using a potable water source. More detailed equipment cleaning procedures are provided in the HASP.

X. References

United States Department of Labor. 1989. Occupational Safety & Health Administration (OSHA), Title 29 Code of Federal Regulations (CFR) Part 1926.651 Subpart P Excavations, .54 Federal Register (FR) 45959, October 31, 1989 and 59 FR 40730, Aug. 9, 1994.

ARCADIS HS Procedure No. ARC HSCS005, Excavation and Trenching, 12 May 2008.

ARCADIS H&S Procedure ARC HSFS019 – Utility Location, 22 February 2008

TGI - SCREENING SOIL FOR METALS WITH PORTABLE X-RAY FLUORESCENCE ANALYZER

Rev: 0

Rev Date: October 16, 2018



VERSION CONTROL

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0	October 16, 2018	All	Rewritten as TGI	Richard Murphy

APPROVAL SIGNATURES

Prepared by:



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10/16/2018

Date:

Technical Expert Reviewed by:



Richard J. Murphy

10/17/2018

Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This technical guidance instruction (TGI) provides general guidance, materials, and methodology for the operation of x-ray fluorescence (XRF) instruments for intrusive field screening/analysis of metals in soil samples. The XRF screening procedures described here are consistent with the approach and methods presented in the *USEPA SW-846 Method 6200 "Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment"*. The instrument manufacturer's instructions should be followed for all instrument procedures.

Intrusive XRF analyses will be conducted on dry, homogenized soil samples. As described in USEPA Method 6200, additional enhancements to sample preparation (i.e., drying, grinding) may also be required to achieve lower detection limits, eliminate spectral interferences, and/or decrease soil heterogeneity issues. Procedures will be adjusted, as necessary, to accommodate additional sample preparation. Most of the procedures described in this TGI pertain to site screening, site characterization (delineation of impacts) or site closure (remediation effectiveness). It is recommended that the results of

XRF analyses are confirmed by submitting a portion (e.g, 1 per 20) of the samples analyzed in the field to a laboratory for analysis.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. Arcadis field sampling personnel should have received specific instrument use and radiation safety training from the manufacturer of the XRF. In addition, Arcadis field sampling personnel will be versed in the relevant TGIs and possess the required skills, training in sample collection and analysis, background and experience necessary to successfully complete the field work.

4 EQUIPMENT LIST

The following materials, as appropriate, will be available during XRF soil sample screening:

- Personal protective equipment (PPE), as required by the site-specific Health and Safety Plan (HASP);
- Dosimetry badges;
- Cleaning and decontamination equipment;
- XRF analyzer (instrument);
- Testing stand/table;
- Traffic cones, delineators, and/or caution tape for securing the work area;
- Lithium-ion battery packs;
- Battery charging system;
- Ziploc-type plastic bags or equivalent;
- Pure element standards (e.g., Pb);
- Equipment blank samples (e.g., pure silicon dioxide);
- Calibration standard (e.g., standard reference materials {SRMs});
- Appropriate soil sampling equipment, containers, labels, and forms;
- Field notebook or daily log sheets;
- Digital camera;
- XRF Operation Manual

5 CAUTIONS

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See appropriate guidance for proper utility clearance protocol. Prior to beginning field work, contact the project technical team to ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members.

Proper training for operation of the instrument and radiation safety training should be completed by each individual using the instrument prior to operation. Staff operating the instrument should be aware of the local, state and federal regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. The instrument operations manual and all appropriate licenses (or copies) should be present with the instrument at all times.

Depending on the sensitivity of the instrument and desired resolution (increasing the precision of the measurement), the analyzer may need to collect spectra from the soil samples from 30 seconds to a minute, or longer (5 minutes). Moisture in the soil samples being analyzed can cause spectral interferences and/or false elevated concentrations to be reported.

Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by spreading out samples in a disposable aluminum pan (or equivalent) and allowed to air dry. If necessary, samples can be dried a convection or toaster oven (USEPA 2007). Samples may also need to be ground and sieved, depending on size of soils and uniformity.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with soil sample handling and collection will be performed in accordance with a site-specific HASP, a copy of which should be present onsite during such activities.

XRF analyzers use either sealed radioisotope sources or x-ray tubes to generate x-rays. The potential for ionizing radiation hazards and shock hazards are present when using an XRF analyzer. Proper training for operation of the instrument and radiation safety training should be completed by each individual using the instrument prior to operation. For sealed radioisotope sources, it is also important to properly label shipping containers for air and ground transport.

Dosimeter badges, TLDs, Self-Reading Dosimeters or equivalent monitoring device will be worn by Arcadis field sampling personnel when handling, using, or inspecting the XRF. The Arcadis Radiation-Sealed Source Health and Safety Standard (Arcadis 2014) should be reviewed prior to field work.

7 PROCEDURE

The following procedure will be used to perform the XRF screening:

Collected Sample Preparation

1. Don PPE, as required by the HASP.
2. If soil samples are saturated, spread out samples in a disposable aluminum pan (or equivalent) and allow to air dry. If necessary, samples can be dried a convection or toaster oven. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Empty the dried soil contents into labeled Ziploc- type baggie and record sample information in field notebook/logs.
3. Remove any debris (e.g., twigs, rocks) from sample. Care should be taken to ensure that slag or paint chips, that are components of the sample, are not removed in this step. If necessary, the homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. Often, the direct analysis through the plastic bag is possible without the more labor-intensive steps of drying, grinding, and sieving.
4. Place Ziploc-type baggie under x-ray window according to manufacturer's instructions.
5. Clean sample preparation equipment according to the procedures in the Field Sampling Plan (FSP).

Calibration and Standardization

1. Instrument calibration processes may incorporate any one of three types of procedures existing for XRF instruments: Fundamental Parameters calibration, empirical calibration, and the Compton peak ratio (or normalization method). The calibration procedure will be dependent upon the XRF instrument and data quality objectives (DQOs) specified. The calibration procedure in the instrument manufacturer's instructions should be followed for each specific instrument.

Collected Sample Analysis

1. Don PPE, as required by the HASP, including dosimetry badges.
2. Turn the analyzer on (per manufacturer's instructions).
3. Check battery life. If low, replace before proceeding.
4. Allow the analyzer to warm up for 15 minutes (per manufacturer's instructions).
5. Define the analyzer operating conditions in the instrument software (per manufacturer instructions). This will include entering target analytes, associated site-specific action limits (ALs), sample analysis time, and sample identification number, as appropriate or available.

6. Ensure that the appropriate materials required to perform energy calibration, calibration verification and blank analyses are available and the procedures (as discussed in Section 4 of this TGI) are followed prior to or during sample analysis.
7. Analyze soil samples according to specified target analytes and associated DQOs and following the instrument manufacturer's instructions. Based on the potential interference among certain analytes (e.g., Pb and As) and moisture content, sample analysis times will be determined based on the sensitivity of the XRF analyzer and level of resolution desired.

Note: Depending on the instrument sensitivity and desired resolution (increasing the precision of the measurement), the analyzer may need to collect spectra from the soil samples from 30 seconds to a minute, or longer (5 minutes). Moisture in the soil samples being analyzed can cause spectral interferences and/or false elevated concentrations to be reported.

1. Once the desired resolution and sensitivity has been met for the target analytes, end the analysis.
2. Remove Ziploc-type baggie from analyzer and collect laboratory analytical sample, if required. Samples will be transferred to sample coolers and stored on ice at 4°C and shipped to the analytical laboratory along with proper documentation.
3. Record readings in the field logs.

In-Situ Sample Analysis

Soil samples can be screened with a portable XRF in-situ as well. Follow **Collected Sample Analysis** steps 1 through 6. The following procedures should then be followed:

1. Prior to taking the in-situ measurement, the measurement location is cleared of any significant vegetation, such as large clumps of grass, and is scuffed or otherwise leveled to provide a flat surface on which to place the instrument window. A Ziploc-type plastic bag/sheet is then placed on the measurement location. This protects the instrument window, preventing it from becoming damaged or contaminated by the media being tested.
2. After the window is pressed to the plastic, the window is opened for a nominal (i.e., programmed) sixty seconds.
3. Because of the shallow penetration of the X-rays in typical soils, the measured concentrations are representative of the concentrations present at the very surface of the material being measured. If conditions representing concentrations over a greater depth are required by the study data quality objectives (i.e., on the order of three to six inches), the collected sample analysis must be used.

8 WASTE MANAGEMENT

Investigation-derived wastes (IDW), including soil cuttings, decontamination liquids, and disposable materials (Ziploc-type bags), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan, FSP, and/or Waste Management Plan (WMP).

9 DATA RECORDING AND MANAGEMENT

XRF analyses and results will be documented in a field logbook or daily logs. Information will include personnel conducting the analyses (or on site), times of arrival and departure, significant weather conditions or indoor temperature or humidity controls, timing of sample analyses, soil descriptions, instrument type, model and quantities of materials used, and sample identification with results. Copies of the field logs will be forwarded to the Project Manager on a daily to weekly basis depending on the data quality objectives. Field logs will be stored in project files.

10 QUALITY ASSURANCE

1. Follow quality assurance/quality control (QA/QC) procedures as specified in the QAPP, and in accordance with manufacturer's instructions and USEPA Method 6200.
2. Perform an energy calibration check sample at least twice daily. This test is typically performed automatically by the instrument during start-up or standardization procedures using a pure element standard (e.g., Pb, Fe, Cu). Appropriate energy calibration information (e.g., date, time) will be recorded in the field log.
3. Analyze an equipment blank at a specified frequency (e.g., once or twice daily) using pure silicon dioxide. Record the date, time, and result in the field log.
4. Analysis of a calibration verification check (CVC) sample will be performed so that the CVC will bracket sample analysis at a specified frequency (e.g., once or twice per day) using SRMs at concentrations above the detection limits from an outside vendor.
5. The measured value for each target analyte should be within $\pm 20\%$ difference of the true value for the CVC to be acceptable. If any measured value falls outside this range, then the check sample should be reanalyzed. If the check sample values continue to fall outside the acceptable range, the instrument should be recalibrated, and then the previous batch of samples reanalyzed after the CVC sample is reanalyzed.
6. Depending on the DQOs and the end use of the data, field duplicate analyses may be performed at a specified frequency (e.g., 1 per 10 samples). Record the date, time, and result in the field logs.
7. Analyze precision measurement [e.g., test relative standard deviation (RSD) amongst 7 replicates] at a specified frequency (e.g., once per day) using field samples. If the RSD value exceeds 20% (30% for Cr), an increase in sample count time is necessary. The sample count time will increase by 30-second increments until an acceptable RSD is achieved. Record the date, time, and result in the field logs.

8. Confirmatory samples to determine comparability of the XRF screening to laboratory results are to be submitted for samples analyzed in the field to a laboratory for analysis at a frequency dependent on the project specific DQOs (e.g., 1 per 20). The confirmatory samples must be splits of the homogenized samples aliquot. The method of confirmatory analysis must meet the project and XRF measurement DQOs. The confirmatory samples should be selected from the lower, middle and upper range of concentrations measured by XRF. The results of the confirmatory analyses and the XRF analyses should be evaluated with a least squares linear regression analysis.

11 REFERENCES

- Arcadis, 2014. *Arcadis Health and Safety Standard - Sealed Source Instrument – Radiation Safety Program*. ARC HSIH011. October 5.
- USEPA, 2007. SW-846 Method 6200 “*Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment.*” February 2007.



Appendix C

**Site Specific Health, Safety, and Environmental Plan Barker
Hughesville and Carpenter-Snow Creek Mining District Cascade
and Judith Basin Counties, Montana, 2023**

Mt. Emmons Mining Company

Site Specific Health, Safety, and Environmental Plan

**Barker Hughesville and Carpenter-Snow Creek Mining
District**

Cascade and Judith Basin Counties, Montana

[Revision 3, September 24, 2025]

Site Specific Health, Safety, and Environmental Plan

Barker Hughesville and Carpenter-Snow Creek Mining District

[Revision 3, September 24, 2025]

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Version Control

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- Appendix B – Supplemental Plans
- Appendix C – Job Safety Analyses, Permits, and H&S Standards
- Appendix D – Safety Data Sheets (SDSs)
- Appendix E – Field Forms

Acronyms and Abbreviations

BHMD	Barker Hughesville Mining District
CSCMD	Carpenter Snow Creek Mining District
CoCs	constituents of concern
COPC	constituents of potential concern
EAP	Emergency Action Plan
FHSHB	Field H&S Handbook
H&S	health and safety
HARC	Hazard Assessment and Risk Control
HESP	Health, Safety, and Environmental Plan
HAZCOM/GHS	Hazard Communication/ Globally Harmonized System
HAZWOPER	Hazardous Waste Operations and Emergency Response
JSA	job safety analysis
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
SDS	safety data sheet
SSE	short-service employees
SSO	Site Safety Officer
THA	Task Hazard Analysis
TIP	Task Improvement Process

Culture of Caring Certification

Arcadis is committed to a Culture of Caring that ensures each Arcadis employee and contractor goes home at the end of the day free from injury or illness. I certify the following has been performed with all Arcadis field staff on this project either in person or by Skype:

- ☒ Reviewed the HSEP including a discussion of hazard identification and controls
 - ☐ If conducting activities deemed by Arcadis to be "High Risk", frontline management has reviewed applicable H&S standards (JSA when authorized by H&S) for these activities with field staff
 - ☐ If permit to work is required, frontline management has reviewed the permit(s) with field staff
- ☒ Reviewed proactive H&S engagement expectations/injury prevention actions
- ☒ Reviewed Stop Work Authority
- ☒ Reviewed the incident reporting process and expectations including when WorkCare should be contacted by staff (WorkCare incident intervention for all minor, non-emergency injuries) and that the WorkCare phone number is programmed into field team cell phone.

For short service employees (SSE) (0-1 years with Arcadis):

- ☐ Coaching and mentoring on Arcadis H&S expectations during project work. Reviewed in detail specific hazards and controls and provided a resource that can be contacted if SSE has questions regarding planned or unplanned work tasks

Resource Name:

Phone Number:

Signed

1 APPLICABILITY

This project Health, Environment, and Safety Plan (HSEP) applies to the specified work as described in Section 3 – Scope of Work that will be performing on-site activities at the Barker Hughesville Mining District (BHMD) and the Carpenter Snow Creek Mining District (CSCMD) located in Cascade and Judith Basin Counties, Montana (hereafter referred to as “the Site”).

All Arcadis site project personnel field staff and subcontractors are required to have reviewed and understand this HSEP prior to completing any on-site work. A signature acknowledgement is required in Section 21 – Acknowledgement. Signing will certify that you have reviewed and understand the HSEP.

A hard copy of this HSEP will be kept on-site while work is being conducted. Additionally, Arcadis will maintain a copy in the Project SharePoint site: ([Health and Safety](#)).

This HSEP has been reviewed and updated to be consistent with *Occupational Safety and Health Administration (OSHA) 29 C.F.R. § 1910.120(b)* and has been prepared in accordance with *EPA’s Emergency Responder Health and Safety Manual, OSWER 9285.3-12 (July 2005 and updates)*. As additional knowledge of the Site’s hazards are identified through the collection of data and pertinent information, the HSEP will be updated, revised and communicated as required. Additional updates will be required as the project progresses. If required, a comprehensive HSEP will be developed if the project transitions to a clean-up operation.

2 PROJECT LOCATION/DESCRIPTION

The Site is located at in Cascade and Judith Counties, Montana in the Little Belt Mountains. The area topography is mountainous.

The work in BHMD is focused in the Liberty Mine Area and includes waste rock piles, draining adits, and streamside tailings as well as abandoned and/or collapsed mine adits. Two flowing adits are also included in the Liberty Mine Area: the Danny T Adit and the Marcelline Shaft. The Liberty Mine Area is bounded on the east by the topographic ridge directly above Liberty Mine adits and by Galena Creek to the west.

The CSCMD consisted of several historical mining and milling areas, although the focus on this investigation is the Cowboy Mine, Haystack Creek Adit, and Black Diamond J Mine Area. The Cowboy Mine and Haystack Mine (including the Haystack Adit) lie within the Carpenter Creek Watershed, while the Black Diamond J Mine area lies within the Snow Creek Watershed.



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2.1 Site Background

The BHMD is located in the Little Belt Mountains within the Dry Fork Belt Creek Watershed. The BHMD has been explored for silver and lead ore deposits since 1879, and mining of these deposits continued throughout the district until the ores began to be depleted in 1883. Several attempts to restore exploration and mining activity have occurred from the 1920s to the 1980s including reopening several mines and adits. However, there has been minimal exploration and mining activity since the 1980s.

The site includes more than 45 abandoned mines, mills, and multiple tailings sites, which are scattered across multiple drainages within the BHMD. The abandoned mines and mills are primarily located within the Galena Creek drainage, which feeds into Dry Fork Belt Creek. The primary constituents of potential concern (preliminary COPCs) for waste rock are identified as arsenic, cadmium, copper, lead, manganese, thallium and zinc. The specific preliminary COPCs for adit water are identified in Danny-T Adit water (total and/or dissolved concentrations) as aluminum, arsenic, cadmium, copper, iron, lead and zinc.

The CSCMD consisted of several historical mining and milling areas. Historical records searches conducted during the RI report include aerial photographs and field reconnaissance, which located 16 mines in the Carpenter Creek drainage, 22 mines in the Snow Creek drainage, 32 mines on the Neihart Slope, and three abandoned mines in or west of the Town of Neihart. There are also mine openings that discharge mine-influenced water, historically referred to as acid mine drainage. The primary COPCs are heavy metals and arsenic.

3 SCOPE OF WORK

As noted above, the project objectives include the investigation of waste rock and adit water at the Site. The following tasks are identified for the project and this HSEP:

1. Driving – Company, rental, and personal vehicles both on and off-site.
2. Area recon and survey- A topographic survey to outline extents of administration boundaries and solid material extents and to provide detailed topographic information for the site. (Arcadis subcontractor to survey, Arcadis personnel to oversee).
3. Test pit excavation and Soil Sampling – Excavation of test pits to collect soil samples from locations selected by Arcadis (Arcadis operator to operate, Arcadis personnel to oversee). Arcadis personnel will then inspect, field screen, and sample the extracted soil cores for laboratory analyses.
4. Manual test pit and Soil Sampling – Manual digging and collection of soil samples from locations selected and sampled by Arcadis personnel. Arcadis personnel will then inspect, field screen, and collect samples for laboratory analyses.
5. Surface Water Sampling – Arcadis personnel will inspect, collect field parameters, and sample the adits using manual methods for laboratory analyses.
6. Walkover Surveys – Arcadis personnel will conduct surveys for the purpose of background sampling in areas outside of the mine waste/rock piles area. This will also include contracted surveyors to conduct regional spatial surveying and the potential for property boundary surveying.

4 ORGANIZATION AND COORDINATION

4.1 Project Manager/Assistant Project Manager

The Project Manager is responsible for verifying that project activities are completed in accordance with the requirements of this HSEP. The Project Manager is responsible for confirming that the project has the equipment, materials, and qualified personnel to fully implement the safety requirements of this HSEP, and/or that subcontractors assigned to this project, meet the requirements established by Arcadis. It is also the responsibility of the Project Manager to:

- Review with project staff the information required in the Culture of Caring Certification included in this HSEP or designate an Associate Project Manager (APM) or Task Manager (TM) to perform this function.
- Review all applicable H&S Standards and ensure that project activities conform to all requirements.
- Obtain client-specific health and safety information and communicate with the client on health and safety issues.
- Communicate with the Site Safety Officer (SSO) on health and safety issues.
- Allocate resources for correction of identified unsafe work conditions.
- Ensure Arcadis site workers have all training necessary for the project.
- Report all injuries, illnesses and near-misses to the client representative, lead incident investigations, and ensure that any recommendations made are implemented.
- Review and update the HSEP when new or updated hazards are discovered.

4.2 Site Safety Officer

The Field Team Leader is responsible for implementing the project scope of work in accordance with the requirements of this HSEP. When working with subcontractors, the Field Team Leader is also responsible for assuring that all subcontractor personnel are working in accordance with their site-specific HSEP and in complying with all Client and Arcadis requirements and standards related to the tasks they are performing. The Field Team Leader will also be responsible for:

- Leading and documenting Tailgate Safety Meetings, to be conducted each morning prior to starting work. This meeting will include identification and discussion of any changed site conditions or additional hazards that may be observed beyond those already identified in this HSEP, the attached JSAs, THAs, or the Client's required Hazard Assessment.
- Inspecting all tools and equipment and confirming that any subcontracted equipment operators have inspected all tools and equipment.
- Reporting any deviations from the scope of work, Stop-Works, or incidents to the PM and/or APM.
- Providing daily updates on project progress from the field.
- Coordinating directly with laboratory or equipment couriers to safely deliver and/or pickup any samples or equipment needed to complete the project.

- Review and update the HSEP when new or updated hazards are discovered.
- Communicate any HSEP updates to all onsite personnel.

4.3 All Personnel

Each person is responsible for completing tasks safely and reporting any unsafe acts or conditions to their supervisor. No person may work in a manner that conflicts with these procedures. Prior to initiating site activities, all Arcadis and subcontractor personnel will receive training in accordance with applicable regulations and be familiar with the requirements and standards referenced in this HSEP. In addition, all personnel will attend daily safety meetings (tailgate meetings) to discuss site-specific hazards prior to beginning each day's work. Every Arcadis employee, subcontractor, and client representative at the Site has the responsibility to stop the work of a coworker or subcontractor if the working conditions or behaviors are considered unsafe. Additional requirements are:

- Stop work and request help when unsure about how to perform a task safely.
- Work safely to ensure personal safety as well as other Site workers and the public.
- Use and maintain all H&S devices as required.
- Immediately report incidents to the Site supervisor.
- Do not use cell phones while operating equipment or vehicles.
- Correct or report unsafe conditions to Site management.
- Acknowledge understanding of the HSEP and any future updates.

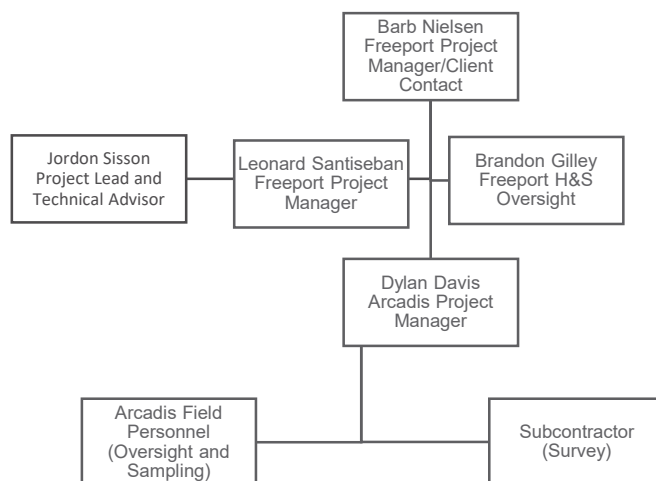
4.4 Contact Information for Key Personnel

Name	Role	Phone	Email
Barb Nielsen	Freeport Project Manager/Client Contact	602-366-8270	bnielsen@fmi.com
Leonard Santisteban	Project Lead and Research Scientist, Environmental Technology/Life Cycle	520-488-2675	lsantist@fmi.com
Jordan Sisson	Project Lead and Technical Advisor	520-437-8678	jsisson@fmi.com
Brandon Gilley	Manager, Health and Safety (FMI)	480-213-3616	bgilley@fmi.com

Site Specific Health, Safety, and Environmental Plan

Name	Role	Phone	Email
Tamra Benzvidez	Freeport H&S Oversight		tbenavid@fmi.com
Dylan Davis	Project Manager (Arcadis)	406-207-6485	dylan.davis@arcadis.com
Anne Thatcher	Senior Advisor (Arcadis)	562-544-6443	Anne.Thatcher@arcadis.com
Oscar Sorensen	Senior Advisor (Arcadis)	303-715-8120	oscar.sorensen@arcadis.com
Allen Long	Principal Engineer (Arcadis)	724-934-9562	Allen.long@arcadis.com
Todd Church	Project Chemist (Arcadis)	315-671-9627	Todd.church@arcadis.com
Kyle Spaulding	Project Geologist (Arcadis)	406-422-7722	Kyle.spaulding@arcadis.com

Lines of Authority



5 EXPECTATIONS

Arcadis project field personnel, as well as any subcontractors working onsite, must always comply with the client's specific H&S requirements. Client-specific H&S requirements are as follows:

- All staff working on Freeport-McMoRan (FMI) property must pass a pre-assignment drug and alcohol screening and be inducted into the current Arcadis/FMI random drug and alcohol screening pool. 20% annual random screening is performed for Arcadis staff and subcontractors working on any FMI properties. Quarterly reporting of drug and alcohol screening results are provided to FMI by the 5th of month (following the end of a quarter). The reporting information requirements are listed in the FMI Contractor Health and Safety Manual.
- All staff working on FMI property must also pass a background check prior to arriving onsite. This can be performed by contacting HR Operations. Note that any person possessing a current Transportation Worker Identification Credential (TWIC) card does not need a separate background check.
- All staff working on FMI projects must obtain the FMI contractor orientation training. This can be scheduled in coordination with Freeport safety. A card will be provided as documentation of the training after completion.
- Light vehicles and all wheeled equipment being parked within the site must utilize chocks or a ready line ditch. Engagement of parking brakes will be used onsite.
- Cell phones or mobile electronic devices are not allowed to be used while driving or operating any equipment.
- All Site workers have the right to stop work if they feel unsafe or have identified an unsafe condition. No penalty will be imposed for stopping work. It is everyone's right and responsibility to stop work.
- Arcadis staff will perform weekly self-audits of work areas and tasks. These will be posted to the SharePoint site for the FMI Project Manager and H&S Representative review. All corrective actions will be assigned to an individual and completed in a manageable time frame.
- FMI will conduct monthly H&S audits of the Arcadis team, including their work areas, tasks, documentation, risk assessment process, Job Safety Analyses (JSAs)/Job Hazard Analyses (JHAs), etc. Corrective actions must be completed by the specified timeframe identified.
- The "buddy system" will be utilized for field personnel that are performing work in pairs or in teams. Field personnel are to monitor each other for signs or symptoms of exposure to heat, weather, chemicals, third party concerns and other safety issues that may arise while working in the field.
- A Site-specific training will be provided to new project personnel including the review and acknowledgement of this Health and Safety Plan.

5.1 Applicable Arcadis and FMI Policies

All site personnel and contractors or subcontractors will follow all Arcadis and Freeport Policies, Freeport Contractor Health and Safety Manual and Standard Operating Procedures. Specific policies are listed in Section 16 and are available for review electronically.

6 MANAGEMENT OF CHANGE

Changes in the scope of the project, site conditions or introduction of new hazards to the project shall require revision of the HSEP by Arcadis and review and approval by FMI. If there is a change, Dylan Davis, Arcadis Project Manager will be notified and will assign the HSEP update to Thomas Nannini, Arcadis HSSE. The revised HSEP will be submitted for review and approval to Barb Nielsen, FMI Project Manager and Brandon Gilley, FMI Senior H&S. The approved revised HSEP will be communicated to the Arcadis field personnel and will require a recertified acknowledgment as per Section 22.

7 COMMUNICATIONS

Communication is an essential component of the Arcadis health and safety program. Project specific communications will include an understanding of the work to be performed and associated hazards and controls.

Prior to the start of the field work, a pre job safety meeting will be conducted and attended by all Arcadis field personnel. The pre job safety meeting will consist of reviewing the HSEP, with emphasis on review of HARCs, RAs and JSAs. Work will not start until all Arcadis field personnel are satisfied with the controls that have been established to the hazard.

Additionally, tailgate safety briefings must be conducted at least once daily. The tailgate safety briefing must be documented on the form included in Appendix E or documented on an equivalent form and maintained with the project files. Alternatively, the tailgate safety briefing may be documented and stored/archived digitally using Arcadis-approved software. The tailgate safety briefing will serve as a final review for hazard identification and controls to be utilized. JSA and the Arcadis FHSHB controls (including any applicable permit or supplemental plans) should be reviewed as part of the briefing to ensure hazard controls are adequate for planned work. A tailgate safety briefing should be conducted again and documented during the same work shift if site conditions change from anticipated conditions.

Arcadis field personnel will have cell phones on their person so they can communicate with required Arcadis personnel. The intent of this project is that Arcadis field personnel will be working together, and verbal communications will be sufficient on site.

8 RISK MANAGEMENT

The following is a listing of hazards identified at the Site, thus far, by the Risk Assessment (Appendix A, also see JSAs in Appendix C):

TASK	ACTIVITY/EXPOSURES	FATAL RISK	CRITICAL CONTROLS
General Site Activities	Covid 19 Virus	Hazardous Substances - Acute	FCX-HS-30 Social Distancing and Face Covering Policy, Arcadis Covid 19 Policy
	Exposure to Biological Agents	Hazardous Substances - Chronic	Arcadis Field Manual, JHA/JSA, Workplace Inspections, Communication, Hazardous Plant Identification
	Cold Stress/Heat Stress/ Exposure to UV	Not Applicable	Arcadis Cold Stress/ Heat Stress Policy, Hydration, Sunscreen, Work/Rest Schedule, Proper Layers
	Severe Weather	Lightning Strikes	Portable Lightning Detector – at least one onsite, Communications, Arcadis Health and Safety Field Handbook
Soil Sampling	Physical Hazards	Moving Parts – Acute Utility Strike- Acute Hearing Loss- Chronic Hazardous Substances- Chronic	Site Orientation, Buddy System, Worker Monitoring, Fatigue Management Plan, JHA, Site Inspections, FCX Fatigue Management Guideline, FCX Blue stake, Basic PPE, Work Gloves (Leather or coated while auguring)
	Chemical	Hazardous Substances – Acute	Sampling Techniques, Monitoring (Visual Dust), PPE, Proper Hygiene, Decontamination
	Mobilization/ Equipment Handling	Vehicle Impact on Person	Exclusion Zone, Smith System training, workplace exam, JHA, Buddy system, Cones, parking procedures, spotters when needed, Basic PPE, vest
Utility Locating and Survey	Uneven ground	Fall from Heights	Daylight hours, JHA, establishing pathways, basic PPE, safety boots

TASK	ACTIVITY/EXPOSURES	FATAL RISK	CRITICAL CONTROLS
	Biologicals (ticks and insects)	Hazardous Substances - Acute	JHA/JSA, Site specific training, Basic PPE, Protective clothing, Bug spray
	Environmental (Heat Stress/Cold Stress)	Not Applicable	Heat stress Program Planning, Employee Monitoring, Hydration, Work/Rest Guidelines
	Physical Hazards	Not Applicable	Written SOP's for Surveying & Utility Locate, JHA Process, Tailgate, HSEP, Basic PPE, Vest
Surface Water Sampling	Physical Hazards	Not Applicable	Buddy System, Fatigue Management Plan, Hydration, Work/Rest, Communication, JHA/Workplace Exam, Worker Monitoring, Safety Meetings
	Chemical	Hazardous Substances - Chronic	Sampling Techniques, Monitoring (Visual Dust), PPE, Proper Hygiene, Decontamination
	Mobilization/ Equipment Handling	Vehicle Impact on Person	Exclusion Zone, Smith System training, workplace exam, JHA, Buddy system, Cones, parking procedures, spotters when needed, Basic PPE, vest
Test Pit Excavation	Physical Hazards (Mechanical Equipment, Noise)	Vehicle Impact on Person	Exclusion Zone, Training, SOP, JHA, signage, work instruction, operators manual, annual assessment process (operating competencies), equipment inspections, basic PPE, vest
	Biologicals (ticks and insects)	Hazardous Substances - Chronic	JHA/JSA, Site specific training, Basic PPE, Protective clothing, Bug spray,
	Mounting/Dismounting equipment	Fall from Heights	Railings, Training, SOP/JHA, signage, work instruction, operators manual, annual assessment process, fall protection, basic PPE, vest

TASK	ACTIVITY/EXPOSURES	FATAL RISK	CRITICAL CONTROLS
Driving vehicles	Physical Hazards	Vehicle Impact on Person/Structure	Air Bags, Seat Belts, Traction Control, Fire Extinguisher, Spotter during interior driving, JHA
	Chemical	Hazardous Substances - Acute	JHA for fueling operations, Equipment checklist, basic PPE

A more detailed Risk Assessment is available in the FMI format located in Appendix A. Arcadis Job Safety Analyses (JSAs) for each task are also provided as Appendix C.

Arcadis Task Hazard Analysis

The scope of work for this project has been subdivided into 4 tasks and each task has been evaluated for hazards using the Hazard Ranking Chart illustrated in Table 1 in accordance with the Arcadis Hazard Assessment and Risk Control (HARC) Health and Safety Standard (AUS HSMS002). In addition to the Arcadis HARC, a risk assessment was completed using the FMI Risk Assessment tool. HARC and Risk Assessments are detailed in Appendix A.

Risk Assessment Matrix		Likelihood Ratings			
Consequences Ratings		A	B	C	D
People	Property	0 Almost Impossible	1 Possible but Unlikely	2 Likely to Happen	4 Almost Certain to Happen
1-Slight or No Health Effect	Slight or No Damage	0-Low	1-Low	2-Low	3-Low
2-Minor Health Effect	Minor Damage	0-Low	3-Low	4-Medium	6-Medium
3-Major Health Effect	Local Damage	0-Low	3-Low	6-Medium	9-High
4-Fatalities	Major Damage	0-Low	4-Medium	8-High	12-High

9 TRAINING

9.1 Site Communications

All Arcadis Staff	Select Arcadis Staff	Subcontractors	Staff Required to Have Training	Training
X		X		HAZCOM/GHS/EAP/PPE (Site Orientation)
X				Arcadis Defensive Driving (Smith On-Line)
	X		Sampling Personnel (anyone who will collect, transport, or ship samples)	DOT HazMat #1
X		X		FMI Contractor Orientation Training
	X	X	All onsite Personnel	FMI Hazard Recognition
	X	X	All onsite Personnel	FMI Workplace Examinations
	X		At least 1 person per work crew	First Aid and CPR – Field Staff
	X	X	Sampling, Oversight, and Operator Personnel	OSHA 40 hr HAZWOPER and Current 8 Hour Refresher.

* Training requirements are based on the tasks that site personnel are performing, and all training may not be required for all tasks. Employees working on the site are trained to the level required by the work, their job function, responsibilities, and hazards they may be exposed to.

** Arcadis has certified that their operators are trained to operate the equipment they will bring on-site.

*** Training certifications are maintained electronically and will be made available for inspection as required.

10 PERSONAL PROTECTION EQUIPMENT (PPE)

10.1 General Requirements

The base level of PPE protection is listed below:

- Hard hat;
- Safety glasses;
- Safety-toed boots;
- Class II traffic vest, Shirt or coat
- Hearing protection (as needed based on monitoring, exposure or task)
- Hand protection (gloves) based on task. If the gloves create more of a hazard than the risk associated with the task, the gloves will not be required.

**Additional PPE measures may be required and are listed in the JSA's and Risk Assessment.*

This follows the PPE Standard within Arcadis's H&S program and meets Freeport requirements. Task-specific PPE is also specified in the JSAs for each task.

11 MEDICAL SURVEILLANCE

Medical surveillance requirements prescribed by the Occupational Safety and Health Administration (OSHA) HAZWOPER regulations apply to potentially impacted soil excavation and handling tasks associated with this project. The Arcadis medical surveillance program requirements for HAZWOPER work are outlined in the Arcadis Medical Monitoring Program Standard ARCHSGE010. All medical surveillance program requirements as indicated must be completed and Site personnel medically cleared before being permitted on the project Site. This is consistent with Arcadis's Medical Surveillance Program and Standard.

12 PERSONAL AND ENVIRONMENTAL MONITORING

A review of project tasks indicates area and personal exposure monitoring is not required based on minimal exposure to constituents of concern. The Arcadis staff will utilize stop work if conditions on site change indicating the need utilize area or personal exposure monitoring. Work will not resume until proper monitoring, engineering controls and/or PPE upgrades are in place to safely perform work

13 SITE ACCESS AND CONTROL

13.1 Site Entrance and Security Check-In Procedure

The BHMD Site is accessible from county road 132. The CSCMD is accessed from Carpenter Creek Rd. The project is on private and public land. Visitors and contractors are to convoy to site starting in Monarch, MT and immediately stop at Arcadis oversight to introduce themselves and sign in. Information including Name and Company will be requested on the sign-in sheet. Following any visit or work at the Site, personnel must then check in with Arcadis oversight and sign out prior to leaving the Site.

14 SANITATION

14.1 Potable Water

An adequate supply of potable water will be brought on site by the Arcadis field prior to the start of work. Additional potable water will be supplied each day as needed. Drinking water will be brought onsite by Arcadis and contractors. Field vehicle(s) will include adequate quantities of potable drinking water and wash water.

14.2 Toilet Facilities

Toilet facilities will be available at the Belt Creek Ranger Station with the address of 4234 US-89, Neihart, MT 59465. These facilities will include hand washing stations (sinks with soap, water, and dryers/paper towels).

Hand sanitizer will also be made available in Arcadis Site vehicles.

15 DECONTAMINATION PROCEDURES

Due to the low hazards associated with the scope of work for this project and/or known or potential contaminant concentrations, basic hygiene best management practices including washing hands/using wet wipes prior to eating, drinking and consuming tobacco products. Used PPE should be safely removed and discarded prior to washing as noted above.

Tools and equipment used for surface water and soil sample collection is to be decontaminated using a PFAS-free, blank soap (liquinox) and water solution. Decontamination wastewater is to be containerized in 55-gallon drums and properly labeled for characterization and off-site disposal following completion of the sampling activities. If conditions change during the course of work warranting additional decontamination protocols, the additional decontamination protocols will be addressed in the applicable task JSA.

16 STANDARD OPERATING PROCEDURES

Arcadis H&S Standards addressing safety-critical work activities are listed below. These standards should be reviewed by the Project Manager, Associate Project Manager and/or Task Manager, and Site personnel prior to start of the project or applicable task to confirm that all requirements are met. Standard Operating Procedures (SOPs) describing the steps in performing the tasks themselves (soil sampling, field documentation, surface water sampling, etc.) are included in the project Work Plan and available in the Arcadis Document Library for personnel reference and field use.

Arcadis Standards:

- ARC HSGE008 – Injury and Illness Prevention Program
- ARC HSFS019 – Utility Location and Clearance
- ARC HSFS012 – Hazardous Waste Operations and Emergency Response
- AUS HSMS002 – Hazard Identification, Risk Assessment and Risk Control
- ARC HSGE007 – Hazard Communication
- ARC HSIH013 – Heat Stress Prevention
- ARC HSMS010 – Incident Reporting and Investigation
- ARC HSGE009 – Stop Work
- ARC HSGE024 – Motor Vehicle Safety Program
- ARC HSIH008 – Hearing Conservation

The Field Health & Safety Handbook (FHSB) is an Arcadis document containing information about topic-specific H&S requirements for the field. This handbook contains relevant general topics and is used as part of the overall HASP process. To aid in the consistency of the HASP process, the handbook will be used as an informational source in conjunction with this HASP.

The following handbook sections are required reading for this project:

- 1.4 TRACK
- 2.7 Stop Work Authority
- 2.11 Drug and Alcohol Awareness
- 3.1 Daily Safety Meetings/Tailgates
- 3.4.1 Vehicle Safety Inspection
- 3.4.2 Driving
- 3.6.1.1 Inhalation First Aid
- 3.6.1.4 Eye Contact First Aid
- 3.12 Severe Weather
- 3.16 Heat and Cold Stress
- 3.17 Biological Hazards
- 3.21 Fatigue Assessment
- 3.22 Personal Protection Equipment

Arcadis project personnel and subcontractors must comply with all FMI H&S Policies including the Contractor H&S Manual. This includes:

- Contractor Orientation
- FMI Policies
 - Standard Safety Requirements Policy
 - Cellular and Handheld Communication Devices
 - Control of Hazardous Energy Sources
 - Fatigue Management
 - Utility Location (Blue Stake)
 - Working at Heights
- FMI Contractor HS Manual
 - Each employee is responsible for learning and abiding by those rules and regulations which are applicable to his or her work, and for reporting and correcting observed or anticipated hazards to his or her immediate supervisor.
 - Report to work fit for duty, well-rested, free from effects of drugs or alcohol.
 - Work safely to ensure personal safety as well as that of co-workers and others.
 - All contract employees are responsible and accountable for working safely and productively, while remaining aware of the hazards of their jobs and following recognized safe job procedures.
 - Follow all health and safety rules and keep work areas clean and free of debris and obstacles.
 - Request help when unsure about how to perform any task safely.
 - Utilize established health and safety controls to reduce risks of the tasks performed.
 - If work cannot proceed safely, stop work and notify their supervisor until the necessary steps have been taken to address and correct the hazards.
 - Report any uncorrected unsafe acts or conditions to the appropriate supervisor.
 - Correct unsafe acts or conditions within the scope of the immediate work.
 - Use and maintain all health and safety devices as required.
 - Not interfere or disable any safety device including remote control, automatic equipment, safety interlocks or warning systems or guards.
 - Immediately report incidents (injury, illness, property damage, near miss, environmental events, etc.) to supervisor.
 - Not tamper with the scene of a safety event.
 - Not tamper with any emergency medical supplies or emergency vehicles.
 - Not engage in horseplay.
 - Not interfere with any radio communications.
 - Not use cell phones or other electronic devices while operating mobile equipment or vehicles.
 - Permits/Audits/Inspections

The most current versions of the Contractor Health and Safety Manual and Policies can be found at <https://www.fcx.com/sites/fcx/files/documents/suppliers/csm.pdf> PERMITS/AUDITS/INSPECTIONS

16.1 Permits

The following will be required prior to invasive (ground-penetration) work at the Site:

- Call-Before-You-Dig (CBYD) Ticket, to be obtained by the drilling subcontractor.

- Arcadis Utility Clearance Checklist
- FCX Utility Clearance/Blue Stake Permit

16.2 Audits/Inspections

The Freeport H&S Representative will conduct client led audits monthly. The findings will be documented and reviewed with Site Management and Site Personnel. Items that are identified during the audit that require action will be assigned to a responsible person and a required action date will be assigned. A response to any action items will be generated and forwarded to the Freeport H&S Representative when the items are completed.

In addition to the Freeport monthly audit, Arcadis is required to perform weekly Site audits during weeks when Freeport H&S is not performing the client led audit. As above, action items will be assigned for issues requiring action, a person responsible for the action will be identified and the actions will be documented upon completion.

This HSEP is an evergreen document and will be updated on at least an annual basis or as additional work tasks are identified.

17 SPILL CONTAINMENT PROGRAM

Arcadis only plans to bring consumer quantities of chemicals to the Site. Pre-preserved laboratory containers will also be transported to and used on-site.

Arcadis plans to refuel equipment during site activities. Refueling will occur by shutting the engine off, ensuring the proper type of fuel, and using nozzles that have automatic shut-off to prevent overfill. Absorbent spill clean-up materials and spill kits shall be available in fueling areas.

Based on the nature and extent of any spill, Arcadis personnel can utilize the safety data sheets (SDS's) instructions to clean up any spilled chemical. SDSs for those chemicals (primarily laboratory container preservatives) are provided in Appendix D, and will be available on-site in Arcadis personnel's vehicle. Based on the low risk of spills, a standalone spill prevention and response plan is not needed.

Release of hazardous materials

In the event of a release of hazardous material to the ground the following procedure will be followed:

Step 1: Initial Assessment – If there is imminent danger such as a fire, call 911. If there is not imminent danger, immediately report the release to Arcadis Project Manager and FMI Project Manager.

Step 2: Contain release - If safe, contain the material by using spill kits. Prevent released material from entering any waterways and use earthen dikes to contain larger spills.

Step 3: Containerize release cleanup material – Contact HSSE Lead to determine proper cleanup procedures including proper containers and labels. Arrange to characterize the cleanup material for proper disposal.

Step 4: Submit a written report to FMI within 24 hours

Hazardous materials with a potential of a release are limited to fuels and oils associated with field vehicles.

Waste management

Small amounts of waste will be generated during the project. This waste includes used PPE and equipment decontamination wipes and water. Solid waste such as PPE and decontamination wipes will be contained in a plastic bag for disposal as general refuse based on generator knowledge. Soil from test pits in waste rock piles.

18 WASTE MANAGEMENT

Small amounts of general refuse will be generated during the project by Arcadis and our subcontractors. This refuse includes used PPE and equipment decontamination wipes, and general office and lunchroom refuse. Solid waste such as PPE and decontamination wipes, and general office and lunchroom refuse will be contained in a plastic bag for disposal as general refuse based on generator knowledge. Liquid waste will be primarily Investigation Derived Waste from the decontamination of field equipment. The liquid waste will be managed in a 55-gallon drum with proper labelling and containment. A record of the management and disposal of the liquid waste will be maintained. Spill or other waste generated will be contained, characterized, properly labelled, and managed in accordance with the relevant legal requirements, Freeport policies and Standard Operating Procedures. Arcadis will notify Freeport Project Manager and will not remove from the site any waste generated on site unless approved by the Freeport Project Manager or Environmental Department.

19 INCIDENT NOTIFICATION, REPORTING AND INVESTIGATION

Freeport requires immediate incident notification to the Project Manager and the H&S Representative via voice. A written preliminary incident report must be forwarded within 24 hours of an incident. Freeport may also require that an incident scene be cordoned off and preserved for further investigation at their discretion.

In the event of an incident, the following notification procedure must be followed:

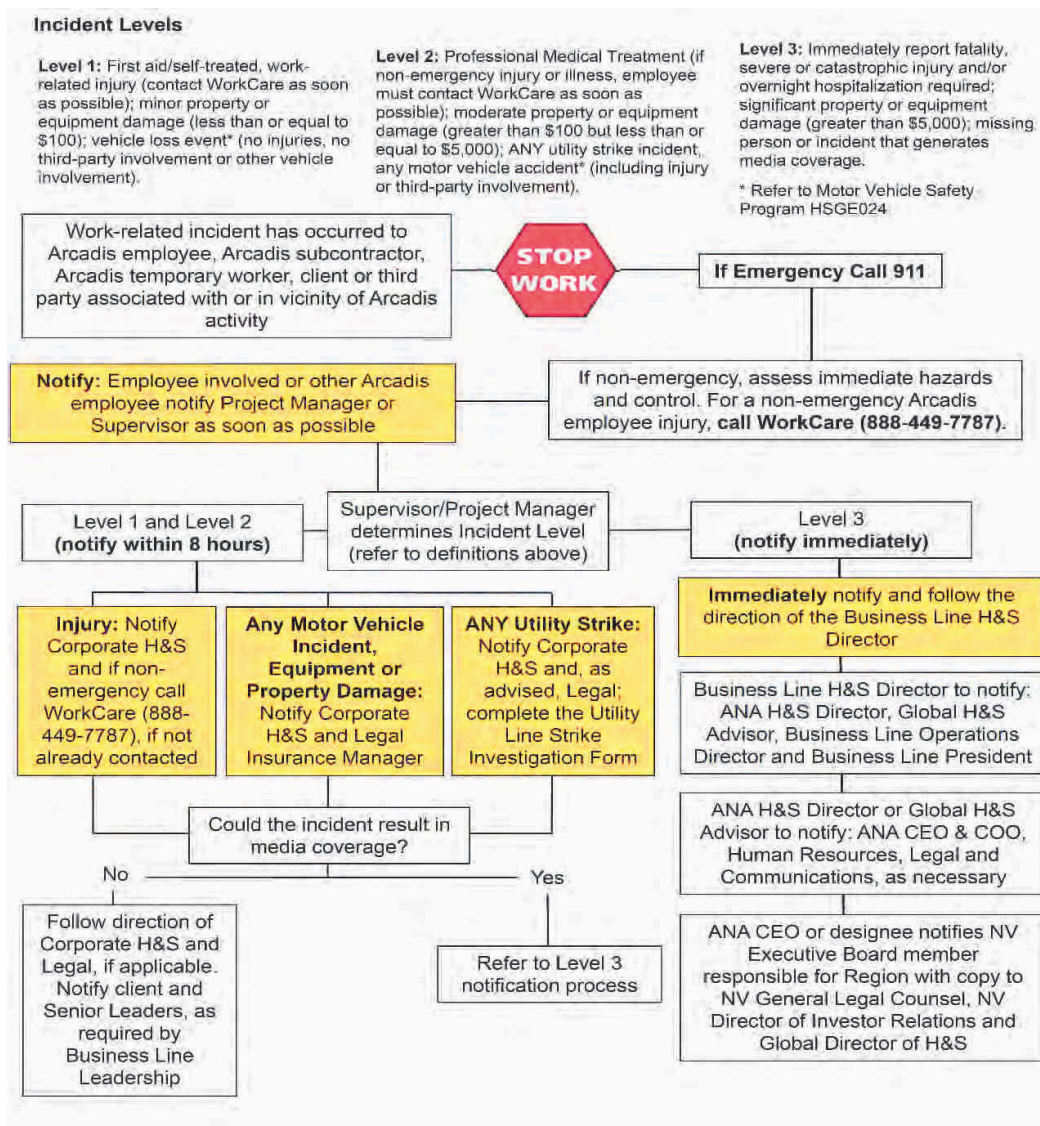
Step 1: Notify FMI Project Manager and Senior H&S Lead immediately

Step 2: Contact Principal-in-Charge / Project Manager / Task Manager

Step 3: Contact H&S Manager

Step 4: Submit a written report to FMI within 24 hours

Arcadis Reporting



20 EMERGENCY PLAN

Use the following notification procedures in the event of an emergency:

- Step 1: Dial 911 (if necessary) and/or WorkCare 1-888-449-7787
- Step 2: Notify the Arcadis Project Manager
- Step 3: Contact Arcadis Corporate H&S
- Step 4: Verbally notify the FMI PM and H&S Representative

Key project personnel contact information is in Section 4.3 of this HSEP.

At least one person per work crew is required to be current in basic First Aid and CPR. Based on the severity of the injury, First Aid can be rendered in the field or at the Site office. All First Aid incidents require that Work Care be contacted to determine if further medical treatment or follow up may be necessary. If an injury is severe enough that the affected individual requires professional medical treatment and can be safely transported, the Task Manager or Sampling Personnel will take the individual to the Benefis East Campus Medical Center (route below). In all other severe injury instances, secure the scene and dial 911.

Should evacuation of the work area become necessary notification will be made verbally or by cell phone. The Site mustering point is at the driveway entrance to the Site.

Hospital name: Benefis East Campus

Hospital address: 1101 26th Street South, Great Falls, MT 59405

Hospital phone: 406-455-5000

Emergency Contact Information and Procedures

Local Police	Norwich Police Department dial 911
Local Ambulance	Norwich Fire Department dial 911
Local Fire Department	Norwich Fire Department dial 911
Local Hospital	Benefis East Campus
Local Weather Data	Weather.com
Poison Control	800 332 3073
National Response Center (all spills in reportable quantities)	800 424 8802
U.S. Coast Guard (spills to water)	800 424 8802
Ranger Station – Belt Creek 4234 US-89, Neihart MT 59465	406-236-5511
Arcadis Project Manager	Dylan Davis, 406-207-6485
Arcadis H&S Manager	Andrew McDonald, 410 923 7820

FMI Contacts	Barb Nielsen, Project Manager, 602 366 8270 Leonard Santisteban, Project Lead and Research, 520 488 2675 Jordan Sisson, Project Lead and Construction, 520 437 8678 Barndon Gilley, Manager H&S, 480-213-3616
WorkCare	1 888 449 7787

20.1 Hospital Information

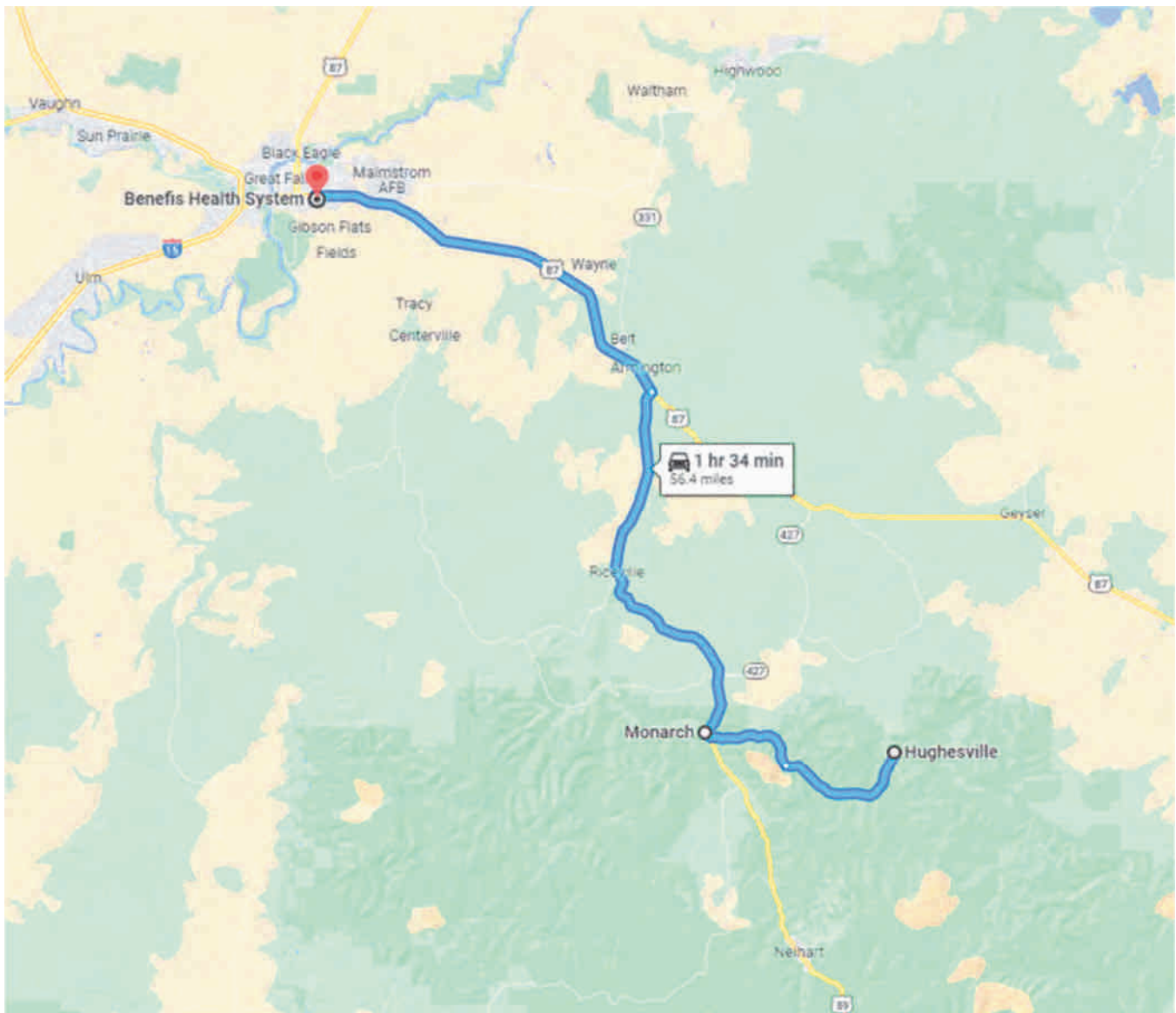
The designated hospital for this project is provided below.

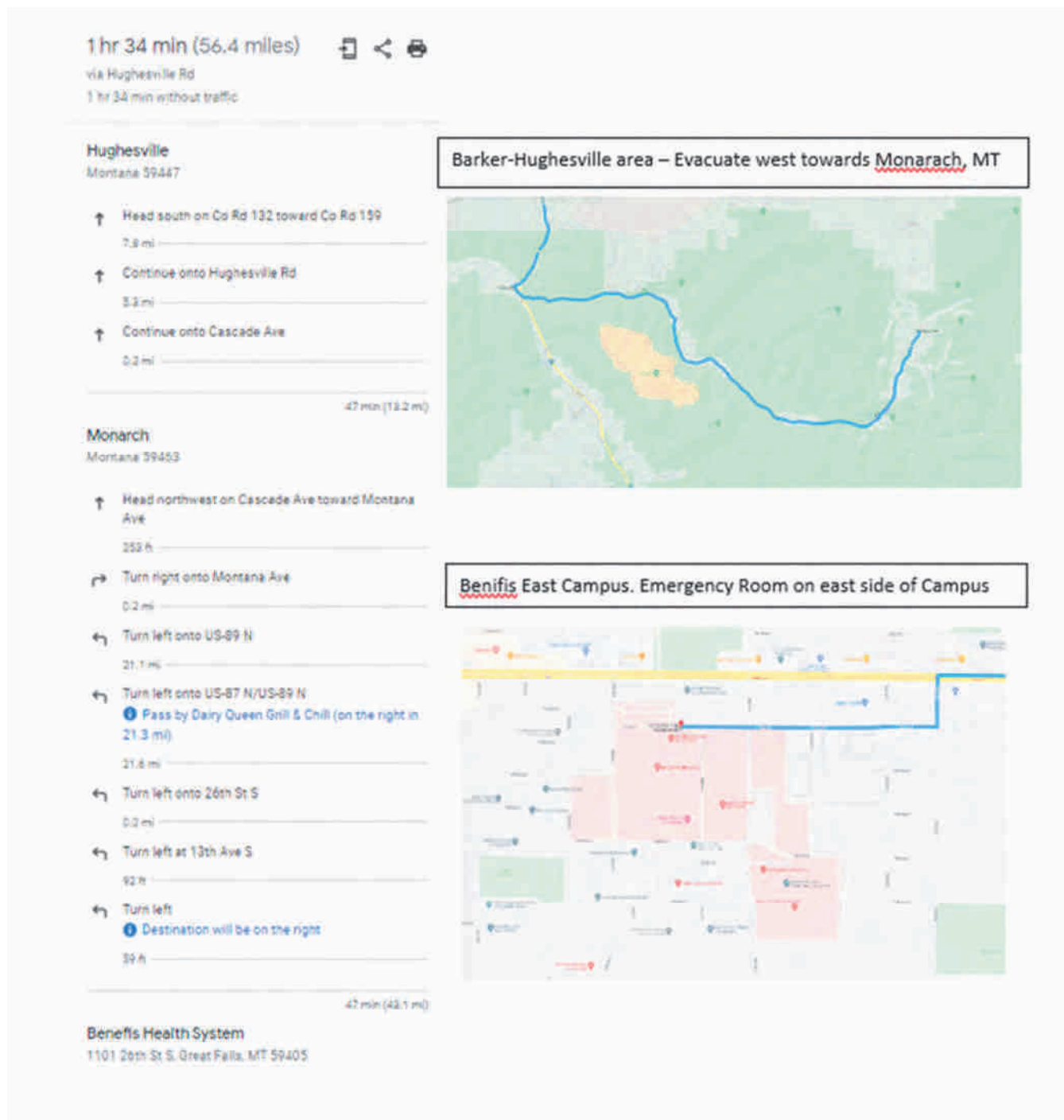
Hospital name: Benefis East Campus

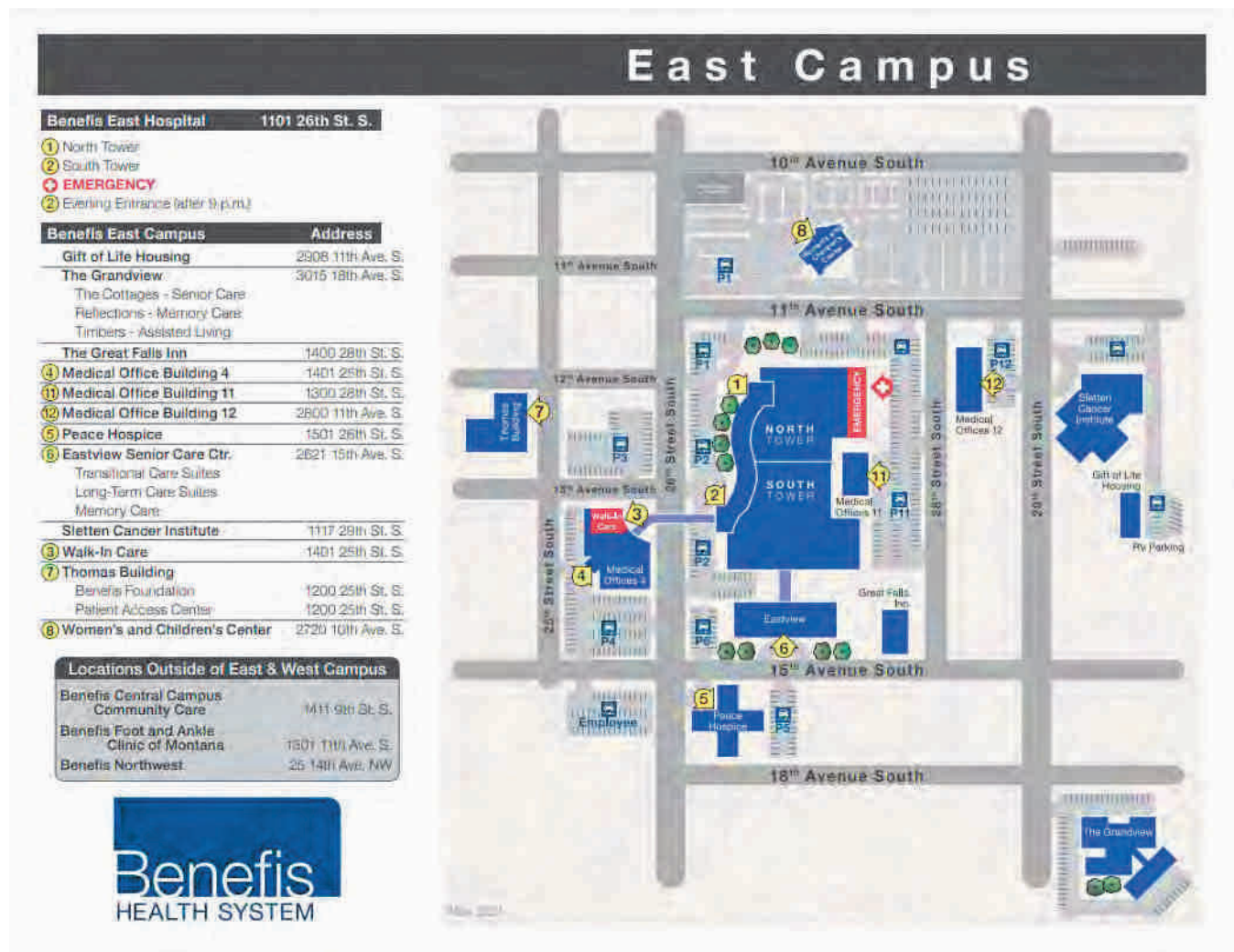
Hospital address: 1101 26th Street South, Great Falls, MT 59405

Hospital phone: 406-455-5000

Hospital route:







21 ACKNOWLEDGEMENT

Signatures

I have read, understand, and agree to abide by the requirements presented in this HSEP. I understand that I have the absolute right to stop work if I recognize an unsafe condition affecting my work until corrected.

[illegible]

Appendix A

Task Hazard Analysis (THA) and FMI Risk Assessment

TASK & RISK REGISTER					
	Task	Pure Risk (highest value)	Controlled Risk (highest value)	Last Reviewed	Comments
1	General Site Activates	4	4		
2	Soil Sampling	6	4		
3	Utility Locating and Survey	4	4		
4	Surface Water Sampling	6	3		
5	Test pit Excavation	9	4		
6	Driving vehicles	6	3		
7	Walkover Surveys	4	4		
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RISK ASSESSMENT

RISK ASSESSMENT TEAM			RISK ASSESSMENT TEAM			SITE - PROJECT NAME		DATE
Name	Company	Position	Name	Company	Position			
Lisa Eichen	Peterson	Project Manager				Barker Hughesville and Carpenter-Groce Creek Mining Districts		8/7/2022
Rita Spaulding	Arcadis	Project Geologist						
Nancy Adams	Arcadis	Systems Developer				LOCATION		REVIEWED BY
Thomas Naramba	Anadarko	Health and Safety				Cascade and Judith Counties		
						ACTIVITY		ACCEPTED BY
						Aerial Recon, Survey, and Soil sampling via test pits and manual methods		
								Date Accepted

TASK	ACTIVITY/EXPOSURES	HAZARDS	TYPE OF EVALUATION	PERSONNEL EXPOSED	FATAL RISK MANAGEMENT (What are the fatal risks)	FATAL RISK MANAGEMENT (What are additional fatal risks)	FATAL RISK MANAGEMENT (What are additional fatal risks)	LIKELIHOOD OF OCCURRENCE (no controls present)	CONSEQUENCE (no controls present)	PURE RISK	Controls Implemented							LIKELIHOOD OF OCCURRENCE (with controls present)	CONSEQUENCE (with controls present)	CONTROLLED RISK		
											CRITICAL CONTROLS (List and Analysis - Signage)	ELIMINATION, SUBSTITUTION AND ENGINEERING CONTROLS (Protection Devices - Hard Barriers - Alarms/Sensors)	% EFFECT	ADMINISTRATIVE CONTROLS (Competencies - Regulation/Procedures - Job Safety Analysis - Signage)	PROCEDURE ASSOCIATED WITH THE ADMINISTRATIVE	% EFFECT	PERSONAL PROTECTIVE EQUIPMENT (Specific or Basic PPE)				% EFFECT	
General Site Activities	Covid 19 Virus	Contracting the Covid-19 Virus	Health	6	Hazardous Substances - Acute	Not Applicable	Not Applicable	1	2	2	COVID-19 Social Distancing and Face Covering Policy, Aratio Covid 19 Policy	Covid-19 Vaccination	80	Personal Hygiene: Hand Washing, Sanitizing, Coughing, Sneezing	COVID-19 Policy	Acute Covid-19 Policy	60	Face Coverings (if close proximity PPE) or	30	1	2	2
	Exposure to Biological Agents	Biologist - Plant, Animal, Insects	Health	6	Hazardous Substances - Chronic	Hazardous Substances - Acute	Not Applicable	2	2	4	Aratio Field Manual, IHA/ISA, Workplace Inspections, Communication, Outreach Bureau - Hazardous Plant Identification	None	0	Aratio Field Manual, IHA, Workplace Inspections, Communication, Outreach Bureau - Hazardous Plant Identification	Aratio Field manual	50	Long Sleeve shirt, bug spray	30	2	2	4	
	Cold Stress/Heat Stress Exposure to UV	Hypothermia/ Heat Stroke/Sun Burn	Health	6	Not Applicable	Not Applicable	Not Applicable	2	2	4	Aratio Cold Stress/Heat Stress Policy, Hydration, Sunscreen, Work/Rest Schedule, Proper Layers	Shaded areas/adequate Conditioning/Use Vehicles	80	Hydration, Schedule, Worker Monitoring	Work/Rest Schedule/Heat Stress Policy	Acute Heat Stress/Cold Stress Policy	60	Basic PPE, long sleeve shirt, proper layers	20	1	2	2
	Physical Hazards	Moving Parts, Utility Strkes, Nearing Loss, Hazardous Substances	Safety	2	Falling Objects	Hazardous Substances - Acute	Not Applicable	2	3	6	Site Orientation, Buddy System, Worker Monitoring, Fatigue Management Plan, IHA, Site Inspections, FCK Fatigue Management Guidelines, FCK Blue state, Basic PPE, Work Gloves (Leather or coated while augring)	None	0	Site Orientation - Buddy System, Worker Monitoring, Fatigue Management Plan, IHA, Site Inspections, FCK Fatigue Management Guidelines, FCK Blue state Policy.	IHA, FCK Blue State Policy, FCK Fatigue Management	60	Basic PPE - Work clothes (Leather or coated while augring)	40	1	3	3	
Soil Sampling	Chemical	Exposure to Co/Cr	Health	2	Hazardous Substances - Acute	Not Applicable	Not Applicable	2	2	4	Sampling Techniques, Monitoring (Visual Duct), PPE, Proper Hygiene, Decontamination	None	0	Sampling Techniques, Visual Duct Monitoring, Proper Hygiene, Decontamination	IHA	50	Basic PPE: Mobile phone while handling samples	20	2	2	4	
	Mobilization/ Equipment Handling	Exposure to public traffic	Safety	2	Vehicle Impact on Person	Not Applicable	Not Applicable	2	3	6	Exclusion Zone, Smith System training, workplace exam, IHA, Buddy system, Cones, parking procedures, spotter when needed, Basic PPE, vest	None	70	Smith System training, workplace exam, IHA, Buddy system, Cones, parking procedures, spotter when needed.	Site orientation, FCK 25 interaction with Heavy Equipment	60	Basic PPE, vest	20	1	3	3	
	Uneven ground	Sprains, strains, broken bones, equipment	Safety	3	Fall from Heights	Not Applicable	Not Applicable	2	2	4	Daylight - hours, IHA, establishing pathways, basic PPE, safety boots	None	0	Daylight - hours, IHA, establishing pathways	IHA, IHA	50	Basic PPE, safety boots in good condition.	20	2	2	4	
Utility Locating and Survey	Biologicals (Ticks and Insects)	Blood borne diseases, Allergic reactions	Health	3	Hazardous Substances - Acute	Not Applicable	Not Applicable	2	2	4	IHA/ISA, Site specific training, Basic PPE, Protective clothing, Bug spray	None	0	IHA/ISA, Site specific training	HESP, IHA	50	Basic PPE, Protective clothing, Bug spray	20	2	2	4	
	Environmental (Heat Stress/Cold Stress)	Heat Stroke/Sun Burn/Cold Stress	Health	3	Not Applicable	Not Applicable	Not Applicable	2	2	4	Heat stress Program Planning, Employee Monitoring, Hydration, Work/Rest Guidelines	None	0	Heat stress Program Planning, Employee Monitoring, Work/Rest Guidelines	HESP, IHA	50	Basic PPE, Hydration	20	2	1	2	
	Physical Hazards	Muscle strains from lifting equipment, ergonomics	Health	3	Not Applicable	Not Applicable	Not Applicable	2	2	4	Written SOP's for Surveying & Utility Locating, IHA Process, Tailgate, HSEP, Basic PPE, Vest.	None	0	Written SOP's for Surveying & Utility Locating, IHA Process, Tailgate, HSEP	HSEP, IHA	50	Basic PPE, Vest.	20	1	2	2	

RISK ASSESSMENT

[illegible]

TASK	ACTIVITY/EXPOSURES	HAZARDS	TYPE OF EVALUATION	PERSONNEL EXPOSED	FATAL RISK MANAGEMENT (What are the fatal risks)	FATAL RISK MANAGEMENT (What are additional fatal risks)	FATAL RISK MANAGEMENT (What are additional fatal risks)	LIKELIHOOD OF OCCURRENCE (no controls present)	CONSEQUENCE (no controls present)	PURE RISK	Controls Implemented							LIKELIHOOD OF OCCURRENCE (with controls present)	CONSEQUENCE (with controls present)	CONTROLLED RISK	
											CRITICAL CONTROLS (List all)	ELIMINATION, SUBSTITUTION and ENGINEERING CONTROLS (Protection Devices - Hard Barriers - Alarms/Sensors)	% EFFECT	ADMINISTRATIVE CONTROLS (Competencies - Regulations/Procedures - Job Safety Analysis - Signals)	PROCEDURE ASSOCIATED WITH THE ADMINISTRATIVE CONTROL	% EFFECT	PERSONAL PROTECTIVE EQUIPMENT (Specific or Basic PPE)				% EFFECT
Surface Water Sampling	Uneven ground	Sprains, strains, broken bones, impairment	Safety	3	Not Applicable	Not Applicable	Not Applicable	2	2	4	Buildup System, Fatigue Management Plan, Hydration, Work/Rest, Communication, JHA/Workplace Exam, Worker Monitoring, Safety Meetings	None	0	Buildup System, Fatigue Management Plan, Work/Rest Communication, JHA/Workplace Exam, Worker Monitoring, Safety Meetings	Procedure First manual	50	Basic PPE, Vest	20	1	2	2
	Chemical	Exposure to CaCl ₂	Health	2	Hazardous Substances - Acute	Not Applicable	Not Applicable	1	2	2	Sampling Techniques, Monitoring (Visual Out), PPE, PPE Regime, Decontamination	None	0	Sampling Techniques, Visual Out Monitoring, PPE, Hygiene, Decontamination	JHA	50	Basic PPE, Nitrile gloves while handling samples	20	1	2	2
	Mobilization/ Equipment Handling	Exposure to public traffic	Safety	2	Vehicle Impact on Person	Not Applicable	Not Applicable	2	3	6	Exclusion Zone, Smith System training, workplace exam, JHA, Buddy system, Cones, parking procedures, spotter when needed, Basic PPE, vest	Exclusion Zone	70	Smith System training, workplace exam, JHA, Buddy system, Cones, parking procedures, spotter when needed	Site orientation, FCX 21 interaction with Heavy Equipment Policy	60	Basic PPE, vest	20	1	3	3
Test pit Excavation	Physical Hazards (Mechanical Equipment, Noise)	Struck by equipment, pinch points, compression, muscle strain, heavy lifting, ergonomics (posturing)	Safety	4	Vehicle Impact on Person	Entanglement and Crushing	Falling Objects	3	3	9	Exclusion Zone, Training, SOP, JHA, signage, work instruction, operation manual, annual assessment process (operating competencies), equipment inspection, basic PPE, vest	Exclusion Zone	70	Training, SOP, JHA, signage, work instruction, operation manual, annual assessment process (operating competencies), equipment inspection	JHA, FCX Management	50	Basic PPE, vest	20	1	3	3
	Biological (ticks and insects)	Blood borne diseases, Allergic reactions	Health	4	Hazardous Substances - Chronic	Not Applicable	Not Applicable	2	2	4	JHA/SA, Site specific training, Basic PPE, Protective clothing, Bug spray	None	0	JHA/SA, Site specific training	HASP, JSA	50	Basic PPE, Protective clothing, Bug spray	20	2	2	4
Drilling vehicles	Mounting/Dismounting equipment	pinch points, falling from heights, slips trips falls, burns, rotating equipments caught in or struck by	Safety	4	Fall from Heights	Not Applicable	Not Applicable	3	3	9	Barriers, Training, SOP/JHA, signage, work instruction, operation manual, annual assessment process, fall protection, basic PPE, vest	Barriers	80	Training, SOP/JHA, signage, work instruction, operation manual, annual assessment process (operating competencies)	Barriers/Decontouring equipment	70	Fall Protection, basic PPE, vest	40	1	3	3
	Physical Hazards	Pinch points, contact with persons, equipment	Safety	6	Vehicle Impact on Person	Not Applicable	Not Applicable	2	3	6	Air bags, seat belts, traction control for exit/guard, traffic cones, Spotter during interior driving, JHA	None	0	Air bags, seat belts, traction control for exit/guard, traffic cones, Spotter during interior driving, JHA	JHA	60	Seatbelts	20	1	3	3
	Chemical	Fueling vehicle, exposure to fuels, oils, greases	Health	6	Hazardous Substances - Acute	Not Applicable	Not Applicable	2	2	4	JHA for fueling operations, Equipment checklists, basic PPE	None	0	JHA, Equipment checklist	JHA	50	Basic PPE	20	1	2	2
Walkover Surveys	Uneven ground	Sprains, strains, broken bones, impairment	Safety	3	Fall from Heights	Not Applicable	Not Applicable	2	2	4	Daylight, focus, JHA, establishing pathways, basic PPE, safety boots	None	0	Daylight, focus, JHA, establishing pathways	JHA	50	Basic PPE, safety boots in good condition	20	2	2	4
	Biological (ticks and insects)	Blood borne diseases, Allergic reactions	Health	3	Hazardous Substances - Acute	Not Applicable	Not Applicable	2	2	4	JHA/SA, Site specific training, Basic PPE, Protective clothing, Bug spray	None	0	JHA/SA, Site specific training	HSEP, JSA	50	Basic PPE, Protective clothing, Bug spray	20	2	2	4
	Environmental (Heat Stress/Cold Stress)	Heat Stroke/Sun Burn/Cold Stress	Health	3	Not Applicable	Not Applicable	Not Applicable	2	2	4	Heat stress Program Planning, Employee Monitoring, Worker/Rest Guidelines	None	0	Heat stress Program Planning, Employee Monitoring, Worker/Rest Guidelines	HSEP, JHA	50	Basic PPE, Hydration	20	2	1	2
	Physical Hazards	Muscle strains from lifting, ergo, ergonomics	Health	3	Not Applicable	Not Applicable	Not Applicable	2	2	4	Written SOP's for Surveying & Utility Locates, JHA Process, Taglines, HSEP, Basic PPE, Vest	None	0	Written SOP's for Surveying & Utility Locates, JHA Process, Taglines, HSEP	HSEP, JHA	50	Basic PPE, Vest	20	1	2	2

COMMENT DESCRIPTIONS

TYPE OF EVALUATION

Safety: Associated with injuries

Health: Associated with occupational diseases or industrial hygiene

Property: Associated with property damage

HAZARD

This is the result from contact with a substance or an energy source (electrical, mechanical, chemical, thermal, pneumatic, hydraulic, etc.) above the capacity limit of the human body, structure or material

LIKELIHOOD OF OCCURRENCE of the event for the operation/project without controls

Unlikely (1) - Highly unlikely to occur during the lifetime of an operation/project.

Possible (2) - Event that may occur during the lifetime of an operation / project.

Likely (3) - Event that may occur (<once per year).

Almost Certain (4) - Recurring event during the lifetime of the operation/ project or >once per year.

CONSEQUENCE if the event occurs (without controls) at the operation/project.

Catastrophic (4): H&S - Multiple fatalities which may result from a physical event (slope failure, personnel transport accident), chemical release event, or clusters of cancer or terminal disease; Property - >\$100 M

financial loss: Environmental - Major onsite degradation or irreparable offsite environmental damage

Significant (3): H&S - One or more fatalities, permanent disabilities, or isolated cancers or terminal/disabling disease; Property - \$50M to \$100M financial loss; Environmental - Significant degradation - onsite impacts or local offsite impacts or reversible impacts

Moderate (2): H&S - Medical treatment or restricted duty or lost time injury, or reversible health effects, or hearing loss; Property - \$25M to \$50M financial loss; Environmental - Short term onsite impact but correctable

Minor (1): H&S - Minimal injury or first aid; Property - \$0-\$25 M financial loss; Environmental - Minimal measurable onsite temporary impact

PURE RISK or risk without controls. Risk (R) = Likelihood X Consequences

R between 8 and 16 = RED - ACTIONABLE - Action Plan Summary Form required. Identify key actions/milestones to be accomplished. Hierarchy of controls required to correct the risk (corrective and preventive actions needed). Determine if interim controls are needed to allow the activity to continue

R 4 to 6* = ORANGE - MONITOR - Monitoring Plan Summary Form required. H&S risks with "unlikely" likelihood and "catastrophic" consequences, or "possible" likelihood and "significant" consequence, the Rating Level is "Monitor" (orange), requiring a formal, documented monitoring plan specific to the risk

R 3* to 6 = YELLOW - MEDIUM SIGNIFICANCE- Monitoring required- proactive measures needed to prevent transition to Actionable. No Action or Monitoring Plan Summary Forms required. Note: risks with potentially fatal "significant" consequences and "unlikely" frequency, the Rating Level is "Medium" (yellow).

R BETWEEN 1 AND 3 = GREEN - LOW - Monitor for trends and patterns which may indicate increasing risk

CRITICAL CONTROLS

List all of the critical controls.

Critical Control definition: is a device, system, or process implemented to eliminate or reduce the risk for a task/job, and if missing or overlooked has the potential to lead to catastrophic outcomes such as serious injury or death.

Example: Fall protection system for working at heights

ELIMINATION, SUBSTITUTION and ENGINEERING CONTROLS (Protection Devices - Hard Barriers -

ELIMINATION: Eliminate total risk - (100%)

SUBSTITUTION: Alternate control with little or no hazard associated with it - (90%)

PROTECTION DEVICES: Devices that avoid contact with the source of the hazard (e.g. pull cord/locking system, secondary containment, ROPS) - (80%)

SOLID BARRIERS: Barriers that cannot be easily circumvented (e.g. spill socks, jersey barriers, etc.) - (70%).

SENSORS & ALARMS: Alarms, sensors, pressure indicators, temperature, speed cameras, etc. (60%).

NOTE: If there is a combination of these controls, consider the highest weighting.

ADMINISTRATIVE CONTROLS (Competencies - Regulations / Procedures - Job Safety Analysis - Signage)

COMPETENCE: Certification of worker to perform task (e.g. welder, rigger, air emission smoke certification, etc.), Annual Assessment Process - (70%)

REGULATION/PROCEDURE: (60%)

JOB SAFETY ANALYSIS (JSA): (50%)

SIGNAGE: Signs that state the hazard and/or prevent a specific act (e.g. Restricted Access, High Noise Area - Hearing Protection Required, No Smoking, etc.) (40%)

NOTE: If there is a combination of these controls, consider the highest weighting.

PROCEDURE ASSOCIATED WITH THE ADMINISTRATIVE CONTROL

Insert Name of Control - Name and responsible document (Regulations/Procedures/ Instructions or other name associated with the task/control)

PERSONAL PROTECTIVE EQUIPMENT (Specific or Basic PPE)

SPECIFIC DEVICE: Air Bag/Fall Cushions/Eyewash/Emergency Shower - (40%)

SPECIFIC PPE: Specific PPE for the task (i.e. welding hood, Acid handling suit, face mask, etc. - (30%)

BASIC PPE: Hard Hat/Safety Glasses/Gloves/Steel Toed Boots - (20%)

NOTE: If there is a combination of these controls, consider the highest weighting.

LIKELIHOOD OF OCCURRENCE of the event for the operation/project with controls

Unlikely (1) - Highly unlikely to occur during the lifetime of an operation/project.

Possible (2) - Event that may occur during the lifetime of an operation / project.

Likely (3) - Event that may occur (<once per year).

Almost Certain (4) - Recurring event during the lifetime of the operation/ project or >once per year.

CONSEQUENCE if the event occurs (with controls) at the operation/project.

Catastrophic (4): H&S - Multiple fatalities which may result from a physical event (slope failure, personnel transport accident), chemical release event, or clusters of cancer or terminal disease; Property - >\$100 M

financial loss: Environmental - Major onsite degradation or irreparable offsite environmental damage

Significant (3): H&S - One or more fatalities, permanent disabilities, or isolated cancers or terminal/disabling disease; Property - \$50M to \$100M financial loss; Environmental - Significant degradation - onsite impacts or local offsite impacts or reversible impacts

Moderate (2): H&S - Medical treatment or restricted duty or lost time injury, or reversible health effects, or hearing loss; Property - \$25M to \$50M financial loss; Environmental - Short term onsite impact but correctable
Minor (1): H&S - Minimal injury or first aid; Property - \$0-\$25 M financial loss; Environmental - Minimal measurable onsite temporary impact

CONTROLLED RISK or risk with controls. Risk (R) = Likelihood X Consequences

R between 8 and 16 = RED - ACTIONABLE - Action Plan Summary Form required. Identify key actions/milestones to be accomplished. Hierarchy of controls required to correct the risk (corrective and preventive actions needed). Determine if interim controls are needed to allow the activity to continue

R 4 to 6* = ORANGE - MONITOR - Monitoring Plan Summary Form required. H&S risks with "unlikely" likelihood and "catastrophic" consequences, or "possible" likelihood and "significant" consequence, the Rating Level is "Monitor" (orange), requiring a formal, documented monitoring plan specific to the risk

R 3* to 6 = YELLOW - MEDIUM SIGNIFICANCE- Monitoring required- proactive measures needed to prevent transition to Actionable. No Action or Monitoring Plan Summary Forms required. Note: risks with potentially fatal "significant" consequences and "unlikely" frequency, the Rating Level is "Medium" (yellow).

R BETWEEN 1 AND 3 = GREEN - LOW - Monitor for trends and patterns which may indicate increasing risk

Supplemental Guidance for Scoring H&S Consequence and Likelihood

Consequence Scores

For example, a haul truck collision is reasonably likely to result in a fatality. If controls are put in place to reduce the likelihood of a collision, the likelihood score would change. However, if a collision is still possible, the consequence is still a fatality.

A single fatality is unacceptable. A Catastrophic consequence, with a rating of 4, is intended to cover outcomes with a large number of fatalities. These

- a mass casualty event (slope failure with the potential to engulf multiple people, destruction of a personnel transport vehicle, underground fire, and
- a gas release capable of engulfing multiple people (e.g. chlorine or H₂S release near an occupied building)

to asbestos, silica, arsenic, or hexavalent chromium)

A significant consequence, with a rating of 3, is intended to cover incidents with the potential to cause one or more fatalities or permanently disabling injuries, or isolated cases of fatal or debilitating disease. These incidents are unacceptable; the rating of 3 does not diminish this. These might include:

- A light vehicle incident
- Fall from height or entanglement in equipment
- A small number of people over-exposed to a carcinogen.

Moderate consequences, rated as 2, are generally significant but reversible. Reportable injuries (medical treatment, restricted duty, and lost time) and reversible health effects would be included here. Mild to moderate hearing loss would may included here, but more significant hearing loss that leads

Incidents with the potential to cause only first aid or less would be 1.

If a health & safety event could involve people outside of our workforce (e.g. community members), review the "Stakeholders..." consequences to consider possible impacts to community relations and social license. In some cases, this could result in a higher consequence score.

Financial and regulatory consequences are unreliable predictors of health & safety risk. Ratings of safety consequences are independent of consequences. If the safety consequence score is 4, but the financial consequence related to the same risk is 3, the consequence score is still 4.

Legal / Compliance can be a significant consideration regarding health & safety. There may be cases where the health and safety consequences are relatively low, but the consequence of non-compliance is substantial.

- Major regulatory compliance—stoppage of work; maximum fines or penalties; repeated violations
- Significant regulatory compliance—mandatory corrective actions; moderate fines/penalties; repeated violations

Likelihood Scores

The likelihood scores are assigned based on the probability of the unintended event. The scores are not assigned based on the frequency of the task. Probabilities are included to provide general guidance to clarify the terms unlikely, possible, etc. The intent is to highlight the differences between the various rankings, not to provide a defined probability of occurrence.

Probability should be considered based on the global industry as the basis, not just an individual site's experience.

Consider the reliability and effectiveness of controls when assigning probabilities. Controls that are high in the hierarchy of controls are more reliable occur during the lifetime of the operation or project.

Assigning scores related to exposure to toxic substances requires input from health and safety professionals with an understanding of industrial hygiene. Consider the level of exposure, the occupational exposure limit, the duration of exposure, and the possible health effects. Hydrogen sulfide and nitrogen dioxide can be lethal after a single substantial overexposure. Silica generally takes long-term overexposure to cause silicosis or cancer.

Ratings and Responses

Actionable risks are unacceptable and must be addressed through the hierarchy of controls. Leadership must determine if it is safe to proceed with the work until action plans are implemented to reduce the risk. Interim controls may be necessary, or it may be necessary to stop the activity until

Risks with potentially catastrophic consequences, which are "highly unlikely to occur during the lifetime of an operation/project" (cell 1-4, rated as orange), and risks with significant safety consequences and the possibility of occurrence "during the lifetime of an operation/project" (cell 2-3, also orange) warrant a formal monitoring process. Consider the process used by Sustainable Development as a guideline.

Fatalities are unacceptable. Freeport-McMoRan covers all fatal risk through our Fatality Prevention Program, which is continually evolving. The ratings in this matrix help in prioritizing this effort. Risks with the potential for a single fatality are rated differently from risks with the potential for mass casualty. The intent is not to diminish the focus on the individual fatality. The intent is to increase the focus on potentially catastrophic incidents.

Risk must be rated through a good-faith effort by personnel with knowledge of the relevant tasks, processes, and exposures. Risk with the potential for severe injury

Revision - January 10, 2017

FCX 4x4 RISK ASSESSMENT MATRIX				CONSEQUENCE	Safety and Health	Legal / Compliance	Environmental**	Stakeholders (Regional, National, International)	Production Capacity	Financial
4	8	12	16	Catastrophic (4)	Multiple fatalities which may result from a physical event (slope failure, personnel transport accident), chemical release event, or clusters of cancer or terminal disease	Major and/or chronic non-compliance issue or Administrative Order/class action lawsuits with merit	Major onsite degradation or irreparable offsite environmental damage	Loss of social license and/or community support or tangible expressions of mistrust across the entire community, setting the agenda for decision makers and key stakeholders	Shut down	>\$100M
3*	6*	9	12	Significant (3)	One or more fatalities, permanent disabilities, or isolated cancers or terminal/disabling disease	Significant non-compliance issue with regulatory requirement NOV with fine potential	Significant degradation - onsite impacts or local offsite impacts or	Organized opposition to operations or tangible expressions of mistrust amongst a majority of community members with significant influence on public opinion	~50%	\$100 - \$50M
3	6									
2	4	6	8	Moderate (2)	Medical treatment or restricted duty or lost time injury, or reversible health effects, or hearing loss	Moderate non-compliance issue with regulatory requirements NOV/NOC with minimal fine	Short term onsite impact but correctable or repairable	Organized group opposition or tangible expressions of mistrust amongst a minority of community members with moderate influence on public opinion and decision makers	~75%	\$50 - \$25M
1	2	3	4	Minor (1)	Minimal injury or first aid	Not a compliance issue with minor regulatory requirements or informal notice	Minimal measurable onsite temporary impact	Minimal reaction from external parties or tangible expressions of mistrust amongst a few community members with some influence on public opinion and decision makers	≥95%	\$25M - \$0
Unlikely (1)	Possible (2)	Likely (3)	Almost Certain (4)	LIKELIHOOD OF OCCURRENCE						
Highly unlikely to occur during the lifetime of an operation / project.	Event that may occur during the lifetime of an operation / project.	Event that may occur (<once per year).	Recurring event during the lifetime of the operation/ project or >once per year.							

*For H&S risks: risks with potentially fatal "significant" consequences and "unlikely" frequency, the Rating Level is "Medium" (yellow), requiring a monitoring effort consistent with Freeport-McMoRan's Fatality Prevention Program. For H&S risks with "unlikely" likelihood and "catastrophic" consequences, or "possible" likelihood and "significant" consequence, the Rating Level is "Monitor" (orange), requiring a formal, documented monitoring plan specific to the risk.

**For risks identified under the biodiversity category on the SD Risk Assessment Form, please use the Biodiversity Consequence Descriptions form in addition to consequence categories on this matrix.

Refer to the Supplemental Guidance tab for additional information on how to apply the consequence and frequency scores.

Rating Level	Response required for risks identified on the SD Risk Assessment Form
Actionable	Action Plan Summary Form required. Identify key actions/milestones to be accomplished.
Monitor	Monitoring Plan Summary Form required.
Medium	Monitoring required; proactive measures needed to prevent transition to Actionable. No Action or Monitoring Plan Summary Forms required.
Low	Monitor for trends and patterns which may indicate increasing risk.

Project Tasks

The following tasks are identified for this project:

1	Driving - Motor vehicles
2	Survey - Land surveying
3	Sampling - Surface water sampling using manual methods
4	Excavation - Using mechanical methods
5	Excavation - Using manual methods
6	Select
7	Select
8	Select
9	Select
10	Select
11	Select
12	Select
13	Select
14	Select
15	Select
16	Select
17	Select
18	Select
19	Select
20	Select

The following documents and/or plans associated with the above task(s) are required and attached:
Not Applicable

☒	Required Checklists/Work Forms
	<i>Tailgate Safety Briefing Form</i>
	<i>Vehicle Inspection Checklist</i>

☐	Required Permits
	<i>Not Applicable</i>

☒	Required H&S Standards
	<i>Utility Location Procedures_ARC HSFS019</i>

Short Service Employees (SSEs)

SSEs (employees who are employed with Arcadis for less than 1 year or are Inexperienced Workers) have the potential to work on this project. If SSEs are utilized, the project team working in conjunction with the SSE's administrative supervisor will ensure requirements of ARC HSGE019 "Short Service Employees" are completed. SSE's will be identified on the project Tailgate Safety Meeting Form.

Roles and Responsibilities

Name	Role	Short Service Employee
1 Joe Gilbert	Project Manager (PM)	No
2 Joe Gilbert	Associate Project Manager (APM)	No
3 Kyle Spaulding	Task Manager	No
4 Betty Walter	Field Technical Lead	No
5 Betty Walter	Site Safety Officer (SSO) (HAZWOPER)	No
6		
7		
8		
9		
10		

Training

All Arcadis employees are required to have the following training to be on site:

Selected Arcadis employees are required to have the following additional training:

H&S Program Orientation (non-certifica
Hazwoper 40-Hour
Defensive Driving - Smith On-Line
DOT HazMat #1
First Aid/CPR
Hazwoper 8-Hour Annual Refresher
None
None
None
None
None
None
None
None
None
Client specific:
Client orientation - FCX 101
Other:

Names or Numbers from above	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
None	
Other:	

The Arcadis Fundamental H&S Principles

Staff working on any of the task(s) listed above must utilize the six Arcadis Fundamental H&S Principles to ensure work is conducted safely. These principles include: 1) Use of TRACK, 2) H&S Planning, 3) Stop Work Authority, 4) "If Not Me Then Who", 5) Stewardship, and 6) Incident Reporting. Every project team member plays an important role in project health and safety. This is more than just having a HASP, training, or PPE. Proactive staff engagement with these principles is critical to a safe work environment.



General Task Hazard Assessment and Risk Control (HARC)

General:		Site-Wide																																																			
The 12 hazard category HARC ratings are not available in this General THA. The mitigated and unmitigated ratings for the hazards presented are based on the Risk Assessment Matrix below. Modify hazards and ratings as necessary to meet project needs.																																																					
<table><tr><th colspan="2">Risk Assessment Matrix</th><th colspan="4">Likelihood Ratings</th></tr><tr><th colspan="2">Consequences Ratings</th><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><th></th><th></th><th>0 Almost Impossible</th><th>1 Possible but Unlikely</th><th>2 Likely to Happen</th><th>3 Almost Certain to Happen</th></tr><tr><td>People</td><td>Property</td><td></td><td></td><td></td><td></td></tr><tr><td>1-Slight or No Health Effect</td><td>Slight or No Damage</td><td>0-Low</td><td>1-Low</td><td>2-Low</td><td>3-Low</td></tr><tr><td>2-Minor Health Effect</td><td>Minor Damage</td><td>0-Low</td><td>2-Low</td><td>4-Medium</td><td>6-Medium</td></tr><tr><td>3-Major Health Effect</td><td>Local Damage</td><td>0-Low</td><td>3-Low</td><td>6-Medium</td><td>9-High</td></tr><tr><td>4-Fatalities</td><td>Major Damage</td><td>0-Low</td><td>4-Medium</td><td>8-High</td><td>12-High</td></tr></table>		Risk Assessment Matrix		Likelihood Ratings				Consequences Ratings		A	B	C	D			0 Almost Impossible	1 Possible but Unlikely	2 Likely to Happen	3 Almost Certain to Happen	People	Property					1-Slight or No Health Effect	Slight or No Damage	0-Low	1-Low	2-Low	3-Low	2-Minor Health Effect	Minor Damage	0-Low	2-Low	4-Medium	6-Medium	3-Major Health Effect	Local Damage	0-Low	3-Low	6-Medium	9-High	4-Fatalities	Major Damage	0-Low	4-Medium	8-High	12-High				
Risk Assessment Matrix		Likelihood Ratings																																																			
Consequences Ratings		A	B	C	D																																																
		0 Almost Impossible	1 Possible but Unlikely	2 Likely to Happen	3 Almost Certain to Happen																																																
People	Property																																																				
1-Slight or No Health Effect	Slight or No Damage	0-Low	1-Low	2-Low	3-Low																																																
2-Minor Health Effect	Minor Damage	0-Low	2-Low	4-Medium	6-Medium																																																
3-Major Health Effect	Local Damage	0-Low	3-Low	6-Medium	9-High																																																
4-Fatalities	Major Damage	0-Low	4-Medium	8-High	12-High																																																
Hazard #1																																																					
Driving - On road - Injury or vehicle damage from motor vehicle accident or incident																																																					
Suggested FHSHB Ref:	3.4	To mitigate this hazard, use TRACK and the following:																																																			
Overall Unmitigated Risk:	HIGH	Smith System (on line)																																																			
Mitigated Risk:	MEDIUM	JSAs																																																			
Comments:	Use Smith System "5-Keys" when driving. See Driving JSA for details.																																																				
Hazard #2																																																					
Driving - Driver - Injury, death or property damage due to driver distraction, fatigue, etc.																																																					
Suggested FHSHB Ref:	3.4, 3.21	To mitigate this hazard, use TRACK and the following:																																																			
Overall Unmitigated Risk:	HIGH	Smith System (on line)																																																			
Mitigated Risk:	LOW	Driver awareness and use of stop work authority																																																			
Comments:	Use route planning. Keep eyes moving while driving. See Driving JSA.																																																				
Hazard #3																																																					
Biological - skin/eye irritation or damage from poisonous plants																																																					
Suggested FHSHB Ref:	3.17.11	To mitigate this hazard, use TRACK and the following:																																																			
Overall Unmitigated Risk:	HIGH	See HASP Tick/Poisonous Plant Section																																																			
Mitigated Risk:	LOW	Job Briefing/Site Awareness																																																			
Comments:	Use skin pre-treatment lotions when available.																																																				
Hazard #4																																																					
Biological - bites or stings from exposure to insects or arachnids																																																					
Suggested FHSHB Ref:	3.17: 2,3,7,8,9,10	To mitigate this hazard, use TRACK and the following:																																																			
Overall Unmitigated Risk:	HIGH	PPE (see HASP "PPE" section)																																																			
Mitigated Risk:	LOW	Job Briefing/Site Awareness																																																			
Comments:	Do body check daily. For ticks see also HASP Tick/Poisonous Plant section																																																				
Hazard #5																																																					
Biological - cuts, scrapes, skin/eye puncture from exposure to physically damaging plants																																																					
Suggested FHSHB Ref:	3.17.11	To mitigate this hazard, use TRACK and the following:																																																			
Overall Unmitigated Risk:	MEDIUM	Job Briefing/Site Awareness																																																			
Mitigated Risk:	LOW	PPE (see HASP "PPE" section)																																																			
Comments:																																																					

General Task HARC (continued)

Hazard #6		
Environmental - Thermal stress - Injury or illness from heat or cold		
Suggested FHSHB Ref:	3.16	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk:	MEDIUM	Field H&S Handbook (see ref. above)
Mitigated Risk:	LOW	JSAs
Comments:	Use job rotation or rest breaks. Stay hydrated and eat regularly.	
Hazard #7		
Environmental - Inclement weather -Injury or equipment damage from inclement weather		
Suggested FHSHB Ref:	3.12	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk:	MEDIUM	Weather Monitoring
Mitigated Risk:	LOW	Cont./Emerg. Planning
Comments:	Use 30/30 rule for lightning. See FHSHB for details.	
Hazard #8		
Motion - Musculoskeletal - Injury from lifting, twisting , stooping, or awkward body positions		
Suggested FHSHB Ref:	3.29.1	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk:	MEDIUM	Engineering Controls (specify in comments)
Mitigated Risk:	LOW	Admin. Controls (specify in comments)
Comments:	Use proper lifting techniques. Use job rotation when applicable. See FHSHB for details.	
Hazard #9		
Motion - Musculoskeletal - Injury from repeated work activity or body motion		
Suggested FHSHB Ref:	3.29.2	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk:	MEDIUM	Engineering Controls (specify in comments)
Mitigated Risk:	LOW	Admin. Controls (specify in comments)
Comments:	Use proper lifting techniques. Use job rotation when applicable. See FHSHB for details.	
Hazard #10		
Gravity - Falls - Injury due to slips and trips		
Suggested FHSHB Ref:	3.26.4, 4.11	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk:	MEDIUM	Site Awareness
Mitigated Risk:	LOW	Housekeeping
Comments:	Use footwear appropriate for site conditions, plan routes and do not hurry while walking.	

Task Specific HARC

Task 1:	Driving - Motor vehicles						
HARC Unmitigated Hazard Types (H-High, M-Medium, L-Low):					FHSB Ref:		3.4
Biological*	-	Chemical	-	Driving*	H	Electrical	-
Environmental*	-	Gravity*	-	Mechanical	-	Motion*	-
Personal Safety	L	Pressure	-	Radiation	-	Sound	L
* Hazard rating, if present, excludes General THA hazards in this category.							
Hazard #1							
Driving - Off road - Injury or vehicle damage from object impact/vehicle rollover/improper load securement							
Suggested FHSB Ref:	3.4.2.1			To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:	HIGH			JSAs			
Mitigated Risk:	LOW			Field H&S Handbook (see ref. above)			
Comments:	Site locations require driving on dirt roads with variable terrain - 4WD is recommended in these areas. Secure loads when applicable and use a spotter when necessary.						
Hazard #2							
Personal safety - Diet and medications- Injury or illness from improper eating and hydration or use of medications that may cause drowsiness during work							
Suggested FHSB Ref:	2.2, 2.11			To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:	MEDIUM			Job Briefing/Site Awareness			
Mitigated Risk:	LOW			Field H&S Handbook (see ref. above)			
Comments:							

Task Specific HARC (continued)

Task 2:	Survey - Land surveying						
HARC Unmitigated Hazard Types (H-High, M-Medium, L-Low):			FHSB Ref: 3.9				
Biological*	M	Chemical	-	Driving*	-	Electrical	-
Environmental*	M	Gravity*	M	Mechanical	-	Motion*	M
Personal Safety	L	Pressure	-	Radiation	-	Sound	L

Hazard #1	
Environmental - Sun or wind -Skin injury from sun or wind exposure	
Suggested FHSB Ref: 3.12	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk: MEDIUM	JSAs
Mitigated Risk: LOW	Field H&S Handbook (see ref. above)
Comments: Site location has the potential to be exposed in areas. Use sunscreen when needed and layer appropriately for the climate.	

Hazard #2	
Biological - skin or eye irritation or injury from exposure to mammal, reptile, amphibian, fish, bird or invertebrate sprays, excretions, urine or saliva	
Suggested FHSB Ref: 3.17	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk: MEDIUM	Job Briefing/Site Awareness
Mitigated Risk: LOW	PPE (see HASP "PPE" section)
Comments:	

Hazard #3	
Radiation - Non-ionizing - Injury or illness due to exposure to non-ionizing radiation including sun exposure	
Suggested FHSB Ref: 2.5, 3.22	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk: MEDIUM	PPE (see HASP "PPE" section)
Mitigated Risk: LOW	H&S Standards
Comments: Use sunscreen when needed and layer appropriately for the climate	

Hazard #4	
Gravity - Falls - Injury due to slips and trips	
Suggested FHSB Ref: 3.26.4, 4.11	To mitigate this hazard, use TRACK and the following:
Overall Unmitigated Risk: MEDIUM	Select
Mitigated Risk: LOW	Select
Comments:	

Task Specific HARC (continued)

Task 3:	Sampling - Surface water sampling using manual methods						
HARC Unmitigated Hazard Types (H-High, M-Medium, L-Low):				FHSB Ref:		3.9	
Biological*	L	Chemical	L	Driving*	-	Electrical	-
Environmental*	M	Gravity*	M	Mechanical	-	Motion*	L
Personal Safety	L	Pressure	-	Radiation	-	Sound	L
Hazard #1							
Environmental - Sun or wind -Skin injury from sun or wind exposure							
Suggested FHSB Ref:	3.12			To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:	MEDIUM			JSAs			
Mitigated Risk:	LOW			Field H&S Handbook (see ref. above)			
Comments:	Site location has the potential to be exposed in areas. Use sunscreen when needed and layer appropriately for the climate.						
Hazard #2							
Chemical- liquids - injury or illness from skin absorption							
Suggested FHSB Ref:	3.9, 3.22, 3.30, 3.33			To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:	MEDIUM			Select			
Mitigated Risk:	LOW			Select			
Comments:	Preservatives are used in sample bottles. Use nitrile gloves when sampling to protect skin from spills.						

Task Specific HARC (continued)

Task 4:	Excavation - Using mechanical methods						
HARC Unmitigated Hazard Types (H-High, M-Medium, L-Low):			FHSB Ref: 4.4				
Biological*	L	Chemical	L	Driving*	-	Electrical	M
Environmental*	L	Gravity*	L	Mechanical	M	Motion*	M
Personal Safety	-	Pressure	L	Radiation	-	Sound	M

Hazard #1	
Motion - Struck by - Bodily injury from impact with moving object	
Suggested FHSB Ref:	2.5, 3.22
Overall Unmitigated Risk:	MEDIUM
Mitigated Risk:	LOW
To mitigate this hazard, use TRACK and the following: Site Awareness Engineering Controls (specify in comments) Exclusion zone, use spotters, Communication with the operator, make eye contact before approaching equipment	
Comments:	

Hazard #2	
Driving - Off road - Injury or vehicle damage from object impact/vehicle rollover/improper load securement	
Suggested FHSB Ref:	3.4.2.1
Overall Unmitigated Risk:	HIGH
Mitigated Risk:	LOW
To mitigate this hazard, use TRACK and the following: Specialized Training per Standard Field H&S Handbook (see ref. above) Operator has correct training, equipment checks	
Comments:	

Hazard #3	
Motion - Process failure - Injury or equipment damage due to improper lockout/tagout	
Suggested FHSB Ref:	3.24
Overall Unmitigated Risk:	MEDIUM
Mitigated Risk:	LOW
To mitigate this hazard, use TRACK and the following: Lockout/Tagout H&S Standards Spotter, training	
Comments:	

Task Specific HARC (continued)

Task 5:	Excavation - Using manual methods						
HARC Unmitigated Hazard Types (H-High, M-Medium, L-Low):				FHSB Ref:		3.27	
Biological*	L	Chemical	L	Driving*	-	Electrical	M
Environmental*	L	Gravity*	L	Mechanical	L	Motion*	M
Personal Safety	-	Pressure	L	Radiation	-	Sound	L
Hazard #1							
Personal safety - Fatigue - Injury or illness caused while working when fatigued							
Suggested FHSB Ref:		3.21		To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:		MEDIUM		Engineering Controls (specify in comments)			
Mitigated Risk:		LOW		Select			
Comments:		Take breaks, switch out crews, Stretch prior to work, wear gloves					
Hazard #2							
Driving - Off road - Injury or vehicle damage from object impact/vehicle rollover/improper load securement							
Suggested FHSB Ref:		3.4.2.1		To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:		HIGH		JSAs			
Mitigated Risk:		LOW		Smith System (on line)			
Comments:		Site locations require driving on dirt roads with variable terrain - 4WD is recommended in these areas. Secure loads when applicable and use a spotter when necessary.					
Hazard #3							
Chemical - solids/particulates, injury or illness from inhalation							
Suggested FHSB Ref:		3.2, 3.22, 3.30, 3.33		To mitigate this hazard, use TRACK and the following:			
Overall Unmitigated Risk:		MEDIUM		JSAs			
Mitigated Risk:		LOW		Job Briefing/Site Awareness			
Comments:		PPE, Gloves					

Appendix B

Supplemental Plans

Tick and Poisonous Plant Hazards

For all projects with outdoor work, biological hazards must be addressed in the tailgate safety meeting each day. The following controls must be used to mitigate biological hazards while working and must also be discussed in the tailgate safety meeting.

Controlling Tick Hazards

Risk Guide for Ticks:

Low	Paved areas; parking lots; well manicured lawns and fields; no work taking place within 15 feet of vegetated areas; work in REGIONS with no tick populations; sub-freezing temperatures, snow or ice cover on ground.*
Medium	Brush hogged fields, wetlands, and grasslands; forested areas with little undergrowth; weeds less than knee height; moderately dense foliage; sporadic or moderately vegetated shaded areas; average leaf accumulation and decaying material on the ground; work taking place in fields after application of insecticide; work in REGIONS with a recognized moderate tick populations; outdoor work during spring, summer and fall months.*
High	Uncut fields, wetlands, forested areas, and grasslands; weeds taller than knee height; heavy dense foliage; heavily vegetated shaded areas; excessive accumulations of leaves and decaying material on the ground; work in REGIONS with recognized heavy tick populations; areas with posted tick hazard warnings; outdoor work during spring, summer and fall months.*

*Cold weather does not eliminate risk of exposure to deer ticks as they may be active all year in areas that experience subfreezing temperatures.

Ticks are ranked as a **High** risk for this project

Care should be taken to avoid walking through or working in tall grasses, overgrown or bushy vegetation to the extent reasonable and practical. No single control is effective against ticks.

Select required controls below:

Engineering Controls

- ☐ Mowing of work area
- ☐ Clearing overgrown vegetation
- ☐ Pesticide application
- ☐ Other: _____

Administrative Controls

- ☒ Complete tick check morning/evening
- ☐ Scheduled tick check: _____
- ☒ Inspect backpacks, equipment cases, etc. daily
- ☒ Vehicle cab - maintain good housekeeping
- ☐ Other: _____

Personal Protective Equipment

☐ Light colored clothing	☐ White coveralls/Tyvek
☐ Light colored hat/hardhat	☐ Taped cuffs/pant legs
☐ Pants tucked in boots	☐ Tick gators
☐ Shirt tucked into pants	☐ Double sided tape/duct tape sticky side out
☐ Long sleeved shirt and long pants	☐ Insect mesh/netting for face/head or whole body suit
☐ White Tyvek pants	☐ Other: _____

Repellents

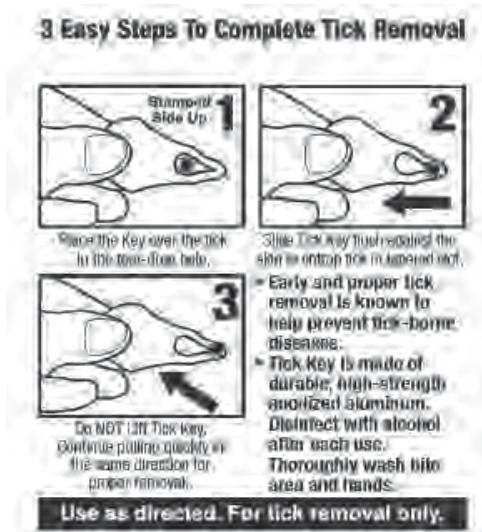
☐ Repellents will not be used	☐ Deet 20-40% applied to skin
☒ Permethrin impregnated clothing (purchased)	☐ Other: _____
☒ Permethrin (0.5% self applied/treated to clothing)	

Permethrin must be applied to clothing within the past 6 weeks or within 6 garment washings. Do not apply permethrin directly to skin. Follow manufacturer's application instructions.

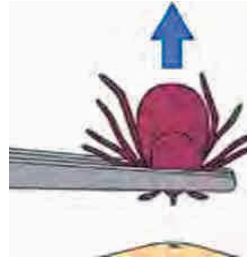
Tick Removal and First Aid

Ticks removed within 24 hours of embedment represent a very low risk for adverse outcomes. Perform tick checks as directed above. To properly remove a tick:

Using a Tick Removal Tool



Using Tweezers



- 1) Use point tip tweezers, if available, to reduce potential of crushing the ticks body
- 2) Grasp the tick as close to skin as possible
- 3) Pull upward with even pressure.

Do not crush tick with fingers

After removal, wash affected area with alcohol or iodine. Wash hands thoroughly after removal. Document date/time of the removal in field notes, field form or H&S app. If rash or fever develops, call WorkCare

Poisonous Plants (Poison Ivy, Poison Oak, Poison Sumac)

All work outdoors, regardless of time of year, must address poisonous plant hazards and controls in the tailgate safety meeting.

Controlling Exposure to Poisonous Plants

Poisonous Plants are ranked as a **High** risk on this project

Select required controls below:

Engineering Controls

- ☐ Not applicable
- ☐ Mowing of work area
- ☐ Clearing overgrown vegetation
- ☐ Herbicide application
- ☐ Other: _____

Administrative Controls

- ☒ Identify and avoid (see ID Quick Guide below)
- ☒ Watch for signs or symptoms of exposure
- ☒ Vehicle cab - maintain good housekeeping
- ☐ Other: _____

Personal Protective Equipment

- ☐ Gloves
- ☐ Hat/hardhat/head covering
- ☐ Pants tucked in boots
- ☐ Shirt tucked into pants
- ☐ Long sleeved shirt and long pants

- ☐ White coveralls/Tyvek
- ☐ Taped cuffs/pant legs
- ☐ Dust mask (during burning activities, etc.)
- ☐ Other: _____

Repellents

☒	Repellents will not be used
☐	Barrier creams
☐	Other: _____

Skin Decontamination

☐	Wash with post-exposure soap and water
☐	Wash with soap and water (use hot water if available)
☒	Hot shower at end of day
☐	Other: _____

Equipment Decontamination

Due to the high risk associated with poisonous plants on this project, portable equipment and tools should be considered contaminated with urushiol (the oil that causes allergic reactions and dermatitis in poisonous plants covered by this plan). Decontaminate by using post-exposure soap and water or alcohol spray if safe to do so for the equipment/tool being cleaned. Larger equipment should be decontaminated prior to performing maintenance by pressure washing or spraying with alcohol spray in area of maintenance (i.e. tires, etc.).

Clothing Decontamination

Wash work clothing in hot water separate from other clothing. Since the project has a high risk for poisonous plants, work boots must be considered contaminated with urushiol. Decontaminate with post-exposure soap and water or hot soap and water. If safe for the boot, consider spraying with alcohol spray if post-exposure soap is not available. Place disposable outer clothing (coveralls, Tyvek, etc.) and disposable gloves in plastic bag for disposal. Wear gloves while removing disposable outer clothing.

First Aid

If skin irritation or other signs of allergic reaction develops contact WorkCare for assistance. Document date and time of exposure, if known, in field notes, field form or H&S app.

Identification Quick Guide

Ticks:

American Dog Tick



Blacklegged (Deer) Tick



Brown Dog Tick



Groundhog Tick



Gulf Coast Tick



Lone Star Tick



Rocky Mountain Wood Tick



Soft Tick



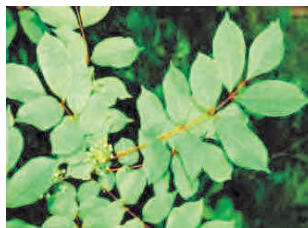
Poison Ivy:



Poison Oak:



Poison Sumac:



For other biological hazards, address the hazards and controls in the JSA for the work task.

Purpose and Scope

Date Completed 6/17/2022

The purpose of this document is to serve as a planning tool and implementation guide to assist the project team, onsite personnel, and the Site Safety Officer (SSO) or other designated responsible party to comply with the requirements set forth by **Cal/OSHA Title 8 CCR 3395 Heat Illness Prevention Standard** and the **Washington State Outdoor Heat Exposure Regulations 296-62-09510 thru 09560**.

NOTE: This HASP Supplement is required to be used in California and Washington states. The Arcadis Health and Safety Standards ARC HSIH013 Heat Stress Prevention, and ARC HSGE008 Injury and Illness Prevention Program (IIPP) must accompany this HASP Supplement. To completely address the regulatory requirements for work in CA and WA states these standards are required to be used in association with the project-specific HASP and this supplement.

The scope of this HIPP applies to Arcadis projects which include, but are not limited to: outdoor operations such as contractor oversight, construction, refining, oil and gas extraction, asbestos removal, and hazardous waste site activities and interior work particularly tasks which require employees to wear PPE which can increase the risk for heat stress for the wearer. This HIPP provides guidance to prevent or reduce the risk of work-related heat illness. This HASP Supplement provides site specific instructions for actions to be completed at the project site.

Project sites in other states and provinces are expected to use this HASP Supplement as a Best Management Practice to prevent heat related illness injuries.

Project Site Name Barker Hughesville and Carpenter-Snow Creek Mining District

Authority and Implementation

The following designated individuals have authority and responsibility for implementing the provisions of this program at the project work site indicated above.

Project Manager	Barker Hughesville and Carpenter-Snow Creek Mining District
Site Safety Officer (SSO)	Joe Gilbert
SSO Designated Alternate	Betty Walter

Acclimatization of Personnel for Heat Stress Prevention

The degree to which personnel have been able to physiologically adjust or acclimatize to working under hot conditions affects ability to safely do work. Acclimatized individuals generally have lower heart rates and body temperatures than unacclimated individuals, and sweat sooner and more profusely. This enables them to maintain lower skin and body temperatures at a given level of environmental heat and work loads than unacclimated workers. Acclimatization can occur after a few days of exposure to the hot work environment. OSHA/NIOSH suggests an acclimatization period of 2-3 days for fit personnel. On the 1st day personnel should spend 50% of the day exposed to / working in the hot environment and increasing the amount of work 10-20% based on personnel response to the hot environment and work load.

Procedures for Provisions for Potable Water

The SSO or designee will be responsible for implementing the following when conditions at the site are anticipated to exceed 80 degrees (°) Fahrenheit (F) / 26.6° Celsius (C)

1. Proper hydration is critical to preventing heat related illness and injury. Project sites will maintain an adequate supply of suitably cool, fresh and pure potable water on site/readily accessible to allow each employee to consume 1 quart (1 L) of water per hour, ideally at a rate of four 8-oz (250 mL) cups per hour.

NOTE: Fresh and pure water is defined as being "odor free and suitably cool". Where suitably cool means water being cooler than the ambient temperature but not so cold as to cause discomfort or prevent drinking.

NOTE: Electrolyte replacement drinks or "Sports Drinks" should be used to replace essential minerals lost during sweating. Sports drinks should supplement water intake e.g. one "sport drink" to every three bottles of water (3 waters : 1 sport drink)

2. During the Tailgate Safety Meeting and site briefings identify and communicate the type and location of the water source. The water source must provide suitably cool, fresh, and pure water in sufficient quantity for all employees at the site. Water shall be provided free of charge or expenses will be reimbursed for employees. If the source is potable plumbed water do not complete Item 6 of this Section.

3. Communicate to staff whether all water for the day will be provided at the start of the shift (e.g., 2 gallons / 8 L per employee for an 8-hour shift), or how and when water will be replenished.

NOTE: A sufficient quantity of water must always be present and readily accessible to allow every employee to consume at least 1 quart (1L) of water per hour. It is suggested to have a minimum of three hours supply of water per employee on hand.

4. Water supplies must be positioned as close as reasonable possible to site workers. Placing water only in shaded areas or by toilet facilities is not sufficient, particularly at large work sites or at multi-story construction sites. Drinking water sources need to be close enough to workers to allow for routine consumption per the rate noted above.

5. Inspect the coolers / water dispensers for cleanliness and replenishment of water and cooling ice routinely based on temperatures and staff size. Cooling ice will be stored in clean coolers if added directly to water dispensers.

NOTE: If the site temperature exceeds 90° F / 32° C the frequency of the cooler inspection will increase to verify water remains cool and the water supply is maintained.

6. Oversee the daily inspection and maintenance of coolers to ensure they are kept clean and in good condition.

Potable Water Source & Location

☐	Potable plumbed source	Location:	
☒	Bottled water in chilled cooler	Location:	Vehicles
☐	Drinking water dispenser & cups	Location:	

Procedures for Provisions for Potable Water Continued

Check which applies. Must check at least one box, or provide additional detail.

☒	Ice will be purchased at the start of each day.
☐	Ice will be provided by an onsite source or vendor service. Ice to be potable
☐	Alternative potable ice source:
☐	Food safe cleaning product for water cooler.
☐	Sufficient amount of drinking water cups for each employee per dispenser.
☐	Other items needed:

Access to Shade

The SSO or designee is responsible for implementing the following for how shade will be coordinated and provided **when temperatures exceed 80° F / 26° C**.

1. Access to shade must be allowed at all times. Before the start of work, the location of the shade areas, the importance of taking shade breaks, recognizing the signs and symptoms of heat illness, the schedule of shade breaks, and the location of shade break locations (if not portable) will be addressed during each Tailgate Safety Meeting and site briefing.

NOTE: Where required by regulation, shade breaks will be taken at a minimum rate of 10 minutes of shade for every two hour work period. As temperature increases shade breaks will increase in frequency. See the Heat Index table below for Heat Index specific Action Levels defining shade break frequency and duration.

2. The amount of shaded area must be able to accommodate all employees taking a recovery or rest break including employees on meal breaks. The shaded area(s) don't need to provide shade to accommodate **all employees** on a site or working a shift at the same time. An example includes rotating routine breaks among employees. Also, additional portable shade structures can be erected on an "as-needed" basis.

Employees must have enough shaded space so they can sit in a normal posture fully in the shade with enough space to allow for sitting without being in physical contact with each other. Employees who desire access to shade must not be deprived of it due to lack of space.

3. Employees who take a preventative cool-down rest;

(1) shall be monitored and asked if they are experiencing symptoms of heat related illness. (2) shall be encouraged to remain in the shade. (3) shall not be ordered back to work until signs or symptoms of heat illness have abated, but in no event less than 5 minutes in addition to the time needed to access the shade.

If an employee exhibits signs or symptoms of heat illness while taking a preventative cool-down rest the SSO will provide appropriate support (e.g. additional hydration and/or call to WorkCare) or emergency response support as needed based on symptoms.

4. Shade structures will be relocated to follow the crew for moving tasks. Shade structures will be placed within 50 feet of the work area, if practical. Shade structures must be no further than a short walk away (e.g. 2-3 minutes) from the work area. This consideration becomes more critical as the temperature rises above 80° F (26 C).

Access to Shade Continued

5. In situations where it is not safe or feasible to provide shade, the SSO will document in the HASP Supplement the unsafe or unfeasible conditions, and include the steps taken to provide alternative cooling measures equivalent to shade.

Unsafe/unfeasible conditions: _____

Alternative Cooling Measures Implemented:

☒	Provide vehicles with working air conditioner to all employees for rest breaks / recovery breaks / meal breaks.
☐	Provide temporary or mobile shade structure(s) that are either ventilated or open to air movement (Secure against wind.)
☐	Provide a building / permanent structure(s) in close proximity to the work area with a cooling environment via mechanical ventilation or open to air movement which will be used for shade. (Job trailer, pavilion, manufacturing building, etc.)
☐	Other: _____

Monitoring of Weather and Heat Index Table

1. The SSO or designee must check the extended weather forecast in advance of the upcoming work on a weekly basis. Work schedules will be adjusted in advance, taking into consideration whether high temperatures or a heat wave is expected.

Accepted weather forecasting resources include webpages "NOAA.gov" or "weather.com" or see the NIOSH Heat Tool (formerly the OSHA Heat Tool app)

<https://www.cdc.gov/niosh/topics/heatstress/heatapp.html>

2. Before work starts for the day or shift, the SSO will review the forecasted temperature and humidity for the (exterior) work site and compare conditions against the National Weather Service Heat Index (below) to evaluate the risk level for heat illness. Determination will be made of whether or not workers will be exposed to a combination of temperature and humidity characterized as "Caution", "Extreme Caution", "Danger" or "Extreme Danger" for heat illnesses.

NOTE: It is important to know the temperature at which these warnings occur. When working outdoors see the Heat Index Table in this supplement for Action Level specific instructions for hazard controls.

3. Where state regulations indicate a thermometer or similar on-site monitoring device will be used at the job site to monitor for sudden increases in temperature. The SSO will be responsible for obtaining a thermometer/weather station prior to the start of work and make it readily visible / accessible where it can easily be monitored throughout the course of the day.

NOTE: If the temperature is **> 80°F (26 C)** shade structures will be opened and made available to workers. If temperature is **≥ 95° F (35 C)** additional preventive measures will be implemented.

Note: The Heat Index table was developed with an expectation of partial shade & light wind conditions present. Work conducted in direct / full sunlight (e.g. no partial shade) and no wind adds up to 15° F (8° C) to the Heat Index evaluation.

Monitoring of Weather and Heat Index Table Continued

Heat Index Action Levels. Below are recommended additional controls. Each level of additional controls is additive as the temperature increases.

CAUTION 80° - 90° F (26° - 32° C). Implement one or more of the following measures: Provide and direct hydration, schedule breaks, ensure lightweight clothing is worn, provide break areas with shade / ventilation / air conditioning.

EXTREME CAUTION 90° - 105° F (32° - 40.5° C). Implement all the previous and add one or more of the following: Provide light duty PPE, cooled break areas, shaded work areas.

NOTE: "Light Duty PPE" includes hard hat sun shades, sun hats, dry or wet evaporative cooling vests, microfiber cooling towels / scarves / headbands / hard hat suspension inserts or sweatbands, hard hat neck shades.

DANGER 105° - 130° F (40.5° - 54.4° C). Implement all the previous and add one or more of the following: cooled work areas, modified work schedule, heavy duty PPE, and personnel physiological monitoring.

NOTE: "Heavy Duty PPE" phase-change cooling vests, gel pack or ice pack equipped cooling vests. Consider engineering controls such as forced ventilation.

EXTREME DANGER $\geq 130^\circ \text{ F}$ ($\geq 54.4^\circ \text{ C}$). If working at this temperature or greater Stop Work until conditions change or hazards are effectively controlled via the items listed above. At this range of temperatures it is critical to implement personnel vital sign monitoring for determining the appropriate frequency and duration of Work / Rest cycles.

Work / Rest Cycle Duration and Frequency Process

All workers, regardless if they are wearing permeable or impermeable clothing, should be monitored when conditions warrant e.g., when temperatures exceed 80°F / 26.6°C. If impermeable clothing is worn (e.g., not standard cotton/synthetic work clothes), it is a best practice to begin monitoring workers when temps are > 70°F in the work area. Prioritize workers completing strenuous tasks. Prioritization should also apply to work conducted indoors, for strenuous tasks, and/or if additional PPE is worn (such as Level C respiratory protection or(CPC). If impermeable clothing, Level C, or CPC is not worn, follow the Heat Index table instructions and evaluate personnel monitoring as part of the high heat measures. Details provided below for appropriate work/rest cycle development with the default rest cycle being a 15-minute interval for every hour when temperatures exceed 90°F.

NOTE: *Warning signs include: When a person's sustained (e.g., several minutes) heart rate exceeds 180 beats per minute (bpm) minus their age (e.g., $180 - \text{age} = X$) for individuals with normal cardiac performance per their physician; or a body core temperature exceeds 101.3°F / 38.5°C for acclimatized workers or 100°F / 38°C for unacclimated workers; a recovery heart rate at 1 minute after a peak work effort is greater than 120 bpm; or there are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness.*

Suggested Frequency and Duration of Work / Rest Cycles Applying Physiological Monitoring of Acclimatized Personnel

Adjusted Temp. (1)	Permeable PPE (2)	Impermeable PPE (3)
$\geq 90^{\circ}\text{ F} / 32^{\circ}\text{ C}$	After ea. 45 mins. of work	After ea. 15 mins. working
$87.5\text{--}90^{\circ}\text{ F} / 30.8\text{--}32.2^{\circ}\text{ C}$	After ea. 60 mins. of work	After ea. 30 mins. Working
$82.5\text{--}87.5^{\circ}\text{ F} / 28.1\text{--}30.8^{\circ}\text{ C}$	After ea. 90 mins. of work	After ea. 60 mins. Working
$77.5\text{--}82.5^{\circ}\text{ F} / 25.3\text{--}28.1^{\circ}\text{ C}$	After ea. 120 mins. of work	After ea. 90 mins. Working
$72.5\text{--}77.5^{\circ}\text{ F} / 22.5\text{--}25.3^{\circ}\text{ C}$	After ea. 150 mins. of work	After ea. 120 mins. Working

NOTES:

(1) Adjusted air temp (ta adj) calculation: $ta\ adj\ F = ta\ F + (13 \times \% \text{ sunshine})$. Measure the air temperature (ta) with a thermometer (shielded from radiant heat). Estimate the percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

(2) Permeable PPE consists of cotton clothing with long sleeves and pants or breathable coveralls.

(3) Add 1.8 °F for Tyvek coveralls; add 5.4 °F for heavy clothing; add 19.8 °F for impermeable/semi-impermeable PPE - Level A/B suits)

Heart Rate Monitoring

When conducting heart rate monitoring, first record a resting heart rate to establish the individuals daily baseline heart rate. Count the radial pulse (located on the inside of the wrist below the thumb) during a 30 second interval before the start of work to establish a baseline heart rate. During rest cycles count the heart rate as early as possible at the beginning of the rest cycle and again 3-5 minutes later. The heart rate should fall and soon approach the individuals baseline heart rate.

- If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
- If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

Body Temperature Monitoring

Use an oral, inner ear, or an infrared type thermometer to measure the body temperature at the end of the work period (If using an oral thermometer record temperature before drinking liquids).

- If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
- If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.
- Do not permit a worker to wear a semi-permeable or impermeable garment when his/her oral temperature exceeds 100.6 °F (38.1 °C).

Procedures for High Heat Conditions and Heat Waves

These procedures are additional preventative measures to be implemented when the temperature is > 95° F (35° C). The SSO or designee is responsible for ensuring effective observation and monitoring of employees during periods of high heat by implementing one or more of the following procedures:

1. SSO or designee will supervise 20 or fewer employees.
2. The "Buddy System" is mandatory. Conduct routine checks for early signs of Heat Illness. Set and verify routine consumption of water & sports drinks in a 3:1 ratio.
3. Maintain regular communication between Project Manager or SSO / designee and field staff (e.g. via mobile phone, radio or another effective means) for observation of early signs of heat illness.
4. Designate one or more employees as authorized to contact emergency medical services and communicating that if no designate is identified and the SSO is unavailable that any employee can call for emergency medical assistance.
5. Modify work schedule to avoid hottest parts of the day (e.g. start work earlier in the AM, stop work for the hottest hours of the day, conduct work during the evening).

Additionally, tailgate Safety Meetings will include a review the high heat procedures, encourage employees to drink plenty of water, and remind employees of the importance to take a preventative or recovery cool-down rest when necessary.

Employees will be observed for alertness and signs and symptoms of heat illness at regular intervals to be documented in the field book or field log.

The "Buddy System" must be implemented. Particular attention needs to be paid to new employees or employees who have yet to acclimate to high heat conditions. Additionally, frequent communication will be maintained with employees working by themselves (via cell phone or two-way radio), to evaluate early warning signs and symptoms of heat illness.

When the SSO is not available, an alternate responsible person must be assigned to look for signs and symptoms of heat illness. Such a designated observer will be trained and know what steps to take if heat illness occurs.

"Heat Wave" Procedures

A "heat wave" as defined by NOAA, is a period of abnormally and uncomfortably hot and unusually humid weather." Typically, a heat wave lasts 2 or more days. A "Heat Wave" as defined for the purposes of this Standard is when temperatures are sustained above 80° F / 26° C. During a heat wave or if site conditions indicate the potential for "Extreme Caution", "Danger" or "Extreme Danger" per the NOAA Heat Index Table the following steps will be taken:

Work schedules will be modified to protect workers from heat illnesses. The SSO or designee in coordination with the project team, will use their Stop Work Authority and evaluate the following actions and document the action in the daily field log

1. Modify work hours to exclude the hottest parts of the day.
2. Reschedule work or specific tasks that require strenuous exertion or Stop Work.

If schedule modifications are not possible, the Heat Illness Prevention Plan will be reviewed before work resumes. At a minimum, procedures for heat illness prevention, the provisions of the high heat procedures, the weather forecast and emergency response protocols will be reviewed.

Employees will be provided with additional water and rest breaks and will be observed more frequently. During work activities and rest breaks, employees will be observed for signs and symptoms of heat illness.

All employees will maintain frequent communication with the SSO or designee, who will be monitoring workers for possible symptoms of heat illness. In the event of large project sites where the SSO may be unable to be near the workers (to directly observe or communicate with them), then communication via a cell phone or radio may be used for this purpose provided reception in the area is reliable.

Procedure for Emergency Response

Emergency procedures include recognizing the symptoms of heat related illness. A critical step also involves ensuring that effective communication is established either through voice, direct observation or electronic means such as via mobile phones or 2-way radios. In an emergency situation it is critical that employees understand the process and contact information for requesting emergency medical support. The reception coverage for the site must be evaluated and understood to ensure adequate communication is in place across the project site. During a heat wave or hot temperatures, workers will be reminded and encouraged to immediately report to the SSO any signs or symptoms of the onset of heat stress they are experiencing.

Procedure for Emergency Response Continued

The SSO or designee is responsible for implementing the following procedures for emergency response. These procedures include, but are not limited to, the following:

- 1.** Prior to assigning staff to a particular work site, during the Tailgate H&S Safety Meeting all site workers will review the HASP along with the identified Hospital precise directions (such as streets or road names, distinguishing features, and distances to major roads), to avoid a delay of emergency medical services.
- 2.** Prior to work, efforts will be made to ensure that a qualified, appropriately trained and equipped personnel are consistently available to render first aid.
- 3.** Prior to the morning Tailgate Safety Meeting, an evaluation of whether or not a language barrier is present at the site for understanding the necessary preventative measures and emergency notifications procedures can be completed. Necessary steps will be taken (such as assigning the responsibility to call emergency medical services to the SSO or an English speaking worker) to ensure that emergency medical services can be immediately called in the event of an emergency.
- 4.** All SSOs and supervisors will carry cell phones or other means of communication to ensure that emergency medical services can be called. Routine checks will be made to ensure the devices are allowed on site, have adequate reception across the site, and are functional prior to each shift.
- 5.** When an employee reports symptoms, or displaying symptoms of possible heat illness, steps will be taken immediately to keep the affected employee cool and comfortable. Evaluate whether 1st aid is to be administered or emergency services are to be contacted or the employee is to be taken to an emergency facility for care.

Procedure for Handling a Sick Employee

Signs of Heat Stress: Excessive fatigue, heavy sweating, headaches, abdominal and/or upper thigh cramps, mild dizziness, elevated pulse.

Signs of Heat Exhaustion: Cool, moist, pale or flushed skin, nausea or vomiting, disorientation or confusion.

Signs of Heat Stroke: Hot, red skin which can feel dry to the touch, or moist from overexertion, changes in consciousness, rapid or weak pulse, shallow rapid breathing.

The SSO or designee is responsible for implementing the following procedures for evaluating and providing care for a sick employee:

- 1.** When an employee displays signs or symptoms consistent with the heat related illness, the SSO or designee will check the sick employee and determine whether resting in the shade and drinking cool water will suffice or if emergency service providers will need to be called.

Procedure for Handling a Sick Employee Continued

If determined to be a **non-emergency** (e.g. heat cramps or heat stress) the SSO will contact **WorkCare Injury Assistance Hotline 1-888-449-7787** for 1st aid medical assistance. In the event of the injury being an emergency, or potentially (e.g. Heat Exhaustion or Heat Stroke) contact emergency support services.

2. When an employee displays possible signs or symptoms of heat illness and no trained first aid worker or supervisor is available at the site, emergency service providers will be called.

3. Emergency service providers will be called immediately if an employee displays signs or symptoms of advanced stage heat related illness like Heat Exhaustion or Heat Stroke (loss of consciousness, incoherent speech, convulsions, red and hot face) or does not get better after drinking cool water in intervals of 8 ounces every 15 minutes and resting in the shade. While the ambulance is in route, assign a person to care for the injured, first aid will be administered (cool the worker by placing them in the shade, remove excess layers of clothing, place ice pack in the armpits and groin area and fan the person). A worker determined to be suffering an advanced stage of heat related illness will not be allowed to leave the site except under medical care, or as directed by a medical professional.

4. If an employee displays signs or symptoms of advanced stage heat related illness (loss of consciousness, incoherent speech, convulsions, red and hot face), and the work site is located more than 20 minutes away from a hospital, call emergency service providers, communicate the signs and symptoms of the victim, and request an Air Ambulance if necessary.

Revisions, notes, amendments, and clarifications specific to this plan will be detailed in the space below:



Arcadis Lone Worker or Remote Location Communication Plan

(For international travel/work, use the Travel Safety and Security Plan template in lieu of this template)

Project Name: Barker Hughesville and Carpenter-Snow Creek Mining District
Project Number: 30088504
Date: 6/15/2022
Revision:

General Information (select all that apply):

- ☐ Worker will be alone
☒ Buddy system will be used
☐ Area is within cell phone service range
☒ Cell phone service is limited or out of range
☐ Worker will be performing high risk activity (Lone Worker is not permitted)
☐ Work will be performed outside normal operating hours (nights or weekends)
☒ Wilderness work
☐ Site is not accessible to standard emergency services
☐ Other unique site conditions that may hinder employee's ability to get help, if required.

Explain:

Communication Plan

Frequency of Communication: 4 HOURS
Planned Start Time: 7:00:00 AM Planned End Time: 7:00:00 PM

Contact Information: Joe Gilbert
Field Worker Name: Betty Walter
Field Worker Phone Number: 406-402-7167
Vehicle Make/Model/ Plate:
Office Contact Name: Joe Gilbert
Office Contact Phone Number: 303-884-3161

Method of Communication:

- ☒ Cell Phone (including text notification) ☐ GPS
☐ Landline ☐ Transponder
☐ 2-way Radio ☐ App:
☐ Satellite Phone ☐ Other:

Contingency Plan (if the Field Worker cannot be reached, describe actions the Office Contact will take)
Office contact will wait until the end of the day. Office Contact will call the Belt Creek Ranger Station 406-236-5511 to check in on the workers.

Notification Log

[illegible]

THIS FORM MUST BE ENTIRELY COMPLETED PRIOR TO BEGINNING ANY INTRUSIVE WORK

Project Name: Barker Hughesville and Carpenter-Snow Start Date: _____

Project #: 30088504 End Date: _____

*Utility markings valid for 15 days. Initiate clearance renewal 5 days prior to expiration for ongoing work***PRE-FIELD WORK REQUIREMENTS**DigSafe 811 notified 48-72 hrs. in advance of work? ☐ DigSafe Ticket #: _____Ticket Expiration Date: _____ [State Utility Laws: www.commongroundalliance.com/map](http://www.commongroundalliance.com/map)Ticket(s) Attached(Y/N)? ☐ List utility owners notified via DigSafe 811 & response status: _____

List add'l. utilities requiring notification not included in DigSafe811 Notice: _____

*Review task details w/ private utility location subcontractor. ID work areas, clearance equipment needed, depth of clearance needed, types of features, utilities, anticipated/known/unknown. Verify DigSafe 811 markings to confirm public utility clearance.*Private Utility Locator Name, if used: _____ AUS onsite meeting (Y/N)? ☐**FIELD WORK REQUIREMENTS***This portion of the checklist must be completed on site. AUS staff must have a minimum of one year of field experience in identifying utilities to complete the checklist. Field staff will review the completed checklist with PM or designee prior to beginning intrusive work.**Heavy equipment/mechanized intrusive work w/in the Arcadis Tolerance Zone (utility or structure present within 30-in. of point of work) REQUIRES pre-approval by Corporate H&S prior to working at all such locations. STOP WORK if the Arcadis Tolerance Zone work has not been approved.*

List work type & locations for utility location and clearance as applicable to this checklist: _____

3 Reliable Lines of Evidence are REQUIRED for EACH INTRUSIVE LOCATION prior to starting any subsurface intrusive work. Check corresponding boxes below to document utility clearance efforts.☐ OneCall/DigSafe 811 Public Utility Locate (required by State law for subsurface work)*811 is only reliable as a Line of Evidence when working in/adjacent to a public ROW or easement.*Marking type: ☐ Paint ☐ Pin Flags/Stakes ☐ Other: _____ ☐ None☐ Client provided maps/drawings (Y/N)? ☐ Maps/drawings not provided (Y/N)?☐ Client Clearance (Y/N)? Name(s)/Affiliation(s): _____☐ Interviews (Y/N)? Name(s)/Affiliation(s): _____☐ Specific subsurface feature types and depths provided by person interviewed (Y/N)?

Details provided: _____

☐ Site Inspected (Y/N)? (document on Pg. 2.) Photo Document Marked Utilities & Structures☐ Public records/Client Dwgs/As-Builts (Y/N)? Type: _____List private locator tools used: ☐ Radio Freq. Detection ☐ Electromagnetic ☐ GPR☐ Metal Detector ☐ Acoustic Pipe Locator ☐ Downhole sonde Other: _____☐ Soft Dig Methods used (Y/N)? ☐ Hand auger ☐ Probing ☐ Hand tools (shovel/rake)☐ Air knife ☐ Hydro Knife ☐ Potholing/Vacuum extraction☐ Other soft dig tools used (Y/N)? If Yes, list here: _____

ALL BOXES BELOW MUST BE COMPLETED BEFORE PROCEEDING

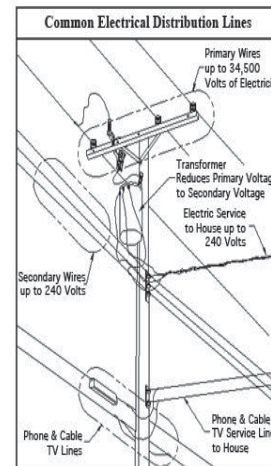
Site inspection also requires investigating vicinity outside of the work area for structures and utilities.

Noting "YES" requires addtl. investigation. Utilities must be field marked prior to intrusive work.

Is the utility present (Y/N)?	Utility Color Code	Is the utility present (Y/N)?	Utility Color Code
☐ Utilities entering/exiting structures?	No Color	☐ Evidence of stormwater network?	Green
☐ Intrusive work area marked out?	White	☐ Curb drains/catch basins/manholes?	Green
☐ Structural features above or below?	White	☐ Stormwater culverts, outfalls?	Green
☐ Public natural gas line or meter?	Yellow	ABOVEGROUND Features Present?	
☐ Private natural gas laterals/feeders?	Yellow	☐ Transportation tunnels/structures/markers present?	
☐ Public electrical service?	Red	☐ Overhead electrical lines?	Red
☐ Conduit from meter or on wall?	Red	☐ < 50 kV w/in 10 ft of work area?	Red
☐ Conduit from poles into ground?	Red	☐ >50-200 kV w/in 15 ft of work area?	Red
☐ Poles/devices w/ no visible lines?	Red	☐ >200-350 kV w/in 20 ft of work area?	Red
☐ Overhead electrical lines?	Red	☐ >350-500 kV w/in 25 ft of work area?	Red
☐ Solar arrays or wind turbines?	Red	☐ >500-750 kV w/in 35 ft of work area?	Red
☐ Public water line(s)?	Blue	☐ >750-1000 kV w/in 45 ft of work area?	Red
☐ Private water line(s) or lateral(s)?	Blue	☐ Aboveground fire suppression?	Blue
☐ Water meter onsite?	Blue	☐ Aboveground communications?	Orange
☐ Fire hydrants/post indicator valves?	Blue	☐ Aboveground chases/racks/trays?	Orange
☐ Irrigation system control box/valve?	Blue	☐ Private/Remediation system lines?	Various
☐ Sprinkler heads, drip lines, vaults?	Blue	☐ Unclassed utilities/anomalies?	Pink
☐ Water dispensers, fill stations?	Blue	☐ Warning signs/stakes/markers present?	
☐ Telecomm. overhead or buried?	Orange	☐ Heavy Equipment: Mark travel route for overhead, next to route, and/or under route (e.g. crush risk) utilities.	
☐ Telecomm. ground box or relays?	Orange	Signs of other utilities/ground disturbance	
☐ Telecomm./security CCTV devices?	Orange	☐ Signs of asphalt or concrete disturbance/repair?	
☐ Public sanitary sewer pipes?	Green	☐ Any ground subsidence or change in vegetation?	
☐ Combined sanitary/storm pipes?	Green	☐ Unknown manholes or valve covers in work area?	
☐ Private sanitary laterals/clean outs?	Green		
☐ Restrooms, kitchens, wash bays?	Green		

Tips for Thorough Utility Location (HSS Section 5.6):

1. Don't forget to look up for utilities
2. Be on-site with Private Utility Locators.
3. Ask Private Locators to "confirm" other's markings.
4. Also clear alternate/backup locations
5. Mark all known utilities.
6. No hammering, no pickaxes, no digging bars, no shortcutting.
7. No excessive turning or downward force of hand tools, especially hand augers.
8. Utilities may run in or directly under asphalt/concrete
9. Heavy equipment may damage shallow utilities. Especially during clearing and grubbing.
10. Use spotter for heavy equipment near aboveground utilities?



☐ Utilities & Structures Checklist reviewed by the PM or Designee (Y/N)? *If no, STOP WORK call PM*
 PM or Designee Name: _____
 Name and Signature of person completing the checklist: _____
 Date of checklist review / update: _____

ALL SUSPECT UTILITY STRIKES REQUIRE CORPORATE H&S NOTIFICATION WITHIN 24 hrs. OF KNOWLEDGE OF STRIKE WITH A CONFIRMED RESPONSE FROM CORPORATE H&S.

Appendix C

Job Safety Analyses, Permits, and H&S Standards

Job Safety Analysis



General

JSA ID	HASP 1	Status	Complete
Job Name	General Industry-Driving - passenger vehicles	Created Date	6/15/2022
Task Description	Driving a car, van, or truck on public roadways.	Completed Date	06/15/2022

Client / Project

Client	Freeport McMoran Copper & Gold
Project Number	30088504
Project Name	Barker Hughesville and Carpenter-Snow Creek Mining District
Project Manager	Joe Gilbert

User Roles

Role	Employee	Due Date	Completed Date
Developer	Betty Walter	6/15/2022	6/15/2022
HASP Reviewer	Select Reviewer	6/15/2022	6/15/2022
Quality Reviewer			

Job Steps

Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
1	Pre-Trip Inspection	1	Failing to perform pre-trip inspections may cause mechanical failure, accident or injury.	Perform walk around of vehicle with particular attention to tire inflation and condition. Check lights, wipers, seatbelts for proper operating condition. Properly adjust seat and mirrors prior to vehicle operation. Use or review vehicle inspection checklist as required under the MVSP.	ARC HSGE024 Motor Vehicle Safety Standard (MVSP)
		2	Scrapes, cuts, burns to hand if inspecting engine fluids and/or tires. Eye splash hazard if inspecting engine fluids. Pinch or crush hazards when opening or closing hood, trunk, or tailgate.	Wear protective gloves and safety glasses as described below when checking under hood or tires. Use TRACK and keep hands clear when opening/closing hood, trunk, or tailgate to avoid crush or pinch hazard.	
		3	Struck by other vehicles while walking around vehicle performing inspections.	Wear high visibility vest, shirt, or coat while performing inspections in parking lots or other areas with a traffic hazard. Remain vigilant of moving vehicles or equipment in area, face oncoming vehicles to extent practical.	
		4	Improperly secured cargo may dislodge creating injury, property damage, or road hazard.	Ensure all cargo is properly secured to prevent movement while the vehicle is in operation. This includes cargo in the cab of the vehicle.	

Job Steps

Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
2	Driving a motor vehicle on public streets	1	Failing to observe traffic flow ahead increases risk of hard braking resulting in potential impact of vehicle ahead, being struck by another vehicle from behind, and decreases decision making time.	Use Smith System Key #1, "Aim High in Steering". Look ahead (15 seconds if possible) to observe traffic flow and traffic signals. Adjust speed accordingly to keep vehicle moving and avoid frequent braking. Select lane of least traffic and adjust speed based on observed signal timing when possible. Avoid following directly behind large vehicles that obscure view ahead.	Smith System "5-Keys" is a registered trademark of Smith System Driver Improvement Institute, Inc.
		2	Failing to observe vehicles, pedestrians, bicyclists, and other relevant objects in vicinity of your vehicle increases risk of side swipes, rear ending, and third party injury.	Use Smith System Key #2, "Get the Big Picture". Maintain 360 degrees of awareness around vehicle. Check a mirror every 6-8 seconds, maintain space around the vehicle, choose a lane that avoids being boxed in. Look for pedestrian activity ahead in crosswalks or sidewalks. Watch for construction zone approach signs and act early by executing lane changes and reducing speed.	
		3	Failing to keep your eyes moving increases risk of not seeing relevant vehicles, pedestrians, and objects in your vicinity that may impair your ability to make timely and appropriate driving decisions and also increases risk of accident.	Use Smith System Key #3, "Keep Your Eyes Moving". Move your eyes every 2 seconds and avoid staring while evaluating relevant objects. Scan major and minor intersections prior to entering them. Check mirrors.	
		4	Failing to maintain space around and in front of your vehicle increases risk of striking another vehicle or being struck by another vehicle. Insufficient space shortens time for effective driving decision making resulting in increased accident risk.	Use Smith System #4, "Leave Yourself an Out". Use 4 second rule when following a vehicle. Avoid driving in vehicle clusters by adjusting speed and using lanes that permit maximum space and visibility. When stopped, keep one car length space in front of vehicle ahead or white line.	
		5	Failing to communicate with other drivers and pedestrians increases risk of striking vehicles, pedestrians, or being struck by other vehicles, especially from the rear.	Use Smith System Key #5, "Make Sure They See You". Brake early and gradually when stopping to reduce potential of being rear ended. Keep foot on brake while stopped. Use turn signals and horn effectively. Establish eye contact with other drivers and pedestrians to extent practical. Use vehicle positioning that promotes being seen.	
		6	Distractions within the vehicle takes focus off driving, increases risk of accident decreases time for making effective driving decisions.	Cell phone use (any type or configuration) is prohibited while the vehicle is in motion. Familiarize yourself with vehicle layout and controls (radio, temperature controls, etc.) prior to operating unfamiliar vehicles. Set controls prior to operating vehicle. Use GPS in unfamiliar areas to avoid use of paper maps/directions while driving. Set GPS prior to vehicle operation. Pull over and stop to modify GPS functions. Avoid consuming food or drink while driving.	

Job Steps

Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
3	Parking	1	Parking vehicle in areas of clustered parked vehicles or near facility entrance may impair visibility to oncoming traffic in lot and increase exposure to pedestrian traffic.	Use pull through parking or back into parking space when permitted or practical. When practical and safe to do so, park away from other vehicles and avoid parking near the facility entrance or loading docks. If available, use a spotter to aid in backing activity. Back no further than necessary and back slowly. Get out and look (GOAL) if uncertain of immediate surroundings. Tap horn prior to backing.	

PPE Personal Protective Equipment

Type	Personal Protective Equipment	Description	Required
Eye Protection	safety glasses	While checking engine or tires	Required
Hand Protection	work gloves (specify type)	Leather or equivalent checking engine or	Required

Supplies

Type	Supply	Description	Required
Communication Devices	mobile phone		Required
	other	Vehicle kit (applies to company trucks)	Required
Miscellaneous	fire extinguisher	Applies to company trucks	Required
	first aid kit	Applies to company trucks	Required

Job Safety Analysis

General

JSA ID	9388	Status	(3) Completed
Job Name	Infrastructure-Field Inspection	Created Date	5/23/2013
Task Description	Field Inspection - Transportation Project	Completed Date	06/30/2014
Template	True	Auto Closed	False

Client / Project

Client	Freeport McMoran
Project Number	30088504
Project Name	Barker Hughesville and Carpenter Snow Creek
PIC	Joe Gilbert
Project Manager	Joe Gilbert

User Roles

Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Hubbard, Lauren M	6/16/2014	6/18/2014	Tremblay, Tony	☒
HASP Reviewer	Tremblay, Tony	7/2/2014	6/29/2014	Ebert, Joachim	☒
Quality Reviewer	Stewart, Stephen J	7/1/2014	7/1/2014	Poudel, Shamir	☒

Job Steps

Job Step No.	Job Step Description	Potential Hazard	Critical Action	H&S Reference
1	Arriving at site	1 Vehicle posing hazard to traveling along roadway	Park in adjacent or nearby designated parking space whenever possible. When none available, park on side street. If it is necessary to park on shoulder, position vehicle as far from travel lane as possible and apply appropriate traffic control per traffic control plan. Avoid parking in an area that impairs sight distance for traffic. Place safety cones in front of and behind vehicle. Activate light bars and other warning devices, including vehicle flashers.	
		2 Vehicle Parking	Use Pull through parking or back into parking space when permitted or practical. If available, use a spotter to aid in backing activity. Back no further than necessary and back slowly. Get out and look (GOAL).	
		3 Wet, icy or snow covered roads.	If road conditions are such that driving is dangerous and there is significant potential for an accident, use Stop Work Authority and reschedule work after roads have been cleared or salted/sanded.	
2	Site Observation/Inventory	1 Struck by vehicle while performing inspection	Plan walking route before leaving vehicle. Walk along designated pathways when available. When not, select route as far as possible from edge of roadway. Always face oncoming traffic and wear Class II or III traffic vest	
		2 Construction traffic hazards: hit by/struck by	Be aware of traffic controls, travel routes and site entry points. Maintain a safe distance from moving vehicles and equipment. Maintain eye contact with equipment operators. When out of vehicle wear Class II or III traffic vest.	
		3 Slips/Trips/Falls	Plan route and do not hurry through the task. Use caution when walking on uneven surfaces. Use proper footwear with good traction. Pay attention to where you are walking- including foot placement. Avoid areas with accumulated materials and debris. Avoid wet, slippery and icy	

			conditions. Maintain a safe distance from open edges, holes, and excavations. Do not walk while looking at plans/documents or talking on cell phone.	
	4	Mine and other Cultural Debris	Avoid walking on mine debris. Use proper footwear with good traction and protective gloves. Do not enter buildings or shacks. Plan your travel path. Focus on walking and do not talk on the phone or write notes during traveling.	
	5	Potentially Impacted Water	Impacted water may and exist and may be flowing. Avoid touching and walking through flowing water. If necessary for inspection, use nitrile gloves. Wash your hands prior to eating or smoking.	
	5	Eye/face injury	Use caution when walking through trees or brush. Wear proper eye protection.	
	6	Animals/Insects	Be aware of surroundings while walking through the site and use repellent spray. If a dangerous or aggravated animal is spotted, leave the area and return to your vehicle and contact animal control. Wear long pants/long sleeve shirt. Observe and avoid ant mounts, wasp nests and other insect hazards.	
	7	Personal Safety	Be aware of surroundings. If suspicious person/people are identified, return to vehicle and if necessary leave site. Avoid working alone in early morning or evenings. Advise supervisor of working hours and when visiting site and let supervisor know when leaving site.	

PPE Personal Protective Equipment			
Type	Personal Protective Equipment	Description	Required
Eye Protection	safety glasses		Required
Foot Protection	steel-toe boots		Required
Hand Protection	work gloves (specify type)	As needed	Required
Head Protection	hard hat		Required
Hearing Protection	ear plugs	NR 30 or better, As needed	As needed
Miscellaneous PPE	traffic vest--Class II or III	II or III per SSO	Required

Supplies			
Type	Supply	Description	Required
Communication Devices	mobile phone		Required
Miscellaneous	fire extinguisher	ABC in vehicle	As needed
	first aid kit	in vehicle	Required
Personal	insect repellent		Required
	sunscreen		Required
	water/fluid replacement		Required

Review Comments		
Reviewer	Comments	
Employee: Role Review Type Completed Date	Tremblay, Tony HASP Reviewer Revise 5/27/2013	Task Description: Field Inspecton - Transportation Project Please add reference to site-specific Traffic Control Plan in Haz 1, step 1 in H&S reference column; Job Step 2, Haz 1 typo - stuck = struck
Employee: Role Review Type Completed Date	Tremblay, Tony HASP Reviewer Revise 6/2/2014	We've recently had some near misses related to folks doing an inspection when roads were slippery (snow/ice). Traveling vehicle lost control and nearly struck employee. Please list another potential hazard: adverse weather which could result in roadway vehicles going out of control creating struck by hazard. Control would be Stop Work, reschedule visit when road conditions are not as hazardous or work within fixed barrier work zone.

Employee: Role Review Type Completed Date	Tremblay, Tony HASP Reviewer Approve 6/29/2014	
Employee: Role Review Type Completed Date	Stewart, Stephen J Quality Reviewer NA 7/1/2014	Nice listing of step-by-step of tasks needed to perform the job. Well thought out process and identification of potential hazards. As Tony notes, weather can be a contributing factor as well and should be listed. Nicely done.

Job Safety Analysis			
General			
JSA ID		Status	
Job Name	Environmental-Other	Created Date	1-19-21 (updated)
Task Description	Working Outdoors (general)	Completed Date	
Template	False	Auto Closed	False

Client / Project	
Client	
Project Number	
Project Name	
PIC	
Project Manager	

User Roles					
Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Cody Johnson	1-19-16	1-19-16	Mike Risher	☒

Job Steps					
Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
1	General Outdoor Activity (Summer)	1	Injury Due to Slips, Trips, Falls over uneven ground or equipment in walking path.	Keep work area free of equipment and debris when not in use. Remove any debris from sampling location. Mark uneven surfaces/holes with colored flags. Wear safety toe boots with good traction.	ARCADIS H&S Handbook Section III (I/M/N).
		2	Dehydration/Heat Stress/Sunburn	Personnel should consume at least 8 ounces of cool water or electrolyte replacement drinks every 20 to 30 minutes. Monitor for potential heat stress by taking scheduled breaks every 1-2 hours when temperature is over 85 degrees Fahrenheit. Use sunscreen as needed and follow manufactures instructions for application.	
		3	Biological Hazards (insect bites/stings, wildlife, poisonous vegetation)	Prior to beginning work, inform FTL of any known allergies. If moving through areas of high vegetation, use a long handled tool to disturb the path in front of you. Have insect repellant available and use as directed. If aggressive wildlife/animals are observed, take shelter in the vehicle and call the Site Safety Officer. Mark hazardous flora with high-visibility tape or cones and maintain a minimum distance of 5 feet.	
		4	Struck by lightning	Check the weather and plan for field activities; reschedule if severe weather is imminent, monitor throughout the day. If lightning is observed, take shelter in the field vehicle - leave all tools where they are, do not carry metal tools/augers. Remain in shelter until 30 minutes after the last lightning strike.	
2	General Outdoor Activity (Winter)	1	Slips/Trips/Falls due to slippery/icy conditions	Use caution when walking on site. Avoid icy areas as much as possible. Use deicer on walkways and in work zone around	ARCADIS H&S Handbook Section III (I/M).

				vehicle. Wear safety toe boots with good traction.	
		2	Falling ice/snow	Assess the site for falling ice/snow from overhead structures (i.e. trees, power lines, roof eaves). Use caution when walking around trees and power lines. Wear hard hat.	
		3	Cold Stress - Frostbite/Hypothermia	Check the weather and plan for field activities at the beginning of the day; reschedule if severe weather is imminent, monitor throughout the day. Take frequent breaks to warm up fingers and toes during cold weather work. Wear clothing suited for cold weather conditions.	

PPE	Personal Protective Equipment		
Type	Personal Protective Equipment	Description	Required
Dermal Protection	long sleeve shirt/pants	Long pants required. Long sleeves optional.	Required
Eye Protection	safety glasses	Tinted and clear. Must meet ANSI z87.1	Required
Foot Protection	rubber boots	To wear over safety boots in cold/wet conditions.	Recommended
	steel-toe boots		Required
Hand Protection	insulated gloves	For cold weather	Recommended
Head Protection	hard hat		Required
Miscellaneous PPE	traffic vest--Class II or III		Required

Supplies			
Type	Supply	Description	Required
Communication Devices	mobile phone		Required
Miscellaneous	fire extinguisher	ABC in vehicle.	Required
	first aid kit		Required
	first aid kit		Required
Personal	eye wash (specify type)	bottle	Required
	insect repellant	Use as needed	Required
	insect repellant	Use as needed	Recommended
	sunscreen	Use as needed	Recommended

Job Safety Analysis

General

JSA ID	12447	Status	(4) Revise
Job Name	Environment-Sample cooler handling	Created Date	3/4/2015
Task Description	Sample Cooler Handling and Shipping	Completed Date	
Template	False	Auto Closed	False

Client / Project

Client	Freeport
Project Number	
Project Name	
PIC	
Project Manager	

User Roles

Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Johnson, Cody Lee	5/11/2015		Risher, Michael G.	☒
HASP Reviewer	Levin, Gordon G.			Risher, Michael G.	☒

Job Steps

Job Step No.	Job Step Description	Potential Hazard	Critical Action	H&S Reference
1	Transfer field samples to sample packing area	1 Lifting heavy coolers may result in muscle strain especially to lower back.	Use proper lifting techniques and keep back straight. Use buddy system for large coolers. Use mechanical aids like hand trucks if readily available to move coolers. Do not over fill coolers with full sample containers for temporary movement to the sample prep area. Ensure an adequate supply of sample coolers are in field. Plan work flow so that the cooler packing area is convenient to vehicle pick-up and drop-off locations.	FHSHB: EE, Ergonomics HASP: Shipping Determination
		2 Hazards to hands from broken glass caused by over tightening lids or improper placement in cooler	Inspect all bottles and bottle caps for cracks/leaks before and after filling container. Do not over tighten sample lids. When handling glass containers, wear cut-resistant gloves in case glass containers break. Clean up any broken bottles immediately, avoid contact with sample preservatives. Wear cut-resistant gloves when handling broken glass.	
		3 Exposure to chemicals (acid preservatives or site contaminants) on the exterior of sample bottles after filling.	Wear protective gloves for acid preservatives and safety glasses with side shields during all sample container handling activities (before and after filling). Once filled, follow project specific HASP PPE requirements for skin and eye protection.	
		4 Samples containing hazardous materials may violate DOT/IATA HazMat shipping regulations	All persons filling a sample bottle or preparing a cooler for shipment must have complete ARCADIS DOT HazMat shipping training. Compare the samples collected to the materials described in the Shipping Determination for the Project and ensure consistency. Re-perform all shipping determinations if samples collected are not compatible with shipping method or if free product is collected, but not anticipated during planning.	
2	Sample cooler selection	1 Sample coolers with defective handles, lid hinges, lid hasps cracked or otherwise damaged may result in injury (cuts to hands, crushing of feet if handle breaks etc.)	Instruct the laboratory to only provide coolers that are new or in like new condition. No rope handled coolers unless part of the manufacturer's handle design. Contact the laboratory if broken or defective coolers are being sent for use in the field. HazMat-marked coolers in poor condition appear	ARCADIS Shipping Guide US-001

				suspicious to shipping facilities and risk not being delivered to the laboratory on time.	
		2	Selection of excessively large coolers introduces lifting hazards once the cooler is filled.	Select coolers and instruct lab to only provide coolers of a size appropriate for the material being shipped. For ordinary sample shipping sample coolers should be 48 quart capacity or smaller to reduce lifting hazards.	
3	Pack Samples	1	Pinch points and abrasions to hands from cooler lid closing unexpectedly	Beware that lid could slam shut; block/brace if needed; be wary of packing in strong winds. New coolers may be more prone to self-closing, tilt cooler back slightly to facilitate keeping lid open.	
		2	Awkward body positions and contact stress to legs and knees when preparing coolers on irregular or hard ground surfaces.	Plan cooler prep activities. Situate cooler where neutral body positions can be maintained if practical, like truck tailgate. Avoid cooler prep on rough gravel surfaces unless knees and legs protected during kneeling.	
		3	Potential for cooler refusal due to melting ice	When packing coolers, melt water from the ice must not be able to escape from the cooler. Sample should be packed, including double bagged ice, inside a liner bag that is sealed after samples are packed. Ensure the liner is sealed in such a way water cannot escape if the cooler were to be placed upside down or on its side. Also be sure to check the water draining spigot, if present, to ensure that it has been taped shut on both the inside and outside of the cooler.	
4	Sealing, labeling and Marking Cooler	1	Cuts to hands and forearms from strapping tape placement or removing old tape and labels	Do not use a fixed, open-blade knife to remove old tags/labels, USE SCISSORS or other safety style cutting device. Only use devices designed for cutting. Do not hurry through task.	
		2	Lifting and awkward body position hazards from taping heavy coolers, dropping coolers on feet during taping.	Do not hurry through the taping tasks, ensure samples in cooler are evenly distributed in cooler to reduce potential for overhanging cooler falling off edge of tailgate/table when taping. If necessary, use strapping tape across the center of the cooler to keep the lid taped down.	
		3	Improper labeling and marking may result in violation of DOT/IATA HazMat shipping regulations delaying shipment or resulting in regulatory penalty	Do not deviate from ARCADIS Shipping Guide or Shipping Determination marking or labeling requirements.	
5	Offering sample cooler to a carrier or lab courier for shipment.	1	Lifting heavy coolers may result in muscle strain especially to lower back.	Refer to previous JSA section 1.1. Prepare coolers and package not to exceed 50 pounds to prevent lifting injuries. Whenever possible, use the buddy system to lift and transport coolers.	
		2	Carrier refusal to accept cooler may cause shipping delay and/or result in violation of DOT HazMat shipping regulations.	Promptly report all rejected and refused shipments to the ARCADIS DOT Program Manager. Do not re-offer shipment if carrier requires additional labels markings or paperwork inconsistent with your training or Shipping Determination without contacting the ARCADIS DOT Compliance Manager.	
		3	Carrying heavy, oversized, and/or multiple packages may result in decreased visibility or mobility, increasing risk for slips, trips, or falls.	Utilize a wheeled cart for transporting heavy, oversized, and/or multiple packages or coolers from vehicles to shipping centers. Obtain help from peers, courier, or shipping facility attendant as needed. Make multiple trips and do not hurry through the task, especially at the end of day when fatigue is an additional hazard.	

PPE Personal Protective Equipment			
Type	Personal Protective Equipment	Description	Required
Eye Protection	safety glasses		Required
Foot Protection	boots	safety toe	Required
	steel-toe boots		Required
Hand Protection	chemical resistant gloves (specify type)	nitrile	Required
	cut-resistant gloves (specify type)	Leather or Kevlar	Required

Supplies			
Type	Supply	Description	Required
Packing supplies	Sample Packing	Sample cooler, fresh ice, plastic bags (Zip-lock or U-Line), trash bags, paper towels, bubble wrap	Required
Office supplies	Cooler Packing	Scissors, packing tape, strapping tape, duct tape, zip-ties	Required

Review Comments		
Reviewer	Comments	
Employee: Role Review Type Completed Date	Levin, Gordon G. HASP Reviewer Revise 3/13/2015	Excellent JSA, covers some quality issues along with safety Please proofread there are a couple of typos where there are extra spaces in words.
Employee: Role Review Type Completed Date	Levin, Gordon G. HASP Reviewer Revise 3/20/2015	Please remove hazard 3 of the sample packing task as use of dry ice is rare and will not be used on the Agrium project sites at this time. May need to be added in the future if collection of fish tissue samples is added to the scope of work. Please add in the section for shipping samples that coolers that leak water from melted ice when the cooler is turned upside down may be refused by the shipping company. The remedy or action is to make sure that all contents of coolers must be sealed inside a plastic liner to ensure that nothing leaks during shipment.
Employee: Role Review Type Completed Date	Levin, Gordon G. HASP Reviewer Revise 4/27/2015	Please revise task 1 point 4 - We do not collect free product by mistake, or ship free product without prior planning. Need to re-word that. A good point that samples need to match the shipping determination and vice versa. Please print that up and let's work on word smithing this point.
Employee: Role Review Type Completed Date	Peterson, Doug J Reviewer Yearly Update 1/17/2017	Reviewed and updated.
Employee: Role Review Type Completed Date	Henwood, Brooke A Reviewer Yearly Update 2/6/2019	Reviewed and updated.

Job Safety Analysis			
General			
JSA ID		Status	
Job Name	Construction-Excavation and trenching	Created Date	1-19-21 (updated)
Task Description	Soil Excavation	Completed Date	
Template	False	Auto Closed	False

Client / Project	
Client	
Project Number	
Project Name	
PIC	
Project Manager	

User Roles					
Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Cody Johnson	1-19-16	1-19-16	Mike Risher	☒

Job Steps					
Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
1	Site preparation	1	Improper utility clearance may result in utility/equipment damage or injury.	Perform utility clearance with a minimum of 3 lines of evidence. Document utility clearance for reference including any ticket numbers or phone numbers of utilities.	
		2	Clearing vegetation may result in impact hazards.	Stand at least 25 ft from clearing operations using manual or mechanized methods. Larger vegetation like trees may be under stress and may break and wood parts may fly in any direction.	
		3	Slip trip and fall hazards from walkover activities (vegetation, uneven surfaces, etc and applies to all job steps in this JSA)	Plan route and focus on the task at hand (walking). Do not walk while looking at utility maps/drawings or talking on cell phones.	
2	Excavation and backfilling	1	Struck by equipment during excavation.	Stay at least 10 feet beyond the reach of excavation equipment unless establishing communication with operator. Wear PPE required by this JSA for increased visibility. Keep unnecessary workers away from the excavation area.	
		2	Equipment/worker falls into excavations from edge collapse	Stand at least 6 ft from edge of excavation. Competent person to oversee sloping, benching, bracing excavation to ensure stability.	
		3	Worker entrapment/suffocation/chemical overexposure/engulfment in excavation	Entry into excavations are prohibited unless approved by a Competent Person. Keep spoil piles at least 2 ft from excavation edge. Ensure proper slope/bench/shielding is in place prior to entry. Air monitor for toxic vapors and oxygen deficiency. Ensure proper means of access and egress.	

		4	Chemical exposure to site contaminants.	Wear protective clothing specified in this JSA, avoid skin contact with soil materials or any liquids in the excavation. Use air monitoring to ensure TLVs are not exceeded. Wash hands and face prior to eating, drinking or consuming tobacco.	
		5	Noise from excavation equipment	Keep distance from equipment to reduce noise levels. If levels cannot be controlled wear hearing protection appropriate for the hazard.	
3	Excavation equipment decontamination	1	Slips and falls on wet surfaces.	Wear footwear appropriate for wet environments. Reduce amount of pressure washing required by removing soils using dry methods to extent practical	
		2	Flying particles from cleaning activities.	Wear eye and skin protection during decontamination activities. Use face shield if overspray or flying debris is a persistent problem. Avoid cleaning (pressure washing) in direction of other nearby workers, keep unnecessary workers clear of decontamination activity.	

PPE	Personal Protective Equipment		
Type	Personal Protective Equipment	Description	Required
Dermal Protection	chemical protective suit (specify type)	Tyvek per SSO	Required
Eye Protection	faceshield	During decontamination (per SSO)	Required
	safety glasses		Required
Foot Protection	rubber boots	Wet environments (per SSO)	Required
	steel-toe boots		Required
Hand Protection	chemical resistant gloves (specify type)	Nitrile when handling impacted soils	Required
	work gloves (specify type)	leather or equivalent (per SSO)	Required
Head Protection	hard hat		Required
Hearing Protection	ear plugs		Required
Miscellaneous PPE	traffic vest--Class II or III	Class II	Required

Supplies			
Type	Supply	Description	Required
Communication Devices	mobile phone		Required
	walkie talkie		Required
Miscellaneous	auxiliary lighting	Light plant for night work	Required
	fire extinguisher	ABC 10 pound minimum	Required
	first aid kit		Required
Personal	eye wash (specify type)	Bottle	Required
	insect repellent		Recommended
	sunscreen		Recommended

Job Safety Analysis			
General			
JSA ID	9726	Status	(3) Completed
Job Name	Environmental-Soil sampling/well installation - manual	Created Date	7/25/2013
Task Description	Soil sampling on reclaimed mine sites.	Completed Date	1/18/2017
Template	False	Auto Closed	False

Client / Project	
Client	
Project Number	
Project Name	
PIC	
Project Manager	

User Roles					
Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Katz, Scott B.	9/2/2013	8/12/2013	Magna, Elisabeth M.	☒
Developer	Behrends, Pete	3/30/2015	3/18/2015	Risher, Mike	☒
HASP Reviewer	Oakeson, Brent B.	8/26/2013	8/21/2013	Balcer, Denis M.	☐
Quality Reviewer	Wilson, Janette D.	8/23/2013	8/23/2013	Suarez, Gustavo	☒

Job Steps					
Job Step No.	Job Step Description		Potential Hazard	Critical Action	H&S Reference
1	Sampling Set-up	1	Underground utilities could be encountered during soil sampling.	Follow the Utility Clearance HS Standard.	Utility Clearance HS Standard ARCHSF019
		2	Hand injuries can occur from lifting heavy equipment out of the vehicle.	Wear gloves at all times. The black metal on the spud bar and Montana sharpshooter can be hot from the sun. Remove equipment from vehicle starting with the items laying on top. Do not try to pull a shovel out from under the spud bar, as it can shift and pinch fingers.	
		3	Slips/Trips/Falls could occur walking over uneven surfaces to the sample location.	Park as close as possible to the sample location. Take multiple trips between the vehicle and sample location if necessary. Do not overload with equipment. Make sure the pathway is visible and keep one hand free to maintain balance over rocky terrain and hills.	
		4	Muscle fatigue from repetitive lifting of equipment.	Use proper lifting techniques as outlined in the Field H&S Handbook. Take several trips if necessary to reduce fatigue. Use proper lifting techniques and carry only one heavy tool at a time.	Field H&S book
2	Soil Sampling	1	Muscle fatigue from repetitive lifting motions	Use the "3 Tool Approach" to dig the soil pit, making sure to use at least 2 people and utilize all 3 tools (spud bar, Montana sharpshooter, and shovel/spade). Pass the tools off between samplers, to reduce bending and lifting. Take breaks as needed.	
		2	Eye Injury from potential rock chips.	Wear safety glasses at all times. Switch between shaded and clear safety glasses if needed.	
		3	Injury to hands from repetitive digging or encountering cobbles/boulders in the soil.	Wear heavy, leather work gloves to protect against blisters and rubbing from using the spud bar and shovel/spade. When using the spud bar and Montana sharpshooter, relax your grip on the handle. Do not grip tightly, or the shock from hitting a cobble or boulder will be transferred into the hands and arms.	

		4	Injury to feet or equipment around the edge of the soil pit.	Practice good housekeeping and keep all equipment away from the soil pit. Place feet in a comfortable stance, but staying away from the sides of the pit. Always wear steel-toed boots. It is possible for the spud bar or Montana sharpshooter to miss the hole and hit near the sides.	
3	Soil Sample Collection	1	Hand injuries from scraping the sidewalls of the pit.	When possible, wear work gloves or Kevlar gloves under nitrile gloves during sampling. Do not scrape soil into your hand, but use a clean Tupperware container.	
		2	Potential to come in contact with contaminated soils.	Always wear eye protection, long sleeves, and nitrile gloves when collecting soil samples.	
		3	Sharp edges and broken glassware can cause lacerations.	Handle glassware carefully, practice good housekeeping, and discard any broken glassware in a safe disposal container.	
		4	Stress and injury to knees from kneeling while sampling.	Rocks and contaminated soils can come in contact with your knees while sampling and the repetitive motion can cause stress. Wear knee pads or use a small padded mat when sampling.	
4	Sampling from an excavator	1	Slips, trips, and falls	Keep tools in the proper areas, ensure good housekeeping. Survey the work area for protruding objects, uneven, wet or soft ground. Maintain good footing. Use benching and shoring to provide a level and secure ground surface. Stay away from edges of excavation.	
		2	Excessive noise is generated by rig operation.	Use hearing protection when equipment is running and soil samples are being collected.	
		3	Contact with heavy equipment.	If sampling from the excavator bucket, make sure the bucket is completely lowered on a firm ground surface, the excavator is in neutral, and eye contact is established with the operator prior to performing sampling.	
		4	Dust and debris can cause eye injury and soil cuttings and/or water could contain COCs.	Wear safety glasses and stay as far away from actual drilling operation as practicable. Wear appropriate gloves to protect from COCs.	
7	Installation of Temporary Piezometer/Well	1	Excessive noise can occur from driving well casing with hammer or macro-core sampler.	Wear hearing protection while equipment is running.	
		2	Body parts or onlookers can be struck when using hand tools	Check swing radius above and around before driving well casing in bore hole. Wear leather gloves and safety glasses.	
		3	Muscle strains can occur when pulling/pushing well materials into place	Stretch out arms/back/shoulder muscles prior to beginning. Take frequent breaks as fatigue sets in and if muscle cramps occur.	
		4	Edges of PVC well casings have sharp edges especially when they have been cut, which can cause lacerations.	File or sand the tops of well casings after they have been cut. Wear leather work gloves.	
		5	Debris in the eyes can occur when working with soil, grout, and bentonite	Use disposable dust mask if excessive dust is created.	
5	Decontaminating Sampling Equipment	1	Exposure to COCs while decontaminating equipment.	Always wear nitrile gloves and safety glasses as outlined in the HASP while decontaminating.	
		2	Cleaning solutions can splash while decontaminating equipment.	Face downwind and position equipment and spray bottle so that wind blows spray away from work area. Make sure that people in vicinity are aware and keep a safe distance upwind. Always wear safety glasses and nitrile gloves	
		3	Fatigue from lifting heavy tools (i.e., spud bar, Montana sharpshooter).	Set heavy tools down in vehicle bed or other suitable location when decontaminating, allowing free use of both hands. This reduces	

				strain of holding heavy equipment in one hand while spraying with the other hand and allows for a more thorough decontamination process.	
6	Filling in Soil Pits	1	Open holes are a tripping hazard.	Fill in holes as best as possible with excesses soil and waste rock. If a hole dug with an excavator cannot be filled (it gets too dark to safely continue working, staff are not finished working in the pit, a Stop Work occurs, etc.) position equipment to cover or block access to the pit and utilize safety cones or delineators with caution tape to highlight the location of the hole. Open holes can cause tripping of other field members or injury to grazing cattle.	

PPE		Personal Protective Equipment		
Type	Personal Protective Equipment	Description	Required	
Dermal Protection	long sleeve shirt/pants		Required	
Eye Protection	safety glasses		Required	
Foot Protection	steel-toe boots		Required	
Hand Protection	chemical resistant gloves (nitrile)		Required	
	work gloves (leather or kevlar)		Required	

Supplies				
Type	Supply	Description	Required	
Communication Devices	mobile phone	Cell Phone Booster	Required	
	other	Satellite Phone	Required	
	Two- way radio	Two-way Radio	Required	
Decontamination	Decon supplies (specify type)		Required	
Miscellaneous	fire extinguisher		Required	
	first aid kit		Required	
Personal	insect repellant		Required	
	sunscreen		Required	

Review Comments		
Reviewer		Comments
Mike Risher	2/13/2015	Edits made
Cody Johnson	3/13/2015	Finalized edits, fixed minor formatting errors
Doug Peterson	1/18/2017	Reviewed and updated.

Job Safety Analysis

General

JSA ID	227	Status	(3) Completed
Job Name	Environment-Surface water sampling	Created Date	5/13/2009
Task Description	Surface water sampling	Completed Date	05/29/2009
Template	True	Auto Closed	False

Client / Project

Client	Arcadis AGMI
Project Number	000000100000
Project Name	GENERAL OVERHEAD
PIC	
Project Manager	

User Roles

Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Coppola, Mija	3/29/2012	5/13/2009	Coppola, Mija	☐
HASP Reviewer	Coppola, Mija	5/27/2009	5/29/2009	Coppola, Mija	☐

Job Steps

Job Step No.	Job Step Description	Potential Hazard	Critical Action	H&S Reference
1	Placement of boat for surface water sampling	1 Slip/trip/falls can occur when accessing or egressing boat	Help each other into and out of the boat for balance. Wear anti-slip footwear with ankle support. Plan route onto and off of boat, do not hurry through task.	Field H&S Handbook V(G)
		2 Clutter and equipment on boat can cause tripping hazard including location and placement of equipment cables, ropes, or chains.	Maintain good housekeeping and aisle space. Secure objects to prevent shifting or movement that could impair walkway. Keep materials clear of designated walkways, cover if practical.	
		3 Boat can be damaged from encountering objects and other protuberances in water during boat operation.	Use qualified boat operator and use spotters if navigating in areas with shallow depths, felled trees in water or rock hazards. Use depth finders as appropriate.	
		4 Muscle strains from moving equipment onto or off of boat.	Use proper techniques by keeping back straight, use buddy system for large or bulky items, and avoid awkward twisting or stooping.	
2	Surface water sampling from boat	1 Slips/trips/falls on wet surfaces and tripping over equipment or supplies.	Wear shoes with anti-slip soles, plan route and do not hurry through task. Do not carry sample coolers or other objects that obscure vision. Stow items under seats in storage area when available.	
		2 Cuts to hands from broken glass	Wear protective gloves when placing or removing bottle lid. Select gloves with good gripping capability on wet glass. Do not over-tighten lids when securing.	
		3 Awkward twisting or body positions, muscle strain.	Avoid extended periods of squatting and avoid bending at the waist. Do not over reach when direct filling containers. Plan sampling activity to account for current and water depth if wading to collect samples.	
		4 Cuts to hands from ropes and cables during sample collection from deep water.	Wear protective gloves. Ensure rope has a thickness appropriate to prevent cuts to hands - 3/8 inch rope suggested minimum thickness. Be aware that water will create drag on sampling device during removal and do not hurry through task.	
3	Surface water sampling from shoreline or wading	1 Muscle strains from carrying equipment to sampling locations.	Make multiple trips if necessary. Coolers with samples will get heavier as job progresses. Use smaller coolers to keep loads light. Do not overfill backpacks.	Field H&S Handbook V(G)

		2	Slips from walking on wet surfaces near shoreline.	Wear boots with good tread and avoid heavily muddied areas.	
		3	Water entering boots can increase the chance for blisters and other skin issues with feet/ankles.	Wear rubber outer boots when appropriate. Waders should be worn when wading into deeper water.	
		4	Falling into water can cause injury/drowning	Wear PFD if falling into water deeper than waist high is a hazard, or if working proximal to turbulent / fast moving water. TRACK water conditions every day as rain/snow thaw can cause water conditions to worsen. Person walking through water should minimize what they are carrying so they can maintain balance.	

PPE Personal Protective Equipment			
Type	Personal Protective Equipment	Description	Required
Eye Protection	safety glasses		Required
Foot Protection	boots		Required
	rubber boots		Required
Hand Protection	chemical resistant gloves (specify type)	nitrile	Required
Hearing Protection	ear plugs		Required
Miscellaneous PPE	other	Waders	Required
	personal flotation device		Required

Supplies			
Type	Supply	Description	Required
Communication Devices	walkie talkie		Required
Decontamination	Decon supplies (specify type)		Required
Miscellaneous	fire extinguisher		Required
	first aid kit		Required
Personal	eye wash (specify type)		Required
	insect repellent		Recommended
	sunscreen		Recommended

Review Comments		
Reviewer		Comments
Employee: Role Review Type Completed Date	Coppola, Mija HASP Reviewer Approve 5/29/2009	

Job Safety Analysis			
General			
JSA ID		Status	
Job Name	General Industry-Surveying - land	Created Date	1/19/21 (updated)
Task Description	Land Survey	Completed Date	
Template	False	Auto Closed	False

Client / Project	
Client	
Project Number	
Project Name	
PIC	
Project Manager	

User Roles					
Role	Employee	Due Date	Completed Date	Supervisor	Active
Developer	Cody Johnson	1-20-16	1-20-16	Mike Risher	☒

Job Steps					
Job Step No.	Job Step Description	Potential Hazard	Critical Action	H&S Reference	
1	Site reconnaissance and walk-around	1 Slips/trips/falls can occur from walking on uneven ground surface.	Survey the site upon arrival. Note any site conditions that may pose a potential hazard.		
		2 Site workers or equipment can be struck by site vehicular traffic	Wear Class II traffic vest and cone off the work area. Follow the JSA and Field H&S Handbook for roadway work.		
2	Deployment and retrieval of traffic control devices during roadway work	1 Stuck by vehicles	Face traffic and use spotter if not facing traffic, stay off the travelled roadway to extent practical, wear Class II (minimum) traffic vest. Familiarize yourself with work zone control layout prior to deploying devices.		
		2 Slips trips and falls on uneven road or land surfaces	Do not carry objects that obscure visibility of ground surface when walking, wear footwear with ankle support and good tread, use buddy system when carrying large bulky objects.		
		3 Lifting heavy or bulky signage or traffic channeling device	Brake down load to manageable size. Do not over reach to grab cones from the interior of the project vehicle. Use proper lifting techniques, maintain good vehicle housekeeping to easily retrieve control devices. Use buddy system to move heavy objects like barrels.		
		4 Pinch points to hands on folding components of sign stands	Wear leather gloves or other suitable glove. Watch for hazard and avoid placing hands in pinch areas. Do not hurry through setup/take down.		
6	Removal of manhole covers	1 Pinch points and scrape hazards when removing MH cover.	Do not place fingers under lid during removal. Use shovels, pry bars, etc. to place under lid edge to lift. Wear sturdy work glove. Wear steel toe boot. Do not purposely drop lids.		
		2 Back/neck/arm/shoulder strains and hand blisters could occur from over	Use proper lifting techniques, keep back straight, lift with legs, use "J" Hook or pry bar, Buddy System required		

			lifting, or not lifting properly.		
7	Equipment set-up, calibration and survey of target area	1	Slips/trips/falls can occur from walking on uneven ground surface.	Watch for uneven ground, debris, and trip hazards. If possible clear area of trip hazards. Wear gloves and heavy denim work pants to avoid cuts when working in heavy brush/briers. Use buddy system to spot for uneven ground while surveying.	
8	Placement of stakes	1	Hands/fingers/arms can get struck by hammer/mallet. Splinters and lacerations can occur if stake splinters during hammering.	Wear leather work gloves and safety glasses when placing stakes.	
9	Placement of monuments	1	Back strain from digging holes or mixing concrete	Use proper shoveling techniques and keep back straight. Use the right tool for the job.	refer to Concrete work JSA
		2	Exposure to concrete can cause skin irritation or illness	Wear impermeable glove during mixing and concrete placement, promptly wash exposed skin. Do not use bare hands to mix, place, or finish concrete.	
		3	Inhalation of concrete dust during mixing	Keep face away from concrete when poured out of bag, Promptly wet concrete to be mixed.	

PPE Personal Protective Equipment			
Type	Personal Protective Equipment	Description	Required
Dermal Protection	long sleeve shirt/pants		Recommended
Eye Protection	safety glasses		Required
Foot Protection	boots	reinforced toe boots	Required
Hand Protection	work gloves (specify type)	Kevlar for machete use, leather for cutting	Required
Head Protection	hard hat		Recommended
Miscellaneous PPE	other	snake chaps	Recommended
	traffic vest--Class II or III	orange during hunting season	Required

Supplies			
Type	Supply	Description	Required
Communication Devices	mobile phone		Required
Miscellaneous	fire extinguisher		Required
	first aid kit		Required
	Other	snake chaps depending on work location	Recommended
Personal	insect repellant		Required
	sunscreen		Required
	water/fluid replacement		Required

Appendix D

Safety Data Sheets (SDSs)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Page 1/10

Printing date: 31.12.2013

Revision: 31.12.2013

1 Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Trade name: **ALCONOX**

1.2 Relevant identified uses of the substance or mixture and uses advised against
No further relevant information available.

Application of the substance / the mixture: Cleaning material/ Detergent

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer/Supplier:

Alconox, Inc.

30 Glenn St., Suite 309

White Plains, NY 10603

Phone: 914-948-4040

Further information obtainable from: Product Safety Department

1.4 Emergency telephone number:

ChemTel Inc.

(800)255-3924, +1 (813)248-0585



2 Hazards identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008



GHS05 corrosion

Eye Dam. 1; H318: Causes serious eye damage.



GHS07

Skin Irrit. 2; H315: Causes skin irritation.

Classification according to Directive 67/548/EEC or Directive 1999/45/EC



Xi; Irritant

R38-41: Irritating to skin. Risk of serious damage to eyes.

Information concerning particular hazards for human and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to the latest editions of the EU-lists, and extended by company and literature data.

The classification is in accordance with the latest editions of international substances lists, and is supplemented by information from technical literature and by information provided by the company.

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008

The product is classified and labelled according to the CLP regulation.

(Contd. on page 2)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

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Printing date: 31.12.2013

Revision: 31.12.2013

Trade name: **ALCONOX**

(Contd. of page 1)

· **Hazard pictograms**



GHS05

· **Signal word:** Danger

· **Hazard-determining components of labelling:**

sodium dodecylbenzene sulfonate

· **Hazard statements**

H315: Causes skin irritation.

H318: Causes serious eye damage.

· **Precautionary statements**

P280 Wear protective gloves/protective clothing/eye protection/face protection.

P264: Wash thoroughly after handling.

P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P310: Immediately call a POISON CENTER or doctor/physician.

P321: Specific treatment (see on this label).

P362: Take off contaminated clothing and wash before reuse.

P332+P313: If skin irritation occurs: Get medical advice/attention.

P302+P352: IF ON SKIN: Wash with plenty of soap and water.

· **Hazard description:**

· **WHMIS-symbols:**

D2B - Toxic material causing other toxic effects



· **NFPA ratings (scale 0 - 4)**



Health = 1

Fire = 0

Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = 1

Fire = 0

Reactivity = 0

· **HMIS Long Term Health Hazard Substances**

None of the ingredients is listed.

· **2.3 Other hazards**

· **Results of PBT and vPvB assessment**

· **PBT:** Not applicable.

· **vPvB:** Not applicable.

(Contd. on page 3)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

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Printing date: 31.12.2013

Revision: 31.12.2013

Trade name: ALCONOX

(Contd. of page 2)

3 Composition/information on ingredients

· **3.2 Mixtures**

· **Description:** Mixture of substances listed below with nonhazardous additions.

· **Dangerous components:**

CAS: 68081-81-2	sodium dodecylbenzene sulfonate Xn R22; Xi R36 Acute Tox. 4, H302; Eye Irrit. 2, H319	10-25%
CAS: 497-19-8 EINECS: 207-838-8 Index number: 011-005-00-2	Sodium Carbonate Xi R36 Eye Irrit. 2, H319	2,5-10%
CAS: 7722-88-5 EINECS: 231-767-1	tetrasodium pyrophosphate substance with a Community workplace exposure limit	2,5-10%
CAS: 151-21-3 EINECS: 205-788-1	sodium dodecyl sulphate Xn R21/22; Xi R36/38 Acute Tox. 4, H302; Acute Tox. 4, H312; Skin Irrit. 2, H315; Eye Irrit. 2, H319	2,5-10%

· **Additional information:** For the wording of the listed risk phrases refer to section 16.

4 First aid measures

· **4.1 Description of first aid measures**

· **After inhalation:** Supply fresh air; consult doctor in case of complaints.

· **After skin contact:**

Immediately wash with water and soap and rinse thoroughly.

If skin irritation continues, consult a doctor.

· **After eye contact:**

Remove contact lenses if worn.

Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor.

· **After swallowing:**

Rinse out mouth and then drink plenty of water.

Do not induce vomiting; call for medical help immediately.

· **4.2 Most important symptoms and effects, both acute and delayed**

No further relevant information available.

· **4.3 Indication of any immediate medical attention and special treatment needed**

No further relevant information available.

5 Firefighting measures

· **5.1 Extinguishing media**

· **Suitable extinguishing agents:**

CO₂, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

(Contd. on page 4)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

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Printing date: 31.12.2013

Revision: 31.12.2013

Trade name: ALCONOX

(Contd. of page 3)

- **5.2 Special hazards arising from the substance or mixture:** No further relevant information available.
- **5.3 Advice for firefighters**
- **Protective equipment:**
Wear self-contained respiratory protective device.
Wear fully protective suit.
- **Additional information:** No further relevant information available.

6 Accidental release measures

- **6.1 Personal precautions, protective equipment and emergency procedures**
Product forms slippery surface when combined with water.
- **6.2 Environmental precautions:** Do not allow to enter sewers/ surface or ground water.
- **6.3 Methods and material for containment and cleaning up:**
Pick up mechanically.
Clean the affected area carefully; suitable cleaners are:
Warm water
- **6.4 Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

- **7.1 Precautions for safe handling**
Prevent formation of dust.
Keep receptacles tightly sealed.
- **Information about fire - and explosion protection:** No special measures required.
- **7.2 Conditions for safe storage, including any incompatibilities**
- **Storage:**
- **Requirements to be met by storerooms and receptacles:** No special requirements.
- **Information about storage in one common storage facility:** Not required.
- **Further information about storage conditions:** Protect from humidity and water.
- **7.3 Specific end use(s):** No further relevant information available.

8 Exposure controls/personal protection

- **Additional information about design of technical facilities:** No further data; see item 7.
- **8.1 Control parameters**

· **Ingredients with limit values that require monitoring at the workplace:**

7722-88-5 tetrasodium pyrophosphate

REL (USA) 5 mg/m³

TLV (USA) TLV withdrawn

EV (Canada) 5 mg/m³

(Contd. on page 5)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Page 5/10

Printing date: 31.12.2013

Revision: 31.12.2013

Trade name: **ALCONOX**

(Contd. of page 4)

- **Additional information:** The lists valid during the making were used as basis.
- **8.2 Exposure controls**
- **Personal protective equipment:**
- **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the skin.
Avoid contact with the eyes and skin.
- **Respiratory protection:**
Not required under normal conditions of use.
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use self-contained respiratory protective device.
- **Protection of hands:**



Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation. Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture. Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

- **Material of gloves**

Butyl rubber, BR
Nitrile rubber, NBR
Natural rubber, NR
Neoprene gloves

The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material cannot be calculated in advance and has therefore to be checked prior to the application.

- **Penetration time of glove material**

The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

- **Eye protection:**



Safety glasses

- **Body protection:** Protective work clothing

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Trade name: ALCONOX

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9 Physical and chemical properties

· 9.1 Information on basic physical and chemical properties

· General Information

· Appearance:

Form:	Powder
Colour:	White
Odour:	Odourless
Odour threshold:	Not determined.

pH-value (10 g/l) at 20 °C:	9,5 (- NA for Powder form)

· Change in condition

Melting point/Melting range:	Not Determined.
Boiling point/Boiling range:	Undetermined.

Flash point:	Not applicable.

Flammability (solid, gaseous):	Not determined.

· Ignition temperature:

Decomposition temperature:	Not determined.

Self-igniting:	Product is not self-igniting.

Danger of explosion:	Product does not present an explosion hazard.

· Explosion limits:

Lower:	Not determined.
Upper:	Not determined.

Vapour pressure:	Not applicable.

Density at 20 °C:	1,1 g/cm ³
Relative density	Not determined.
Vapour density	Not applicable.
Evaporation rate	Not applicable.

· Solubility in / Miscibility with water:

Soluble.

Partition coefficient (n-octanol/water):	Not determined.

· Viscosity:

Dynamic:	Not applicable.
Kinematic:	Not applicable.

· Solvent content:

Organic solvents:	0,0 %

Solids content:	100 %

9.2 Other information	No further relevant information available.

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GHS

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10 Stability and reactivity

- **10.1 Reactivity**
- **10.2 Chemical stability**
- **Thermal decomposition / conditions to be avoided:**
No decomposition if used according to specifications.
- **10.3 Possibility of hazardous reactions**
Reacts with acids.
Reacts with strong alkali.
Reacts with strong oxidizing agents.
- **10.4 Conditions to avoid:** No further relevant information available.
- **10.5 Incompatible materials:** No further relevant information available.
- **10.6 Hazardous decomposition products:**
Carbon monoxide and carbon dioxide
Phosphorus compounds
Sulphur oxides (SO_x)

11 Toxicological information

- **11.1 Information on toxicological effects**
- **Acute toxicity:**
- **Primary irritant effect:**
- **On the skin:** Irritant to skin and mucous membranes.
- **On the eye:** Strong irritant with the danger of severe eye injury.
- **Sensitization:** No sensitizing effects known.
- **Additional toxicological information:**
The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version:
Irritant
Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.

12 Ecological information

- **12.1 Toxicity**
- **Aquatic toxicity:** No further relevant information available.
- **12.2 Persistence and degradability:** No further relevant information available.
- **12.3 Bioaccumulative potential:** Not worth-mentioning accumulating in organisms
- **12.4 Mobility in soil:** No further relevant information available.
- **Additional ecological information:**
- **General notes:**
Water hazard class 2 (German Regulation) (Self-assessment): hazardous for water.
Do not allow product to reach ground water, water course or sewage system.
Danger to drinking water if even small quantities leak into the ground.
- **12.5 Results of PBT and vPvB assessment**
- **PBT:** Not applicable.

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- **vPvB:** Not applicable.
- **12.6 Other adverse effects:** No further relevant information available.

13 Disposal considerations

· 13.1 Waste treatment methods

· **Recommendation**

Smaller quantities can be disposed of with household waste.

Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.

The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.

· **Uncleaned packaging:**

- **Recommendation:** Disposal must be made according to official regulations.
- **Recommended cleansing agents:** Water, if necessary together with cleansing agents.

14 Transport information

· 14.1 UN-Number · DOT, ADR, IMDG, IATA, ICAO	Not Regulated
· 14.2 UN proper shipping name · DOT, ADR, IMDG, IATA, ICAO	Not Regulated
· 14.3 Transport hazard class(es) · DOT, ADR, IMDG, IATA, ICAO · Class	Not Regulated
· 14.4 Packing group · DOT, ADR, IMDG, IATA, ICAO	Not Regulated
· 14.5 Environmental hazards: · Marine pollutant:	No
· 14.6 Special precautions for user	Not applicable.
· 14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code	Not applicable.
· UN "Model Regulation":	Not Regulated

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GHS

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Trade name: ALCONOX

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15 Regulatory information

- **15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture**
- **United States (USA)**
- **SARA**

· **Section 355 (extremely hazardous substances):**

None of the ingredients is listed.

· **Section 313 (Specific toxic chemical listings):**

None of the ingredients is listed.

· **TSCA (Toxic Substances Control Act):**

All ingredients are listed.

· **Proposition 65 (California):**

· **Chemicals known to cause cancer:**

None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for females:**

None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for males:**

None of the ingredients is listed.

· **Chemicals known to cause developmental toxicity:**

None of the ingredients is listed.

· **Carcinogenic Categories**

· **EPA (Environmental Protection Agency)**

None of the ingredients is listed.

· **IARC (International Agency for Research on Cancer)**

None of the ingredients is listed.

· **TLV (Threshold Limit Value established by ACGIH)**

None of the ingredients is listed.

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**

None of the ingredients is listed.

· **OSHA-Ca (Occupational Safety & Health Administration)**

None of the ingredients is listed.

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GHS

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Trade name: **ALCONOX**

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· **Canada**

· **Canadian Domestic Substances List (DSL)**

All ingredients are listed.

· **Canadian Ingredient Disclosure list (limit 0.1%)**

None of the ingredients is listed.

· **Canadian Ingredient Disclosure list (limit 1%)**

497-19-8	Sodium Carbonate
7722-88-5	tetrasodium pyrophosphate
151-21-3	sodium dodecyl sulphate

· **15.2 Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Relevant phrases**

H302: Harmful if swallowed.

H312: Harmful in contact with skin.

H315: Causes skin irritation.

H319: Causes serious eye irritation.

R21/22: Harmful in contact with skin and if swallowed.

R22: Harmful if swallowed.

R36: Irritating to eyes.

R36/38: Irritating to eyes and skin.

· **Abbreviations and acronyms:**

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road) IMDG: International Maritime Code for Dangerous Goods DOT: US Department of Transportation

IATA: International Air Transport Association

GHS: Globally Harmonized System of Classification and Labelling of Chemicals

ACGIH: American Conference of Governmental Industrial Hygienists

NFPA: National Fire Protection Association (USA)

HMIS: Hazardous Materials Identification System (USA)

WHMIS: Workplace Hazardous Materials Information System (Canada)



SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : ADVANCED GEL HAND SANITIZER

Other means of identification : not applicable

Recommended use : Hand Sanitizer

Restrictions on use : Reserved for industrial and professional use.

Product dilution information : Product is sold ready to use.

Company : Ecolab Inc.
370 N. Wabasha Street
St. Paul, Minnesota USA 55102
1-800-352-5326

Emergency telephone : 1-800-328-0026 (US/Canada), 1-651-222-5352 (outside US)

Issuing date : 03/28/2014

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids : Category 3

Eye irritation : Category 2A

GHS Label element

Hazard pictograms :



Signal Word : Warning

Hazard Statements : Flammable liquid and vapor.
Causes serious eye irritation.

Precautionary Statements : **Prevention:**
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Keep container tightly closed.
Response:
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/ attention. In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
Storage:
Store in a well-ventilated place. Keep cool.
Disposal:
Dispose of contents/ container to an approved waste disposal plant.

Other hazards : None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Pure substance/mixture : Mixture

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

Chemical Name	CAS-No.	Concentration (%)
ethanol	64-17-5	60 - 100

SECTION 4. FIRST AID MEASURES

In case of eye contact	: Rinse with water.
In case of skin contact	: Rinse with water.
If swallowed	: Rinse mouth. Get medical attention if symptoms occur.
If inhaled	: Get medical attention if symptoms occur.
Protection of first-aiders	: No special precautions are necessary for first aid responders.
Notes to physician	: Treat symptomatically.

See toxicological information (Section 11)

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	: Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Unsuitable extinguishing media	: High volume water jet
Specific hazards during fire fighting	: Fire Hazard Keep away from heat and sources of ignition. Flash back possible over considerable distance. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas.
Hazardous combustion products	: Carbon oxides
Special protective equipment for fire-fighters	: Use personal protective equipment.
Specific extinguishing methods	: Use water spray to cool unopened containers. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. In the event of fire and/or explosion do not breathe fumes.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	: Remove all sources of ignition. Ensure clean-up is conducted by trained personnel only. Refer to protective measures listed in sections 7 and 8.
Environmental precautions	: Do not allow contact with soil, surface or ground water.
Methods and materials for containment and cleaning up	: Eliminate all ignition sources if safe to do so. Stop leak if safe to do so. Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13). Flush away traces with water. For large spills, dike spilled material or otherwise contain material to ensure runoff does not reach a waterway.

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

SECTION 7. HANDLING AND STORAGE

- Advice on safe handling : Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapors). Keep away from fire, sparks and heated surfaces.
- Conditions for safe storage : Keep away from heat and sources of ignition. Keep in a cool, well-ventilated place. Keep away from oxidizing agents. Keep out of reach of children. Keep container tightly closed. Store in suitable labeled containers.
- Storage temperature : 0 °C to 35 °C

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Ingredients	CAS-No.	Form of exposure	Permissible concentration	Basis
ethanol	64-17-5	TWA	1,000 ppm	ACGIH
		TWA	1,000 ppm 1,900 mg/m ³	NIOSH REL
		TWA	1,000 ppm 1,900 mg/m ³	OSHA Z1

- Engineering measures : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Personal protective equipment

- Eye protection : No special protective equipment required.
- Hand protection : No special protective equipment required.
- Skin protection : No special protective equipment required.
- Respiratory protection : No personal respiratory protective equipment normally required.
- Hygiene measures : No specific measures identified.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

- Appearance : gel
- Color : opaque, white
- Odor : alcoholic
- pH : 6.3 - 8.5, 100 %
- Flash point : 23 °C closed cup
- Odor Threshold : no data available
- Melting point/freezing point : no data available
- Initial boiling point and boiling range : no data available

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

Evaporation rate	: no data available
Flammability (solid, gas)	: no data available
Upper explosion limit	: no data available
Lower explosion limit	: no data available
Vapor pressure	: no data available
Relative vapor density	: no data available
Relative density	: 0.869 - 0.873
Water solubility	: no data available
Solubility in other solvents	: no data available
Partition coefficient: n-octanol/water	: no data available
Autoignition temperature	: no data available
Thermal decomposition	: no data available
Viscosity, kinematic	: no data available
Explosive properties	: no data available
Oxidizing properties	: no data available
Molecular weight	: no data available
VOC	: no data available

SECTION 10. STABILITY AND REACTIVITY

Chemical stability	: Stable under normal conditions.
Possibility of hazardous reactions	: No dangerous reaction known under conditions of normal use.
Conditions to avoid	: Heat, flames and sparks.
Incompatible materials	: None known.
Hazardous decomposition products	: Carbon oxides

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure : Inhalation, Eye contact, Skin contact

Potential Health Effects

Eyes	: Causes serious eye irritation.
Skin	: Health injuries are not known or expected under normal use.
Ingestion	: Health injuries are not known or expected under normal use.
Inhalation	: Health injuries are not known or expected under normal use.
Chronic Exposure	: Health injuries are not known or expected under normal use.

Experience with human exposure

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

Eye contact : Redness, Pain, Irritation

Skin contact : No symptoms known or expected.

Ingestion : No symptoms known or expected.

Inhalation : No symptoms known or expected.

Toxicity

Acute oral toxicity : Acute toxicity estimate : > 5,000 mg/kg

Acute inhalation toxicity : no data available

Acute dermal toxicity : no data available

Skin corrosion/irritation : no data available

Serious eye damage/eye irritation : no data available

Respiratory or skin sensitization : no data available

Carcinogenicity

IARC No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

OSHA No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

NTP No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive effects : no data available

Germ cell mutagenicity : no data available

Teratogenicity : no data available

STOT-single exposure : The substance or mixture is not classified as specific target organ toxicant, single exposure.

STOT-repeated exposure : no data available

Aspiration toxicity : no data available

Ingredients

Acute inhalation toxicity : ethanol
4 h LC50 rat: 117 mg/l

Ingredients

Acute dermal toxicity : ethanol
LD50 rabbit: 15,800 mg/kg

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Environmental Effects : Harmful to aquatic life.

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

Product

Toxicity to fish : no data available

Toxicity to daphnia and other aquatic invertebrates : no data available

Toxicity to algae : no data available

Ingredients

Toxicity to fish : ethanol
96 h LC50 Fish: 11,000 mg/l

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

Other adverse effects

no data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods : The product should not be allowed to enter drains, water courses or the soil. Where possible recycling is preferred to disposal or incineration. If recycling is not practicable, dispose of in compliance with local regulations. Dispose of wastes in an approved waste disposal facility.

Disposal considerations : Dispose of as unused product. Empty containers should be taken to an approved waste handling site for recycling or disposal. Do not re-use empty containers.

RCRA - Resource Conservation and Recovery Authorization Act Hazardous waste : D001 (Ignitable)

SECTION 14. TRANSPORT INFORMATION

The shipper/consignor/sender is responsible to ensure that the packaging, labeling, and markings are in compliance with the selected mode of transport.

Land transport (DOT)

UN number : 1170
Description of the goods : Ethanol solutions
Class : 3
Packing group : III
Environmentally hazardous : no

Sea transport (IMDG/IMO)

UN number : 1170
Description of the goods : ETHANOL SOLUTION

SAFETY DATA SHEET

ADVANCED GEL HAND SANITIZER

Class : 3
Packing group : III
Marine pollutant : no

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Fire Hazard
Acute Health Hazard

SARA 302 : SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

California Prop 65

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

The ingredients of this product are reported in the following inventories:

1907/2006 (EU) :
not determined

Switzerland. New notified substances and declared preparations :
not determined

United States TSCA Inventory :
On TSCA Inventory

Canadian Domestic Substances List (DSL) :
This product contains one or several components that are not on the Canadian DSL nor NDSL.

Australia Inventory of Chemical Substances (AICS) :
not determined

New Zealand. Inventory of Chemical Substances :
not determined

Japan. ENCS - Existing and New Chemical Substances Inventory :
not determined

Japan. ISHL - Inventory of Chemical Substances (METI) :
not determined

Korea. Korean Existing Chemicals Inventory (KECI) :
not determined

Philippines Inventory of Chemicals and Chemical Substances (PICCS) :

SAFETY DATA SHEET

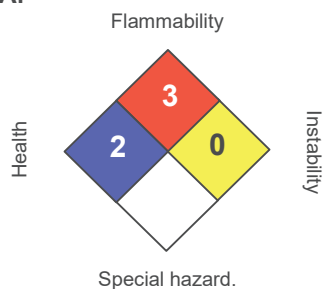
ADVANCED GEL HAND SANITIZER

not determined

China. Inventory of Existing Chemical Substances in China (IECSC) :
not determined

SECTION 16. OTHER INFORMATION

NFPA:



HMIS III:

HEALTH	2
FLAMMABILITY	3
PHYSICAL HAZARD	0

0 = not significant, 1 = Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

Issuing date : 03/28/2014
Version : 1.0
Prepared by : Regulatory Affairs

REVISED INFORMATION: Significant changes to regulatory or health information for this revision is indicated by a bar in the left-hand margin of the SDS.

The information provided in this Material Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

CONTACT
0800 990 3258
enquiries@reagent.co.uk



ReAgent

SAFETY DATA SHEET BUFFER SOLUTION pH 10 BLUE

According to Regulation (EC) No 1907/2006

1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

PRODUCT NAME BUFFER SOLUTION pH 10 BLUE
 PRODUCT NO. 2098
 APPLICATION General chemical reagent
 SUPPLIER Reagent Chemical Services
 18 Aston Fields Road
 Whitehouse Industrial Estate
 Runcorn
 Cheshire WA7 3DL
 T: 01928 716903
 F: 01928 716425
 E: info@reagent.co.uk
 EMERGENCY TELEPHONE Emergency Telephone : +44 (0) 1928 716903 Between 08.30 - 17.00

2 HAZARDS IDENTIFICATION

Not regarded as a health or environmental hazard under current legislation.

3 COMPOSITION/INFORMATION ON INGREDIENTS

Name	EC No.	CAS-No.	Content	Classification
SODIUM TETRABORATE	215-540-4	1303-96-4	< 1	-

The Full Text for all R-Phrases are Displayed in Section 16

4 FIRST-AID MEASURES

INHALATION

Remove victim immediately from source of exposure. Provide rest, warmth and fresh air. Get medical attention if any discomfort continues.

INGESTION

Do not induce vomiting. Immediately rinse mouth and drink plenty of water (200-300 ml). Get medical attention immediately!

SKIN CONTACT

Immediately remove contaminated clothing. Wash the skin immediately with soap and water. Get medical attention if irritation persists after washing.

EYE CONTACT

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

5 FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA

The product is non-combustible. Use fire-extinguishing media appropriate for surrounding materials.

6 ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS

Wear protective clothing as described in Section 8 of this safety data sheet.

SPILL CLEAN UP METHODS

Absorb in vermiculite, dry sand or earth and place into containers. Wash contaminated area with water.

7 HANDLING AND STORAGE

USAGE PRECAUTIONS

Avoid spilling, skin and eye contact.

BUFFER SOLUTION pH 10 BLUE**STORAGE PRECAUTIONS**

Store in tightly closed original container in a dry and cool place.

STORAGE CLASS

Chemical storage.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	Std	TWA - 8 hrs		STEL - 15 min		Notes
SODIUM TETRABORATE			5 mg/m3			

ENGINEERING MEASURES

Provide adequate ventilation.

HAND PROTECTION

Wear protective gloves. Rubber or plastic

EYE PROTECTION

Wear safety glasses. If risk of splashing, wear safety goggles or face shield.

HYGIENE MEASURES

Wash at the end of each work shift and before eating, smoking and using the toilet. Wash promptly if skin becomes wet or contaminated. Promptly remove any clothing that becomes wet or contaminated. When using do not eat, drink or smoke.

9 PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE	Liquid				
COLOUR	Blue				
ODOUR	Odourless				
SOLUBILITY	Miscible with water.				
BOILING POINT (°C)	About 100	pH-VALUE, CONC. SOLUTION		10	

10 STABILITY AND REACTIVITY**STABILITY**

Stable under normal temperature conditions.

11 TOXICOLOGICAL INFORMATION**HEALTH WARNINGS**

Although not classified as hazardous, the product should be treated with the care and attention appropriate to chemicals.

12 ECOLOGICAL INFORMATION**ECOTOXICITY**

Although not classified as environmentally hazardous, harmful effects cannot be excluded in the event of improper handling or disposal.

13 DISPOSAL CONSIDERATIONS**DISPOSAL METHODS**

Dispose of waste and residues in accordance with local authority requirements.

14 TRANSPORT INFORMATION

ADR CLASS	Not classified for transportation.

15 REGULATORY INFORMATION**RISK PHRASES**

NC Not classified.

SAFETY PHRASES

NC Not classified.

BUFFER SOLUTION pH 10 BLUE

STATUTORY INSTRUMENTS

Chemicals (Hazard Information and Packaging) Regulations. Control of Substances Hazardous to Health.

APPROVED CODE OF PRACTICE

Classification and Labelling of Substances and Preparations Dangerous for Supply. COSHH essentials: Easy steps to control chemicals.
Control of Substances Hazardous to Health Regulations.

GUIDANCE NOTES

Workplace Exposure Limits EH40. Introduction to Local Exhaust Ventilation HS(G)37.

NATIONAL REGULATIONS

Control of Substances Hazardous to Health Regulations 2002 (as amended)

16 OTHER INFORMATION

REVISION COMMENTS

Change to section 1

REVISION DATE 23/09/2008

REV. NO./REPL. SDS GENERATED Supercedes issue October 2001

SDS NO. 10682

RISK PHRASES IN FULL

NC Not classified.

Buffer Solution pH 4.00

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 07/19/2013

Revision date: 12/21/2016

Supersedes: 08/06/2014

Version: 1.3

SECTION 1: Identification

1.1. Identification

Product form : Mixture
Product name : Buffer Solution pH 4.00
Product code : LC12270

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : For laboratory and manufacturing use only.
Recommended use : Laboratory chemicals
Restrictions on use : Not for food, drug or household use

1.3. Details of the supplier of the safety data sheet

LabChem Inc
Jackson's Pointe Commerce Park Building 1000, 1010 Jackson's Pointe Court
Zelienople, PA 16063 - USA
T 412-826-5230 - F 724-473-0647
info@labchem.com - www.labchem.com

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Not classified

2.2. Label elements

Not classified as a hazardous chemical.

2.3. Other hazards

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substance

Not applicable

3.2. Mixture

Name	Product identifier	%	GHS-US classification
Water	(CAS No) 7732-18-5	98.94	Not classified
Potassium Hydrogen Phthalate	(CAS No) 877-24-7	1.02	Eye Irrit. 2B, H320
Formaldehyde, 37% w/w	(CAS No) 50-00-0	0.04	Flam. Liq. 3, H226 Acute Tox. 4 (Oral), H302 Acute Tox. 4 (Dermal), H312 Acute Tox. 2 (Inhalation:vapour), H330 Skin Corr. 1C, H314 Eye Dam. 1, H318 Carc. 1A, H350 STOT SE 1, H370 Aquatic Acute 2, H401

Full text of hazard classes and H-statements : see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).
First-aid measures after inhalation : Allow victim to breathe fresh air. Allow the victim to rest.

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First-aid measures after skin contact	: Remove affected clothing and wash all exposed skin area with mild soap and water, followed by warm water rinse.
First-aid measures after eye contact	: Rinse immediately with plenty of water. Obtain medical attention if pain, blinking or redness persist.
First-aid measures after ingestion	: Rinse mouth. Do NOT induce vomiting. Obtain emergency medical attention.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries	: Not expected to present a significant hazard under anticipated conditions of normal use.

4.3. Indication of any immediate medical attention and special treatment needed

No additional information available

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	: Foam. Dry powder. Carbon dioxide. Water spray. Sand.
Unsuitable extinguishing media	: Do not use a heavy water stream.

5.2. Special hazards arising from the substance or mixture

Reactivity	: None.

5.3. Advice for firefighters

Firefighting instructions	: Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Prevent fire-fighting water from entering environment.
Protection during firefighting	: Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment	: Safety glasses.
Emergency procedures	: Evacuate unnecessary personnel.

6.1.2. For emergency responders

Protective equipment	: Equip cleanup crew with proper protection.
Emergency procedures	: Ventilate area.

6.2. Environmental precautions

Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up	: Soak up spills with inert solids, such as clay or diatomaceous earth as soon as possible. Collect spillage. Store away from other materials.

6.4. Reference to other sections

See Heading 8. Exposure controls and personal protection.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	: Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor.
Hygiene measures	: Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions	: Keep container closed when not in use.
Incompatible products	: Strong oxidizers.
Incompatible materials	: None known.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Potassium Hydrogen Phthalate (877-24-7)

Not applicable

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Formaldehyde, 37% w/w (50-00-0)		
ACGIH	ACGIH Ceiling (mg/m³)	0.37 mg/m³
OSHA	OSHA PEL (TWA) (ppm)	0.75 ppm
OSHA	OSHA PEL (STEL) (ppm)	2 ppm
IDLH	US IDLH (ppm)	20 ppm
NIOSH	NIOSH REL (TWA) (ppm)	0.016 ppm
NIOSH	NIOSH REL (ceiling) (ppm)	0.1 ppm 15 min.
Water (7732-18-5)		
Not applicable		

8.2. Exposure controls

Appropriate engineering controls : Emergency eye wash fountains should be available in the immediate vicinity of any potential exposure.

Personal protective equipment : Safety glasses. Gloves.



Hand protection : Wear protective gloves.

Eye protection : Chemical goggles or safety glasses.

Respiratory protection : Respiratory protection not required in normal conditions.

Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Color	: Colorless
Odor	: Odorless
Odor threshold	: No data available
pH	: 4
Melting point	: No data available
Freezing point	: No data available
Boiling point	: No data available
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Non flammable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: No data available
Specific gravity / density	: 1
Solubility	: Soluble in water.
Log Pow	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: No data available
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: Not applicable.
Oxidizing properties	: None.

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9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

None.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

None.

10.4. Conditions to avoid

Extremely high or low temperatures.

10.5. Incompatible materials

Strong oxidizers.

10.6. Hazardous decomposition products

Formaldehyde. Carbon monoxide. Carbon dioxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure : Skin and eye contact

Acute toxicity : Not classified

Potassium Hydrogen Phthalate (877-24-7)	
LD50 oral rat	≥ 3200 mg/kg
ATE US (oral)	3200.000 mg/kg body weight

Formaldehyde, 37% w/w (50-00-0)	
LD50 oral rat	500 mg/kg
ATE US (oral)	500.000 mg/kg body weight
ATE US (dermal)	2000.000 mg/kg body weight
ATE US (vapors)	0.578 mg/l/4h

Water (7732-18-5)	
LD50 oral rat	≥ 90000 mg/kg
ATE US (oral)	90000.000 mg/kg body weight

Skin corrosion/irritation : Not classified
pH: 4

Serious eye damage/irritation : Not classified
pH: 4

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Formaldehyde, 37% w/w (50-00-0)	
IARC group	1 - Carcinogenic to humans

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : Based on available data, the classification criteria are not met.

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SECTION 12: Ecological information

12.1. Toxicity

Formaldehyde, 37% w/w (50-00-0)	
LC50 fish 1	41 mg/l (LC50; 96 h)
EC50 Daphnia 1	14.7 mg/l (EC50; 24 h)
EC50 Daphnia 2	2 mg/l
Threshold limit algae 1	2.5 mg/l (EC0; 192 h)

12.2. Persistence and degradability

Buffer Solution pH 4.00	
Persistence and degradability	Not established.
Potassium Hydrogen Phthalate (877-24-7)	
Persistence and degradability	Not established.
Formaldehyde, 37% w/w (50-00-0)	
Persistence and degradability	Readily biodegradable in water. Biodegradability in soil: no data available. No test data on mobility of the components available. Photodegradation in the air.
Biochemical oxygen demand (BOD)	0.64 g O ₂ /g substance
Chemical oxygen demand (COD)	1.06 g O ₂ /g substance
ThOD	1.068 g O ₂ /g substance
BOD (% of ThOD)	0.6 (5 days; Literature study)
Water (7732-18-5)	
Persistence and degradability	Not established.

12.3. Bioaccumulative potential

Buffer Solution pH 4.00	
Bioaccumulative potential	Not established.
Potassium Hydrogen Phthalate (877-24-7)	
Bioaccumulative potential	Not established.
Formaldehyde, 37% w/w (50-00-0)	
Log Pow	-0.78 - 0.0
Bioaccumulative potential	Bioaccumulation: not applicable.
Water (7732-18-5)	
Bioaccumulative potential	Not established.

12.4. Mobility in soil

Formaldehyde, 37% w/w (50-00-0)	
Ecology - soil	Toxic to flora.

12.5. Other adverse effects

Effect on the global warming	: No known effects from this product.
GWPmix comment	: No known effects from this product.
Other information	: Avoid release to the environment.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations	: Dispose in a safe manner in accordance with local/national regulations.
Ecology - waste materials	: Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Not regulated

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SECTION 15: Regulatory information

15.1. US Federal regulations

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory

This product or mixture does not contain a toxic chemical or chemicals in excess of the applicable de minimis concentration as specified in 40 CFR §372.38(a) subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

Formaldehyde, 37% w/w (50-00-0)	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	100 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Delayed (chronic) health hazard
SARA Section 313 - Emission Reporting	0.1 %

15.2. International regulations

CANADA

Buffer Solution pH 4.00	
WHMIS Classification	Uncontrolled product according to WHMIS classification criteria
Potassium Hydrogen Phthalate (877-24-7)	
WHMIS Classification	Class D Division 2 Subdivision B - Toxic material causing other toxic effects
Formaldehyde, 37% w/w (50-00-0)	
Listed on the Canadian DSL (Domestic Substances List)	
WHMIS Classification	Class B Division 3 - Combustible Liquid Class D Division 1 Subdivision A - Very toxic material causing immediate and serious toxic effects Class D Division 2 Subdivision A - Very toxic material causing other toxic effects Class D Division 2 Subdivision B - Toxic material causing other toxic effects Class E - Corrosive Material
Water (7732-18-5)	
WHMIS Classification	Uncontrolled product according to WHMIS classification criteria

EU-Regulations

No additional information available

National regulations

Formaldehyde, 37% w/w (50-00-0)	
Listed on the Canadian IDL (Ingredient Disclosure List)	

15.3. US State regulations

California Proposition 65 - This product contains, or may contain, trace quantities of a substance(s) known to the state of California to cause cancer, developmental and/or reproductive harm

Formaldehyde, 37% w/w (50-00-0)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	Non-significant risk level (NSRL)
Yes	Yes	No	No	40 µg/day

SECTION 16: Other information

Revision date : 12/21/2016
Other information : None.

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Full text of H-phrases: see section 16:

H226	Flammable liquid and vapor
H302	Harmful if swallowed
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage
H318	Causes serious eye damage
H320	Causes eye irritation
H330	Fatal if inhaled
H350	May cause cancer
H370	Causes damage to organs
H401	Toxic to aquatic life

NFPA health hazard

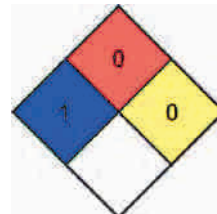
: 1 - Exposure could cause irritation but only minor residual injury even if no treatment is given.

NFPA fire hazard

: 0 - Materials that will not burn.

NFPA reactivity

: 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health

: 1 Slight Hazard - Irritation or minor reversible injury possible

Flammability

: 0 Minimal Hazard - Materials that will not burn

Physical

: 0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.

Personal protection

: A

A - Safety glasses

SDS US LabChem

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Issue Date: 2006-06

Section 1 - Chemical Product and Company Identification

61

Material Name: Nitric Acid

CAS Number: 7697-37-2

Chemical Formula: HNO₃

Structural Chemical Formula: HNO₃

EINECS Number: 231-714-2

ACX Number: X1002177-5

Synonyms: ACIDE NITRIQUE; ACIDO NITRICO; AQUA FORTIS; AZOTIC ACID; AZOTOWY KWAS; ENGRAVER'S ACID; ENGRAVERS ACID; HYDROGEN NITRATE; KYSELINA DUSICNE; NITAL; NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH >70% NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH NOT >70% NITRICACID; NITROUS FUMES; NITRYL HYDROXIDE; RED FUMING NITRIC ACID (RFNA); SALPETERSAURE; SALPETERZUUROPOLOSSINGEN; WHITE FUMING NITRIC ACID (WFNA)

General Use: Manufacture of organic and inorganic nitrates and nitro compounds for fertilizers, dye intermediates and many organic chemicals.

Used for etching and cleaning metals.

Operators should be trained in procedures for safe use of this material.

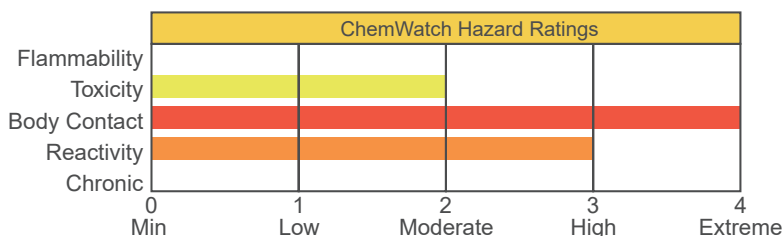
Section 2 - Composition / Information on Ingredients

Name	CAS	%
nitric acid	7697-37-2	>95
OSHA PEL TWA: 2 ppm; 5 mg/m ³ .	NIOSH REL TWA: 2 ppm (5 mg/m ³); STEL: 4 ppm (10 mg/m ³).	DFG (Germany) MAK TWA: 2 ppm; PEAK: 2 ppm.
ACGIH TLV TWA: 2 ppm; STEL: 4 ppm.	IDLH Level 25 ppm.	
EU OEL STEL: 2.6 mg/m ³ (1 ppm).		

Section 3 - Hazards Identification



Fire Diamond



HMIS	
3	Health
0	Flammability
2	Reactivity

ANSI Signal Word

Danger!



☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Clear to yellow fuming liquid; acrid, suffocating odor. Corrosive. Other Acute Effects: lung damage. Chronic Effects: tooth erosion, bronchitis. Strong oxidizer.

Potential Health Effects

Target Organs: eyes, skin, respiratory system, teeth

Primary Entry Routes: inhalation, ingestion, skin contact, eye contact

Acute Effects

Inhalation: The vapor is extremely discomforting and corrosive to the upper respiratory tract and lungs and the material presents a hazard from a single acute exposure or from repeated exposures over long periods.

Inhalation hazard is increased at higher temperatures.

Reactions may occur following a single acute exposure or may only appear after repeated exposures.

Reactions may not occur on exposure but response may be delayed with symptoms only appearing many hours later. The material may produce respiratory tract irritation which produces an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system. Unlike most organs the lung can respond to a chemical insult or agent by first trying to remove or neutralize the irritant and then repairing the damage. The repair process, which initially developed to protect mammalian lungs from foreign matter and antigens, may however, cause further damage the lungs when activated by hazardous chemicals. The result is often the impairment of gas exchange, the primary function of the lungs.

Inhalation of nitric acid mist or fumes at 2 to 25 ppm over an 8 hour period may cause pulmonary irritation and symptoms of lung damage.

Only several minutes of exposure to concentrated atmosphere i.e. 200 ppm may cause severe pulmonary damage and even fatality. Death may be delayed for several days.

Exposure to nitric acid fumes (with concurrent inhalation of nitrogen dioxide and nitric oxide) may elicit prompt irritation of the upper respiratory tract leading to coughing, gagging, chest pain, dyspnea, cyanosis if concentrations are sufficiently high and duration of exposure sufficiently long, pulmonary edema.

Eye: The liquid is extremely corrosive to the eyes and contact may cause rapid tissue destruction and is capable of causing severe damage with loss of sight.

The vapor is extremely discomforting to the eyes and is capable of causing pain and severe conjunctivitis.

Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.

The material may produce moderate eye irritation leading to inflammation.

Repeated or prolonged exposure to irritants may produce conjunctivitis.

Eye contact with concentrated acid may give no pain, whilst diluted solution causes intense pain and both can cause permanent eye damage or blindness. Burns may result in shrinkage of the eyeball, symblepharon (adhesions between tarsal and bulbar conjunctivae), permanent corneal opacification, and visual impairment leading to blindness.

Skin: The liquid is extremely corrosive to the skin and contact may cause tissue destruction with severe burns.

Bare unprotected skin should not be exposed to this material.

The vapor is highly discomforting to the skin.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Skin contact causes yellow discoloration of the skin, blisters and scars that may not heal. The skin may be stained bright-yellow or yellowish brown due to the formation of xanthoproteic acid. Dilute solutions may harden the epithelium without producing overt corrosion.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The material is extremely corrosive if swallowed and is capable of causing burns to mouth, throat, esophagus, with extreme discomfort, pain and may be fatal.

Even a small amount causes severe corrosion of the stomach, burning pain, vomiting and shock, possibly causing non-healing scarring of the gastrointestinal tract and stomach. Death may be delayed 12 hours to 14 days or to several months. Such late fatalities are attributed to a chemical lobular pneumonitis secondary to aspiration. Survivors show stricture of the gastric mucosa and subsequent pernicious anemia.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: Prolonged or repeated overexposure to low concentrations of vapor may cause chronic bronchitis, corrosion of teeth, even chemical pneumonitis.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If available, administer medical oxygen by trained personnel.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water. Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Immediately transport to hospital or doctor. DO NOT delay.

Skin Contact: Immediately flush body and clothes with large amounts of water, using safety shower if available.

Quickly remove all contaminated clothing, including footwear.

Wash affected areas with water (and soap if available) for at least 15 minutes. Transport to hospital or doctor. DO NOT delay.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

Immediately transport to hospital or doctor. DO NOT delay.

See
DOT
ERG

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to strong acids:

1. Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
2. Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.
3. Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
4. Strong acids produce a coagulation necrosis characterized by formation of a coagulum (eschar) as a result of the desiccating action of the acid on proteins in specific tissues.

INGESTION:

1. Immediate dilution (milk or water) within 30 minutes post-ingestion is recommended.
2. Do not attempt to neutralize the acid since exothermic reaction may extend the corrosive injury.
3. Be careful to avoid further vomiting since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
4. Charcoal has no place in acid management.
5. Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:

1. Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
2. Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:

1. Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjunctival cul-de-sacs. Irrigation should last at least 20-30 minutes. Do not use neutralizing agents or any other additives. Several liters of saline are required.
2. Cycloplegic drops (1% cyclopentolate for short-term use or 5% homatropine for longer term use), antibiotic drops, vasoconstrictive agents, or artificial tears may be indicated dependent on the severity of the injury.
3. Steroid eye drops should only be administered with the approval of a consulting ophthalmologist.

Section 5 - Fire-Fighting Measures

Flash Point: Nonflammable

Autoignition Temperature: Not applicable

LEL: Not applicable

UEL: Not applicable

Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).
Carbon dioxide.

General Fire Hazards/Hazardous Combustion Products: Will not burn but increases intensity of fire.

Heating may cause expansion or decomposition leading to violent rupture of containers.

Heat affected containers remain hazardous.

Contact with combustibles such as wood, paper, oil or finely divided metal may cause ignition, combustion or violent decomposition.

May emit irritating, poisonous or corrosive fumes.

Decomposes on heating and produces toxic fumes of nitrogen oxides (NO_x) and nitric acid.

Fire Incompatibility: Oxidizing agents as a class are not necessarily combustible themselves, but can increase the risk and intensity of fire in many other substances.

Reacts vigorously with water and alkali.

Avoid reaction with organic materials/compounds, powdered metals, reducing agents and hydrogen sulfide (H_2S) as ignition may result.

Reacts with metals producing flammable/explosive hydrogen gas.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.

Fight fire from a safe distance, with adequate cover.

Extinguishers should be used only by trained personnel.

Use water delivered as a fine spray to control fire and cool adjacent area.

Avoid spraying water onto liquid pools.

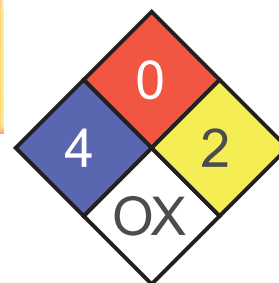
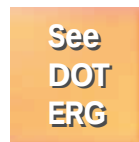
Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protected location.

If safe to do so, remove containers from path of fire.

If fire gets out of control withdraw personnel and warn against entry.

Equipment should be thoroughly decontaminated after use.



Fire Diamond

Section 6 - Accidental Release Measures

Small Spills: Dangerous levels of nitrogen oxides may form during spills of nitric acid.

Wear fully protective PVC clothing and breathing apparatus.

Clean up all spills immediately. No smoking, bare lights, ignition sources.

Avoid all contact with any organic matter including fuel, solvents, sawdust, paper or cloth and other incompatible materials, as ignition may result.

Avoid breathing dust or vapors and all contact with skin and eyes.

Control personal contact by using protective equipment.

Contain and absorb spill with dry sand, earth, inert material or vermiculite. DO NOT use sawdust as fire may result.

Scoop up solid residues and seal in labeled drums for disposal.

Neutralize/decontaminate area.

Use soda ash or slaked lime to neutralize.

Large Spills: DO NOT touch the spill material. Restrict access to area.

Clear area of personnel and move upwind. Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.

No smoking, flames or ignition sources. Increase ventilation.

Contain spill with sand, earth or other clean, inert materials.

NEVER use organic absorbents such as sawdust, paper, cloth; as fire may result. Avoid any contamination by organic matter.

Use spark-free and explosion-proof equipment.

Collect any recoverable product into labeled containers for possible recycling. DO NOT mix fresh with recovered material.

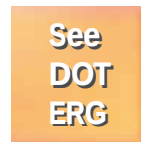
Collect residues and seal in labeled drums for disposal.

Wash area and prevent runoff into drains. Decontaminate equipment and launder all protective clothing before storage and reuse.

If contamination of drains or waterways occurs advise emergency services.

DO NOT USE WATER OR NEUTRALIZING AGENTS INDISCRIMINATELY ON LARGE SPILLS.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).



Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Do not allow clothing wet with material to stay in contact with skin.

Avoid all personal contact, including inhalation.

Wear protective clothing when risk of exposure occurs.

Use in a well-ventilated area.

WARNING: To avoid violent reaction, ALWAYS add material to water and NEVER water to material.

Avoid smoking, bare lights or ignition sources.

Avoid contact with incompatible materials.

When handling, DO NOT eat, drink or smoke.

Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling. Work clothes should be laundered separately.

Launder contaminated clothing before reuse.

Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.

Recommended Storage Methods: Stainless steel drum. Check that containers are clearly labeled.

Packaging as recommended by manufacturer.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.

Local exhaust ventilation may be required for safe working, i. e. , to keep exposures below required standards; otherwise, PPE is required.

If risk of overexposure exists, wear NIOSH-approved respirator.

Correct fit is essential to obtain adequate protection.

In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus.

Personal Protective Clothing/Equipment:

Eyes: Chemical goggles. Full face shield.

DO NOT wear contact lenses. Contact lenses pose a special hazard; soft contact lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Bare unprotected skin should not be exposed to this material. Impervious, gauntlet length gloves i.e., butyl rubber gloves or Neoprene rubber gloves or wear chemical protective gloves, e.g. PVC.

Wear safety footwear or safety gumboots, e.g. Rubber.

Respiratory Protection:

Exposure Range >2 to <25 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask

Exposure Range 25 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face

Other: Operators should be trained in procedures for safe use of this material.

Acid-resistant overalls or Rubber apron or PVC apron.

Ensure there is ready access to an emergency shower.

Ensure that there is ready access to eye wash unit.

Ensure that there is ready access to breathing apparatus.

Glove Selection Index:

BUTYL Best selection

HYPALON Best selection

NEOPRENE..... Best selection

NEOPRENE/NATURAL..... Best selection

PE/EVAL/PE Best selection

SARANEX-23 Best selection

NATURAL RUBBER..... Satisfactory; may degrade after 4 hours continuous immersion

NATURAL+NEOPRENE..... Satisfactory; may degrade after 4 hours continuous immersion

PVC..... Poor to dangerous choice for other than short-term immersion

NITRILE+PVC..... Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear, colorless to slightly yellow liquid. Sharp strong odor.

CAUTION: exothermic dilution hazard.

HIGHLY CORROSIVE. Corrosive to most metals. Powerful oxidizing agent.

Darkens to brownish color on aging and exposure to light.

Physical State: Liquid

Odor Threshold: 0.75 to 2.50 mg/m³

Vapor Pressure (kPa): 8.26

Vapor Density (Air=1): 1.5

Formula Weight: 63.02

Specific Gravity (H₂O=1, at 4 °C): 1.3-1.42

pH: < 1

pH (1% Solution): 1

Boiling Point: 83 °C (181 °F) at 760 mm Hg

Freezing/Melting Point: -42 °C (-43.6 °F)

Volatile Component (% Vol): 100 (nominal)

Decomposition Temperature (°C): Not applicable

Water Solubility: Soluble in all proportions

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Presence of heat source and direct sunlight. Storage in unsealed containers. Hazardous polymerization will not occur.

Storage Incompatibilities: Segregate from reducing agents, finely divided combustible materials, combustible materials, sawdust, metals and powdered metals.

Avoid contamination of water, foodstuffs, feed or seed.

Segregate from alkalis, oxidizing agents and chemicals readily decomposed by acids, i.e. cyanides, sulfides, carbonates.

Section 11 - Toxicological Information

Toxicity

Oral (human) LD₅₀: 430 mg/kg

Inhalation (rat) LC₅₀: 2500 ppm/1 hr

Unreported (man) LD₅₀: 110 mg/kg

Irritation

Nil reported

See RTECS QU 5775000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.

Ecotoxicity: LC₅₀ Starfish 100-300 mg/l/48 hr /Aerated water conditions; LC₅₀ Shore crab 180 mg/l/48 hr /Static, aerated water conditions; LC₅₀ Cockle 330-1000 mg/l/48 hr /Aerated water conditions

BCF: no food chain concentration potential

Biochemical Oxygen Demand (BOD): none

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Special hazards may exist - specialist advice may be required.
 Consult manufacturer for recycling options.
 Follow applicable federal, state, and local regulations.
 Treat and neutralize at an approved treatment plant.
 Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.
 Puncture containers to prevent reuse and bury at an authorized landfill.

Section 14 - Transport Information

DOT Hazardous Materials Table Data (49 CFR 172.101):

Note: This material has multiple possible HMT entries. Choose the appropriate one based on state and condition of specific material when shipped.

Shipping Name and Description: Nitric acid *other than red fuming, with more than 70 percent nitric acid*

ID: UN2031

Hazard Class: 8 - Corrosive material

Packing Group: I - Great Danger

Symbols:

Label Codes: 8 - Corrosive, 5.1 - Oxidizer

Special Provisions: B47, B53, T10, TP2, TP12, TP13

Packaging: Exceptions: None **Non-bulk:** 158 **Bulk:** 243

Quantity Limitations: Passenger aircraft/rail: Forbidden **Cargo aircraft only:** 2.5 L

Vessel Stowage: Location: D **Other:** 44, 66, 89, 90, 110, 111



Shipping Name and Description: Nitric acid *other than red fuming, with not more than 70 percent nitric acid*

ID: UN2031

Hazard Class: 8 - Corrosive material

Packing Group: II - Medium Danger

Symbols:

Label Codes: 8 - Corrosive

Special Provisions: B2, B47, B53, IB2, T8, TP2, TP12

Packaging: Exceptions: None **Non-bulk:** 158 **Bulk:** 242

Quantity Limitations: Passenger aircraft/rail: Forbidden **Cargo aircraft only:** 30 L

Vessel Stowage: Location: D **Other:**



Shipping Name and Description: Nitric acid, red fuming

ID: UN2032

Hazard Class: 8 - Corrosive material

Packing Group: I - Great Danger

Symbols: + - Override definitions

Label Codes: 8 - Corrosive, 5.1 - Oxidizer, 6.1 - Poison *or* Poison Inhalation Hazard *if inhalation hazard, Zone A or B*

Special Provisions: 2, B9, B32, B74, T20, TP2, TP12, TP13, TP38, TP45

Packaging: Exceptions: None **Non-bulk:** 227 **Bulk:** 244

Quantity Limitations: Passenger aircraft/rail: Forbidden **Cargo aircraft only:** Forbidden

Vessel Stowage: Location: D **Other:**



Section 15 - Regulatory Information

EPA Regulations:

RCRA 40 CFR: Not listed

CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4) 1000 lb (453.5 kg)

SARA 40 CFR 372.65: Listed

SARA EHS 40 CFR 355: Listed

RQ: 1000 lb

TPQ: 1000 lb

TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Group, Inc. extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.



MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

MSDS NO: 248

Version:3

Date: August, 2010

1. Chemical Product and Company Identification

Gasco Affiliates, LLC
320 Scarlett Blvd.
Oldsmar, FL 34677

TELEPHONE NUMBER: (800) 910-0051
FAX NUMBER: (866) 755-8920
E-MAIL: info@gascogas.com

24-HOUR EMERGENCY NUMBER: 1-800-424-9300

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR
CHEMICAL NAME: Isobutylene in air
COMMON NAMES/ SYNONYMS: None
TDG (Canada) CLASSIFICATION: 2.2
WHIMIS CLASSIFICATION: A

2. COMPOSITION/ INFORMATION ON INGREDIENTS

INGREDIENT	%VOLUME	PEL-OSHA	TLV-ACGIH	LD ₅₀ or LC ₅₀ Route/Species
Isobutylene FORMULA: C ₄ H ₈	0.0001-0.9	N/A	N/A	N/A
Air FORMULA: Mixture	99.0 to 99.9999	N/A	N/A	N/A

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Release of this product may produce oxygen-deficient atmospheres (especially in confined spaces or other poorly ventilated environments); individuals in such atmospheres may be asphyxiated. Isobutylene may cause drowsiness and other central nervous system effects in high concentrations; however, due to the low concentration of this gas mixture, this is unlikely to occur.

ROUTE OF ENTRY:

Skin Contact No	Skin Absorption No	Eye Contact No	Inhalation Yes	Ingestion No
HEALTH EFFECTS:				
Exposure Limits Yes	Irritant No	Sensitization No	Reproductive Hazard No	Mutagen No

Carcinogenicity: --NTP: No IARC: No OSHA: No

EYE EFFECTS:

N/A.

SKIN EFFECTS:

N/A.



MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

INGESTION EFFECTS:

Ingestion unlikely. Gas at room temperature.

INHALATION EFFECTS:

Due to the small size of this cylinder, no unusual health effects from over-exposure are anticipated under normal routine use.

NFPA HAZARD CODES

Health: 1
Flammability: 0
Reactivity: 0

HMIS HAZARD CODES

Health: 1
Flammability: 0
Reactivity: 0

RATING SYSTEM

0= No Hazard
1= Slight Hazard
2= Moderate Hazard
3= Serious Hazard
4= Severe Hazard

4. FIRST AID MEASURES

EYES:

N/A

SKIN:

N/A

INGESTION:

Not required

INHALATION:

PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH THE SELF-CONTAINED BREATHING APPARATUS. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. If breathing has stopped administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. FIRE-FIGHTING MEASURES

These containers hold gas under pressure, with no liquid phase. If involved in a major fire, they should be sprayed with water to avoid pressure increases, otherwise pressures will rise and ultimately they may distort or burst to release the contents. The gases will not add significantly to the fire, but containers or fragments may be projected considerable distances - thereby hampering fire fighting efforts.

6. ACCIDENTAL RELEASE MEASURES

In terms of weight, these containers hold very little contents, such that any accidental release by puncturing etc. will be of no practical concern.

7. HANDLING AND STORAGE

Suck back of water into the container must be prevented. Do not allow backfeed into the container. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Use only in well-ventilated areas. Do not heat cylinder by any means to increase rate of product from the cylinder. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Use adequate ventilation for extended use of gas.



MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

9. PHYSICAL AND CHEMICAL PROPERTIES

PARAMETER:	VALUE:
Physical state	: Gas
Evaporation point	: N/A
pH	: N/A
Odor and appearance	: Colorless, odorless gas

10. STABILITY AND REACTIVITY

Stable under normal conditions. Expected shelf life 48 months.

11. TOXICOLOGICAL INFORMATION

No toxicological damage caused by this product.

12. ECOLOGICAL INFORMATION

No ecological damage caused by this product.

13. DISPOSAL INFORMATION

Do not discharge into any place where its accumulation could be dangerous. Used containers are acceptable for disposal in the normal waste stream as long as the cylinder is empty and valve removed or cylinder wall is punctured; but GASCO encourages the consumer to return cylinders.

14. TRANSPORT INFORMATION

	<u>United States DOT</u>	<u>Canada TDG</u>
PROPER SHIPPING NAME:	Compressed Gas N.O.S. (Isobutylene in Air)	Compressed Gas N.O.S. (Isobutylene in Air)
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN1956	UN1956
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. REGULATORY INFORMATION

Isobutylene is listed under the accident prevention provisions of section 112(r) of the Clean Air Act (CAA) with a threshold quantity (TQ) of 10,000 pounds.

16. OTHER INFORMATION

This MSDS has been prepared in accordance with the Chemicals (Hazard Information and Packaging for Supply (Amendment) Regulation 1996. The information is based on the best knowledge of GASCO, and its advisors and is given in good faith, but we cannot guarantee its accuracy, reliability or completeness and therefore disclaim any liability for loss or damage arising out of use of this data. Since conditions of use are outside the control of the Company and its advisors we disclaim any liability for loss or damage when the product is used for other purposes than it is intended.

MSDS/S010/248/ August, 2010

SAFETY DATA SHEET

EC-CON-1413BT (1413 uS/cm Conductivity Calibration Solutions)

Last updated on 7th March 2013

1. PRODUCT IDENTIFICATION AND COMPANY INFORMATIONS

Product Name:	1413 uS/cm KCl Conductivity Calibration Solution
Product Number:	01X211207
Chemical Family:	Mixture of inorganic chemical
Company Informations:	EUTECH INSTRUMENTS PTE LTD. THERMO FISHER SCIENTIFIC Blk 55, Ayer Rajah Crescent, #04-16/24, Singapore 139949, Website: http://www.eutechinst.com E-mail: eutech@thermofisher.com
Telephone No:	(65) 6778 6876
Fax No:	(65) 6773 0836
Product Use:	Laboratory and Industrial Reagent for analysis

2. HAZARD IDENTIFICATION

GHS Classification:	Not classified as a hazardous chemical according to GHS
According to Regulation (EC) No. 1272/2008	Not classified as a hazardous chemical
According to Directive 67/548/EEC	Not classified as a dangerous chemical
Label elements	The product does not need to be labeled in accordance with EC directives or respective national laws.
Other Hazards	None known

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical characterization: Mixtures		
Components:		
CAS: 7447-40-7, EC-No: 231-211-8 Formula: KCl	Potassium Chloride	< 0.1 %
CAS: 7732-18-5, EC-No: 231-791-2	Deionized water	>99.9 %

4. FIRST AID MEASURES

Description of first aid measures:	
After inhalation:	Remove to fresh air. Call a physician if breathing becomes difficult.
After skin contact:	Wash off with soap and plenty of water. Call a physician if irritation develops.
After eye contact:	Rinse out with plenty of water for at least 15 minutes. If pain persists, summon medical advice.
After swallowing:	Wash out mouth with plenty of water, provided person is conscious. Obtain medical attention if feeling unwell.

5. FIRE FIGHTING MEASURES

Extinguishing media:	
Suitable extinguishing media:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Special hazards arising from the substance or mixture	Potassium oxides
Protective equipment:	Do not stay in dangerous zone without suitable chemical protection clothing and self-contained breathing apparatus.
Further information:	The product itself does not burn.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	Use personal protective equipment. Ensure adequate ventilation. Evacuate personnel to safe areas.
Environmental precautions:	Prevent further leakage or spillage if safe to do so.
Methods and material for containment and cleaning up:	Soak up with inert absorbent material and dispose of properly. Clean up affected area.

7. HANDLING AND STORAGE

Precautions for safe handling	Avoid contact with skin and eyes.
Conditions for safe storage, including any incompatibilities	Keep container tightly closed in a dry and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters:	
Appropriate engineering controls	Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal Protective Equipment:	
Eye/face protection	Safety glasses with side-shields. Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Skin protection	Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
Body Protection:	Impervious clothing. Protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Respiratory protection	Normal room ventilation is adequate.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Liquid, colorless
Odor:	Odorless
Odour threshold:	No data available
pH-value:	Approximately 7
Boiling point (deg C):	Approximately 100

Melting point (deg C):	Not applicable
Flash point:	No data available
Evaporation rate	No data available
Flammability (solid, gas)	No data available
Lower Explosion limits:	No data available
Upper Explosion limits:	No data available
Vapour pressure	No data available
Vapour density	No data available
Specific gravity:	1.0-1.03 g/cm ³
Water solubility	Soluble
Partition coefficient: octanol/water	No data available
Autoignition temperature	No data available
Decomposition temperature	Not applicable
Viscosity	No data available
Explosive properties	No data available
Oxidizing properties	No data available
Other information	No further relevant information available

10. STABILITY AND REACTIVITY

Reactivity	No data available.
Chemical stability	Stable under standard ambient conditions
Possibility of hazardous reactions	Not to be expected because of low concentration of the dissolved substances
Conditions to avoid	Heating
Incompatible materials	Strong acids, Strong oxidizing agents
Hazardous decomposition products	No data available

11. TOXICOLOGICAL INFORMATION

Product toxicity	No data available
Potential Health Effects:	
Inhalation:	May harmful if inhaled. May cause respiratory tract irritation
Skin Contact:	May cause skin irritations.
Eye Contact:	May cause eye irritations.
Ingestion:	Harmful if swallowed.
Specific target organ toxicity-single exposure	No data available
Specific target organ toxicity-repeated exposure	No data available

12. ECOLOGICAL INFORMATION

Toxicity:	No data available
Persistence and degradability	No data available
Bioaccumulative potential	No data available
Mobility in soil	No data available
Results of PBT and vPvB assessment	No data available

Other adverse effects	No further relevant information available.
Additional ecological information:	No ecological problems are to be expected when the product is handled and used with due care and attention.

13. DISPOSAL CONSIDERATION

Waste disposal:	Liquid may be flushed to the sewer. Always dispose of in accordance with local, state and federal regulation
Recommended cleaning agent:	Water.

14. TRANSPORT INFORMATION

UN-Number ADR/RID, IMDG, IATA	Not regulated
UN proper shipping name · ADR/RID, IMDG, IATA	Not hazardous goods
Transport hazard class(es) ADR, IMDG, IATA	Not regulated
Packing group ADR, IMDG, IATA	Not regulated
Environmental hazards- Marine pollutant:	No
Special precautions for user:	No data available

15. REGULATORY INFORMATION

This safety datasheet complies with the requirements of Regulation According to Regulation (EC) No. 1272/2008 and GHS system.	
Chemical safety assessment:	No data available

16. OTHER INFORMATION

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Company will not be held liable for any damage resulting from handling or from contact with the above product. Abbreviations and acronyms: ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road RID: Regulations Concerning the International Transport of Dangerous Goods by Rail IMDG: International Maritime Code for Dangerous Goods IATA: International Air Transport Association GHS: Globally Harmonized System of Classification and Labeling of Chemicals	

Health & Safety data sheets

SECTION 1 - IDENTIFICATION OF PREPARATION

Product name:

- 240 mV ORP Solution

Code No. :

- HI 7021

Application:

- ORP solution for Gold and Platinum Electrodes

**Manufacturer
identification:**

HANNA INSTRUMENTS
V.le delle Industrie 12
Ronchi di Villafranca
PADOVA ITALY

SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS

Chemical characterization:

- Solution in water

SECTION 3 - HAZARD IDENTIFICATION

N/A

SECTION 4- FIRST AID MEASURES

Eye contact:

- Irrigate thoroughly with water. If discomfort persists, obtain medical attention

Skin contact:

- Wash off thoroughly with water.

Ingestion:

- Wash out mouth thoroughly with water.

Inhalation:

- Remove from exposure. Rest and keep warm.

SECTION 5 - FIRE FIGHTING MEASURES

Special risks:

- May evolve toxic fumes in fire

Fire extinguisher:

- N/A

Special fire fighting precautions:

- None

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

Health & Safety data sheets

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Wear appropriate protective clothing.

If local regulations permit, mop up with plenty of water and run to waste, diluting greatly with running water. Otherwise transfer to container and arrange removal by disposal company.

SECTION 7- HANDLING AND STORAGE

Handling:

- Under no circumstances eat or drink while handling this material
- Wash hands and face after working with material

Storage:

- Store at room temperature (@ 15-25°C)
- Protect from direct sunlight and moisture
- Keep container well closed
- Keep away from children

SECTION 8- EXPOSURE CONTROL/PERSONAL PROTECTION

As appropriate to quantity handled

Respiratory protection:

- Not applicable

Protective gloves:

- Rubber or plastic

Eye protection:

- Goggles/face shield

SECTION 9- PHYSICAL/CHEMICAL PROPERTIES

Appearance and odor:

- Yellow liquid
- Odorless

Water reactivity:

- Non-reactive

Solubility in water:

- Miscible in any proportion

Melting point:

- N/A

Boiling point:

- N/A

SECTION 10- STABILITY AND REACTIVITY

Stability:

- Stable

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

Health & Safety data sheets

SECTION 11- TOXICOLOGICAL INFORMATION

- **In case of eye contact:**
May cause irritation
- **In case of ingestion of large amounts:**
Gastrointestinal symptoms

SECTION 12- ECOLOGICAL INFORMATION

No environmental hazard is anticipated provided that the material is handled and disposed of with due care and attention.

SECTION 13- DISPOSAL CONSIDERATIONS

Waste disposal:

Chemical residues are generally classified as special waste and as such are covered by regulations which vary according to location. Contact your local waste disposal authority for advice, or pass to a chemical disposal company.

SECTION 14- TRANSPORT INFORMATION

UN-No.:	IMDG class: NR
IMO: NR	Packaging group:
IATA: NR	Packaging group:

Correct technical name: Not-Restricted
ADR/RID: NR

SECTION 15- REGULATORY INFORMATION

Labeling according to EEC directives:

R-phrases: -

S-phrases: -

SECTION 16- OTHER INFORMATION

Emergency telephone number 0039-049-9070211

last rev. June 2002

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

SAFETY DATA SHEET

Creation Date 26-Jun-2014

Revision Date 28-Dec-2021

Revision Number 4

1. Identification

Product Name Buffer Solution, pH 7.00, Color-Coded Yellow, Certified

Cat No. : AC611060000; AC611060040; AC611065000

Synonyms No information available

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US**:001-201-796-7100 / **Europe**: +32 14 57 52 99
CHEMTREC Tel. No.**US**:001-800-424-9300 / **Europe**:001-703-527-3887

2. Hazard(s) identification

Classification

Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label Elements

None required

Hazards not otherwise classified (HNOC)

None identified

3. Composition/Information on Ingredients

Component	CAS No	Weight %
Water	7732-18-5	99.18
Dihydrogen potassium phosphate	7778-77-0	0.7
Sodium hydroxide	1310-73-2	0.1
FD&C yellow No. 5	1934-21-0	0.0 - 0.02

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention if symptoms occur.
Skin Contact	Rinse skin with water. Get medical attention if symptoms occur.
Inhalation	Remove to fresh air. If breathing is difficult, give oxygen. Get medical attention if symptoms occur.
Ingestion	Do NOT induce vomiting. Get medical attention if symptoms occur.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.
Unsuitable Extinguishing Media	No information available
Flash Point	Not applicable
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Non-combustible. None reasonably foreseeable.

Hazardous Combustion Products
None under normal use conditions.

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health
1

Flammability
0

Instability
0

Physical hazards
N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment as required. Ensure adequate ventilation. Avoid contact with skin, eyes or clothing.
Environmental Precautions	Avoid release to the environment.
Methods for Containment and Clean	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

Up

7. Handling and storage

Handling Wear personal protective equipment/face protection. Ensure adequate ventilation. Avoid contact with skin, eyes or clothing. Avoid ingestion and inhalation.

Storage. Keep containers tightly closed in a dry, cool and well-ventilated place. Incompatible Materials. None known.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Sodium hydroxide	Ceiling: 2 mg/m ³	(Vacated) Ceiling: 2 mg/m ³ TWA: 2 mg/m ³	IDLH: 10 mg/m ³ Ceiling: 2 mg/m ³	Ceiling: 2 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

OSHA - Occupational Safety and Health Administration

NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Yellow
Odor	Odorless
Odor Threshold	No information available
pH	7.00 @ 25°C
Melting Point/Range	0 °C / 32 °F
Boiling Point/Range	100 °C / 212 °F
Flash Point	Not applicable
Evaporation Rate	No information available
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	760 mmHg @ 20 °C
Vapor Density	No information available
Specific Gravity	1.0
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available

Autoignition Temperature
Decomposition Temperature
Viscosity

No information available
No information available
No information available

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid None known.

Incompatible Materials None known

Hazardous Decomposition Products None under normal use conditions

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information No acute toxicity information is available for this product
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	-	-	-
Dihydrogen potassium phosphate	LD50 = 3200 mg/kg (Rat)	LD50 > 4640 mg/kg (Rabbit)	LC50 > 0.83 mg/L (Rat) 4 h
Sodium hydroxide	LD50 = 325 mg/kg (Rat)	LD50 = 1350 mg/kg (Rabbit)	Not listed
FD&C yellow No. 5	12750 mg/kg (Mouse)	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed
Dihydrogen potassium phosphate	7778-77-0	Not listed	Not listed	Not listed	Not listed	Not listed
Sodium hydroxide	1310-73-2	Not listed	Not listed	Not listed	Not listed	Not listed
FD&C yellow No. 5	1934-21-0	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known

STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects, both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Sodium hydroxide	-	LC50: = 45.4 mg/L, 96h static (Oncorhynchus mykiss)	-	Not listed
FD&C yellow No. 5	Not listed	LC50: > 1000 ppm/48 h (Oryzias latipes)	Not listed	Not listed

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility No information available.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT Not regulated
TDG Not regulated
IATA Not regulated
IMDG/IMO Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
Water	7732-18-5	X	ACTIVE	-
Dihydrogen potassium phosphate	7778-77-0	X	ACTIVE	-
Sodium hydroxide	1310-73-2	X	ACTIVE	-
FD&C yellow No. 5	1934-21-0	X	ACTIVE	-

Legend:

TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)

X - Listed

'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL

Water	7732-18-5	X	-	231-791-2	X	X		X	X	KE-35400
Dihydrogen potassium phosphate	7778-77-0	X	-	231-913-4	X	X	X	X	X	KE-28622
Sodium hydroxide	1310-73-2	X	-	215-185-5	X	X	X	X	X	KE-31487
FD&C yellow No. 5	1934-21-0	X	-	217-699-5	X	X	X	X	X	KE-06857

KECL - NIER number or KE number (<http://ncis.nier.go.kr/en/main.do>)

U.S. Federal Regulations

SARA 313 Not applicable

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Sodium hydroxide	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA

Component	Hazardous Substances RQs	CERCLA EHS RQs
Sodium hydroxide	1000 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Water	-	-	X	-	-
Sodium hydroxide	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Authorisation/Restrictions according to EU REACH

Component	REACH (1907/2006) - Annex XIV - Substances Subject to Authorization	REACH (1907/2006) - Annex XVII - Restrictions on Certain Dangerous Substances	REACH Regulation (EC 1907/2006) article 59 - Candidate List of Substances of Very High Concern (SVHC)
Sodium hydroxide	-	Use restricted. See item 75. (see link for restriction details)	-
FD&C yellow No. 5	-	Use restricted. See item 75. (see link for restriction details)	-

<https://echa.europa.eu/substances-restricted-under-reach>

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
Water	7732-18-5	Listed	Not applicable	Not applicable	Not applicable
Dihydrogen potassium phosphate	7778-77-0	Listed	Not applicable	Not applicable	Not applicable
Sodium hydroxide	1310-73-2	Listed	Not applicable	Not applicable	Not applicable
FD&C yellow No. 5	1934-21-0	Not applicable	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
Water	7732-18-5	Not applicable	Not applicable	Not applicable	Not applicable
Dihydrogen potassium phosphate	7778-77-0	Not applicable	Not applicable	Not applicable	Not applicable
Sodium hydroxide	1310-73-2	Not applicable	Not applicable	Not applicable	Annex I - Y35
FD&C yellow No. 5	1934-21-0	Not applicable	Not applicable	Not applicable	Not applicable

16. Other information

Prepared By

Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date

26-Jun-2014

Revision Date

28-Dec-2021

Print Date

28-Dec-2021

Revision Summary

This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS



HI 98703-1
Turbidity Calibration Standard Cuvette, < 0.10 NTU

Safety Data Sheet

According to Regulation (EC) No. 1907/2006
OSHA Regulation 29 CFR 1910.1200
Canadian Regulation SOR/88-66

Revision Date: 2016-12-02
Reason for Revision: Removed DSD/DPD Regulation Info

SECTION 1: IDENTIFICATION OF THE PRODUCT AND COMPANY

Product Name: HI 98703-1 Turbidity Calibration Standard
Cuvette, < 0.10 NTU

Application: Standard Solution for Calibration of Turbidity
Meter

Company Information (USA):

Hanna Instruments, Inc.
584 Park East Dr, Woonsocket, Rhode Island, USA 02895

Technical Service Contact Information:

1-800-426-6287 (8:30AM - 5:00PM ET)
+1-401-766-4260 (8:30AM - 5:00PM ET)

USA Emergency Contact Information:

1-800-424-9300 (Chemtrec 24Hr. Emergency)

International Emergency Contact Information:

+1-703-527-3887 (Chemtrec 24Hr. Emergency)

E-mail Address:

tech@hannainst.com

SECTION 2: HAZARD IDENTIFICATION

Non-hazardous product as specified in OSHA Regulation 29 CFR 1910.1200.

Non-hazardous product as specified in Canadian Regulation SOR/88-66.

Non-hazardous product as specified in Regulation (EC) 1272/2008.

SECTION 3: COMPOSITION AND COMPONENT INFORMATION

Deionized Water

SECTION 4: FIRST AID MEASURES

After Inhalation: None required

After Skin Contact: None required

After Eye Contact: None required

After Swallowing: None required

General Information: Not available

SECTION 5: FIRE-FIGHTING MEASURES

Suitable Extinguishing Media:

Water spray, Carbon Dioxide, Dry Chemical Powder, Appropriate Foam.

Special Risks:

None

Special Protective Equipment:

No special fire precautions are required.

Additional Information:

NA

Safety Data SheetAccording to Regulation (EC) No. 1907/2006
OSHA Regulation 29 CFR 1910.1200
Canadian Regulation SOR/88-66**SECTION 6: ACCIDENTAL RELEASE MEASURES****Personal Precautions:**

None

Environmental Precautions:

None

Additional Notes:

None

SECTION 7: HANDLING AND STORAGE**Handling:**

No restrictions

Storage:

Keep container closed and protected from direct sunlight. Store at room temperature (+15°C to +25°C).

SECTION 8: EXPOSURE CONTROL/PERSONAL PROTECTION**Engineering:**

Maintain general industrial hygiene practice.

Personal Protective Equipment:

Not required

Respiratory Protection:

Not required

Protective Gloves:

Not required

Eye Protection:

Not required

Industrial Hygiene:

Not required

SECTION 9: PHYSICAL/CHEMICAL PROPERTIES**Appearance:** Colorless liquid**Odor:** Odorless**Density at 20°C:** 1.0 g/cm³**Melting Point:** 0 °C**Boiling Point:** 100 °C**Solubility:** Soluble**pH at 20°C:** ~ 7**Explosion Limit:** NA**Flash Point:** NA**Thermal Decomp.:** NA**SECTION 10: STABILITY AND REACTIVITY****Conditions to be Avoided:**

Heating

Hazardous Decomposition Products:

None

Hazardous Polymerization:

Will not occur.

Substances to be Avoided:

The generally known reaction partners of water

Further Information:

Not available

Safety Data Sheet

According to Regulation (EC) No. 1907/2006
OSHA Regulation 29 CFR 1910.1200
Canadian Regulation SOR/88-66

SECTION 11: TOXICOLOGICAL INFORMATION

Product Toxicity

Non-toxic.

Potential Health Effects:

Inhalation: Slight irritations.

Eye Contact: Slight irritations.

Component Toxicity

Acute Toxicity:

Not Available

Chronic Toxicity:

Not Available

Additional Data:

Not Available

SECTION 12: ECOLOGICAL INFORMATION

No environmental hazard.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal: Can be safely disposed of as ordinary refuse.

SECTION 14: TRANSPORTATION INFORMATION

Land:

Not subject to transport regulations

Sea:

Not subject to transport regulations

Air:

Not subject to transport regulations

SECTION 15: REGULATORY INFORMATION

Complies with European Regulations (EC) No. 1907/2006 and No. 1272/2008.

Complies with OSHA Regulation 29 CFR 1910.1200.

Complies with Canadian Regulation SOR/88-66.

All chemical substances in this product are listed on the TSCA Inventory.

SECTION 16: OTHER INFORMATION

Text of phrases under Section 3

NA

Revision Information

Revision Date: 2016-12-02

Supersedes edition of: 2013-12-06

Reason for revision: Removed DSD/DPD Regulation Info

Legend NA: Not Applicable
ND: Not Determined

THE INFORMATION CONTAINED HEREIN IS BASED ON THE PRESENT STATE OF OUR KNOWLEDGE. IT CHARACTERIZES THE PRODUCT WITH REGARD TO THE APPROPRIATE SAFETY PRECAUTIONS. IT DOES NOT REPRESENT A GUARANTEE OF THE PROPERTIES OF THE PRODUCT.



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

1. IDENTIFICATION

Product Name	Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)
Other Names	Multi-Purpose, Ammonium Phosphate, Monoammonium Phosphate
Recommended use of the chemical and restrictions on use	
Identified uses	Fire Extinguishing Agent
Restrictions on use	Consult applicable fire protection codes
Company Identification	Badger Fire Protection 8767 Seminole Trail, Suite 202 Ruckersville, VA 22968 USA (434)-964-3200
Customer Information Number	
Emergency Telephone Number	
CHEMTREC Number	(800) 424-9300 (703) 527-3887 (International)
Issue Date	December 10, 2019
Supersedes Date	August 27, 2019

Safety Data Sheet prepared in accordance with OSHA's Hazard Communication Standard (29 CFR 1910.1200, the Canadian Hazardous Products Regulations (HPR) and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

2. HAZARD IDENTIFICATION

This SDS covers the product listed above as sold in pressurized and non-pressurized containers. GHS classifications for both forms are listed below.

GHS Classification – Pressurized

Hazard Classification

Gas under pressure – Compressed gas

Label Elements

Hazard Symbols



Signal Word: Warning

Hazard Statements

Contents under pressure; may explode if heated.



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

2. HAZARD IDENTIFICATION

Precautionary Statements

Prevention

None

Response

None

Storage

Protect from sunlight.

Store in well-ventilated place.

Disposal

None

GHS Classification: Non - pressurized

Hazard Classification

This product is classified as not hazardous in accordance with the Globally Harmonized System of Classification and Labelling (GHS).

Label Elements

Hazard Symbols

None

Signal Word: None

Hazard Statements

None

Precautionary Statements

Prevention

None

Response

None

Storage

None

Disposal

None

Other Hazards

This product may contain small quantities of quartz (crystalline silica) as an impurity. Prolonged exposure to respirable crystalline silica dust at concentrations exceeding the occupational exposure limits may increase the risk of developing a disabling lung disease known as silicosis. IARC found limited evidence for pulmonary carcinogenicity of crystalline silica in humans.

Specific Concentration Limits

The values listed below represent the percentages of ingredients of unknown toxicity.

Acute oral toxicity < 10%

Acute dermal toxicity < 10%

Acute inhalation toxicity < 10%

Acute aquatic toxicity < 10%



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

3. COMPOSITION/INFORMATION ON INGREDIENTS

This product is a mixture.

Component	CAS Number	Concentration*
Calcium Carbonate	471-34-1	10 – 30%
Mica	12001-26-2	0.5 – 1.5%
Kaolin Clay	1332-58-7	0.5 – 1.5%
Non-hazardous ingredients		
Monoammonium Phosphate	7722-76-1	45 – 70%
Ammonium Sulfate	7783-20-2	10 – 30%

Note: Pressurized product uses nitrogen or compressed air as the expellant.

*Exact concentration withheld as trade secret.

4. FIRST- AID MEASURES

Description of necessary first-aid measures

Eyes

Immediately flood the eye with plenty of water for at least 15 minutes, holding the eye open. Obtain medical attention if soreness or redness persists.

Skin

Wash skin thoroughly with soap and water. Obtain medical attention if irritation persists.

Ingestion

Dilute by drinking large quantities of water and obtain medical attention.

Inhalation

Move victim to fresh air. Obtain medical attention immediately for any breathing difficulty.

Most important symptoms/effects, acute and delayed

Aside from the information found under Description of necessary first aid measures (above) and Indication of immediate medical attention and special treatment needed, no additional symptoms and effects are anticipated.

Indication of immediate medical attention and special treatment needed

Notes to Physicians

Treat symptomatically.

5. FIRE - FIGHTING MEASURES

Suitable Extinguishing Media

This preparation is used as an extinguishing agent and therefore is not a problem when trying to control a fire. Use extinguishing agent appropriate to other materials involved. Keep pressurized containers and surroundings cool with water spray as they may rupture or burst in the heat of a fire.

Specific hazards arising from the chemical

Pressurized containers may explode in heat of fire.

Special Protective Actions for Fire-Fighters

Wear full protective clothing and self-contained breathing apparatus as appropriate for specific fire conditions.



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Wear appropriate protective clothing. Prevent skin and eye contact. Remove leaking container to a safe place. Ventilate the area.

Environmental Precautions

Prevent large quantities of the material from entering drains or watercourses.

Methods and materials for containment and cleaning up

Sweep up or vacuum and transfer into suitable containers for recovery or disposal.

7. HANDLING AND STORAGE

Precautions for safe handling

Wear appropriate protective clothing. Prevent skin and eye contact.

Conditions for safe storage

Pressurized containers should be properly stored and secured to prevent falling or being knocked over. Do not drag, slide or roll pressurized containers. Do not drop pressurized containers or permit them to strike against each other. Never apply flame or localized heat directly to any part of the pressurized or plastic container. Store pressurized and plastic containers away from high heat sources. Storage area should be:
- cool - dry - well ventilated - under cover - out of direct sunlight

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure limits are listed below, if they exist.

Calcium Carbonate

OSHA PEL: 15 mg/m³ TWA, total dust
5 mg/m³ TWA, respirable fraction

Mica

ACGIH TLV: 3 mg/m³ TWA, measured as respirable fraction of the aerosol.
OSHA PEL: 20 mppcf, <1% crystalline silica

Kaolin

ACGIH TLV: 2 mg/m³ TWA, for particulate matter containing no asbestos and <1% Crystalline silica
OSHA PEL: 15 mg/m³ TWA, total dust
5 mg/m³ TWA, respirable fraction

Particulates not otherwise classified /regulated

OSHA PEL: 50 mppcf or 15 mg/m³ TWA, total dust
15 mppcf or 5 mg/m³ TWA, respirable fraction

Appropriate engineering controls

Use with adequate ventilation. If this product is used in a pressurized system, there should be local procedures for the selection, training, inspection and maintenance of this equipment. When used in large volumes, use local exhaust ventilation.



SAFETY DATA SHEET

Commercial ABC Dry Chemical

(Fire Extinguishing Agent, Pressurized and Non-pressurized)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Individual protection measures

Respiratory Protection

Not normally required. Use dust mask where dustiness is prevalent, or TLV is exceeded. In oxygen deficient atmospheres, use a self contained breathing apparatus, as an air purifying respirator will not provide protection.

Skin Protection

Gloves

Eye/Face Protection

Chemical goggles or safety glasses with side shields.

Body Protection

Normal work wear.

9. PHYSICAL AND CHEMICAL PROPERTIES

Non- Pressurized

Appearance

Physical State	Color
Solid (powder)	Pale Yellow

Odor	Odorless

Odor Threshold	No data available

pH	Not applicable

Specific Gravity	No data available

Boiling Range/Point (°C/F)	Not applicable

Melting Point (°C/F)	No data available

Flash Point (PMCC) (°C/F)	Not flammable

Vapor Pressure	No data available

Evaporation Rate (BuAc=1)	No data available

Solubility in Water	No data available

Vapor Density (Air = 1)	Not applicable

VOC (g/l)	None

VOC (%)	None

Partition coefficient (n-octanol/water)	No data available

Viscosity	No data available

Auto-ignition Temperature	No data available

Decomposition Temperature	No data available

Upper explosive limit	No data available

Lower explosive limit	No data available

Flammability (solid, gas)	No data available

Expellant - Nitrogen

Appearance

Physical State	Color
Compressed gas	Colorless

Odor	None

Odor Threshold	No data available

pH	Not applicable

Specific Gravity	0.075 lb/ft ³ @70°F as vapor

Boiling Range/Point (°C/F)	-196°C/-321 °F

Melting Point (°C/F)	-210°C/-346°F

Flash Point (PMCC) (°C/F)	Not flammable



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

9. PHYSICAL AND CHEMICAL PROPERTIES

Vapor Pressure	No data available
Evaporation Rate (BuAc=1)	Not applicable
Solubility in Water	0.02 g/L
Vapor Density (Air = 1)	0.97
VOC (g/l)	Not applicable
VOC (%)	Not applicable
Partition coefficient (n-octanol/water)	No data available
Viscosity	Not applicable
Auto-ignition Temperature	No data available
Decomposition Temperature	No data available
Upper explosive limit	Not explosive
Lower explosive limit	Not explosive
Flammability (solid, gas)	Not flammable

10. STABILITY AND REACTIVITY

Reactivity

Pressurized containers may rupture or explode if exposed to heat.

Chemical Stability

Stable under normal conditions.

Possibility of hazardous reactions

Hazardous polymerization will not occur.

Conditions to Avoid

Exposure to direct sunlight - contact with incompatible materials

Incompatible Materials

Strong oxidizing agents - strong acids - sodium hypochlorite

Hazardous Decomposition Products

Oxides of carbon - ammonia - oxides of phosphorus - nitrogen oxides

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Mica:

Oral LD50 (Rat) >2000 mg/kg

Kaolin (clay):

Oral LD50 (Rat) >5000 mg/kg

Dermal LD50 (Rabbit) >5000mg/kg

Nitrogen

Simple asphyxiant

Specific Target Organ Toxicity (STOT) – single exposure

Nitrogen: Exposure to nitrogen gas at high concentrations can cause suffocation by reducing oxygen available for breathing. Breathing very high concentrations can cause dizziness, shortness of breath, unconsciousness or asphyxiation.



SAFETY DATA SHEET

Commercial ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

11. TOXICOLOGICAL INFORMATION

Specific Target Organ Toxicity (STOT) – repeat exposure

No relevant studies identified.

Serious Eye damage/Irritation

Mica: Not irritating (rabbit)

Skin Corrosion/Irritation

Mica: Not irritating (rabbit)

Respiratory or Skin Sensitization

No relevant studies identified.

Carcinogenicity

This product may contain small quantities of quartz (crystalline silica) as an impurity. Prolonged exposure to respirable crystalline silica dust at concentrations exceeding the occupational exposure limits may increase the risk of developing a disabling lung disease known as silicosis. IARC has classified Silica Dust, Crystalline, in the form of quartz or cristobalite as 1 (carcinogenic to humans).

Germ Cell Mutagenicity

No relevant studies identified.

Reproductive Toxicity

No relevant studies identified.

Aspiration Hazard

Not an aspiration hazard.

12. ECOLOGICAL INFORMATION

Ecotoxicity

No relevant studies identified.

Mobility in soil

No relevant studies identified.

Persistence/Degradability

No relevant studies identified.

Bioaccumulative Potential

No relevant studies identified.

Other adverse effects

No relevant studies identified.

13. DISPOSAL CONSIDERATIONS

Disposal Methods

Dispose of container in accordance with all applicable local and national regulations.



SAFETY DATA SHEET

Commercial ABC Dry Chemical

(Fire Extinguishing Agent, Pressurized and Non-pressurized)

14. TRANSPORT INFORMATION

Safety Data Sheet information is intended to address a specific material and not various forms or states of containment.

Special Precautions for Shipping:

Individuals must be certified as Hazardous Material Shipper for all transportation modes.

Pressurized Fire Extinguishers are considered a hazardous material by the US Department of Transportation and Transport Canada.

DOT CFR 172.101 Data	Fire extinguishers, 2.2, UN1044
UN Proper Shipping Name	Fire extinguishers
UN Class	(2.2)
UN Number	UN1044
UN Packaging Group	Not applicable
Classification for AIR Transportation (IATA)	Consult current IATA Regulations prior to shipping by air.
Classification for Water Transport IMDG	Consult current IMDG Regulations prior to shipping by water.

When shipping via ground, portable fire extinguishers pressurized to less than 241 psi and of less than 1100 cubic inches in size meet the requirements of "Limited Quantity" as referenced in 49 CFR 173.309 (2010). There is no limited quantity designation for fire extinguishers when shipped by air or water.

This section is believed to be accurate at the time of preparation. It is not intended to be a complete statement or summary of the applicable laws, rules, or hazardous material regulations, and is subject to change. Users have the responsibility to confirm compliance with all laws, rules, and hazardous material regulations in effect at the time of shipping.

15. REGULATORY INFORMATION

United States TSCA Inventory

This product contains ingredients that are listed on or exempt from listing on the EPA Toxic Substance Control Act Chemical Substance Inventory.

Canada DSL Inventory

All ingredients in this product are listed on the Domestic Substance List (DSL) or the Non-Domestic Substance List (NDSL) or are exempt from listing.

SARA Title III Sect. 311/312 Categorization: Pressurized

Gas under pressure

SARA Title III Sect. 311/312 Categorization: Non-pressurized

None

SARA Title III Sect. 313

This product does not contain any chemicals that are listed in Section 313 at or above de minimis concentrations.



SAFETY DATA SHEET

Commercial ABC Dry Chemical

(Fire Extinguishing Agent, Pressurized and Non-pressurized)

16. OTHER INFORMATION

NFPA Ratings

NFPA Code for Health - 1

NFPA Code for Flammability - 0

NFPA Code for Reactivity - 0

NFPA Code for Special Hazards - None

Legend

ACGIH: American Conference of Governmental Industrial Hygienists

CAS#: Chemical Abstracts Service Number

EC50: Effect Concentration 50%

IARC: International Agency for Research on Cancer

LC50: Lethal Concentration 50%

LD50: Lethal Dose 50%

N/A: Denotes no applicable information found or available

OSHA: Occupational Safety and Health Administration

PEL: Permissible Exposure Limit

STEL: Short Term Exposure Limit

TLV: Threshold Limit Value

TSCA: Toxic Substance Control Act

Revision Date: December 10, 2019

Replaces: August 27, 2019

Changes made: Update to Sections 3, 8 and 9.

Information Source and References

This SDS is prepared by Hazard Communication Specialists based on information provided by internal company references.

Prepared By:

EnviroNet LLC.

The information and recommendations presented in this SDS are based on sources believed to be accurate. Badger Fire Protection assumes no liability for the accuracy or completeness of this information. It is the user's responsibility to determine the suitability of the material for their particular purposes. In particular, we make NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, with respect to such information, and we assume no liability resulting from its use. Users should ensure that any use or disposal of the material is in accordance with applicable Federal, State, and local laws and regulations.



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

1.) Identification of the Mixture and of the Company

Product identifier: **Aervoe Construction Marking Paint - Aerosol**

Product name: **Construction Marking Paint**

Fluorescent Colors	Non-Fluorescent Colors	16 oz. I.A.C.
246 Red	251 Black	261 Red
247 Orange	252 Yellow	262 Yellow
248 Green	254 Blue	263 Blue
249 Pink	255 White	266 Black
250 Blue	256 Red	267 White
253 Yellow	257 Orange	272 Fluorescent Orange
283 Red-Orange	258 Hi Vis Yellow	274 Fluorescent Green
	259 Green	275 Florescent Red-Orange
	260 Purple	276 Fluorescent Yellow
		279 Fluorescent Pink

Relevant identified uses of the substance: Designed to adhere to most surfaces, including pavement, gravel, and soil.

Uses advised against: Do not apply if surface is wet, or if rain is imminent within 4 hours of application.

CAS No:	Not Applicable (mixture)
EC No:	Not Applicable (mixture)
Index No:	Not Applicable (mixture)
Manufacturer/Supplier:	Aervoe Industries Incorporated
Street address/P.O. Box:	1100 Mark Circle
Country ID/Postcode/Place:	Gardnerville, Nevada 89410
Telephone number:	1-775-782-0100
e-mail:	mailbox@aervoe.com
National contact:	Aervoe Industries Incorporated
For Product Information:	1-800-227-0196
Emergency telephone number:	1-800-424-9300 (CHEMTREC – 24 hrs)

2. Hazards identification

Classifications

Physical Hazards: Aerosol - Category 1
 Flam. Gas. 1
 Liquefied Gas
 Flam. Liq. 2

Health Hazards: Car 1B
 Muta 1B
 Asp Tox. 1
 Eye Irrit. - 2
 Rep. 2
 Skin. Irr. 2
 STOT SE3



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

Environmental Hazards: Aquatic Chronic 2

Labeling

Signal Word: Danger

Hazard Statements: H220 – Extremely flammable gas
H222 – Extremely flammable aerosol
H225 – Highly flammable liquid and vapour.
H229 - Pressurized container: may burst if heated
H304 – May be fatal if swallowed and enters airways.
H315 – Causes skin irritation.
H319 – Causes serious eye irritation.
H336 – May cause drowsiness or dizziness.
H340 – May cause genetic defects
H350 – May cause cancer
H361 – Suspected of damaging fertility or the unborn child .
H373 – May cause damage to nervous system through prolonged or repeated exposure(Inhalation)
H411 - Toxic to aquatic life with long lasting effects

Precautionary Statements: P101 - If medical advice is needed, have product container or label at hand
P102 - Keep out of reach of children
P103 - Read label before use
P210 - Keep away from heat/sparks/open flames/hot surfaces - no smoking
P211 - Do not spray on an open flame or other ignition source
P251 - Pressurized container: Do not pierce or burn, even after use
P261 - Avoid breathing dust/fume/gas/mist/vapours/spray
P262 - Do not get in eyes, on skin, or on clothing
P264 - Wash ... thoroughly after handling
P280 - Wear protective gloves/eye protection/face protection

P303+P361+P353 - If on skin or hair, remove/takeoff immediately all contaminated clothing. Rinse skin with water/shower.
P410+P412 - Protect from sunlight. Do not expose to temperatures exceeding 50°C/122°F
P501 - Dispose of contents/container in accordance with local/regional/national/international regulation



Symbols/Pictograms:

3. Composition / Information on Ingredients

Composition



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

Chemical	Synonyms	CAS Number	EINECS Number	Weight Percent	Hazard Category	H-Code
Hydrocarbon Propellant	LPG	68476-86-8	270-705-8	10-30%	Liquefied Gas Flam. Gas 1	H220 H229
Hexane	n-Hexane	110-54-3	203-777-6	5-10%	Flam. Liq. 2 Repr. 2 Asp. Tox. 1 STOT RE 2 * Skin Irrit. 2 STOT SE 3 Aquatic Chronic 2	H225 H361f *** H304 H373 ** H315 H336 H411
Aliphatic Petroleum Distillates	Solvent Naphtha	64742-89-8	265-192-2	5-10%	Flam Liq. 2 Skin Irr. 2 Asp. Tox. 1 STOT SE 3 Aquatic Tox. 2	H224 H304 H315 H336 H411
Aliphatic Petroleum Distillates	Solvent Naphtha	64742-88-7	265-191-7	1-5%	Asp. Tox. 1	H304
Aliphatic Petroleum Distillates	Solvent Naphtha	8032-32-4	232-453-7	1-5%	Carc. 1B Muta. 1B Asp. Tox. 1	H350 H340 H304
Non-fluorescent colors also contain:						
Acetone	Propanone	67-64-1	200-662-2	1-5%	Flam. Liq. 2 Eye Irrit. 2 STOT SE 3	H225, H319, H336
#262 Also Contains						
Ethanol	Ethyl Alcohol	64-17-5	200-578-6	1-5%	Flam. Liq. 2	H225

Other Product Information

Chemical Identity: Mixture

4.) First Aid Measures

General Advice:

If symptoms persist, always call a doctor.

Inhalation First Aid:

Remove victim to fresh air and provide oxygen if breathing is difficult. If not breathing, give artificial respiration, preferably mouth to mouth. Get medical attention immediately.

Skin Contact First Aid:

Wash with soap and water. Remove contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse.

Eye Contact First Aid:

If contact with eyes, immediately flush eyes with plenty of water for at least 15 minutes, while holding eyelids open. Get medical attention immediately.



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

Ingestion First Aid: If swallowed, wash out mouth with water provided the person is conscious. Do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Most Important Symptoms/Effects: Exposure may cause slight irritation to the skin, eyes, and respiratory tract. Excessive exposure may cause central nervous system effects.

5. Fire Fighting Measures

Flammable Properties:	Aerosol
Auto Ignition Temperature:	Not Available
Suitable extinguishing media:	Carbon dioxide, dry chemical, water spray.
Unsuitable extinguishing media:	None known
Special hazards arising from the substance or mixture:	None known
Hazardous combustion products:	Carbon dioxide, Carbon monoxide
Fire & Explosion Hazards:	Closed Containers may rupture due to the buildup of pressure from extreme temperatures.

Precautions for fire-fighters: Use water spray to cool containers exposed to heat or fire to prevent pressure build up. In the event of a fire, wear full protective clothing and NIOSH- approved self-contained breathing apparatus with full face piece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

PERSONAL PRECAUTIONARY MEASURES:

- 1) Follow personal protective equipment recommendations found in section 8.
- 2) Maintain adequate ventilation.

SPILL CLEAN-UP PROCEDURES:

- 1.) Evacuate unprotected personnel from the area.
- 2.) Remove sources of ignition if safe to do so.
- 3.) Pickup spilled materials using non-sparking tools and place in an appropriate container for disposal.
- 4.) Contain spill to prevent material from entering sewage or ground water systems.
- 5.) Always dispose of waste materials in accordance with all EU, National and Local Regulations.

7. Handling and Storage

Handling:

Flammable Aerosol, use in a well ventilated area.
Do not use near sources of ignition.
Do not to eat, drink and smoke while working with this material.
Wash hands after use.

Conditions for safe storage, including any incompatibilities:

Store out of direct sunlight.
Storage Temperature: 32° to 120°F (0° to 49°C).
No known incompatibilities.



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

8. Exposure Controls / Personal Protection

Appropriate engineering controls:

Ensure adequate ventilation. A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits.

Keep away from sources of ignition.

Take precautionary measures against static discharge.

Personal Protection:

Eye & face protection devices such as safety glasses, safety goggles or face shield are recommended.

Skin protection

Wear the appropriate protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Respiratory protection:

Use only in an adequately ventilated area. For unknown vapor concentrations use a positive-pressure, pressure-demand, self-contained breathing apparatus (SCBA).

Hazardous Ingredient	CAS Number	ACGIH TLV (TWA)	ACGIH TLV (STEL)	OSHA PEL (TWA)	OSHA PEL (STEL)
Aliphatic Petroleum Distillates	64742-88-7	N/A	N/A	N/A	N/A
Aliphatic Petroleum Distillates	64742-89-8	N/A	N/A	N/A	N/A
Hydrocarbon Propellant	68476-86-8	N/A	N/A	N/A	N/A
Aliphatic Petroleum Distillates	8032-32-4	N/A	N/A	N/A	N/A
Hexane	110-54-3	50PPM	N/A	500PPM	N/A
Acetone	67-64-1	250PPM	500PPM	1000PPM	N/A
Ethanol	64-17-5	N/A	1000PPM	1000PPM	N/A

*Values are based on the 2019 Guide to Occupational Exposure Values by ACGIH

9. Information on Basic Physical and Chemical Properties

Appearance: Color varies by product.	Odor: Hydrocarbon Odor
Odor Threshold: N/AV	pH: Not Applicable (solvent Base)
Melting Point: N/AV	Freezing Point: N/AV
Initial Boiling Point: N/AV	Boiling Point Range: N/AV
Flash Point: <0° F (-18° C)	Evaporation Rate: Faster than n-Butyl Acetate
Flammability Solid/Gas: Flammable gas	LEL: 0.9% UEL: 13%
Vapor Pressure: N/AV	Vapor Density: Heavier Than Air
Relative Density: N/AV	Solubility: Negligible
Partition Coefficient: n-octanol/ water: N/AV	Auto-ignition Temperature: N/AV
Decomposition Temperature: N/AV	Viscosity: N/AV



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

Explosive Properties: N/AV

Oxidizing Properties: N/AV

10. Stability & Reactivity

Possibility of hazardous reactions: Hazardous polymerization will not occur under normal conditions

Chemical stability: Stable under normal conditions

Conditions to avoid: Heat and ignition sources

Incompatible materials: Strong Oxidizing Agents

Hazardous decomposition products: Will not occur

11. Toxicological Information

Reports have associated repeated and prolonged overexposure to solvents with permanent brain and nervous system damage. Repeated overexposure can also damage kidneys, lungs, liver, heart and blood

Routes of exposure: Eyes, skin, ingestion, and/or inhalation

Acute toxicological data:

(Acetone) Acute oral LD50: 5800mg/kg(rat)

(Acetone) LC50: 21000 ppm / 8 hr (rat)

(Hexane) LD50: 2870 mg/kg (Rat-Oral)

Eye irritation data:

Eye Irrit 2

Skin irritation/sensitization/absorption data:

Skin Irrit 2

Reproductive toxicity data:

Reproductive 2

Mutagenicity data:

Muta 1B

Symptoms associated with physical contact:

N/AV

Acute/chronic effects from short/long term exposure:

Irritating to skin. Prolonged/repeated contact may cause defatting of the skin which can lead to dermatitis. Not expected to be a skin sensitizer.

Known reportable carcinogens via the following agencies:

NTP:

N/AV

IARC:

IARC3:Classification not possible from current data

OSHA:

TLV-A4

12. Ecological Information

Ecotoxicity: **No Data Available**

Persistence and degradability: **No Data Available**



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

Bioaccumulative potential: **No Data Available**

Mobility in soil: **No Data Available**

Results of PBT and vPvB assessment: **No Data Available**

Other adverse effects: **No Data Available**

13. Disposal Considerations

Waste Disposal: Dispose of material in accordance with EU, national and local requirements. For proper disposal of used material, an assessment must be completed to determine the proper and permissible waste management options permitted under applicable rules, regulations and/or laws governing your location.

Product / Packaging disposal: Dispose of packaging in accordance with federal, state and local requirements, regulations and/or laws governing your location.

14. Transportation Information

US DOT

UN Number	Proper Shipping Name	Hazard Class	Packing Group	Marine Pollutant	Special Provisions
UN1950	Aerosols	2.1	Not Applicable	Not Applicable	Reference 49 CFR 172.101

IMDG

UN Number	Proper Shipping Name	Hazard Class	Packing Group	Marine Pollutant	Special Provisions
UN1950	Aerosols	2.1	Not Applicable	Not Applicable	Reference IMDG code part 3

IATA:

UN Number	Proper Shipping Name	Hazard Class	Packing Group	Marine Pollutant	Special Provisions
UN1950	Aerosols, Flammable	2.1	Not Applicable	Not Applicable	Reference IATA Dangerous Goods Regulation

15. Regulatory Information

Workplace classification:

This product is considered hazardous under the OSHA Hazard Communication Standard (29 CFR 1910.1200). The Occupational Safety and Health Administration's interpretation of the product's hazard to workers.

SARA Title 3:

Section 311/312 Categorizations (40 CFR 372): This product is a hazardous chemical under 29 CFR 1910.1200, and is categorized as an immediate and delayed health, and flammability physical hazard. Superfund Amendment and Reauthorization Act (SARA) category. SARA requires reporting any spill of any hazardous substance.



Safety Data Sheet (SDS)

Date Prepared/Revised: 1/4/22 Version no.: 07 Supersedes: (6/3/21)

TSCA status: All chemicals in this product are listed, or are exempt from listing, on the TSCA Inventory.

WHMIS: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the (M)SDS contains all of the information required by the CPR.

PROP 65 (CA): WARNING: Cancer and Reproductive Harm – www.P65Warnings.ca.gov.

16. Other Information

This SDS has been completed in accordance with GHS Rev04 (2011): U.S OSHA, CMA, ANSI, Canadian WHMIS standards, and European Directives.

Date of Preparation/Revision: 1/4/22

Supersedes: (6/3/21)

To the best of our knowledge, the information contained herein is believed to be accurate. However, the above data does not imply any guarantee or warranty of any kind, expressed or implied. The final determination of the suitability of any material is the sole responsibility of the user. All materials made present un-known hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee these are the only hazards existing.

SAFETY DATA SHEET

Creation Date 21-May-2012

Revision Date 04-Jul-2019

Revision Number 6

1. Identification

Product Name Sodium hydroxide, 33wt% solution in water

Cat No. : AC358620000; AC358620050; AC358620051; AC358620250; AC358625000

Synonyms No information available

Recommended Use Laboratory chemicals.

Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number

For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US**:001-201-796-7100 / **Europe**: +32 14 57 52 99
CHEMTREC Tel. No.**US**:001-800-424-9300 / **Europe**:001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Corrosive to metals	Category 1
Skin Corrosion/Irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word

Danger

Hazard Statements

May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

**Precautionary Statements****Prevention**

Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep only in original container

Response

Immediately call a POISON CENTER or doctor/physician

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Skin

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Ingestion

IF SWALLOWED: Rinse mouth. DO NOT induce vomiting

Spills

Absorb spillage to prevent material damage

Storage

Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Water	7732-18-5	67-68
Sodium hydroxide	1310-73-2	32-33

4. First-aid measures

General Advice

Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact

Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Call a physician immediately.

Inhalation

If not breathing, give artificial respiration. Remove from exposure, lie down. Do not use

	mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Call a physician immediately.
Ingestion	Do NOT induce vomiting. Clean mouth with water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Most important symptoms and effects	Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	CO ₂ , dry chemical, dry sand, alcohol-resistant foam.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Oxidizing Properties	Not oxidising
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes.

Hazardous Combustion Products

Sodium oxides.

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health
3

Flammability
1

Instability
0

Physical hazards
N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment as required. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system.

Methods for Containment and Clean Up Keep in suitable, closed containers for disposal. Soak up with inert absorbent material.

7. Handling and storage

Handling	Do not get in eyes, on skin, or on clothing. Wear personal protective equipment/face protection. Use only under a chemical fume hood. Do not breathe mist/vapors/spray. Do not ingest. If swallowed then seek immediate medical assistance.

Storage

Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area.
Keep only in the original container.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Sodium hydroxide	Ceiling: 2 mg/m ³	Ceiling: 2 mg/m ³ TWA: 2 mg/m ³	IDLH: 10 mg/m ³ Ceiling: 2 mg/m ³	Ceiling: 2 mg/m ³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

OSHA - Occupational Safety and Health Administration

NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures

Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment**Eye/face Protection**

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection

Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Odorless
Odor Threshold	No information available
pH	14
Melting Point/Range	8 °C / 46.4 °F
Boiling Point/Range	120 °C / 248 °F
Flash Point	No information available
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	No information available
Specific Gravity	1.36
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available

10. Stability and reactivity

Reactive Hazard	Yes
Stability	Stable under recommended storage conditions.
Conditions to Avoid	Exposure to air. Incompatible products.
Incompatible Materials	Acids, Organic materials, Metals, Aluminium, copper, Zinc
Hazardous Decomposition Products	Sodium oxides
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

No acute toxicity information is available for this product

Oral LD50

Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Dermal LD50

Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Vapor LC50

Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	-	-	-
Sodium hydroxide	140 - 340 mg/kg (Rat)	1350 mg/kg (Rabbit)	Not listed

Toxicologically Synergistic Products

No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation

No information available

Sensitization

No information available

Carcinogenicity

The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed
Sodium hydroxide	1310-73-2	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects

No information available

Reproductive Effects

No information available.

Developmental Effects

No information available.

Teratogenicity

No information available.

STOT - single exposure

Respiratory system

STOT - repeated exposure

None known

Aspiration hazard

No information available

Symptoms / effects, both acute and delayed

Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Endocrine Disruptor Information

No information available

Other Adverse Effects

The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Contains no substances known to be hazardous to the environment or that are not degradable in waste water treatment plants. Large amounts will affect pH and harm aquatic organisms. Contains a substance which is: Harmful to aquatic organisms. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Sodium hydroxide	Not listed	LC50: = 45.4 mg/L, 96h static (Oncorhynchus mykiss)	Not listed	Not listed

Persistence and Degradability Soluble in water Persistence is unlikely based on information available. Miscible with water

Bioaccumulation/ Accumulation No information available.

Mobility . Will likely be mobile in the environment due to its water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No UN1824
 Proper Shipping Name SODIUM HYDROXIDE SOLUTION
 Hazard Class 8
 Packing Group II

TDG

UN-No UN1824
 Proper Shipping Name SODIUM HYDROXIDE SOLUTION
 Hazard Class 8
 Packing Group II

IATA

UN-No UN1824
 Proper Shipping Name SODIUM HYDROXIDE SOLUTION
 Hazard Class 8
 Packing Group II

IMDG/IMO

UN-No UN1824
 Proper Shipping Name SODIUM HYDROXIDE SOLUTION
 Hazard Class 8
 Packing Group II

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Water	7732-18-5	X	ACTIVE	-
Sodium hydroxide	1310-73-2	X	ACTIVE	-

Legend:

TSCA - Toxic Substances Control Act, (40 CFR Part 710)

X - Listed

'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Water	7732-18-5	X	-	231-791-2	X	X	X	X	KE-35400
Sodium hydroxide	1310-73-2	X	-	215-185-5	X	X	X	X	KE-31487

U.S. Federal Regulations**SARA 313** Not applicable**SARA 311/312 Hazard Categories** See section 2 for more information**CWA (Clean Water Act)**

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Sodium hydroxide	X	1000 lb	-	-

Clean Air Act Not applicable**OSHA - Occupational Safety and Health Administration** Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Sodium hydroxide	1000 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals.**U.S. State Right-to-Know Regulations**

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Water	-	-	X	-	-
Sodium hydroxide	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
 DOT Marine Pollutant N
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.**Other International Regulations****Mexico - Grade** No information available**16. Other information**

Prepared By Regulatory Affairs
 Thermo Fisher Scientific
 Email: EMSDS.RA@thermofisher.com

Creation Date 21-May-2012
Revision Date 04-Jul-2019

Print Date

04-Jul-2019

Revision Summary

This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Creation Date 12-Nov-2010

Revision Date 06-Jul-2018

Revision Number 7

1. Identification

Product Name Sulfuric Acid (Certified ACS Plus)

Cat No. : A300-212; A300-225LB; A300-500; A300-612GAL; A300-700LB;
A300C212; A300C212EA; A300P500; A300S212; A300S212EA;
A300S500; A300SI212;

Synonyms Hydrogen sulfate; Vitriol brown oil; Oil of vitriol

Recommended Use Laboratory chemicals.

Uses advised against Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number

CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word

Danger

Hazard Statements

May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

**Precautionary Statements****Prevention**

Do not breathe dust/fume/gas/mist/vapors/spray
Wear protective gloves/protective clothing/eye protection/face protection
Wash face, hands and any exposed skin thoroughly after handling
Use only outdoors or in a well-ventilated area
Keep only in original container

Response

Immediately call a POISON CENTER or doctor/physician

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Skin

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Ingestion

IF SWALLOWED: Rinse mouth. DO NOT induce vomiting

Storage

Store locked up
Store in a well-ventilated place. Keep container tightly closed

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

None identified

WARNING. Cancer - <https://www.p65warnings.ca.gov/>.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Sulfuric acid	7664-93-9	90 - 98
Water	7732-18-5	2 - 10

4. First-aid measures

General Advice

Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact

Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Immediate medical attention is required.

Inhalation

Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion

Do not induce vomiting. Never give anything by mouth to an unconscious person. Call a

physician or Poison Control Center immediately.

Most important symptoms and effects

Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Notes to Physician

Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media CO₂, dry chemical, dry sand, alcohol-resistant foam.

Unsuitable Extinguishing Media DO NOT USE WATER

Flash Point Not applicable
Method - No information available

Autoignition Temperature No information available

Explosion Limits

Upper No data available

Lower No data available

Sensitivity to Mechanical Impact No information available

Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes.

Hazardous Combustion Products

Sulfur oxides Hydrogen

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health
3

Flammability
0

Instability
2

Physical hazards
W

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe vapors or spray mist. Do not ingest.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from water. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Sulfuric acid	TWA: 0.2 mg/m ³	(Vacated) TWA: 1 mg/m ³ TWA: 1 mg/m ³	IDLH: 15 mg/m ³ TWA: 1 mg/m ³	TWA: 1 mg/m ³

Legend**ACGIH** - American Conference of Governmental Industrial Hygienists**OSHA** - Occupational Safety and Health Administration**NIOSH IDLH**: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health**Engineering Measures**

Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment**Eye/face Protection**

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection

Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear, Colorless to brown
Odor	Odorless
Odor Threshold	No information available
pH	0.3 (1N)
Melting Point/Range	10 °C / 50 °F
Boiling Point/Range	290 - 338 °C / 554 - 640.4 °F
Flash Point	Not applicable
Evaporation Rate	Slower than ether
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	< 0.001 mmHg @ 20 °C
Vapor Density	3.38 (Air = 1.0)
Specific Gravity	1.84
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	340°C
Viscosity	No information available
Molecular Formula	H ₂ SO ₄
Molecular Weight	98.08

10. Stability and reactivity

Reactive Hazard

Yes

Stability

Reacts violently with water. Hygroscopic.

Conditions to Avoid	Incompatible products. Excess heat. Exposure to moist air or water.
Incompatible Materials	Water, Organic materials, Strong acids, Strong bases, Metals, Alcohols, Cyanides, Sulfides
Hazardous Decomposition Products	Sulfur oxides, Hydrogen
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50

Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Dermal LD50

Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Vapor LC50

Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sulfuric acid	2140 mg/kg (Rat)	Not listed	LC50 85 - 103 mg/m ³ (Rat) 1 h
Water	-	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Causes severe burns by all exposure routes

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen. Exposure to strong inorganic mists containing sulfuric acid may cause cancer by inhalation.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Sulfuric acid	7664-93-9	Group 1	Known	A2	X	A2
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed

IARC: (International Agency for Research on Cancer)

IARC: (International Agency for Research on Cancer)

Group 1 - Carcinogenic to Humans

Group 2A - Probably Carcinogenic to Humans

Group 2B - Possibly Carcinogenic to Humans

NTP: (National Toxicity Program)

Known - Known Carcinogen

Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

ACGIH: (American Conference of Governmental Industrial Hygienists)

A1 - Known Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Animal Carcinogen

ACGIH: (American Conference of Governmental Industrial Hygienists)

Mexico - Occupational Exposure Limits - Carcinogens

Mexico - Occupational Exposure Limits - Carcinogens

A1 - Confirmed Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Confirmed Animal Carcinogen

A4 - Not Classifiable as a Human Carcinogen

A5 - Not Suspected as a Human Carcinogen

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure	Respiratory system
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects, both acute and delayed	Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

This product contains the following substance(s) which are hazardous for the environment. .

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Sulfuric acid	-	LC50: > 500 mg/L, 96h static (Brachydanio rerio)	-	EC50: 29 mg/L/24h

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility No information available.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN1830
Proper Shipping Name	Sulfuric acid
Hazard Class	8
Packing Group	II

TDG

UN-No	UN1830
Proper Shipping Name	SULFURIC ACID
Hazard Class	8
Packing Group	II

IATA

UN-No	UN1830
Proper Shipping Name	SULFURIC ACID
Hazard Class	8
Packing Group	II

IMDG/IMO

UN-No	UN1830
Proper Shipping Name	SULFURIC ACID
Hazard Class	8
Packing Group	II

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Sulfuric acid	X	X	-	231-639-5	-		X	X	X	X	X
Water	X	X	-	231-791-2	-		X	-	X	X	X

Legend:

X - Listed

E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.

F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.

P - Indicates a commenced PMN substance

R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

S - Indicates a substance that is identified in a proposed or final Significant New Use Rule

T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.

XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).

Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Sulfuric acid	7664-93-9	90 - 98	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Sulfuric acid	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration

Not applicable

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Sulfuric acid	1000 lb	1000 lb

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Sulfuric acid	7664-93-9	Carcinogen	-	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Sulfuric acid	X	X	X	X	X
Water	-	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ): Y
 DOT Marine Pollutant N
 DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 12-Nov-2010
Revision Date 06-Jul-2018
Print Date 06-Jul-2018
Revision Summary SDS sections updated. 2.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

Issuing date:

05/22/2015

Revision date:

N/A

Revision number:

N/A

1. Identification of the substance/preparation and the company/undertaking

GHS product identifier

Product name: SPF 50 Broad Spectrum Sunscreen lotion

Other mean of identification

Product code(s): **18-157PQ**
UN-Number: Not applicable
Synonyms: None

Recommended use of the chemical and restrictions on use

Recommended use: Sunscreen
Uses advised against: Not Available

Supplier address/information

Product Quest Mfg. LLC
330 Carswell Avenue
Holly Hill FL 32117
386.239.8787

Emergency telephone number: Not Available

2. Hazards Identification

Classification

Not considered hazardous.

Hazard identifier	Category
Not applicable	Not applicable

GHS label elements, including precautionary statements

Emergency overview

Issuing date:

Revision date:

Revision number:

In case of accidental ingestion, seek professional assistance or contact Poison Control Center immediately.

Appearance: Smooth off white lotion

Physical state: lotion

Odor: Sweet, fatty,
ozonated**Precautionary statements**

General advice:

- If product is swallowed, seek medical attention.

Eyes:

- Immediately flush eyes with plenty of water. Get medical attention, if irritation persists.

Inhalation:

- No harmful effects have been reported upon inhalation.

Storage:

- Store in a dry location.

Disposal:

- Dispose of in accordance with Federal, State and Local laws.

Hazard not otherwise classified (HNOC)

Not applicable

Other information

3. Composition/Information on ingredients

Chemical name	CAS-No	Weight %	Trade Secret
Avobenzone		3.0%	Not available
Homosalate		13.0%	Not available
Octisalate		5.0%	Not available
Octocrylene		7.0%	Not available
Oxbenzone		4.0%	Not available

4. First aid measures

Description of necessary first-aid measures

Eye contact: No harmful effects have been reported upon contact with the eyes.

Issuing date:

Revision date:

Revision number:

Skin contact: No harmful effects have been reported upon contact with skin.

Inhalation: N/A

Ingestion: In case of accidental ingestion, seek professional assistance or contact Poison Control Center immediately.

Most important symptoms/effects: Not available

Indication of immediate medical attention and special treatment needed, if necessary

Notes to Physician: Not Available

5. Fire-fighting measures

Suitable extinguishing media: CO₂, dry chemicals, foam or water spray

Unsuitable extinguishing media: None

Specific hazards arising from the chemical

Not available

Explosion data:

- Not available

Protective equipment and precautions for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, (MSHA/NIOSH approved or equivalent) and full throttle gear.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Not available

Environmental precautions

No special requirements for spills and leaks.

Methods and materials for containment and cleaning up

- Methods for containment: Not available
- Methods for cleaning up: Not available

7. Handling and storage

Precautions for safe handling

Handling:

No special handling procedures required.

Conditions for safe storage, including any incompatibilities

Issuing date:

Revision date:

Revision number:

Storage: Store in dry location.

Incompatible products:
Not available

8. Exposure controls/personal protection

Control parameters

Exposure guidelines

Chemical name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Not available			Not available
Not available			Not available
Not available			Not available
Not available			Not available

Appropriate engineering controls

Engineering measures: Not required

Individual protection measures, such as personal protective equipment

Eye/face protection: Not required

Skin and body protection: Not required

Respiratory protection: Not required

Hygiene measures: None

9. Physical and chemical properties

Information on basic physical and chemical properties

Physical state: Lotion

Odor: Sweet, fatty, ozonated

Appearance: Smooth off-white lotion

Odor threshold: Not available

Property	Values	Remarks/Method
pH	7.50 – 8.50	
Melting point/range	Not available	
Boiling point/boiling range	Not available	
Flash point	Not available	
Evaporation rate	Not available	
Flammability (solid, gas)	Not available	
Flammability limits in air	Not available	
-upper flammability limit	Not available	
-lower flammability limit	Not available	
Vapor pressure	Not available	

Issuing date:

Revision date:

Revision number:

Vapor density	Not available
Specific gravity	1.00 – 1.04
Water solubility	Miscible
Solubility in other solvents	Not available
Partition coefficient: n-octanol/water	Not available
Auto ignition temperature	Not available
Decomposition temperature	Not available
Viscosity	23,000 – 40,000 cP
Flammable properties	N/A
Explosive properties	N/A
Oxidizing properties	N/A

Other information

VOC content (%): Not available

10. Stability and reactivity**Reactivity**

Not Available

Chemical stability

Not Available

Possibility of hazardous reactions

Not Available

Conditions to avoid

Open flames and high temperatures

Incompatible materials

Not Available

Hazardous decomposition products

Not Available

11. Toxicological information**Information on likely routes of exposure****Product information:**

- Inhalation: No data available
- Eye contact: No data available
- Skin contact: No data available
- Ingestion: No data available

Issuing date:

Revision date:

Revision number:

Chemical name	LD50 oral	LD50 dermal	LC50 inhalation
Not available			Not available
Not available			Not available
Not available			Not available
Not available			Not available

Symptoms related to the physical, chemical and toxicological characteristics

Not available

Delayed and immediate effects and also chronic effects from short and long term exposure

- Sensitization: Not available
- Mutagenic effects: Not available
- Carcinogenicity: Not available
- Reproductive toxicity: Not available
- STOT – single exposure: Not available
- STOT – repeated exposure: Not available
- Aspiration hazard: Not available

Numerical measures of toxicity – product

Not available

12. Ecological information**Ecotoxicity**

Chemical name	Toxicity to algae	Toxicity to fish	Toxicity to micro-organisms	Daphnia Magna (water flea)
Not available				Not available
Not available				Not available
Not available				Not available
Not available				Not available

Persistence and Degradability

Not available

Bioaccumulation

Not available

Chemical name	Low Pow
Not available	Not available
Not available	Not available
Not available	Not available

Issuing date:

Revision date:

Revision number:

Not available

Not available

Other adverse effects: None

13. Disposal considerations

Waste disposal methods

Dispose of in accordance with Federal, State and Local laws.

Contaminated packaging

Not available

Chemical name	RCRA	RCRA – Basis for listing	RCRA – D series wastes	RCRA – U series wastes
Not available				Not available
Not available				Not available
Not available				Not available
Not available				Not available

14. Transport information

Notes:

DOT

- UN-Number Not available
- Proper shipping name Not available
- Hazard class Not available
- Reportable quantity (RQ) Not available
- Description Not available
- Emergency response guide Not available
- Number Not available

TDG

- UN-Number Not available
- Proper shipping name Not available
- Hazard class Not available
- Description Not available

MEX

- UN-Number Not available
- Proper shipping name Not available
- Hazard class Not available
- Description Not available

ICAO

- UN-Number Not available
- Proper shipping name Not available
- Hazard class Not available
- Description Not available

Issuing date:

Revision date:

Revision number:

IATA

• UN-Number	Not available
• Proper shipping name	Not available
• Hazard class	Not available
• ERG code	Not available
• Description	Not available

IMDG/IMO

• UN-Number	Not available
• Proper shipping name	Not available
• Hazard class	Not available
• Subsidiary class	Not available
• EmS number	Not available
• Description	Not available

RID

• UN-Number	Not available
• Proper shipping name	Not available
• Hazard class	Not available
• Classification code	Not available
• Description	Not available

ADR

• UN-Number	Not available
• Proper shipping name	Not available
• Hazard class	Not available
• Classification code	Not available
• Tunnel restriction code	Not available
• Description	Not available
• ADR/RID – Labels	Not available

ADN

• Proper shipping name	Not available
• Hazard class	Not available
• Classification code	Not available
• Special provisions	Not available
• Description	Not available
• Limited quantity	Not available
• Ventilation	Not available

15. Regulatory information**Interventional inventories**

• TSCA(Complies?)	☐ Yes ☐ No/ECSC	XXX

Legend

TSCA: United States Toxic Substances Control Act 8(b) inventory

U.S. Federal regulations

TEXT

Issuing date:

Revision date:

Revision number:

SARA 311/312 Hazard categories

- Acute health hazard: No
- Chronic health hazard: No
- Fire hazard: No
- Sudden release of pressure hazard: No
- Reactive hazard: No

Clean Water Act

This product **does/does not** contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

CERCLA

Chemical name	Hazardous substances RQs	Extremely hazardous substances RQs	RQ
Not available			Not available
Not available			Not available
Not available			Not available
Not available			Not available

U.S. state regulations

California Proposition 65: This product does not contain any Proposition 65 chemicals.

U.S. state Right-to-Know regulations

“X” designates that the ingredients are listed on the state Right-to-Know list

Chemical name	New Jersey	Massachusetts	Pennsylvania	Illinois	Rhode Island
Not available	Not available	Not available	Not available	Not available	Not available
Not available	Not available	Not available	Not available	Not available	Not available
Not available	Not available	Not available	Not available	Not available	Not available
Not available	Not available	Not available	Not available	Not available	Not available

U.S. EPA label information

EPA Pesticide registration number: Not available

16. Other information

	Health hazard	Flammability	Instability/Physical Hazard	Physical/Chemical Hazards/Personal protection
NFPA				Not available
HMIS				Not available

SAFETY DATA SHEET

Issuing date:

Revision date:

Revision number:

Prepared by:

TEXT

Issuing date:

TEXT

Revision date:

TEXT

Revision note:

TEXT

General Disclaimer

The information provided on this SDS is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of Safety Data Sheet



SAFETY DATA SHEET

1. Identification

Product identifier	UNLEADED GASOLINE
Other means of identification	
SDS number	002-GHS
Synonyms	Regular/Premium/Midgrade - Unleaded Gasoline, RFG - Reformulated Unleaded Gasoline, Conventional Unleaded Gasoline, Oxygenated Unleaded Gasoline, Non-Oxygenated Unleaded Gasoline, CARB (California Air Resource Board) Unleaded Gasoline, RBOB - Reformulated Blendstock for Oxygenate Blending, CBOB - Conventional Blendstock for Oxygenate Blending, Petrol, Motor Fuel. See section 16 for complete information.
Recommended use	Motor Fuel Motor fuels.
Recommended restrictions	None known.
Manufacturer/Importer/Supplier/Distributor information	
Manufacturer/Supplier	Valero Marketing & Supply Company and Affiliates One Valero Way San Antonio, TX 78269-6000 210-345-4593 CorpHSE@valero.com
General Assistance	Industrial Hygienist
E-Mail	24 Hour Emergency 866-565-5220
Contact Person	1-800-424-9300 (CHEMTREC USA)
Emergency Telephone	

2. Hazard(s) identification

Physical hazards	Flammable liquids	Category 1
Health hazards	Skin corrosion/irritation	Category 2
	Germ cell mutagenicity	Category 1B
	Carcinogenicity	Category 1B
	Reproductive toxicity	Category 2
	Specific target organ toxicity, single exposure	Category 3 narcotic effects
	Specific target organ toxicity, repeated exposure	Category 2
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, long-term hazard	Category 2
OSHA defined hazards	Not classified.	
Label elements		

Signal word

Danger

Hazard statement

Extremely flammable liquid and vapor. Causes skin irritation. May cause genetic defects. May cause cancer. Suspected of damaging fertility or the unborn child. May cause drowsiness or dizziness. May cause damage to organs (blood, liver, kidney) through prolonged or repeated exposure. May be fatal if swallowed and enters airways. Toxic to aquatic life with long lasting effects.

Precautionary statement**Prevention**

Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting// equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Do not breathe gas/mist/vapors/spray. Wash thoroughly after handling. Wear protective gloves/protective clothing/eye protection/face protection. Use only outdoors or in a well-ventilated area. Avoid release to the environment.

Response

If exposed or concerned: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. If swallowed: Immediately call a poison center/doctor. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. In case of fire: Use alcohol-resistant foam, carbon dioxide, dry powder or water fog for extinction. Collect spillage.

Storage

Store locked up. Store in a well-ventilated place. Keep container tightly closed. Keep cool.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC)

None known.

3. Composition/information on ingredients**Mixtures**

Chemical name	CAS number	%
Gasoline	86290-81-5	80-100
Toluene	108-88-3	0-30
Hexane (Other Isomers)	96-14-0	5-25
Xylene (o, m, p isomers)	1330-20-7	0-25
Octane (All isomers)	111-65-9	0-18.5
Ethanol	64-17-5	0-10
1,2,4, Trimethylbenzene	95-63-6	0-6
n-Heptane	142-82-5	1-5
Pentane	109-66-0	1-5
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

4. First-aid measures**Inhalation**

Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.

Skin contact

Remove contaminated clothing and shoes. Wash off immediately with soap and plenty of water. Get medical attention if irritation develops or persists. Wash clothing separately before reuse. Destroy or thoroughly clean contaminated shoes. If high pressure injection under the skin occurs, always seek medical attention.

Eye contact

Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention.

Ingestion

Rinse mouth thoroughly. Do not induce vomiting without advice from poison control center. Do not give mouth-to-mouth resuscitation. If vomiting occurs, keep head low so that stomach content does not get into the lungs. Never give anything by mouth to a victim who is unconscious or is having convulsions. Get medical attention immediately.

Most important symptoms/effects, acute and delayed

Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

UNLEADED GASOLINE

913457 Version #: 03 Revision date: 23-May-2014 Print date: 23-May-2014

Prepared by 3E Company

Indication of immediate medical attention and special treatment needed

In case of shortness of breath, give oxygen. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

General information

If exposed or concerned: get medical attention/advice. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before re-use.

5. Fire-fighting measures

Suitable extinguishing media

Water spray. Water fog. Foam. Dry chemical powder. Carbon dioxide (CO₂).

Unsuitable extinguishing media

Do not use a solid water stream as it may scatter and spread fire.

Specific hazards arising from the chemical

Vapor may cause flash fire. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.

Special protective equipment and precautions for firefighters

Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask.

Fire-fighting equipment/instructions

Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask. Withdraw immediately in case of rising sound from venting safety devices or any discoloration of tanks due to fire. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Move containers from fire area if you can do it without risk. In the event of fire, cool tanks with water spray. Cool containers exposed to flames with water until well after the fire is out. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors may form explosive air mixtures even at room temperature. Prevent buildup of vapors or gases to explosive concentrations. Some of these materials, if spilled, may evaporate leaving a flammable residue. Water runoff can cause environmental damage. Use compatible foam to minimize vapor generation as needed.

Specific methods

Use water spray to cool unopened containers.

General fire hazards

Extremely flammable liquid and vapor. Containers may explode when heated.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Keep unnecessary personnel away. Local authorities should be advised if significant spills cannot be contained. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. See Section 8 of the SDS for Personal Protective Equipment.

Methods and materials for containment and cleaning up

Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Stop leak if you can do so without risk. This material is a water pollutant and should be prevented from contaminating soil or from entering sewage and drainage systems and bodies of water. Dike the spilled material, where this is possible. Prevent entry into waterways, sewers, basements or confined areas.

Use non-sparking tools and explosion-proof equipment.

Small Spills: Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. This material and its container must be disposed of as hazardous waste.

Large Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent product from entering drains. Do not allow material to contaminate ground water system. Should not be released into the environment.

Environmental precautions

Gasoline may contain oxygenated blend products (Ethanol, etc.) that are soluble in water and therefore precautions should be taken to protect surface and groundwater sources from contamination. If facility or operation has an "oil or hazardous substance contingency plan", activate its procedures. Stay upwind and away from spill. Wear appropriate protective equipment including respiratory protection as conditions warrant. Do not enter or stay in area unless monitoring indicates that it is safe to do so. Isolate hazard area and restrict entry to emergency crew. Extremely flammable. Review Firefighting Measures, Section 5, before proceeding with clean up. Keep all sources of ignition (flames, smoking, flares, etc.) and hot surfaces away from release. Contain spill in smallest possible area. Recover as much product as possible (e.g. by vacuuming). Stop leak if it can be done without risk. Use water spray to disperse vapors. Use compatible foam to minimize vapor generation as needed. Spilled material may be absorbed by an appropriate absorbent, and then handled in accordance with environmental regulations. Prevent spilled material from entering sewers, storm drains, other unauthorized treatment or drainage systems and natural waterways. Contact fire authorities and appropriate federal, state and local agencies. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, contact the National Response Center at 1-800-424-8802.

7. Handling and storage

Precautions for safe handling

Eliminate sources of ignition. Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity. Wear personal protective equipment. Do not breathe dust/fume/gas/mist/vapors/spray. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. Avoid prolonged exposure. Use only with adequate ventilation. Wash thoroughly after handling. The product is extremely flammable, and explosive vapor/air mixtures may be formed even at normal room temperatures. DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. When using, do not eat, drink or smoke. Avoid release to the environment.

Conditions for safe storage, including any incompatibilities

Flammable liquid storage. Do not handle or store near an open flame, heat or other sources of ignition. This material can accumulate static charge which may cause spark and become an ignition source. The pressure in sealed containers can increase under the influence of heat. Keep container tightly closed in a cool, well-ventilated place. Keep away from food, drink and animal feedings. Keep out of the reach of children.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Components	Type	Value
Benzene (CAS 71-43-2)	STEL	5 ppm
	TWA	1 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Cumene (CAS 98-82-8)	PEL	245 mg/m3 50 ppm
Cyclohexane (CAS 110-82-7)	PEL	1050 mg/m3 300 ppm
Ethanol (CAS 64-17-5)	PEL	1900 mg/m3 1000 ppm
Ethylbenzene (CAS 100-41-4)	PEL	435 mg/m3 100 ppm
n-Heptane (CAS 142-82-5)	PEL	2000 mg/m3 500 ppm
n-Hexane (CAS 110-54-3)	PEL	1800 mg/m3 500 ppm
Octane (All isomers) (CAS 111-65-9)	PEL	2350 mg/m3 500 ppm
Pentane (CAS 109-66-0)	PEL	2950 mg/m3 1000 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	PEL	435 mg/m3 100 ppm

US. OSHA Table Z-2 (29 CFR 1910.1000)

Components	Type	Value
Benzene (CAS 71-43-2)	Ceiling	25 ppm
	TWA	10 ppm
Toluene (CAS 108-88-3)	Ceiling	300 ppm
	TWA	200 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	25 ppm
Benzene (CAS 71-43-2)	STEL	2.5 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
	TWA	0.5 ppm
Cumene (CAS 98-82-8)	TWA	50 ppm
Cyclohexane (CAS 110-82-7)	TWA	100 ppm
Ethanol (CAS 64-17-5)	STEL	1000 ppm
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm
Gasoline (CAS 86290-81-5)	STEL	500 ppm
	TWA	300 ppm
Hexane (Other Isomers) (CAS 96-14-0)	STEL	1000 ppm
	TWA	500 ppm
n-Heptane (CAS 142-82-5)	STEL	500 ppm
	TWA	400 ppm
n-Hexane (CAS 110-54-3)	TWA	50 ppm
Octane (All isomers) (CAS 111-65-9)	TWA	300 ppm
Pentane (CAS 109-66-0)	TWA	600 ppm
Toluene (CAS 108-88-3)	TWA	20 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	STEL	150 ppm
	TWA	100 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	125 mg/m3
		25 ppm
Benzene (CAS 71-43-2)	STEL	1 ppm
	TWA	0.1 ppm
Cumene (CAS 98-82-8)	TWA	245 mg/m3
		50 ppm
Cyclohexane (CAS 110-82-7)	TWA	1050 mg/m3
		300 ppm
Ethanol (CAS 64-17-5)	TWA	1900 mg/m3
		1000 ppm
Ethylbenzene (CAS 100-41-4)	STEL	545 mg/m3
		125 ppm
	TWA	435 mg/m3
		100 ppm
Hexane (Other Isomers) (CAS 96-14-0)	Ceiling	1800 mg/m3
		510 ppm
	TWA	350 mg/m3
		100 ppm
n-Heptane (CAS 142-82-5)	Ceiling	1800 mg/m3
		440 ppm
	TWA	350 mg/m3
		85 ppm
n-Hexane (CAS 110-54-3)	TWA	180 mg/m3
		50 ppm
Octane (All isomers) (CAS 111-65-9)	Ceiling	1800 mg/m3
		385 ppm
	TWA	350 mg/m3
		75 ppm
Pentane (CAS 109-66-0)	Ceiling	1800 mg/m3

UNLEADED GASOLINE

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Prepared by 3E Company

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Toluene (CAS 108-88-3)	TWA	610 ppm
		350 mg/m ³
	STEL	120 ppm
		560 mg/m ³
Xylene (o, m, p isomers) (CAS 1330-20-7)	TWA	150 ppm
		375 mg/m ³
	STEL	100 ppm
		655 mg/m ³
	TWA	150 ppm
		435 mg/m ³
		100 ppm

Biological limit values

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
Benzene (CAS 71-43-2)	25 µg/g	S-Phenylmercapturic acid	Creatinine in urine	*
Ethylbenzene (CAS 100-41-4)	0.7 g/g	Sum of mandelic acid and phenylglyoxylic acid	Creatinine in urine	*
n-Hexane (CAS 110-54-3)	0.4 mg/l	2,5-Hexanedione, without hydrolysis		*
	0.4 mg/l	2,5-Hexanedione, without hydrolysis	Urine	*
Toluene (CAS 108-88-3)	0.3 mg/g	o-Cresol, with hydrolysis	Creatinine in urine	*
	0.03 mg/l	Toluene	Urine	*
	0.02 mg/l	Toluene	Blood	*
Xylene (o, m, p isomers) (CAS 1330-20-7)	1.5 g/g	Methylhippuric acids	Creatinine in urine	*

* - For sampling details, please see the source document.

Exposure guidelines

US - California OELs: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
Cumene (CAS 98-82-8)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.
Toluene (CAS 108-88-3)	Can be absorbed through the skin.

US - Minnesota Haz Subs: Skin designation applies

Cumene (CAS 98-82-8)	Skin designation applies.
Toluene (CAS 108-88-3)	Skin designation applies.

US - Tennessee OELs: Skin designation

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.

US. NIOSH: Pocket Guide to Chemical Hazards

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

Appropriate engineering controls

Provide adequate general and local exhaust ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof equipment.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses. If splash potential exists, wear full face shield or chemical goggles.
Skin protection	
Hand protection	Avoid exposure - obtain special instructions before use. Wear protective gloves. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier.
Other	Wear chemical-resistant, impervious gloves. Full body suit and boots are recommended when handling large volumes or in emergency situations. Flame retardant protective clothing is recommended.
Respiratory protection	Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. If workplace exposure limits for product or components are exceeded, NIOSH approved equipment should be worn. Proper respirator selection should be determined by adequately trained personnel, based on the contaminants, the degree of potential exposure and published respiratory protection factors. This equipment should be available for nonroutine and emergency use.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Consult supervisor for special handling instructions. Avoid contact with eyes. Avoid contact with skin. Keep away from food and drink. Wash hands before breaks and immediately after handling the product. Provide eyewash station and safety shower. Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance	Light straw to red clear liquid with characteristic strong odor of gasoline.
Physical state	Liquid.
Form	Liquid.
Color	Light straw to red clear.
Odor	Characteristic Gasoline Odor (Strong).
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	44.01 °F (6.67 °C) May start to solidify at this temperature. This is based on data for the following ingredient: Cyclohexane. Weighted average: -91.9 deg C (-133.4 deg F)
Initial boiling point and boiling range	80.06 - 440.06 °F (26.7 - 226.7 °C)
Flash point	-40.0 °F (-40.0 °C) (closed cup)
Evaporation rate	10 - 11 BuAc
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	1.3 %
Flammability limit - upper (%)	7.1 %
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	60.8 - 101.3 kPa (20°C)
Vapor density	3 - 4 (Air=1)
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Very slightly soluble.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	> 500 °F (> 260 °C)
Decomposition temperature	Not available.
Viscosity	Not available.

Other information

Flash point class	Flammable IA
VOC (Weight %)	100 %

10. Stability and reactivity

Reactivity	None known.
Chemical stability	Stable under normal temperature conditions and recommended use.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Heat, flames and sparks. Ignition sources. Contact with incompatible materials. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Ingestion	Swallowing or vomiting of the liquid may result in aspiration into the lungs.
Inhalation	In high concentrations, mists/vapors may irritate throat and respiratory system and cause coughing. May cause drowsiness or dizziness.
Skin contact	Causes skin irritation. Prolonged contact may cause dryness of the skin.
Eye contact	May cause eye irritation.

Symptoms related to the physical, chemical and toxicological characteristics	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

Information on toxicological effects

Acute toxicity	Based on available data, the classification criteria are not met.

Components	Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)		
Acute		
<i>Dermal</i>		
LD50	Rabbit	> 3160 mg/kg
<i>Inhalation</i>		
LC50	Rat	> 2000 mg/l, 48 Hours
<i>Oral</i>		
LD50	Rat	6 g/kg
Benzene (CAS 71-43-2)		
Acute		
<i>Oral</i>		
LD50	Rat	3306 mg/kg
Cumene (CAS 98-82-8)		
Acute		
<i>Inhalation</i>		
LC50	Mouse	2000 mg/l, 7 Hours
	Rat	8000 mg/l, 4 Hours
<i>Oral</i>		
LD50	Rat	1400 mg/kg
Cyclohexane (CAS 110-82-7)		
Acute		
<i>Oral</i>		
LD50	Rat	12705 mg/kg

Components	Species	Test Results
Ethanol (CAS 64-17-5)		
Acute		
<i>Inhalation</i>		
LC50	Rat	30000 mg/m3
Ethylbenzene (CAS 100-41-4)		
Acute		
<i>Dermal</i>		
LD50	Rabbit	> 5000 mg/kg
<i>Oral</i>		
LD50	Rat	5.46 g/kg
n-Heptane (CAS 142-82-5)		
Acute		
<i>Inhalation</i>		
LC50	Rat	103 mg/l, 4 Hours
n-Hexane (CAS 110-54-3)		
Acute		
<i>Oral</i>		
LD50	Rat	28710 mg/kg
Octane (All isomers) (CAS 111-65-9)		
Acute		
<i>Inhalation</i>		
LC50	Rat	118 mg/l, 4 Hours
Pentane (CAS 109-66-0)		
Acute		
<i>Inhalation</i>		
LC50	Rat	364 mg/l, 4 Hours
Toluene (CAS 108-88-3)		
Acute		
<i>Dermal</i>		
LD50	Rabbit	14.1 ml/kg
<i>Inhalation</i>		
LC50	Rat	8000 mg/l, 4 Hours
<i>Oral</i>		
LD50	Rat	2.6 g/kg
Xylene (o, m, p isomers) (CAS 1330-20-7)		
Acute		
<i>Oral</i>		
LD50	Rat	4300 mg/kg
Skin corrosion/irritation	Causes skin irritation.	
Serious eye damage/eye irritation	Based on available data, the classification criteria are not met.	
Respiratory or skin sensitization		
Respiratory sensitization	Based on available data, the classification criteria are not met.	
Skin sensitization	Based on available data, the classification criteria are not met. This substance may have a potential for sensitization which may provoke an allergic reaction among sensitive individuals.	
Germ cell mutagenicity	May cause genetic defects. In in-vitro experiments, neither benzene, toluene nor xylene changed the number of sister-chromatid exchanges (SCEs) or the number of chromosomal aberrations in human lymphocytes. However, toluene and xylene caused a significant cell growth inhibition which was not observed with benzene in the same concentrations. In in-vivo experiments, toluene changed the number of sister-chromatid exchanges (SCEs) in human lymphocytes. Toluene may cause heritable genetic damage.	

Carcinogenicity May cause cancer.

IARC Monographs. Overall Evaluation of Carcinogenicity

Benzene (CAS 71-43-2)	1 Carcinogenic to humans.
Cumene (CAS 98-82-8)	2B Possibly carcinogenic to humans.
Ethylbenzene (CAS 100-41-4)	2B Possibly carcinogenic to humans.
Gasoline (CAS 86290-81-5)	2B Possibly carcinogenic to humans.
Toluene (CAS 108-88-3)	3 Not classifiable as to carcinogenicity to humans.
Xylene (o, m, p isomers) (CAS 1330-20-7)	3 Not classifiable as to carcinogenicity to humans.

NTP Report on Carcinogens

Benzene (CAS 71-43-2)	Known To Be Human Carcinogen.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Reproductive toxicity	Suspected of damaging fertility or the unborn child. Benzene, xylene and toluene have demonstrated animal effects of reproductive toxicity. Animal studies of benzene have shown testicular effects, alterations in reproductive cycles, chromosomal aberrations and embryo/fetotoxicity. Ethanol has demonstrated human effects of reproductive toxicity. Can cause adverse reproductive effects - such as birth defects, miscarriages, or infertility. Avoid exposure to women during early pregnancy. Avoid contact during pregnancy/while nursing.
Specific target organ toxicity - single exposure	May cause drowsiness or dizziness.
Specific target organ toxicity - repeated exposure	May cause damage to the following organs through prolonged or repeated exposure: Blood. Kidneys. Liver.
Aspiration hazard	May be fatal if swallowed and enters airways.
Chronic effects	Repeated exposure of laboratory animals to high concentrations of gasoline vapors has caused kidney damage and cancer in rats and cancer in mice. Gasoline was evaluated for genetic activity in assays using microbial cells, cultured mammalian cells and rat bone marrow cells. The results were all negative so gasoline was considered nonmutagenic under these conditions. Overexposure to this product or its components has been suggested as a cause of liver abnormalities in laboratory animals and humans. Lifetime studies by the American Petroleum Institute have shown that kidney damage and kidney cancer can occur in male rats after prolonged inhalation exposures at elevated concentrations of total gasoline. Kidneys of mice and female rats were unaffected. The U.S. EPA Risk Assessment Forum has concluded that the male rat kidney tumor results are not relevant for humans. Total gasoline exposure also produced liver tumors in female mice only. The implication of these data for humans has not been determined.
Further information	Symptoms may be delayed.

12. Ecological information

Ecotoxicity Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Components		Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	7.19 - 8.28 mg/l, 96 hours
Benzene (CAS 71-43-2)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	8.76 - 15.6 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	7.2 - 11.7 mg/l, 96 hours
Cumene (CAS 98-82-8)			
Aquatic			
Crustacea	EC50	Brine shrimp (Artemia sp.)	3.55 - 11.29 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	2.7 mg/l, 96 hours
Cyclohexane (CAS 110-82-7)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	3.961 - 5.181 mg/l, 96 hours
		Striped bass (Morone saxatilis)	8.3 mg/l, 96 hours

Components		Species	Test Results
Ethanol (CAS 64-17-5)			
Aquatic			
Algae	EC50	Freshwater algae	275 mg/l, 72 Hours
		Marine water algae	1970 mg/l
Fish	LC50	Fathead minnow (Pimephales promelas)	> 100 mg/l, 96 hours
		Freshwater fish	11200 mg/l, 96 Hours
Invertebrate	EC50	Freshwater invertebrate	5012 mg/l, 48 Hours
		Marine water invertebrate	857 mg/l, 48 Hours
Ethylbenzene (CAS 100-41-4)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	1 - 4 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4 mg/l, 96 hours
n-Heptane (CAS 142-82-5)			
Aquatic			
Fish	LC50	Western mosquitofish (Gambusia affinis)	4924 mg/l, 96 hours
n-Hexane (CAS 110-54-3)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	2.101 - 2.981 mg/l, 96 hours
Toluene (CAS 108-88-3)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	5.46 - 9.83 mg/l, 48 hours
Fish	LC50	Pink salmon (Oncorhynchus gorbuscha)	6.86 - 8.48 mg/l, 96 hours
Xylene (o, m, p isomers) (CAS 1330-20-7)			
Aquatic			
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	8 mg/l, 96 Hours
Persistence and degradability		Not available.	
Bioaccumulative potential		Not available.	
Partition coefficient n-octanol / water (log Kow)			
Benzene (CAS 71-43-2)		2.13	
Cumene (CAS 98-82-8)		3.66	
Cyclohexane (CAS 110-82-7)		3.44	
Ethanol (CAS 64-17-5)		-0.31	
Ethylbenzene (CAS 100-41-4)		3.15	
Hexane (Other Isomers) (CAS 96-14-0)		3.6	
Octane (All isomers) (CAS 111-65-9)		5.18	
Pentane (CAS 109-66-0)		3.39	
Toluene (CAS 108-88-3)		2.73	
Xylene (o, m, p isomers) (CAS 1330-20-7)		3.2	
n-Heptane (CAS 142-82-5)		4.66	
n-Hexane (CAS 110-54-3)		3.9	
Mobility in soil		Not available.	
Other adverse effects		Not available.	
13. Disposal considerations			
Disposal instructions		Dispose in accordance with all applicable regulations. This material and its container must be disposed of as hazardous waste. Dispose of this material and its container to hazardous or special waste collection point. Incinerate the material under controlled conditions in an approved incinerator. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container.	
Hazardous waste code		D001: Waste Flammable material with a flash point <140 °F D018: Waste Benzene	

US RCRA Hazardous Waste U List: Reference

Benzene (CAS 71-43-2)	U019
Cumene (CAS 98-82-8)	U055
Cyclohexane (CAS 110-82-7)	U056
Toluene (CAS 108-88-3)	U220
Xylene (o, m, p isomers) (CAS 1330-20-7)	U239

Waste from residues / unused products Dispose of in accordance with local regulations.

Contaminated packaging Offer rinsed packaging material to local recycling facilities.

14. Transport information

DOT

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	139, B33, B101, T8
Packaging exceptions	150
Packaging non bulk	202
Packaging bulk	242

IATA

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	Yes
ERG Code	3H
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	
Marine pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Central nervous system
Blood
Aspiration
Skin
Eye
Respiratory tract irritation
Flammability

CERCLA Hazardous Substance List (40 CFR 302.4)

Benzene (CAS 71-43-2)	LISTED
Cumene (CAS 98-82-8)	LISTED
Cyclohexane (CAS 110-82-7)	LISTED
Ethanol (CAS 64-17-5)	LISTED
Ethylbenzene (CAS 100-41-4)	LISTED
Gasoline (CAS 86290-81-5)	LISTED
Hexane (Other Isomers) (CAS 96-14-0)	LISTED
n-Heptane (CAS 142-82-5)	LISTED
n-Hexane (CAS 110-54-3)	LISTED
Octane (All isomers) (CAS 111-65-9)	LISTED
Pentane (CAS 109-66-0)	LISTED
Toluene (CAS 108-88-3)	LISTED
Xylene (o, m, p isomers) (CAS 1330-20-7)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - No
	Delayed Hazard - No
	Fire Hazard - No
	Pressure Hazard - No
	Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Toluene	108-88-3	0-30
Xylene (o, m, p isomers)	1330-20-7	0-25
1,2,4, Trimethylbenzene	95-63-6	0-6
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Pentane (CAS 109-66-0)

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

Toluene (CAS 108-88-3) 6594

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Toluene (CAS 108-88-3) 35 % weight/volumn

DEA Exempt Chemical Mixtures Code Number

Toluene (CAS 108-88-3) 594

US. Massachusetts RTK - Substance List

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. New Jersey Worker and Community Right-to-Know Act

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Pennsylvania Worker and Community Right-to-Know Law

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Gasoline (CAS 86290-81-5)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Rhode Island RTK

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. California Proposition 65**US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance**

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
Toluene (CAS 108-88-3)

International Inventories

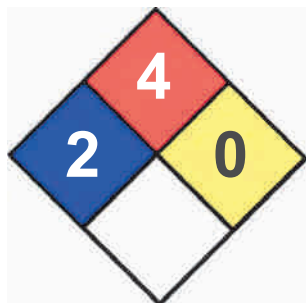
Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).

A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	13-May-2013
Revision date	23-May-2014
Version #	03
Further information	HMIS® is a registered trade and service mark of the NPCA.
NFPA Ratings	



References	ACGIH EPA: AQUIRE database NLM: Hazardous Substances Data Base US. IARC Monographs on Occupational Exposures to Chemical Agents HSDB® - Hazardous Substances Data Bank IARC Monographs. Overall Evaluation of Carcinogenicity National Toxicology Program (NTP) Report on Carcinogens ACGIH Documentation of the Threshold Limit Values and Biological Exposure Indices

Disclaimer	This material Safety Data Sheet (SDS) was prepared in accordance with 29 CFR 1910.1200 by Valero Marketing & Supply Co., ("VALERO"). VALERO does not assume any liability arising out of product use by others. The information, recommendations, and suggestions presented in this SDS are based upon test results and data believed to be reliable. The end user of the product has the responsibility for evaluating the adequacy of the data under the conditions of use, determining the safety, toxicity and suitability of the product under these conditions, and obtaining additional or clarifying information where uncertainty exists. No guarantee expressed or implied is made as to the effects of such use, the results to be obtained, or the safety and toxicity of the product in any specific application. Furthermore, the information herein is not represented as absolutely complete, since it is not practicable to provide all the scientific and study information in the format of this document, plus additional information may be necessary under exceptional conditions of use, or because of applicable laws or government regulations.



SAFETY DATA SHEET

Diesel Fuel

1. IDENTIFICATION

Product Identifier Diesel Fuel

Synonyms: Diesel Fuel, Motor Vehicle Diesel Fuel, Dyed Diesel, * DieselOne®, * DieselOne® w/Platinum Plus DFX, Low Sulfur Diesel (LSD), Ultra Low Sulfur Diesel (ULSD)

Intended use of the product: Fuel

Contact: Global Companies LLC
Water Mill Center
800 South St.
Waltham, MA 02454-9161
www.globalp.com

Contact Information: EMERGENCY TELEPHONE NUMBER (24 hrs): CHEMTREC (800) 424-9300
COMPANY CONTACT (business hours): 800-542-0778

2. HAZARD IDENTIFICATION

According to OSHA 29 CFR 1910.1200 HCS

Classification of the Substance or Mixture

Classification (GHS-US):

Flam. Liquid	Category 3	H226
Skin Corrosion/Irritation	Category 2	H315
Aspiration Hazard	Category 1	H304
STOT SE	Category 3	H336
Carcinogenicity	Category 2	H350
Aquatic Chronic	Category 2	H411
Serious Eye Damage/ Irritation	Category 2B	H319

Labeling Elements



Signal Word (GHS-US):

Hazard Statements (GHS-US):

Danger

H226 – Flammable liquid and vapor.

H315 – Causes Skin irritation.

H304 – May be fatal if swallowed and enters airways.

H336 – May cause drowsiness or dizziness.

H350 – May cause cancer.

H411 – Toxic to aquatic life with long lasting effects.

H319 – May cause eye damage/irritation.

Precautionary Statements (GHS-US):

P210 - Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

P233 - Keep container tightly closed.

P240 – Ground/bond container and receiving equipment.



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P241 – Use explosion-proof electrical/ventilating/lighting equipment pursuant to applicable electrical code.
P242 – Use only non-sparking tools.
P243 – Take precautionary measures against static discharge.
P261 – Avoid breathing dust/fume/gas/mist/vapors/spray.
P264 – Wash skin thoroughly after handling.
P271 – Use only outdoors or in a well-ventilated area.
P273 – Avoid release to the environment.
P280 – Wear protective gloves/protective clothing/eye protection/face protection.
P303+361+353 – If on skin (or hair): Take off immediately all contaminated clothing. Rinse with water/shower.
P308+311 – If exposed or concerned: Get medical advice/attention.
P301+310 – If swallowed: Immediately call a poison center/doctor/...
P331 – Do NOT induce vomiting.
P370+P378 – In case of fire use firefighting foam or other appropriate media for Class B fires to extinguish.
P403+235 – Store in a well-ventilated place. Keep cool.
P405 – Store locked up.
P501 – Dispose of contents/container in accordance with local/regional/national/international regulation.

Other information:

NFPA 704
Health: 1
Fire: 2
Reactivity: 0



3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Composition Information Mixture

Name	Product Identifier (CAS#)	% (w/w)	Classification
Diesel Fuel	68476-34-6	100	Flam Liq. 3, H226; Skin Irrit. 2, H315; Aspiration 1, H304; STOT SE 3, H336; Carc.2. H350; Aquatic chronic 2, H411
Naphthalene	91-20-3	<0.1	Carc. 2, H351; Acute Tox. 4, H302; Aquatic Acute 1, H400; Aquatic Chronic 1, H410

Additional Formulation Information:

Diesel Fuel consists of C9+ hydrocarbons resulting from distillation of crude oil.

Low Sulfur Diesel Fuel typically contains less than 500 ppm of sulfur

Ultra Low Sulfur Diesel Fuel typically contains less than 15 ppm of sulfur

4. FIRST AID MEASURES

Route	Measures
Inhalation	Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.



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Route	Measures
Ingestion	Aspiration Hazard: DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Ingestion may cause gastrointestinal disturbances including irritation, nausea, vomiting, and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory failure, and death.
Eye Contact	In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention. In case of contact lenses, remove immediately.
Skin Contact	Remove contaminated clothing and shoes. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and of the area of the body burned.

Most Important Symptoms

Contact with eyes and face may cause irritation. Long-term exposure may cause dermatitis (itching, irritation, pain and swelling).

Inhalation may cause irritation and significant or long term exposure could cause respiratory insufficiency and pulmonary edema.

Ingestion may cause aspiration, gastrointestinal disturbance, and CNS effects.

Immediate Medical Attention and Special Treatment

For contact with skin or eyes, immediately wash or flush contaminated eyes with gently flowing water. If possible, irrigate each eye continuously with 0.9% saline (NS). If ingested, rinse mouth. Do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs).

If inhaled, administer oxygen or establish a patent airway if breathing is labored. Suction if necessary. Monitor closely, anticipate seizures. Consider orotracheal or nostracheal intubation of airway control if patient is unconscious or is in severe respiratory distress.

Discard any clothing or shoes contaminated as they may be flammable.

5. FIRE-FIGHTING MEASURES

Extinguishing Media

Foam, carbon dioxide, dry chemical are most suitable

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO₂, water spray, firefighting foam, or Halon. Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other firefighting equipment.

LARGE FIRES: Foam, carbon dioxide, dry chemical. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Specific Hazards / Products of Combustion

Moderate fire hazard when exposed to heat or flame with a very low flash point. Product is flammable and easily ignited when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Combustion may produce smoke, carbon monoxide and other products of incomplete combustion.

Special Precautions and Protective Equipment for Firefighters

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied firefighting foam.



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Fighting Equipment/Instructions

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH- approved pressure-demand self-contained breathing apparatus with full face piece and protective clothing.

Refer to Section 9 for fire properties of this chemical including flash point, auto ignition temperature, and explosive limits.

6. ACCIDENTAL RELEASE MEASURES

ACTIVATE FACILITY SPCC, SPILL CONTINGENCY or EMERGENCY PLAN.

Personal Precautions

Due to high vapor density, flammable / toxic vapors may be present in low lying areas, dikes, pits, drains, or trenches. Vapors may accumulate in low lying areas and reach ignitable concentrations. Ventilate the area. Use of non-sparking tools and intrinsically safe equipment is recommended. Potential for flammable atmosphere should be monitored using a combustible gas indicator positioned downwind of the spill area. Refer to Sections 2 and 7 for further hazard warnings and handling instructions.

Use appropriate personal protective equipment to prevent eye/skin contact and absorption. Use NIOSH approved respiratory protection, if warranted, to prevent exposures above permissible limits. Refer to Section 8. Contaminated clothing should not be near sources of ignition.

Emergency Measures

As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions. Consider wind direction. Secure all ignition sources (flame, spark, hot work, hot metal, etc.) from area. Evaluate the direction of product travel, diking sewers, etc. to confirm spill areas. Do not touch or walk-through spilled material. For large spills, isolate initial action distance downwind 1,000 ft. (300 m).

Environmental Precautions

Stop the spill to prevent environmental release if it can be done safely. Product is toxic to aquatic life. Take action to isolate environmental receptors including drains, storm sewers and natural water bodies. Keep on impervious surface if at all possible. Use water sparingly to prevent product from spreading. Foam and absorbents may be used to reduce / prevent airborne release.

Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Follow federal, state or local requirements for reporting environmental release where necessary. Refer to Section 15 for further information.

Containment and Clean-Up Methods

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of firefighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with dry earth, sand or other non-combustible, inert oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container with clean, non-sparking tools for reclamation or disposal. Response and cleanup crews must be properly trained and must utilize proper protective equipment. Refer to Section 8 for appropriate protective equipment.

7. HANDLING AND STORAGE

USE ONLY AS A FUEL.

DO NOT SIPHON BY MOUTH.

Handling Precautions

Handle as a flammable liquid. Keep away from heat, sparks, and open flame. No smoking. Electrical equipment should be approved for classified area. Bond and ground containers during product transfer pursuant to NFPA 70 and API RP 2003 to reduce the possibility of static-initiated fire or explosion. Follow precautions to prevent static initiated fire.

Use good personal hygiene practices. Use only with protective equipment specified in Section 8. Avoid repeated and/or prolonged skin exposure. Use only outdoors or in well ventilated areas. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this



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product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves. Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API RP 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage

Large quantities of diesel fuel are stored in tanks or portable containers at an ambient storage temperature. Separate from incompatible chemicals (Refer to Section 10) by distance or secondary containment. Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers that are clearly labeled. Label all secondary containers that this material is transferred into with the chemical name and associated hazard(s). Empty product containers or vessels may contain flammable vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Storage tanks should have a venting system. If stored in small containers, the area should be well ventilated, away from ignition sources and protected from potential damage or vehicular traffic. Post "No Smoking" signs in product storage areas. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code" or applicable building code. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks in Flammable and Combustible Liquid Service" and API RP 2015 "Safe Entry and Cleaning of Petroleum Storage Tanks".

Incompatibles

Keep away from strong oxidizers, ignition sources and heat.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Limits

Component	CAS #	List	Value
Diesel Fuel	68476-34-6	ACGIH TLV-TWA	100 mg/m ³ *
Naphthalene	91-20-3	ACGIH TLV-TWA OSHA PEL ACGIH STEL	10 ppm 10 ppm 15 ppm

*Critical effects; Skin; A3; CNS impairment.

Engineering Controls

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces. Intrinsically safe equipment and non-sparking tools shall be used in circumstances where concentrations may exceed lower flammable limits. Grounding and bonding shall be used to prevent accumulation and discharge of static electricity. Emergency shower and eyewash should be provided in proximity to handling areas in the event of exposure to decontaminate.

Personal Protective Equipment

Exposure	Equipment
Eye / Face	Wear appropriate chemical protective glasses or goggles or face shields to prevent skin and eye contact especially caused from splashing.
Skin	Wear appropriate personal protective clothing to prevent skin contact. Gloves constructed of nitrile, neoprene or PVC are recommended when handling this material. Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure.



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Exposure	Equipment
Respiratory	A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations. Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.
Thermal	Product is stored at ambient temperature. No thermal protection is required except for emergency operations involving actual or potential for fire. Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

9. PHYSICAL AND CHEMICAL PROPERTIES

Property	Value
Appearance	Clear or straw-colored liquid. May be dyed red for distribution.
Odor	Mild characteristic petroleum distillate odor.
Odor Threshold	<1 ppm
pH	Not available
Melting Point	-22 to -0.4 °F (-30 to -18 °C)
Boiling Point Range	320 to 690 °F (160 to 366 °C)
Flash Point	> 125.6 °F (52 °C) PMCC
Evaporation Rate	Slow, varies with conditions
Flammability	Flammable liquid (OSHA defined)
Flammable Limits	0.6 % - 6.5%
Vapor Pressure	0.009 psia @ 70 °F
Vapor Density	> 1 (air=1)
Specific Gravity	0.83-0.86 @ 60 °F (16 °C) (water=1)
Solubility	Insoluble in water; miscible with other petroleum solvents.
Partition Coefficient (N-octanol/water)	Log Kow range of 3.3 to >6.0
Autoignition Temperature	494 °F (257 °C)
Decomposition Temperature	When heated it emits acrid smoke and irritating vapors.
Viscosity	<3 cSt
Percent Volatiles	100

10. STABILITY AND REACTIVITY

Stability

This is a stable material that is flammable liquid (OSHA/GHS hazard category 3). Stable during transport.

Reactivity

Material is not self-reacting. Flammable concentrations may be present in air. Compound can react with oxidizing materials.



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Diesel Fuel

Possibility of Hazardous Reactions

Hazardous polymerization will not occur.

Incompatibility

Keep away from strong oxidizers such as nitric and sulfuric acids.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, static electricity, welding, smoking and other ignition sources.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

11. TOXICOLOGICAL INFORMATION

Acute Toxicity:

Acute Toxicity (Inhalation LC50)

Diesel Fuel (68476-34-6)

LC50 Inhalation Rat >6 mg/l/4h

Acute Toxicity (Dermal LD50)

Diesel Fuel (68476-34-6)

LD50 Dermal Rabbit >5000 mg/kg

Acute Toxicity (Oral LD50)

Diesel Fuel (68476-34-6)

LD50 Oral Rabbit >5000 mg/kg

Skin Corrosion/Irritation: Prolonged and repeated contact may cause skin irritation leading to dermatitis. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

Serious Eye Damage/Irritation: Causes serious eye irritation.

Respiratory or Skin Sensitization: Not classified

Germ Cell Mutagenicity: Not classified

Teratogenicity: Not available

Carcinogenicity: OSHA: NO, IARC: Group 3, NTP: NO, ACGIH: NOIC:A3, NIOSH: NO

IARC: Group 3 – Not classifiable as to their carcinogenicity to humans ACGIH: A3 – Confirmed animal carcinogen with unknown relevance to humans

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

IARC classifies whole diesel fuel exhaust particulates (byproduct of combustion of this material) carcinogenic to humans (Group 1) and NIOSH regards diesel fuel exhaust particulate as a potential occupational carcinogen.

Reproductive Toxicity: Not classified

Specific Target Organ Toxicity (Repeated Exposure): Not classified

Specific Target Organ Toxicity (Single Exposure): Inhalation exposure may cause drowsiness or dizziness by inhalation exposure.

Aspiration Hazard: The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Potential Health Effects: Vapor irritating to skin, eyes, nose, and throat. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

WARNING: The burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of



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Diesel Fuel

combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

12. ECOLOGICAL INFORMATION

Toxicity:

This material is expected to be toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.

Data for Component: Diesel Fuel (68476-34-6)

Material is toxic to aquatic organisms based on an acute basis (LC50/EC50 >1 but $\leq$ 10 mg/L in the most sensitive species tested).

Material is a long-term aquatic hazard based on a chronic basis (LC50/EC50 >1 but $\leq$ 10 mg/L in the most sensitive species tested).

Persistence and Degradation: This material is not expected to be readily biodegradable.

Bioaccumulative Potential: Not available

Mobility in Soil: Not available

Other Adverse Effects: None known

Other Information: Avoid release to the environment.

13. DISPOSAL CONSIDERATIONS

Consult federal, state and local waste regulations to determine appropriate disposal options. May be considered a hazardous waste if disposed. Direct solid waste (landfill) or incineration at a solid waste facility is not permissible. Do not discharge to sanitary or storm sewer. Personnel handling waste containers should follow precautions provided in this document.

Shipping containers must be DOT authorized packages. Follow licensure and regulations for transport of hazardous material and hazardous waste as applicable.

14. TRANSPORT INFORMATION

US DOT

UN Identification Number	NA 1993
Proper Shipping Name	Diesel fuel
Hazard Class and Packing Group	3, PGIII
Shipping Label	Flammable liquid
Placard / Bulk Package	Flammable liquid, 1993
Emergency Response Guidebook Guide Number	128

This product may be re-classified as a "Combustible Liquid" meeting the definition in 49 CFR 173.120 unless transported by vessel or aircraft.

Specific placard requirements must be met for shipments of this product as a Combustible Liquid by rail (See 49 CFR 172.332).

Non-bulk packages ($\leq$ 119 gal) of Combustible Liquids in package sizes less than the product reportable quantity are not regulated as hazardous materials if the material does not meet any other hazard class.

IATA Information

UN Identification Number	UN 1202
Proper Shipping Name	Diesel fuel
Hazard Class and Packing Group	3, PGIII
ICAO Label	3
Packing Instructions Cargo	310
Max Quantity Per Package Cargo	220L
Packing Instructions Passenger	309Y
Max Quantity per Package Passenger	60L



SAFETY DATA SHEET

Diesel Fuel

ICAO

UN Identification Number	UN 1202
Shipping Name / Description	Diesel fuel
Hazard Class and Packing Group	3, PG III
IMDG Label	3

IMDG

UN Identification Number	UN 1202
Shipping Name / Description	Diesel fuel
Hazard Class and Packing Group	3, PGIII
IMDG Label	3
EmS Number	F-E-S-E
Marine Pollutant	Yes

15. REGULATORY INFORMATION

U.S. Federal, State, and Local Regulatory Information

Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

OSHA Hazard Communication Standard

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning And Community Right-to-Know Act of 1986) Sections 311 and 312

Immediate (Acute) Health Hazard	Yes
Delayed (Chronic) Health Hazard	Yes
Fire Hazard	Yes
Reactive Hazard	No
Sudden Release of Pressure Hazard	No

Clean Water Act (Oil Spills)

Any spill or release of this product to "navigable waters" (Essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA Section 103 and SARA Section 304 (Release to the Environment)

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts this material. This product does not contain any chemicals subject to the reporting requirements of CERCLA Section 103 or SARA 304.

SARA Section 313- Supplier Notification

This product does not contain any chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372.

EPA Notification (Oil Spills)

If there is a discharge of more than 1,000-gallons of oil into or upon navigable waters of the United States, or if it is the second spill event of 42 gallons or more of oil into water within a twelve (12) month period, a written report must be submitted to the Regional Administrator of the EPA within sixty days of the event.

Pennsylvania Right to Know Hazardous Substance list:

The following product components are cited in the Pennsylvania Special Hazardous Substance List, and are present at levels which require reporting.

Component	CAS	Amount
Diesel Fuel	68476-34-6	100%



SAFETY DATA SHEET

Diesel Fuel

New Jersey Right to Know Hazardous Substance list:

The following product components are cited in the New Jersey Right to Know Hazardous Substance List, and are present at levels which require reporting.

Component	CAS	Amount
Diesel Fuel	68476-34-6	100%

California Proposition 65 WARNING: This product contains chemicals known to the State of California to cause Cancer or Reproductive Toxicity.

Component	CAS	Amount
Naphthalene	91-20-3	<0.1%

U.S. Toxic Substances Control Act

All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30.

CEPA - Domestic Substances List (DSL)

All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

Canadian Regulatory Information (WHMIS)

Class B3 – Combustible Liquid

Class D2A – Materials causing other toxic effects. (Very Toxic)

16. OTHER INFORMATION

Version	5
Issue Date	June 26, 2019
Prior Issue Date	May 20, 2016

Description of Revisions

Update viscosity information in Section 9. Update transportation information in Section 14 to clarify US DOT re-classification option as a Combustible Liquid.

Abbreviations

°F	Degrees Fahrenheit (temperature)	mL	Milliliter
<	Less than	mm ²	Square millimeters
=	Equal to	mmHg	Millimeters of mercury (pressure)
>	Greater than	N/A	Not applicable
AP	Approximately	N/D	Not determined
C	Centigrade (temperature)	ppm	Parts per million
kg	Kilogram	sec	Second
L	Liter	ug	Micrograms
mg	Milligrams		

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists	CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
AIHA	American Industrial Hygiene Association	DOT	U.S. Department of Transportation
AL	Action Level	EC50	Ecological concentration 50%
ANSI	American National Standards Institute	EPA	U.S. Environmental Protection Agency
API	American Petroleum Institute	ERPG	Emergency Response Planning Guideline
CAS	Chemical Abstract Service	GHS	Global Harmonized System



SAFETY DATA SHEET

Diesel Fuel

HMIS	Hazardous Materials Information System	REL	Recommended Exposure Limit (NIOSH)
IARC	International Agency for Research On Cancer	RVP	Reid Vapor Pressure
IATA	International Air Transport Association	SARA	Superfund Amendments and
IMDG	International Maritime Dangerous Goods	SCBA	Self Contained Breathing Apparatus
Koc	Soil Organic Carbon	SPCC	Spill Prevention, Control, and
LC50	Lethal concentration 50%		Countermeasures
LD50	Lethal dose 50%	STEL	Short Term Exposure Limit (generally 15
MSHA	Mine Safety and Health Administration		minutes)
NFPA	National Fire Protection Association	TLV	Threshold Limit Value (ACGIH)
NIOSH	National Institute of Occupational Safety and	TSCA	Toxic Substances Control Act
	Health	TWA	Time Weighted Average (8 hr.)
NOIC	Notice of Intended Change	UN	United Nations
NTP	National Toxicology Program	UNECE	United Nations Economic Commission for
OPA	Oil Pollution Act of 1990		Europe
OSHA	U.S. Occupational Safety & Health	WEEL	Workplace Environmental Exposure Level
	Administration		(AIHA)
PEL	Permissible Exposure Limit (OSHA)	WHMIS	Canadian Workplace Hazardous Materials
RCRA	Resource Conservation and Recovery Act		Information System
	Reauthorization Act of 1986 Title III		

Disclaimer of Expressed and Implied Warranties

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

**** End of Safety Data Sheet ****

Appendix E

Field Forms

Field Safety Forms (FSF)

1 - Vehicle Weekly Inspection Form

2 - Tailgate Safety Briefing Form

Arcadis Weekly Vehicle Inspection Form



Vehicle # / License Plate #

Lease Plan # / Last 6 of Vin #

		Inspection Date											
		Odometer reading											
Driver / Inspector Name													
Check the appropriate box and enter repair date for identified repairs:		OK	Needs Repair	Repair Date	OK	Needs Repair	Repair Date	OK	Needs Repair	Repair Date	OK	Needs Repair	Repair Date
Interior	Horn operational												
	Door Locks operational												
	Seat Belts in good repair												
	Seats and Seating Controls												
	Steering Wheel - No Excessive Play												
	Interior Lights and Light Controls												
	Instrument Panel/Gauges												
	Wiper Controls operational												
	Heat/Defrost/Air Conditioning working												
	Rear View Mirror present												
	Backup Camera/Sensors working												
	Jack and Lug Wrench present												
Exterior ¹	Lights and Signals operational												
	Tires properly inflated/good tread depth												
	Spare Tire properly inflated												
	Doors operational												
	Windows Not Cracked/Damaged												
	Side View Mirrors												
	Body Panels and Bumpers												
Engine & Brakes	Engine Start & Running Smoothly												
	Fluid Levels, No Noticeable Leaks												
	Belts tight, no cracks												
	Brakes operational, no squeaking												
Emergency Equipment ²	First Aid Kit, inspected weekly												
	Fire Extinguisher properly secured												
	Fire Extinguisher inspected weekly												
	Orange/Yellow emergency warning light												
	Roadside Assistance Information												
	Recommend spotter cones available												
Cargo	Cargo Secure and Properly Distributed												
	Securing Devices in Good Condition												
Registration	License Plate /Tags												
	Registration and Insurance												
	City/State Inspection Decal												
	Lease Plan information/Fuel Card												

¹ Note all damages to the vehicle on the back of this page

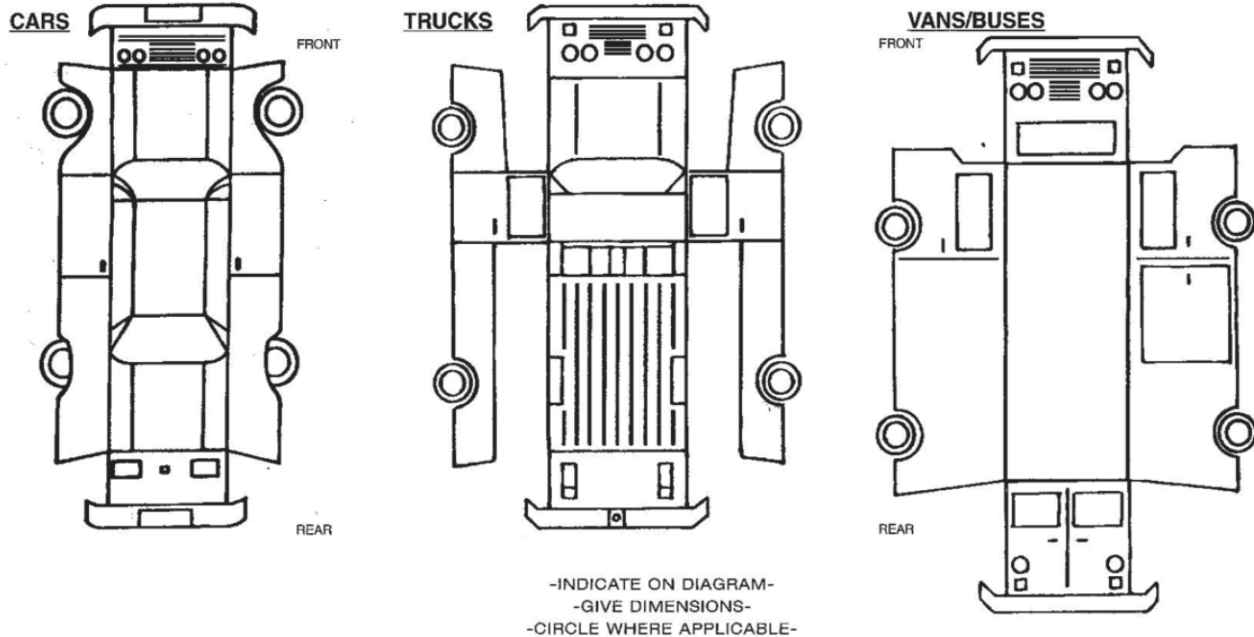
² Emergency Equipment required per Motor Vehicle Standard ARC HSGE024

Note All Vehicle Damage Below

All Vehicle Damage must be reported to Sue Berndt (Corporate Legal), Andrew McDonald (Corporate H&S), and Roger Elliot (Corporate Fleet Manger)

CODES:

B-BENT	CPM-COVERED WITH PROTECTIVE MATERIAL-UNABLE TO DETERMINE DEFECTS IF ANY	DMC-DUST AND MUD COVERED UNABLE TO DETERMINE OTHER DEFECTS IF ANY	P-PUNCTURED
BR-BROKEN		G-GOUGED OR CUT	R-RUSTY
BU-BULGE	CSA-CHAFED AND SCRATCHED ALL OVER	GC-GLASS CRACKED	S-SCRATCHED
C-CHAFED	CR-CRACKED	HS-HAIRLINE SCRATCH	SC-SCRAPPED
CH-CHIPPED	D-DENTED	M-MISSING	SM-SMASHED
			ST-STAINED AND/OR SOILED
			T-TORN



Notes:

Tread guide: If a tread gauge is not available coins may be used to determine remaining tread. 2/32" is the minimum by law in most states (top of Lincoln's head on penny), 4/32" is minimum recommended for wet surfaces (top of Washington's head on quarter), 6/32" is minimum recommended for snowy surfaces (top of Lincoln Memorial on penny). Vehicle tires should be replaced if the tread depth is less than 6/32".



Reference JSA 10907 For Weekly Vehicle Inspection

Control Number: TSM- 30088504

TSM + project number plus date as follows: xxxxxxxx.xxxx.xxxx - dd/mm/year

TAILGATE HEALTH & SAFETY MEETING FORM

Project Name: _____ Project Location: _____

Date: _____ Time: _____ Conducted by: _____ Signature/Title: _____

Issues or concerns from previous day's activities:

Task anticipated to be performed today:

☐ Additional permits/checklists attached

USE TRACK! Evaluate the hazards (h) for the tasks being performed today and rank as Low (L), Medium (M) or High (H). Use relevant JSAs, FHSB, permit or other work standard to communicate controls (c) to be used to eliminate or mitigate identified hazards.

☐ Gravity (i.e., ladder, trips) (L M H) ☐ Motion (i.e., traffic, machinery) (L M H) ☐ Mechanical (i.e., augers, motors) (L M H)

h: _____ h: _____ h: _____

c: _____ c: _____ c: _____

☐ Electrical (i.e., utilities) (L M H) ☐ Pressure (i.e., gas cyl., wells) (L M H) ☐ Environment (i.e., heat, cold) (L M H)

h: _____ h: _____ h: _____

c: _____ c: _____ c: _____

☐ Chemical (i.e., fuel, acid, paint) (L M H) ☐ Biological (i.e., ticks, poison ivy) (L M H) ☐ Radiation (i.e., alpha, sun, laser) (L M H)

h: _____ h: _____ h: _____

c: _____ c: _____ c: _____

☐ Sound (i.e., machinery) (L M H) ☐ Personal (i.e. alone, night) (L M H) ☐ Driving (i.e. car, ATV, boat) (L M H)

h: _____ h: _____ h: _____

c: _____ c: _____ c: _____

☐ Refer to the attached Hazard Analysis Sheet(s) or JSA

Comments:

Signature and Certification: I have read and understand the project specific HASP for this project.

SSE Employee*	Non-Life Threatening Injury or Illness Call WorkCare 1-888-449-7787		
	Printed Name/Signature/Company	Sign In Time	Sign Out Time

I will STOP the job any time anyone is concerned or uncertain about health & safety or if anyone identifies a hazard or additional mitigation not recorded in the site, project, job or task hazard assessment.

I will be alert to any changes in personnel, conditions at the work site or hazards not covered by the original hazard assessments.

If it is necessary to **STOP THE JOB**, I will perform **TRACK**; and then amend the hazard assessments or the HASP as needed.

I will not assist a subcontractor or other party with their work unless it is absolutely necessary and then only after I have done TRACK and I have thoroughly controlled the hazard.

All site staff should arrive fit for work. If not, they should report to the supervisor any restrictions or concerns.

In the event of an injury, employees will call **WorkCare at 1.888.449-7787** and then notify the field supervisor.

Utility strike, motor vehicle accident or 3rd party property damage - field supervisor will immediately notify the Project or Task Manager

*Short Service Employee (SSE) working for Arcadis <1 year.

Lockout/Tagout Exchange of Information Documentation

The LO/TO standard requires that Arcadis exchange energy control procedures with outside employers who service and/or maintain equipment/machines owned by Arcadis that require LO/TO. Arcadis staff will use this form to notify all parties that they must comply with any identified restrictions and prohibitions, as outlined below. This form should be completed by an Arcadis Qualified LO/TO staff person in conjunction with the outside employer's LO/TO Authorized representative. This exchange of information must occur before service/maintenance activities begin on Arcadis-owned equipment. If Arcadis staff will also be working on this equipment or in surrounding areas, then attach this documentation form to the Equipment Specific LO/TO Procedure and the LO/TO Permit to Work.

1. Identification of Outside Employer(s):

Company: _____

Name: _____

Address: _____

Telephone #: _____

2. Identify Location of Equipment: _____

Identify Equipment/Machine to be serviced: _____

Hazardous energy control procedures for the equipment/machine have been exchanged? _____

(No response would trigger Stop Work Authority)

3. After comparing the Arcadis and Outside Employer LO/TO programs/procedures, identify any specific restrictions/prohibitions or procedural steps below:

4. Affected Persons (listed below) shall review, understand and comply with the above-identified specific restrictions/prohibitions or procedural steps.

(Printed Name)

(Signature)

5. Acknowledged acceptance of the provisions of this exchange of information form:

Outside Employer Representative: _____

(LO/TO Qualified) (Signature) (Date)

Arcadis Authorized LO/TO Staff: _____

(Signature) (Date)

Lockout Tagout (LO/TO) Periodic Inspection Checklist



Periodic inspections of energy control procedure(s) are required at least annually to ensure that the requirements of the established energy control procedure and the LO/TO standard are being followed. This form must be attached to the Periodic Inspection Log. The Arcadis LO/TO TIP may be used in place of this checklist.

All **No** responses require an update to the written LO/TO procedure.

		Yes/No	Details
1	Is all machinery or equipment capable of movement, required to be de-energized or disengaged and locked-out during cleaning, servicing, adjusting or setting up operations, whenever required?		
2	Where the power disconnecting means for equipment does not also disconnect the electrical control circuit:	--	--
2a	Are the appropriate electrical enclosures identified?		
2b	Is means provided to assure the control circuit can also be disconnected and locked-out?		
2c	Is the locking-out of control circuits in lieu of locking-out main power disconnects prohibited?		
3	Are all equipment control valve handles provided with a means for locking-out?		
4	Does the lock-out procedure require that stored energy (mechanical, hydraulic, air, etc.) be released or blocked before equipment is locked-out for repairs?		
5	Are appropriate employees provided with individually keyed personal safety locks?		
6	Are employees required to keep personal control of their key(s) while they have safety locks in use?		
7	Is it required that only the employee exposed to the hazard, place or remove the safety lock?		
8	Is it required that employees check the safety of the lock-out by attempting a startup after making sure no one is exposed?		
9	Are employees instructed to always push the control circuit stop button immediately after checking the safety of the lock-out?		
10	Is there a means provided to identify any or all employees who are working on locked-out equipment by their locks or accompanying tags?		
11	Are a sufficient number of accident preventive signs or tags and safety padlocks provided for any reasonably foreseeable repair emergency?		
12	When machine operations, configuration or size requires the operator to leave his or her control station to install tools or perform other operations, and that part of the machine could move if accidentally activated, is such element required to be separately locked or blocked out?		
13	In the event that equipment or lines cannot be shut down, locked-out and tagged, is a safe job procedure established and rigidly followed?		

Lockout Tagout (LO/TO) Periodic Inspection Log



Machine ID# or Equipment ID# _____

Written LOTO Procedure ID# _____

Date of Inspection	Authorized Person Conducting Inspection	Additional Staff Included in Inspection	LO/TO Procedure Adequate? (Yes/No)	List changes to the LOTO Procedure

All No responses require an update to the written LO/TO procedure.

Lockout Tagout (LO/TO) Periodic Inspection Log



Machine ID# or Equipment ID# _____

Written LOTO Procedure ID# _____

Date of Inspection	Authorized Person Conducting Inspection	Additional Staff Included in Inspection	LO/TO Procedure Adequate? (Yes/No)	List changes to the LOTO Procedure

All No responses require an update to the written LO/TO procedure.

Equipment Lockout / Tagout (LO/TO) Permit to Work

Equipment:		Project Number:	
Project Name:		Project Location:	
Name of Authorized Person in Control of LO/TO Process:		Name of Authorized Person applying Equip Isolation Device:	
Name of Authorized Person that verified Hazardous Energy Source is controlled:		Name of NFPA 70e Authorized Person (If Required):	
Start Date for LO/TO Procedure:		Estimated Date of Completion for LO/TO Procedure:	
Estimated Start Time for LO/TO Procedure:		Estimated Completion Time for LO/TO Procedure:	

TRACKing the LO/TO Work Permit

THINK THROUGH THE TASK

Job Task: (Brief summary of what hazardous energy control work is proposed)

WORKFORCE INVOLVED/AFFECTED BY LO/TO WORK

Check all that apply

Name	Company	Phone Number	Revised LO/TO Procedure	LO/TO Authorized Person	NFPA 70e Authorized Person	Affected Employee	Affected Employee Trained
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐
			☐	☐	☐	☐	☐

Comments/Additional Details:

RECOGNIZE THE HAZARDOUS ENERGY SOURCE (check all that apply) and ASSESS THE RISK (Low-Moderate-High)

YES	NO	Type of Hazardous Energy	SELECT ↓	YES	NO	Type of Hazardous Energy	SELECT ↓
☐	☐	Electrical		☐	☐	Thermal	
☐	☐	Mechanical		☐	☐	Gravitational (Stored)	
☐	☐	Hydraulic		☐	☐	Pressure (Stored)	
☐	☐	Pneumatic		☐	☐	Hazardous Material	
☐	☐	Chemical		☐	☐	Other Hazard	

CONTROL THE WORKING ENVIRONMENT

Written LO/TO Procedure	YES	NO	Written LO/TO Procedure Eception	YES	NO
Developed an Equipment LO/TO Procedure	☐	☐	Written LO/TO Procedure Eception	☐	☐
Identified all hazardous energy sources	☐	☐	Equipment has been removed from service	☐	☐
Equipment LO/TO Procedure Reviwed with the past 12 months	☐	☐	Locking devices and Tags in use	☐	☐
Identified all hazardous energy sources	☐	☐	Equipment reduced to zero energy state	☐	☐
Notified affected employees	☐	☐	Equipment has been isolated	☐	☐
Locking devices and Tags in use	☐	☐	Equipment isolation tested/verified	☐	☐

All No responses; Use Stop Work Authority- Explain Control Work Environment:

LO/TO POINTS ISOLATED BY AUTHORIZED PERSON(S) Reference Written LO/TO Procedure

Hazard	Action Required	Lock ID / #	Authorized Person Name	Date LOTO Applied	Date LO/TO Removed

EMERGENCY CONTACT LIST

Emergency Contact:	Phone 1:	Phone 2:	Location:
Emergency (FIRE/EMS):			
Emegerncy (Facility):			
Work Care:	888.449.7787	-----	
Project Manager:			
Site Safety Officer:			
Client Contact:			
Other:			

***Include any Task Specific JSA's with this permit to work.**

KEEP H&S FIRST IN ALL THINGS

I understand the nature of the work for this permit, and certify that this permit meets the requirements specified in the Arcadis LO/TO Standard.

Completed Permit to Work Must Be Retained in Project File for 12 Months

APPROVAL OF LO/TO WORK PERMIT- By ARCADIS LO/TO Authorized Person:

Name: _____	Office Location: _____
Title: _____	Date: _____

THIS FORM MUST BE ENTIRELY COMPLETED PRIOR TO BEGINNING ANY INTRUSIVE WORK

Project Name: Barker Hughesville and Carpenter-Snow Start Date: _____

Project #: 30088504 End Date: _____

*Utility markings valid for 15 days. Initiate clearance renewal 5 days prior to expiration for ongoing work***PRE-FIELD WORK REQUIREMENTS**DigSafe 811 notified 48-72 hrs. in advance of work? ☐ DigSafe Ticket #: _____Ticket Expiration Date: _____ [State Utility Laws: www.commongroundalliance.com/map](http://www.commongroundalliance.com/map)Ticket(s) Attached(Y/N)? ☐ List utility owners notified via DigSafe 811 & response status: _____

List add'l. utilities requiring notification not included in DigSafe811 Notice: _____

*Review task details w/ private utility location subcontractor. ID work areas, clearance equipment needed, depth of clearance needed, types of features, utilities, anticipated/known/unknown. Verify DigSafe 811 markings to confirm public utility clearance.*Private Utility Locator Name, if used: _____ AUS onsite meeting (Y/N)? ☐**FIELD WORK REQUIREMENTS***This portion of the checklist must be completed on site. AUS staff must have a minimum of one year of field experience in identifying utilities to complete the checklist. Field staff will review the completed checklist with PM or designee prior to beginning intrusive work.**Heavy equipment/mechanized intrusive work w/in the Arcadis Tolerance Zone (utility or structure present within 30-in. of point of work) REQUIRES pre-approval by Corporate H&S prior to working at all such locations. STOP WORK if the Arcadis Tolerance Zone work has not been approved.*

List work type & locations for utility location and clearance as applicable to this checklist: _____

3 Reliable Lines of Evidence are REQUIRED for EACH INTRUSIVE LOCATION prior to starting any subsurface intrusive work. Check corresponding boxes below to document utility clearance efforts.☐ OneCall/DigSafe 811 Public Utility Locate (required by State law for subsurface work)
*811 is only reliable as a Line of Evidence when working in/adjacent to a public ROW or easement.*Marking type: ☐ Paint ☐ Pin Flags/Stakes ☐ Other: _____ ☐ None☐ Client provided maps/drawings (Y/N)? ☐ Maps/drawings not provided (Y/N)?☐ Client Clearance (Y/N)? Name(s)/Affiliation(s): _____☐ Interviews (Y/N)? Name(s)/Affiliation(s): _____☐ Specific subsurface feature types and depths provided by person interviewed (Y/N)?

Details provided: _____

☐ Site Inspected (Y/N)? (document on Pg. 2.) Photo Document Marked Utilities & Structures☐ Public records/Client Dwgs/As-Builts (Y/N)? Type: _____List private locator tools used: ☐ Radio Freq. Detection ☐ Electromagnetic ☐ GPR☐ Metal Detector ☐ Acoustic Pipe Locator ☐ Downhole sonde Other: _____☐ Soft Dig Methods used (Y/N)? ☐ Hand auger ☐ Probing ☐ Hand tools (shovel/rake)☐ Air knife ☐ Hydro Knife ☐ Potholing/Vacuum extraction☐ Other soft dig tools used (Y/N)? If Yes, list here: _____

ALL BOXES BELOW MUST BE COMPLETED BEFORE PROCEEDING

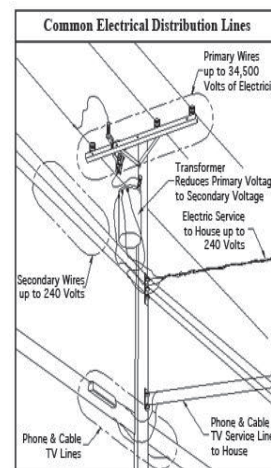
Site inspection also requires investigating vicinity outside of the work area for structures and utilities.

Noting "YES" requires addtl. investigation. Utilities must be field marked prior to intrusive work.

Is the utility present (Y/N)?	Utility Color Code	Is the utility present (Y/N)?	Utility Color Code
☐ Utilities entering/exiting structures?	No Color	☐ Evidence of stormwater network?	Green
☐ Intrusive work area marked out?	White	☐ Curb drains/catch basins/manholes?	Green
☐ Structural features above or below?	White	☐ Stormwater culverts, outfalls?	Green
☐ Public natural gas line or meter?	Yellow	ABOVEGROUND Features Present?	
☐ Private natural gas laterals/feeders?	Yellow	☐ Transportation tunnels/structures/markers present?	
☐ Public electrical service?	Red	☐ Overhead electrical lines?	Red
☐ Conduit from meter or on wall?	Red	☐ < 50 kV w/in 10 ft of work area?	Red
☐ Conduit from poles into ground?	Red	☐ >50-200 kV w/in 15 ft of work area?	Red
☐ Poles/devices w/ no visible lines?	Red	☐ >200-350 kV w/in 20 ft of work area?	Red
☐ Overhead electrical lines?	Red	☐ >350-500 kV w/in 25 ft of work area?	Red
☐ Solar arrays or wind turbines?	Red	☐ >500-750 kV w/in 35 ft of work area?	Red
☐ Public water line(s)?	Blue	☐ >750-1000 kV w/in 45 ft of work area?	Red
☐ Private water line(s) or lateral(s)?	Blue	☐ Aboveground fire suppression?	Blue
☐ Water meter onsite?	Blue	☐ Aboveground communications?	Orange
☐ Fire hydrants/post indicator valves?	Blue	☐ Aboveground chases/racks/trays?	Orange
☐ Irrigation system control box/valve?	Blue	☐ Private/Remediation system lines?	Various
☐ Sprinkler heads, drip lines, vaults?	Blue	☐ Unclassed utilities/anomalies?	Pink
☐ Water dispensers, fill stations?	Blue	☐ Warning signs/stakes/markers present?	
☐ Telecomm. overhead or buried?	Orange	☐ Heavy Equipment: Mark travel route for overhead, next to route, and/or under route (e.g. crush risk) utilities.	
☐ Telecomm. ground box or relays?	Orange	Signs of other utilities/ground disturbance	
☐ Telecomm./security CCTV devices?	Orange	☐ Signs of asphalt or concrete disturbance/repair?	
☐ Public sanitary sewer pipes?	Green	☐ Any ground subsidence or change in vegetation?	
☐ Combined sanitary/storm pipes?	Green	☐ Unknown manholes or valve covers in work area?	
☐ Private sanitary laterals/clean outs?	Green		
☐ Restrooms, kitchens, wash bays?	Green		

Tips for Thorough Utility Location (HSS Section 5.6):

1. Don't forget to look up for utilities
2. Be on-site with Private Utility Locators.
3. Ask Private Locators to "confirm" other's markings.
4. Also clear alternate/backup locations
5. Mark all known utilities.
6. No hammering, no pickaxes, no digging bars, no shortcutting.
7. No excessive turning or downward force of hand tools, especially hand augers.
8. Utilities may run in or directly under asphalt/concrete
9. Heavy equipment may damage shallow utilities. Especially during clearing and grubbing.
10. Use spotter for heavy equipment near aboveground utilities?



☐ Utilities & Structures Checklist reviewed by the PM or Designee (Y/N)? *If no, STOP WORK call PM*
 PM or Designee Name: _____

Name and Signature of person completing the checklist: _____

Date of checklist review / update: _____

ALL SUSPECT UTILITY STRIKES REQUIRE CORPORATE H&S NOTIFICATION WITHIN 24 hrs. OF KNOWLEDGE OF STRIKE WITH A CONFIRMED RESPONSE FROM CORPORATE H&S.

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