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Groundwater Monitoring Work Plan for Petroleum Release at the Corporate Air Facility - Bert Mooney Airport

Butte, Montana | Facility ID 47-00018 (TID 28319) | Release 0959 | Work Plan 35090

Prepared for:

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1 Executive Summary

Water and Environmental Technologies (WET) presents this Groundwater Monitoring Work Plan (WP) for the petroleum release at Corporate Air (Facility), as required in the Montana Department of Environmental Quality (DEQ) WP request letter dated September 2, 2025. The site location is depicted in **Figure 1,** and the site features are depicted in **Figure 2**.

WET and DEQ met on September 17, 2025 to discuss the scope of work which includes:

- Monitoring groundwater at Facility monitoring wells annually for 2 years, which includes:
  - Gauging fluid levels at MW-3R, MW-4, MW-7, MW-8 and MW-10.
  - Collecting groundwater samples at monitoring wells MW-3R and MW-8 by low-flow sampling methodology according to DEQ's Groundwater Sampling Guidance.
  - Analyzing groundwater samples for petroleum constituents as required by the DEQ Montana Risk-Based Corrective Action Guidance for Petroleum Releases, volatile petroleum hydrocarbons (VPH), Extractable Petroleum Hydrocarbons (EPH) screen, and the intrinsic biodegradation indicators (IBIs), Nitrite/Nitrate, Dissolved Iron and Manganese, Sulfate and Methane.
  - Disposing of purge water according to the DEQ Purge Water Disposal flow chart.
- Validating all laboratory analytical data using DEQ's Data Validation Summary Form (DVSF).
- Discussing ongoing WP tasks and results with DEQ's project manager (PM) and submitting written agreed-upon WP modifications as required to complete the WP objectives.
- Updating a Release Closure Plan (RCP) and discussing results with DEQ's PM.
- Preparing and submitting a Groundwater Report detailing the method and results of all groundwater monitoring events completed under this WP, which will include:
  - Discussion of the monitoring method results, deviations from the approved WP, assessment of attenuation rates, recommendations, and conclusions.
  - Cumulative groundwater data tables.
  - Updated site features and potentiometric surface maps.
  - Appended groundwater monitoring field forms, laboratory analytical data, completed DVSFs, and the RCP.

2 Facility History and Release Background

2.1 Facility History

The Facility is currently owned and operated as Bert Mooney Airport by Corporate Air. Monitoring at the Facility dates back to the discovery of the release in 1991. Monitoring has shown that the dissolved phase plume appears to be stable or shrinking with natural attenuation limiting migration. The contamination exists at the groundwater table which limits human and environmental exposures levels. The Facility has operated as a municipal airport since 1927, and a new terminal adjacent to the facility was opened in 2018. The Facility will continue to operate as an airport for the foreseeable future.

2.2 Release Background

In 1991 a release was discovered at the Facility; seven underground storage tanks (USTs) were removed including three containing aviation gas, one containing auto gas and three containing jet fuel. Impacts from the aviation gas and auto gas releases appeared to be limited to the underlaying soil and did not result in light non-aqueous phase liquid (LNAPL) in groundwater; soil contamination at the avgas and auto gas release sites were treated with soil venting systems and closed in 1993. Release #0959 (jet fuel) is the subject of this Work Plan. Soil contamination was treated with soil venting systems at all three release sites, through 1993. Approximately 600 cubic yards of contaminated soil were removed from the area impacted by jet fuel in 1991 and were landfarmed until 1995, at which point analytical results supported closure of the landfarm.

The 1991 investigation included installation of four monitoring wells (MW3, MW-4, MW-5 and MW-6) which revealed a plume in the vicinity of the source area. In April 1992, a product recovery system was installed at the jet fuel area in well MW-3; however, the system was terminated in August 1992 due to poor recovery rates. Groundwater sampling was conducted until 1995, at which point the site was placed on inactive status based on minimal risk to downgradient receptors and favorable sampling results from the landfarm.

In 1998 the site was reactivated. Three new monitoring wells were installed (MW-7, MW-8, and MW-9) in November 1998, and sample results revealed that free product was still present in MW-3 and MW-5. Two additional monitoring wells (MW-10 and MW-11) were installed in December 1999. A belt skimmer was installed in MW-3 in March 2000, which was operated intermittently until 2002, at which point a 4-inch diameter recovery well (RW-1) was installed and became operational in June 2002. The skimmer operated intermittently until November 2003, at which point the belt skimmer was shut-down and the site again became inactive.

In 2012, after eight years of inactivity a number of wells had been buried or destroyed. Absorbent socks were installed in wells with free product (MW-3, MW-5, and RW-1) with limited recovery. Product recovery efforts by hand-bailing were also conducted in 2015 with limited success. Groundwater sample results from 2015 demonstrated hydrocarbon concentrations above RBSLs persisted in the dissolved phase groundwater plume around wells MW-3 and RW-1, which also contained free product. However, analytical results were below RBSLs in remaining Facility monitoring wells.

A Petroleum Mixing Zone Closure was explored in 2018, but site operator opted out of the closure. Facility operations around the monitoring wells lead to destruction of wells, and MW-3 was replaced with MW-3R in November 2023 and groundwater monitoring found only one HHS exceedance in MW-3R. Monitoring has shown that the dissolved phase plume appears to be stable or shrinking with natural attenuation limiting migration. Contamination exists at the groundwater table which does not present a pathway to human or environmental exposure; groundwater is 30 feet below ground surface and a groundwater moratorium exists in Butte which prevents the use of ground water. The Facility has operated as a municipal airport since 1927, and the Facility will continue to operate as an airport for the foreseeable future.

3 Objectives of Groundwater Monitoring

The objectives of groundwater monitoring are to assess the status of the release and recommend a pathway to resolve the release. These objectives will be met by collecting groundwater samples for laboratory analysis, comparing results to appropriate screening levels, estimating rate of natural attenuation, and evaluating remedial actions.

4 Minimum Work Plan Tasks

4.1 Work Plan Preparation

WET personnel prepared this WP in response to the DEQ WPR letter dated September 2, 2025.

4.2 Project Management

WET personnel will provide Didrik Strand (Owner) and DEQ's project manager with any ongoing WP tasks and relevant results on an as-needed basis. Other duties associated with this task include scheduling field work, project reporting administration, monitoring the project budget and deliverables, and any submitted written agreed-upon WP modifications to complete the objectives.

4.3 Mobilization

Two total mobilizations for a Staff Engineer are required for this WP. Each round-trip mobilization is approximately 10 miles, will take approximately 30 minutes, and includes 1 hour of loading/unloading time.

4.4 Fluid Level Measurements

Three monitoring wells are to have fluid level measurements only: MW4, MW-7 and MW-10. Fluid levels will be measured with an oil-water interface meter in accordance with WET standard operating procedure (SOP) SOP-5: Measurement of Fluid Levels and recorded on the WET Groundwater Sampling Form in accordance with WET SOP-1: Field Logbook and Field Sampling Forms. SOPs are included as **Appendix A**. Depth to product (if present) and depth to water will be recorded.

Samples will

be collected using a submersible pump, disposable polyethylene tubing, and low-flow purge and sample procedures

4.5 Groundwater Monitoring

WET will conduct two groundwater monitoring events of wells MW-3R and MW-8. These wells will be monitored on an annual schedule over two years (2026-2028). Fluid levels will be measured with an oil-water interface meter prior to purging the well. Any monitoring well containing free product will not be sampled. Monitoring wells will be purged and sampled using a submersible pump, disposable polyethylene tubing, and low-flow sample procedures specified in WET SOP-8B: Groundwater Sampling – Low Flow Method (**Appendix A**), and DEQ's

Groundwater Sampling guidance (2018). Groundwater field parameters for each well will be measured by YSI® Professional Plus Quatro Cable multi-meter, HACH turbidity meter, and an oil/water interface probe as outlined in WET SOP-6: Measurement of Field Parameters (**Appendix A**). Field parameter measurements consist of recording initial depth to water, temperature, specific conductivity (SC), dissolved oxygen (DO), pH, oxidation reduction potential (ORP), turbidity, final depth to water, and volume during purging. Temperature and drawdown will be monitored but are not subject to stabilization criteria. Field parameter readings should be recorded every 3-5 minutes until three consecutive readings are within stabilization range. Once parameters stabilize according to the criteria in **Table 1**, a groundwater sample will be collected in laboratory-supplied bottles.

Table 1. Stabilization Parameters

Water Quality Parameter	Unit	Stabilization Range	Exception
pH	standard units (s.u.)	±0.1 s.u.	
Specific Conductance (SC)	microsiemens per centimeter (µS/cm)	±3%	
Dissolved Oxygen (DO)	milligrams per liter (mg/L)	±10%	<0.50 mg/L
Turbidity	nephelometric turbidity units (NTU)	±10%	<5 NTU
Oxidation/Reduction Potential (ORP)	millivolts (mV)	±10 mV	

Reusable equipment (oil-water interface probe) will be decontaminated in accordance with WET SOP-2: Equipment Decontamination (**Appendix A**).

4.6 Laboratory Analysis

Groundwater samples will be submitted to Energy Laboratories in Helena, Montana for the analyses and methods listed in **Table 2** and following procedures outlined in WET SOP-3: Sample Nomenclature, Documentation, and Chain of Custody (**Appendix A**) and WET SOP-4: Sample Package and Shipping (**Appendix A**). Sample containers, preservation, and analytical methods are provided in Table 2.

Table 2. Laboratory Analyses

Container(s)	Preservation	Analysis	Method
Three 40-mL VOA vials	HCl	VPH	MA-VPH
Three 40-mL VOA vials	HCl	1,2-DCA	SW8260B
		EDB & EDC	SW8011
Two 40-mL VOA vials	H_2SO_4	Methane	SW8015M

One 250-mL poly	None	Sulfate	E300.0
One 250-mL poly	EDTA	Sulfite	A4500-SO3B
One 250-mL poly	Filtered/HNO_3	Dissolved Fe/Mn	E200.7/8
One 250-mL poly	H_2SO_4	Nitrate, Nitrite, Nitrate+Nitrite	E353.2

IBIs are included in this sample suite to provide further confirmation of plume stability/reduction trends.

4.7 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) samples including duplicates and field blanks (water) will be collected at a minimum frequency of 1 per 20 natural samples (5%) as outlined in WET SOP-16: Quality Control Sampling. The duplicate will be collected at a location that has historically exhibited detections of contaminants of concern by splitting a natural sample in the field. The field blank will be collected during representative sampling conditions at the Facility by pouring laboratory provided organic-free deionized water into laboratory provided sample containers. QA/QC samples will be analyzed for the same constituents as the natural samples.

Energy Laboratories will conduct all analyses of collected soil and groundwater samples and provide a laboratory QC report for each analysis. WET personnel will validate all laboratory analytical data using DEQ's Data Validation Summary Form (DVSF). This summary form will be included in the final report.

4.8 Investigation Derived Waste (IDW) Management, Characterization, and Disposal

Following the DEQ disposal of untreated purge water from monitoring guidance dated July 15, 2015, the purge water originates from the shallowest aquifer, is not likely to result in an exceedance of soil screening levels, is not discharged to a surface water, and is not from a mine audit or long-term pumping test. Therefore, the purge water from the groundwater sampling event will be discharged to pervious Facility ground. All non-reusable sampling equipment and spent personal protective equipment will be disposed of in garbage bags.

4.9 Reporting

Upon completion of the WP tasks, WET will prepare a Groundwater Monitoring Report in the DEQ guidance format detailing the results of groundwater monitoring, including the following:

- Discussion of the monitoring method results, deviations from the approved work plan, assessment of attenuation rates (on-site and off-site), recommendations, and conclusions.
- Cumulative groundwater data tables.
- Updated site features and potentiometric surface maps.
- Appended groundwater monitoring field forms, laboratory analytical data, completed data validation summaries, and an updated Release Closure Plan.

5 Cost and Schedule

5.1 Cost

Work effort level has been estimated using best professional judgement and typical scenarios related to work of this type. A detailed cost estimate is included as **Appendix B**.

5.2 Schedule

WET will begin implementation of the WP immediately upon DEQ approval. Groundwater monitoring will be conducted during the seasonal low conditions in the late fall of 2025 or winter of 2026, followed by reporting completed in spring 2027. Notification for each event will also be sent to the Facility Owner and the DEQ Project Manager prior to activities.

Figure 1

Site Location – Aerial

Property Boundary

N
W
E
S

NO.	DESCRIPTION	DATE	DRAFT	REVIEW
1				
2				
3				
4				
5				

NOTES

SITE LOCATION

CORPORATE AIR - BERT MOONEY AIRPORT, BUTTE, MT

FIGURE 1

JOB#: CORPAIRM01

DATE:2/26/2024

Path: M:\CORPAIRM01\GIS\CorpAirM01\CorpAirM01.aprx, Author: kkresan

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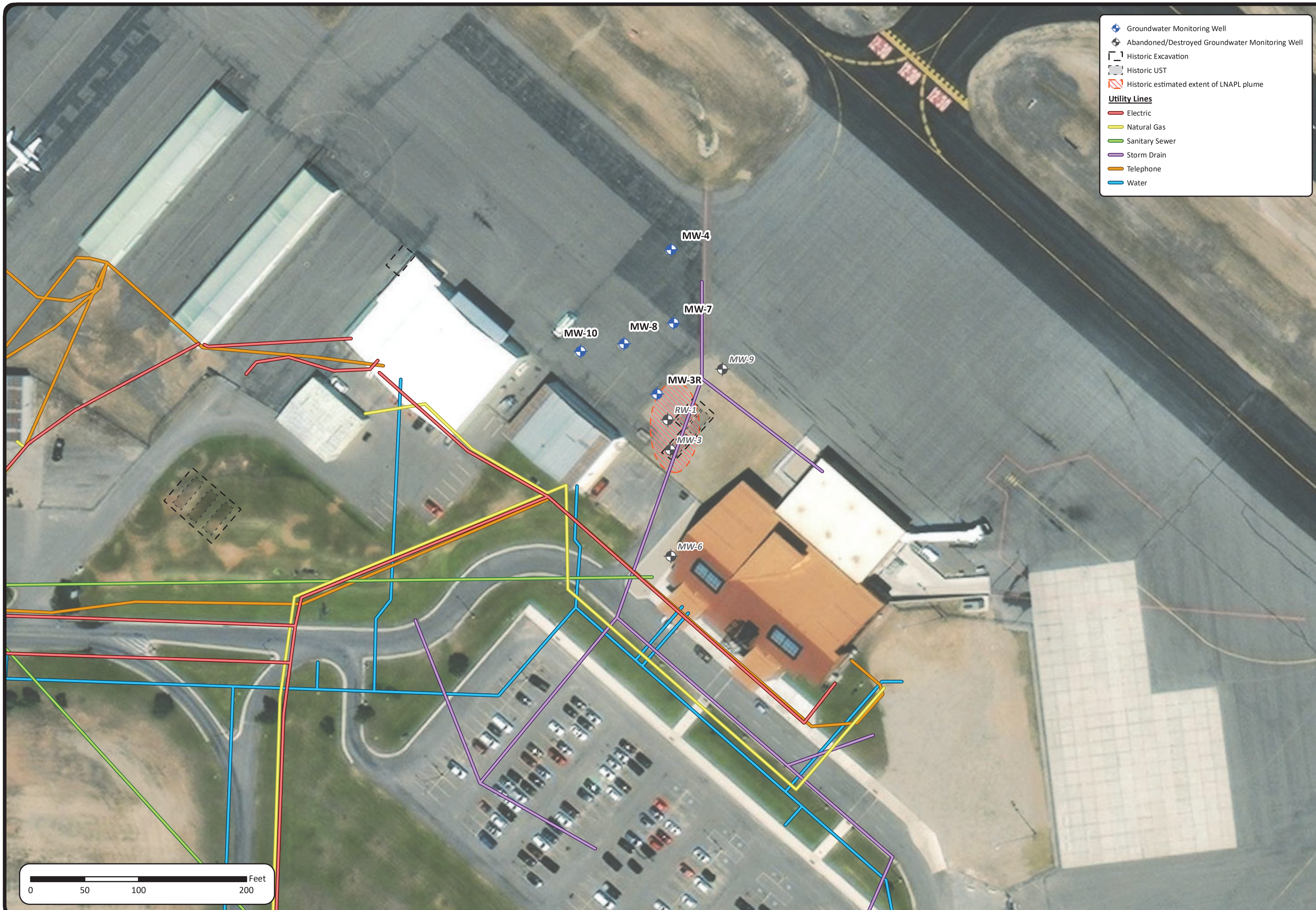
Figure 2

Site Map



NO.	DESCRIPTION	DATE	DRAFT	REVIEW
1	DESTROYED WELLS, MW-3R	1/29/24	KK	IS
2	ADD UTILITY LINES, HISTORIC EXCAVATIONS	2/26/24	KK	IS
3				
4				
5				

NOTES:
Utility and historic excavation locations are approximate.

MONITORING WELLS

CORPORATE AIR - BERT MOONEY AIRPORT, BUTTE, MT

FIGURE 2

JOB#: CORPAIRM01

DATE: 2/26/2024

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Appendix A

WET Standard Operating Procedures

SOP-4

SAMPLE PACKAGE AND SHIPPING

PACKAGING

All environmental samples collected should be packaged and shipped using the following procedures:

1. Label all sample containers with indelible ink (on the side, not on the cap or lid). Place labeled sample bottles in a high-quality cooler containing an adequate amount of ice (sealed inside two Ziploc bags) to maintain a temperature of 4°C or less inside the cooler. Freeze packs, or “Blue Ice” is NOT to be used. Ensure the cooler drain plug is taped shut.
2. Place the samples in an upright position and wrap the samples with absorbent, cushioning material for stability during transport. Samples should not be loose; the cooler should be able to withstand tough handling during shipment without sample breakage.
3. Fill out the appropriate shipping forms and place in a Ziploc bag then tape it to the inside lid of the shipping container. Shipping forms usually consist of a chain-of-custody form, which documents the samples included in the shipment and specifies the laboratory analyses for each sample.
4. Close and seal the cooler using strapping tape.
5. Place completed sample custody seals on the cooler such that the seals will be broken when the cooler is opened. The custody seal must contain, at minimum, the signature of the person relinquishing custody of the samples and the date the cooler is sealed. Secure the custody seals on the cooler with clear strapping tape.
6. Secure the shipping label with address, phone number, and return address clearly visible.

Note—A chain-of-custody form should be totally unique to a single cooler or shipping container. A cooler should only contain samples that are listed on the chain-of-custody form inside that cooler, and the chain-of-custody form should not list any samples that are not in that cooler. For large sample efforts requiring samples be shipped in two or more coolers, DO NOT fill out a single chain-of-custody form for the entire set of samples and place multiple copies of the same form in multiple coolers. Place only one chain-of-custody in one of the coolers.

SHIPPING HAZARDOUS MATERIALS/WASTE

Hazardous materials need to be shipped using procedures specified under Federal Law. Samples need to be shipped in Ziploc bags or paint cans filled with packing material, depending on the level of hazard. Special package labeling may be needed. Consult the project manager for specific shipping procedures.

SOP-5

FIELD MEASUREMENT OF GROUNDWATER LEVELS/LIGHT NON-AQUEOUS PHASE LIQUID LEVELS

INTRODUCTION

In general, groundwater levels [and Light Non-Aqueous Phase (LNAPL) levels, if applicable] in wells will be measured prior to commencing development, purging, sampling, pumping tests, or other activities that disturb the fluid pressure relationships in the well. Measurements may be taken during such events for purposes other than determining static conditions and may also be taken to determine static conditions after such activities if an appropriate period of time has elapsed to allow steady-state conditions to return.

EQUIPMENT

- Electronic water level monitoring probe (for water levels only)
- Electronic multi-phase interface monitoring probe (for measuring water levels and LNAPL levels)
- Keys for well locks
- Tools to open well covers (e.g., socket wrench, spanner wrench, etc.)
- Watch or stopwatch
- Pens and field logbook or other appropriate field forms (e.g., groundwater purge and sample forms)
- Monitoring well construction data (for total depth and screen intervals of well)
- Personnel and equipment decontamination supplies (refer to SOP-2)

PROCEDURES

1. If more than one well will be measured, conduct measurements in the order of lowest to highest chemical concentrations previously detected in samples from the monitoring wells.
2. Allow the well to equilibrate by removing the protective cap and leaving the well open for a period before beginning taking measurements. Generally, removing all site well caps prior to collecting the first liquid level measurement provides sufficient time to reach equilibrium.
3. Examine the monitoring well for any structural damage, poorly fitting caps, and leaks into the inner casing. Record all well maintenance issues on the appropriate field sampling form or field log book.
4. If LNAPL is not present, use a pre-cleaned water level probe or equivalent to measure depth to water from the indicated survey mark on the well casing. If a mark is not present, measure from the top of the northern side of the well casing.
5. If LNAPL may be present, use a pre-cleaned, electric, multi-phase interface probe to measure the depth of the LNAPL and depth to water. Record both measurements on the sampling form or field logbook. Unless otherwise instructed, always measure depths to LNAPL layer and groundwater from the indicated survey mark. If a mark is not present, measure from the top of the northern side of the well casing.

6. Repeat measurements at least once by lifting the probe tape at least one foot out of the well allowing the measurer to confirm the accurate foot, tenth-of-a-foot, and hundredth-of-a-foot mark on the tape.
7. Follow personnel and equipment decontamination procedures outlined in SOP-2.

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SOP-1

FIELD LOGBOOK AND FORMS

All pertinent field investigation and sampling information will be recorded in a field logbook, field form, or a Daily Activity Log (DAL) during each day of the field effort and at each sample site. The field crew leader will be responsible for ensuring that sufficient detail is recorded in the field logbook or DAL. No general rules can specify the extent of information that must be entered in the field logbook or form. However, field logbooks, field forms, or DALs must contain sufficient information such that someone could reconstruct all field activities without relying on the memory of the field crew. All entries shall be made in indelible ink, weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author.

At a minimum, entries on the field sheet or in field notebook must include:

- Project information and location
- Project and task number
- Date and applicable times
- Name(s) of field personnel
- Environmental, site, or weather conditions
- Safety briefing attendance
- Details of actual work effort, particularly any deviations from the field work plan or standard operating procedures
- Comments or observations regarding any unusual circumstances
- Any field measurements made (e.g., PID readings, pH, temperature)

For sampling efforts, specific details for each sample should be recorded using a standardized field form designed specifically for the sampling activity being conducted (e.g., low-flow groundwater monitoring, soil gas sampling). Sampling field forms contain fill-in-the-blank type information to ensure that all pertinent information will be recorded. In addition to the items listed above, the following information is recorded on field forms during sampling efforts:

- Sample identification
- Date and time samples were collected
- Sampling methods, particularly any deviations from field work plan or standard operating procedures
- Field data and measurements
- Containers used to collect samples
- Sample preparation (filtration, preservation)
- Analyses and methods requested
- Note any QA/QC samples collected (duplicates, blanks)

Strict custody procedures will be maintained with the field forms. Field forms must always remain with the field team while being used in the field. Upon completion of the field effort, the original field forms will be scanned and copied to the project folder. Original field forms will be filed in an appropriately secure manner.

SOP-2

EQUIPMENT DECONTAMINATION

INTRODUCTION

The purpose of this section is to describe general decontamination procedures for field equipment. Decontamination will be performed on all non-dedicated and non-disposable sampling equipment that may contact potentially contaminated media. Field personnel must wear disposable latex or nitrile gloves while decontaminating equipment at the project site and change gloves between every sample. Personnel must take every precaution to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

EQUIPMENT

- Liquinox (or equivalent laboratory-grade detergent)
- Sufficient volume of tap water
- Sufficient volume of deionized water
- Sufficient volume of methanol or pesticide-grade acetone for organics
- Sufficient volume of any other decontamination solutions specifically required by the project work plan.
- Necessary containers for each decontamination station (totes or tubs, graduated cylinders or similar tubes, spray bottles, etc.)
- Tarp or other platform to form barrier between decontamination stations and ground (if necessary)
- Applicable brushes (if necessary)
- Aluminum foil (for soil sampling devices)
- Latex or nitrile gloves
- Paper towels
- Garbage bags

PROCEDURES

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone downwind from the sampling area to reduce the chances of windborne contamination.
2. Visually inspect sampling equipment for contamination; use brush to remove visible material.
3. The general decontamination sequence for field equipment includes washing with Liquinox (or equivalent laboratory-grade detergent), deionized water rinse, additional solution rinse specified by project work plan, and triple deionized water rinse.
4. Store equipment in clean containment or according to project work plan if not used immediately.
5. All disposable items (e.g., paper towels, latex gloves), as well as rinse and wash water generated during decontamination, should be disposed of in accordance with SOP-17 (Management of Investigation-Derived Waste).

SOP-3

SAMPLE NOMENCLATURE, DOCUMENTATION, AND CHAIN OF CUSTODY

INTRODUCTION

Sample documentation is an important step to ensure the laboratory, project manager, and field personnel are informed on the status of field samples. Depending on the specifics required for each project, several forms will need to be filled out. Most sample documentation forms are pre-printed carbonless triplicates, enabling copies to be filed or mailed from labs or offices. The forms will be completed by field personnel, who have custody of the samples. The office copy will be kept in the project file and subsequent copies sent to the laboratory, or other designated parties.

Responsibility for completing the forms will be with each field crew leader. It is important that the field crew leader is familiar with the completion process for filling out forms, and the expected information is included.

Potential documents to be completed clearly in indelible ink for each sample generated include:

- Field form(s) or field logbook
- Chain-of-custody forms
- Custody seal(s)

A chain-of-custody form will be generated for all samples collected in the field for laboratory analysis. The sampler may use a project-specific chain-of-custody form or a chain-of-custody form provided by the laboratory. It is of the upmost importance that the chain-of-custody form be filled out correctly. This form is the first thing that third parties and regulators verify when assessing the quality of the job.

FIELD EQUIPMENT

- Indelible ink pen(s)
- Field form(s) or field logbook
- Chain-of-custody form(s)
- Custody seal(s)

PROCEDURES

Sample custody records must be maintained from the time of sample collection until the time of sample delivery to the analytical laboratory and should accompany the sample through analysis and final disposition. The information to be included on the chain-of¬-custody form will include, but is not limited to:

- Accounting and reporting information
- Project number and/or site name (If there are any questions about this, contact the project manager)
- Sampler's name, information, and signature
- Unique sample identification number or name
- Date and time of sample collection

- Number of containers
- Sample media (e.g., soil, water, vapor, etc.)
- Sample preservative (if applicable)
- Requested analyses
- Comments or special instructions to the laboratory

Each sample will be assigned a unique sample identification number or name. The information on the chain-of-custody form, including the sample identification number or name, must correspond to the information recorded by the sampler on the field forms (refer to SOP-01) and the label on the sample container.

A sample is considered under a person's control when it is in their possession such that tampering is prevented. This includes placing the samples in an area of controlled access such as a building or locking the samples in a vehicle. When custody of a sample is relinquished by the sampler, the sampler will sign and date the chain-of-custody form and note the time that custody was relinquished. The person receiving custody of the sample will also sign and date the form and note the time that the sample was accepted into custody. Samples will be shipped to the analytical laboratory following the procedures in SOP-04. If an overnight shipping service is used to transport the samples to the laboratory, custody of the samples will be relinquished to the shipping service. The shipping service will not sign the chain-of-custody form; however, the samples can be tracked while in the custody of the shipping service. More than one sample may be included on a chain-of-custody form, if all the samples are for the same project. Copies of the chain-of-custody form will be maintained in the project file, in accordance with standardized or project-specific data management procedures.

SOP-6

MEASUREMENT OF FIELD PARAMETERS: Temperature, Dissolved Oxygen (DO), Specific Conductance, pH, Oxidation Reduction Potential, and Turbidity

INTRODUCTION

This guideline describes the procedures typically used to measure the temperature, DO, Specific Conductance (SC), pH, Oxidation Reduction Potential (ORP), also referred to as redox potential, and turbidity of ground- or surface water.

EQUIPMENT

- Multi-parameter water quality meter
- Flow-through cell or plastic cup
- Transport/calibration cup
- Probe sensor guard
- Operations manual
- Spare batteries
- Standard conductivity calibration solutions [447, 1413, 2074, 8974 microSiemens per centi meter (μS/cm)]
- pH buffers (4.00, 7.00, 10.00)
- ORP calibration solution
- Pens, field logbook, and/or appropriate field forms (e.g., groundwater purge and sample form)
- Personnel and equipment decontamination supplies

PROCEDURES

Calibrate multi-parameter water quality meter at the office prior to commencement of field activities to check instrument is in proper working order. At a minimum, calibrate before use each day (or more frequently as necessary) as indicated below. The initial daily calibration may be performed at the office (if located in proximity to the site), motel, or in the field.

1. Press the On/Off key. Check the battery charge indicator located at the bottom of the liquid crystal display (LCD) screen. Replace batteries if the battery charge indicator is low.
2. Calibrate the meters according to the manufacturer's instructions. *Note: The meter must be calibrated for each field parameter in accordance with the instructions in the operations manual at the beginning of each sampling day. Additional calibrations may be performed during the day if deemed necessary.*
3. If instruments were used in humid or wet environmental conditions, store them in the case open overnight for evaporation so that moisture and mold do not infiltrate sensitive parts.
4. Multi-parameter water quality meter use:
    a. Connect the probe sensor to the flow-through cell. If the flow cell is not used, make sure the probe sensor guard is installed.
    b. Begin passing water into the flow-through cell. If the flow-through cell is not used, place the probe module into a sample of the water or directly into the body of water being evaluated. Be sure to completely immerse all sensors into the water.
    c. Provide a constant flow of fresh water across the probe module to actuate readings.

d. Observe the meter's LCD display and record the values on the groundwater purge and sample form or field logbook.
e. Once purging is complete, remove the probe from the sample water and rinse the probes and flow-through cell with distilled water.

5. Place the probe sensor in the transport/calibration cup with 0.5-1 inch of 4.00 pH buffer for short-term/overnight storage for optimal calibration conditions the next day. Place the probe sensor in the transport/calibration cup with 0.5-1 inch of potable water for long-term storage. The transport/calibration cup should be sealed to prevent evaporation. *Note: Storing the probes in dry conditions will damage the sensors.*
6. Turbidity meter use:
   a. Fill a turbidity meter sample vial with water to the fill indication line. Cap the vial securely.
   b. Dry the outside of the sample vial. Line the arrow or alignment indication line on the vial with the arrow or alignment indication line on the turbidity meter. Push the vial all the way into the sample vial port. Ensure that the cap/cover is closed all the way.
   c. Ensure that the turbidity meter is on a level surface and will not be disturbed during the analysis process. Press the Read key. Do not disturb the turbidity meter or open the cap/cover during reading.
   d. Record the value provided. If the reading seems inaccurate, ensure that the sample vial is dry and does not have any streaking or staining and re-read the sample.

SOP-8B

GROUNDWATER SAMPLING—LOW FLOW METHOD

INTRODUCTION

These instructions are in general accordance with the United States Environmental Protection Agency (EPA) Region One Low-Stress (Low-Flow) Standard Operating Procedure (September 2017), and are applicable for using an adjustable rate submersible, peristaltic, or bladder pump with the pump's intake placed at the midpoint of a 10-foot or less well screen or an open interval. Field instruments are already calibrated. The equipment is set up according to the diagram at the end of these instructions.

EQUIPMENT

- Documentation Items:
    - Field sampling forms or field tablet with appropriate Survey123 sampling forms
    - Pens and indelible markers
- Sampling Items:
    - Sample bottle(s)
    - Preservative(s)
    - Coolers for sample bottle(s)
    - Ice for cooler(s)
    - Filter(s) (if required)
    - Laboratory-grade deionized (DI) water (for field blanks)
- Equipment/Instrumentation:
    - Water level or interface meter
    - Pump
    - Pump controller
    - Tubing (poly and silicone)
    - Appropriately sized t-splitter
    - Bailer(s) and rope
    - Multi-parameter meter (temperature, dissolved oxygen [DO], specific conductance [SC], pH, oxidation/reduction potential [ORP]) with low-flow cell
    - Turbidity meter
    - Graduated cup
- Power (if required)
    - Generator
    - Air compressor
    - Fuel
- Investigation-Derived Waste (IDW)
    - Sampling tote with elevated rack (if necessary)
    - Five-gallon bucket(s)
    - Purge water tank (if necessary)
    - 2L graduated cylinders (for decontamination)
    - Decontamination liquids (tap water, laboratory-grade detergent, distilled or DI water, acids, etc.)

All sampling equipment shall be inspected for damage and repaired, if necessary, prior to arriving on-site.

GENERAL PROCEDURES—PURGING

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/ open interval).
2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, and set up the equipment.
3. Check well casing for a reference mark. If missing, make a reference mark on the northern side of the casing and notate in the field sampling form. Measure the water level (initial) to 0.01 ft. and record this information.
4. Measure product level, if present, and water level and record this information on the field sampling form. For wells of 2-inch diameter or less, the water level or interface meter will have to be removed from the well to install the pump, but then lowered back down the well after the pump is installed to monitor water level during the purge.
    a. If free product is present, the well is not to be sampled.
    b. If the water column is less than the length of the pump being used, or 12" if using a peristaltic pump, bailing the sample is the best option. See step 6c for bailing instructions.
5. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen, which is often the midpoint of the screen interval for fully submerged well screens, or at the midpoint of the portion of screen penetrating the saturated zone for well screens straddling the water table.
    a. a. Attach the pump discharge line to the t-splitter.
    b. b. Attach tubing between the other side of the t-splitter to the lower stem of the multi-parameter meter low-flow cell.
    c. c. Attach tubing to the lower part of the t-splitter and either a valve end or a clamp on the end of the tubing. This is for turbidity readings, as they must be collected prior to entering the low-flow cell.
    d. d. Attach tubing from the upper stem of the multi-parameter meter low-flow cell and run it to a purge tank or bucket.
6. Start the pump and monitor the water level to assess if drawdown is occurring.
    a. a. Slow the rate if drawdown occurs until water level holds stable or is drawing down slowly enough that it will not exceed the 0.33 ft max or below the top of the well screen.
    b. b. If the rate cannot be lowered enough to avoid excess drawdown (>0.33 ft), then record this deviation in the sampling form. If the water level stabilizes after exceeding 0.33 ft, calculate the volume of water between the initial water level and the stabilized water level and purge at least that amount of water before collecting a sample.
    c. c. If the well runs dry or the water level gets to a point where the pump can no longer produce water, then a bailer can be used. Collect samples for containers in order of priority, and if enough water is left in the well, collect a sample for the multi-parameter storage cup for a single set of parameters.
    d. d. Once the water level is stable, record the pump settings and purge rate using a graduated cup and a timing device. *Note: Flow rate should not exceed 500 mL/min.*
7. After starting the pump, turn on the multi-parameter and turbidity meters and take readings every three to five minutes. Three consecutive readings must be within stabilization criteria before collecting a sample. Stabilization criteria may be set by the specific project, but otherwise, use the stabilization criteria defined in table 1 below.

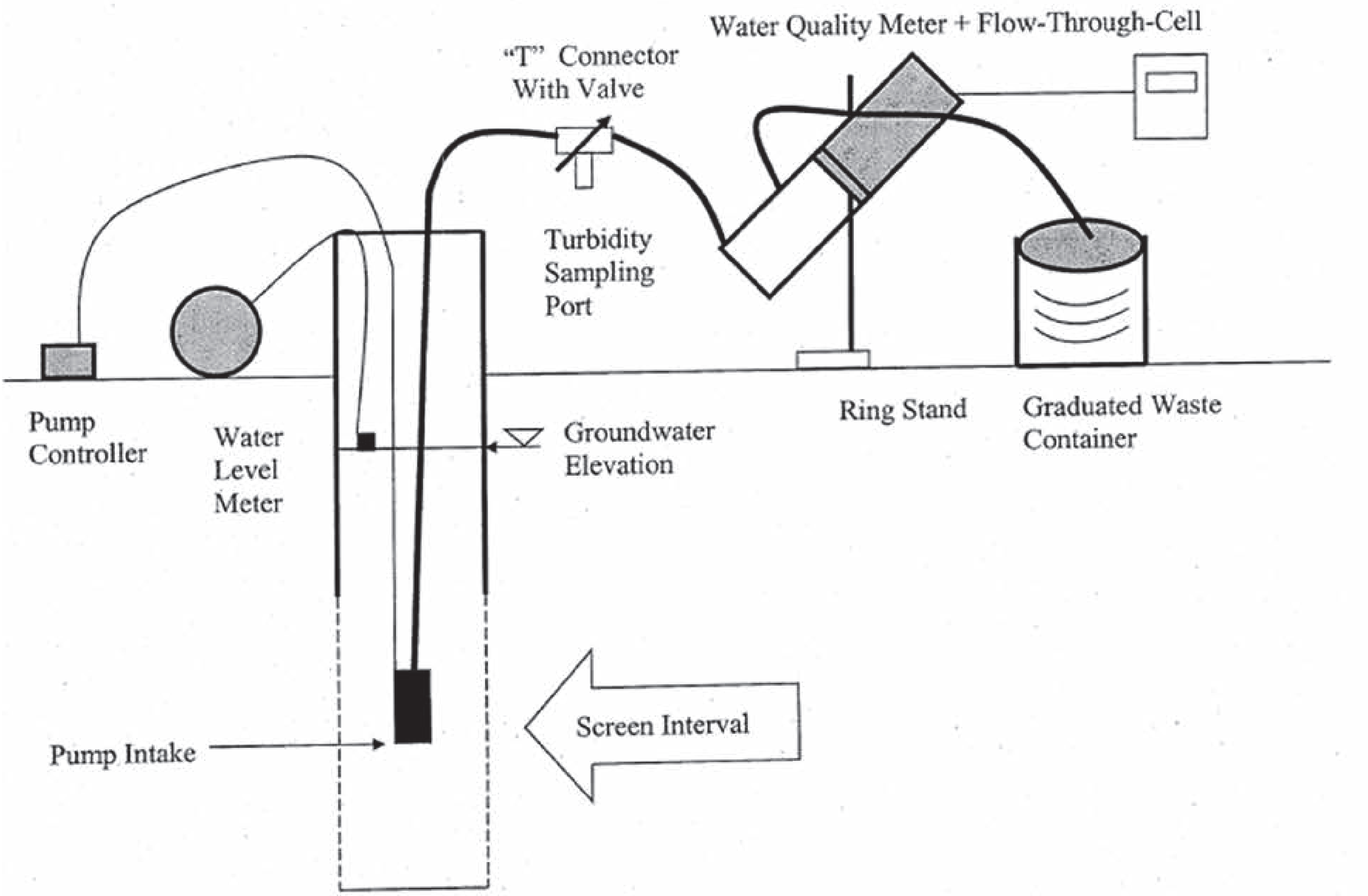
Table 1. Stabilization Criteria

Parameter	Unit	Stabilization Criteria	Exception
Dissolved Oxygen (DO)	milligrams per liter (mg/L	10%	<0.50 mg/L
Oxidation/Reduction Potential (ORP)	millivolts (mV)	±10 mV	
pH	standard units (s.u.)	±0.1 s.u.	
Specific Conductance (SC)	microsiemens per centimeter (µS/cm)	3%	
Turbidity	nephelometric turbidity units (NTU)	10%	<5 NTU

If these parameters do not stabilize by 30 minutes since start of purge, collect the sample and note a deviation of non-stabilized parameters and list which ones in field documentation.

8. Once criteria is met to collect a sample, turn off the multi-parameter and turbidity meters and disconnect the pump discharge tubing from the t-splitter and begin collecting water in the sample containers in order of priority. Collect, preserve, close, and store samples as soon as possible and according to the analytical method(s). *Note: Make sure sample collection takes place over a containerized area (sampling tote or bucket) so that spills are captured.*
    a. If collecting samples for organic compounds, including petroleum hydrocarbons, ensure that all engines (vehicles, generators, etc.) operate 20 feet downwind of the sampling area. Engines will be shut down prior to opening sample collection containers. During sample collection, pumps and meters should be powered using the vehicle battery or a portable battery. Use of disposable gloves will be used whenever fueling generators, to eliminate the possibility of cross-contamination of samples.
    b. Volatiles and dissolved gas analysis samples should be collected first, followed by semi-volatile organic compounds, then inorganic parameters, as required by the sampling and analysis plan.
    c. Field duplicate samples should be collected in conjunction with the natural/original/parent sample.
    d. Field equipment rinse samples should be collected in the same manner as a natural sample, after the decontamination process.
    e. Field blank samples are collected by pouring laboratory-grade DI water into sampling containers.
9. Once samples are collected, acquire a final depth-to-water measurement, and turn off the pump. Record the total purged volume by calculating the time from pump start to stop with the purge rate. Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



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QUALITY CONTROL SAMPLING

Quality Control (QC) samples are submitted along with natural samples to provide supporting laboratory data to validate laboratory results. QC samples are submitted blind except for matrix spikes and trip blanks, and do not have any unique identifying codes that would enable the lab or others to bias these samples in any way. Usually, the time or sampling location is modified in a way which will separate blank and standard samples from the rest of the sample train. QC samples are identified only on field forms and in field notebooks. The following codes are typically used:

N	Natural Sample	Soil, water, air, or other of interest material from a field site
SP	Split Sample	A portion of a natural sample collected for independent analysis; used in calculating laboratory precision
D	Duplicate Sample	Two samples taken from the same media under similar conditions; also used to calculate precision Two samples taken from the same media under similar conditions; also used to calculate precision
FB	Field Blank	Deionized water collected in sample bottle; used to detect contamination introduced during the sampling process.
RB	Rinsate Blank	Deionized water run through or over decontaminated equipment; used to verify the effectiveness of equipment decontamination procedures
MS/MSD	Matrix Spike/Matrix Spike Duplicate	Certified materials of known concentration; used to assess Spike Duplicate laboratory precision and accuracy
TB	Trip Blank	Inert material (deionized water or diatomaceous earth) included in sample cooler; sent by the lab, the sample is used to detect any contamination or cross-contamination during handling and transportation.

In general, selected QC samples will be inserted into the sample train within a group of twenty samples. QC samples will be prepared in the field, apart from trip blanks. Trip blanks will be supplied by the laboratory and will accompany each sample cooler containing samples for analysis of volatile organic compounds.

Typical QC sample collection frequencies are presented in the table below. However, at some sites, especially ones where streams or ponds are sampled, QC samples may need to be taken at a higher frequency. Refer to the project-specific sampling and analysis plan or quality assurance plan for the appropriate QC sample frequency. Each field crew leader will be responsible for all QC samples prepared by that crew.

QC Sample	Purpose	Collection Frequency
Field Duplicate	Measure analytical precision	1 per every 20 samples
Matrix Spike/ Matrix Spike Duplicate	Measure analytical accuracy	1 per every 20 samples
Equipment Rinse Blanks	Evaluate effectiveness of equipment decontamination and sample handling procedures.	1 per sampling event per media type
Field Blank	Assess possible cross-contamination of samples due to ambient conditions during sample collection	1 per sampling event
Trip Blank	Evaluate sample preservation, packing, shipping, and storage	1 per cooler containing samples with volatile constituents

Methods for computing data validation statements can be found in EPA documents or obtained from Geomatrix.