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VIA MT FILE TRANSFER SERVICE

Mr. Aaron Studer
Husky (US) GPC Inc.
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Canada

November 24, 2025

Grace Miller, Environmental Project Officer
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RE: Groundwater Monitoring Work Plan #35104 for the Petroleum Release at the Former Husky Service Station, Corner of Highway 44 and Montana Street, Valier, Pondera County, Montana, Facility ID 56-13802, Release 3197, TID 30489

Hydrometrics is pleased to transmit, on behalf of Husky (US) GPC Inc., one electronic copy of the 2026 – 2027 Work Plan (#35104) for the Petroleum Release at the Former Husky Service Station in accordance with the request from MDEQ dated November 10, 2025. The Work Plan includes two groundwater sampling events, an interim data report, and a Groundwater Monitoring Report. Hydrometrics will schedule the groundwater monitoring events discussed in the Work Plan following MDEQ approval.

If you have any questions, feel free to contact me at (406) 594-8583.

Sincerely,

Juliann Clum
Environmental Scientist

FORMER HUSKY SERVICE STATION

CORNER OF HIGHWAY 44 AND MONTANA STREET

VALIER, MONTANA

GROUNDWATER MONITORING WORK PLAN

(Work Plan # 35104)

Prepared for:

Former Husky Service Station
Corner of Highway 44 and Montana Street
Valier, MT
DEQ Facility ID #56-13802, Release #3197

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

November 2025

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CORNER OF HIGHWAY 44 AND MONTANA STREET

VALIER, MONTANA

GROUNDWATER MONITORING WORK PLAN

(Work Plan # 35104)

PROJECT CONTACT PAGE

Facility:	Former Husky Service Station
Facility Address:	Corner of Highway 44 and Montana Street Valier, MT
DEQ Facility ID No.:	56-13802
Release No.:	3197
Work Plan No.:	35104
Work Plan:	Former Husky Service Station Groundwater Monitoring Work Plan
Responsible Party:	Husky (US) GPC Inc. 225 6 Ave SW PO Box 766 Calgary, AB T2P 0M5 Canada
Contact Person:	Mr. Aaron Studer aaron.studer@cenovus.com 1-306-825-1293
Consultant:	Ms. Juliann Clum Hydrometrics, Inc. 3020 Bozeman Ave. Helena, MT 59601 406-594-8583

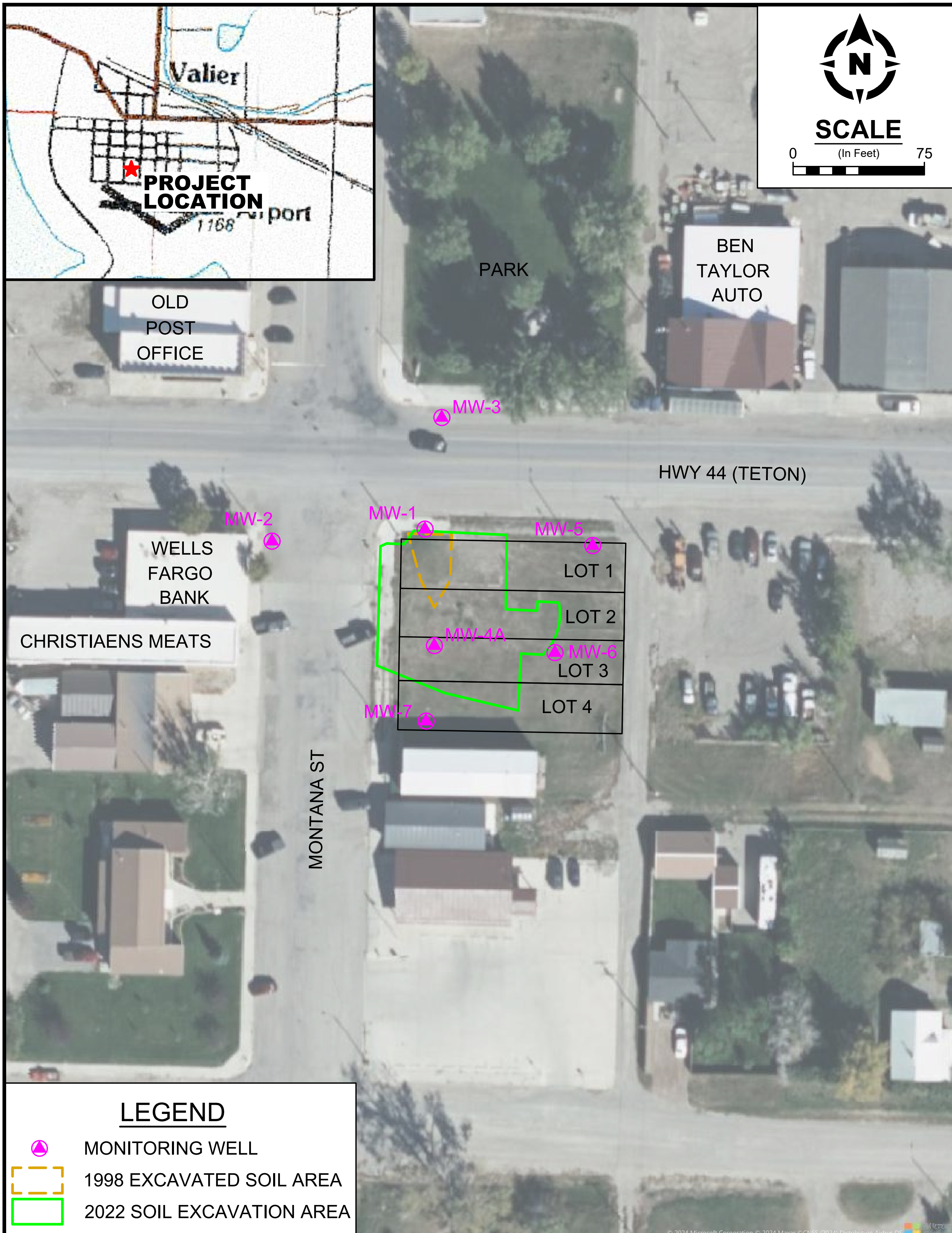
FORMER HUSKY SERVICE STATION
CORNER OF HIGHWAY 44 AND MONTANA STREET
VALIER, MONTANA
GROUNDWATER MONITORING WORK PLAN
(Work Plan # 35104)

1.0 INTRODUCTION

Hydrometrics, Inc. has prepared this Groundwater Monitoring Work Plan for the former Husky Service Station Site (DEQ Facility ID #56-13802, Release #3197) located on the southeast corner of the Montana Street and Highway 44 (Teton Avenue) intersection in Valier, Montana at the request of the Montana Department of Environmental Quality (MDEQ, 2025). The Work Plan has been prepared in accordance with MDEQ's Montana Groundwater Monitoring Work Plan and Report Guidance for Petroleum Releases (MDEQ, 2021).

1.1 SITE LOCATION AND BACKGROUND

The former Husky Service Station (Site), located on the southeast corner of Montana Street and Highway 44 (Teton Avenue) in Valier, Montana was leased to several operators until it was closed in 1965. The Site property is Lot 1 and the East 50 feet of Lot 2 in the Valier original Townsite Subdivision in Pondera County. August Habets bought the property from Husky Oil Company in approximately 1970, and apparently paid property taxes on the Site after the purchase. However, the deed was apparently not recorded. Mr. Habets stopped paying property taxes on the property in 1998 and property taxes were delinquent until November 2022 when Kenneth Jr and Jacqueline Wheeler took title of the property and adjacent lots through a tax deed transfer. Figure 1-1 shows the vicinity map of the Site and the existing Site conditions. Properties that are adjacent to the Site include the Montana Department of Transportation (MDT) Right-of-Way (ROW) to the north of the Site and parcels beneath and to the south of the Site owned by Mr. & Mrs. Wheeler (Lots 1, 2 and 3 formerly owned by August Habets) and the Valier Volunteer Fire Department (Lot 4).



FORMER HUSKY SERVICE STATION FACILITY ID 56-13802, RELEASE 3197 VALIER, PONDERA COUNTY, MONTANA	VICINITY MAP	FIGURE 1-1

Updated by: ltaborsky 6/14/2024 10:52 AM
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Hydrometrics, Inc.

Two underground storage tanks (USTs), which both at one point in time contained gasoline, were removed as directed by August Habets on July 14, 1997 (documentation is not clear and indicates that in fact two tanks were removed; however, the reported sizes of the tanks range from a 400- or 500-gallon tank to a 500- or 1,000-gallon tank). During removal of the USTs, a release was reported to the Montana Department of Environmental Quality (MDEQ).

Subsequent cleanup efforts were continued by August Habets in 1998. However, due to budget restrictions excavation was halted. Soil samples taken from the excavation indicated Gasoline Range Organics (GRO) were still present in the soils on the excavation boundaries, ranging from 920 parts per million (ppm) to 2470 ppm in the excavation sidewalls and from 170 ppm to 380 ppm in the excavation bottom. Records indicate that the average depth of the excavation was approximately 11 feet (3.3 meters), with some areas excavated as deep as 13 feet (3.9 meters). Refer to Figure 1-1 for the approximate excavation boundaries.

Investigations conducted at the Site from 2006 to 2019 have been summarized in detail in previous reports for the Site in Valier (Hydrometrics, 2006, 2007, 2008, 2009, 2010, 2012ab, 2013ab, 2014ab, and 2016ab) and will not be detailed here. However, groundwater results from 2018 showed two of the seven Site monitoring wells (MW-4 and MW-1) contained benzene and C5-C8 aliphatics above the applicable Risk Based Screening Levels (RBSLs) for groundwater (Hydrometrics, 2018). In 2019, groundwater sampling results showed benzene (57 - 697 ug/L) persisted at MW-4 and MW-1 above the RBSL of 5 ug/L (Hydrometrics, 2020).

In 2021, a remedial investigation was conducted at the request of MDEQ with the objective to further define the extent and magnitude of petroleum contamination of soil remaining in the vicinity (west, east, and south) of monitoring wells MW-1 and MW-4 (Hydrometrics, 2021). Six soil borings (SB-15 through SB-20) were advanced to a target depth of 24 feet (7.3 meters), three of which were terminated between 19 and 22 feet (5.8 and 6.7 meters) due to refusal in the tight clay materials at depth. Analytical data showed concentrations of benzene, C5-C8 aliphatics, and C9-C10 aromatics in soil higher than applicable RBSLs in three soil borings, and concentrations of benzene above RBSLs in two soil borings. Petroleum impacted soils were defined as having concentrations of hydrocarbons above the Tier 1 RBSLs for soil less than 10 feet (3.0 meters) to groundwater (DEQ, 2024). Based on this data and soil boring results from earlier investigations (2008 and 2012), the extent and magnitude of impacted soils at the Site that were not removed as part of the 1998 excavation and remedial action was reasonably defined.

In an effort to move the petroleum release Site to final closure, corrective action activities were conducted in August 2022 to remove bulk petroleum impacted soil from the vadosezone and smear-zone, to the extent practicable with the goal of significantly reducing groundwater contamination at the Site, which would place Husky in a position to proceed to closure of the Site, either due to a lack of groundwater contamination or through a PMZ (Hydrometrics, 2022 and 2023a). A total of 2209 cubic yards (4060 tons) of contaminated soil was removed from the Site and disposed offsite during August of 2022. Excavation removed soil impacted by petroleum contamination to the maximum extent practical, to a depth of up to 27 feet (8.2 meters) below ground surface in some locations. Field and laboratory soil (confirmation) sampling at the extents of the excavation confirmed some residual petroleum impacted soils were left in place, including one sample on the north wall of the excavation (excavation was limited by Highway 44 and the traffic light foundation) and eight samples on the floor of the excavation (24 to 27 feet depth (7.3 to 8.2 meters)). Refer to Figure 1-1 for excavation boundaries.

Monitoring wells MW-1 and MW-4 were the only Site wells to show petroleum impacts prior to excavation and the impact of the cleanup on groundwater quality was to be assessed by the collection of groundwater samples from these two monitoring wells within and immediately adjacent to the area of soil removal. Monitoring well MW-4, located downgradient of the former tank basin, was removed during excavation and subsequently replaced (as MW-4A) in clean backfill at the same location. Monitoring well MW-4A was dry during both post-excavation Site visits on November 10, 2022 and May 18, 2023. The impact of the cleanup on groundwater quality was assessed by the collection of groundwater samples from monitoring well MW-1 located immediately adjacent to the north wall of the excavation where residual petroleum impacted soils were left in place due to constraints of removal. As described in the Final Cleanup Report (Hydrometrics, 2023a), results of groundwater monitoring conducted at MW-1 (including a duplicate sample) on May 18, 2023 showed no petroleum constituents above Montana Tier 1 Groundwater RBSLs (May 2018).

Semi-annual groundwater monitoring at MW-4A and MW-1 was conducted in November 2023 and May 2024 to capture seasonal data required by MDEQ to evaluate the site for closure (Hydrometrics, 2023b, 2023c, 2024). Monitoring well MW-4A had insufficient water to sample in November 2023. Wells at this Site have historically shown extremely slow recharge from an apparent perched aquifer within a tight silty clay. The clayey native (and backfill) soils surrounding the former source area and existing wells restrict movement of water (and contamination) into or out of the area. In May 2024, the water level in MW-4A was recorded near 17 feet (5.2 meters) below ground surface; a sample and field parameters were collected from the first water to surface due to a lack of sufficient water to evaluate stabilization of field parameters. Groundwater samples collected from MW-1 (including a duplicate) in November 2023 were analyzed for Volatile Petroleum Hydrocarbons (VPH) constituents and lead scavengers: 1,2 Dichloroethane (DCA; method SW8260B) and 1,2 Dibromoethane (EDB; method SW8011). Lead scavengers had not previously been analyzed at the Former Husky Service Station but were requested by MDEQ to ensure data coverage for Site closure. In November 2023, groundwater monitoring results from monitoring wells MW-1 showed no exceedances of groundwater standards or RBSLs (MDEQ, 2024; Table 3) for petroleum constituents or additives. Groundwater results from May 2024 showed petroleum constituents below detection or below standards, with exception to benzene at both MW-1 (266 ug/L) and MW-4A (16 ug/L). Concentrations of benzene in May 2024 were an order of magnitude lower at MW-1 and two orders of magnitude lower at MW-4A than peak concentrations at these locations in 2015 and 2012, respectively. Due to the existence of benzene above the RBSLs and historic data showing concentrations to be within the range of prior groundwater results but significantly lower than peak levels (stable or decreasing) at MW-1 and MW-4A, Husky formerly requested that the Site be moved toward closure through a Petroleum Mixing Zone (PMZ) in August 2024 (Hydrometrics, 2024).

Compliance monitoring of VPHs at MW-1 and MW-4A continued during the spring high water event in May 2025 to capture groundwater data needed to determine the path to Site closure. The groundwater level at monitoring well MW-4A had not stabilized at background groundwater levels, however, provided sufficient water for purge during low flow sampling. Analytical results showed benzene at both wells and C5-C8 aliphatics at MW-1 continue at concentrations above the respective RBSLs. All other VPH parameters were below RBSLs.

Groundwater depth at the seven monitoring wells has been observed at approximately 3 to 10 feet (0.9 to 3.0 meters) below ground surface, when stabilized. Groundwater level monitoring was discontinued at MW-7 in May 2024 due to lack of landowner access. Groundwater flow direction based on regional topography and groundwater elevations in the seven wells suggest groundwater flow is to the north-northwest and south away from the former tank basin area. The groundwater elevations have historically created an apparent mound in the former tank area.

2.0 OBJECTIVE OF WORK PLAN

Concentrations of petroleum constituents at this Site fluctuate periodically but are generally stable (within historic ranges) or have decreased over time. Continued monitoring at wells MW-1 and MW-4A was recommended annually for two years to reestablish rates of attenuation after disturbance of the system due to Remedial Activities (RA). The objective of this Work Plan is to provide guidance for annual monitoring to capture remaining data needed to move the Site to closure. This Work Plan describes protocol for the collection of groundwater from two monitoring wells (MW-1 and MW-4A) for laboratory analysis of VPH constituents.

3.0 PROPOSED FIELD WORK

Hydrometrics will perform project management duties including Client and MDEQ consultation, preparing reports, collecting and analyzing groundwater samples, and providing Site recommendations. The following Site work will be completed as requested by MDEQ. The standard operating procedures (SOPs) shown in Appendix A will be used to guide the collection and documentation of groundwater samples, sample handling and shipping procedures, and measurement of field parameters.

3.1 GROUNDWATER MONITORING

Groundwater will be monitored during the spring of 2026 and 2027 during high groundwater conditions. Groundwater depth will be measured at all seven existing monitoring wells, as allowable by property owner access. Groundwater samples will be collected for laboratory analysis from MW-1 and MW-4A, as water levels allow. Groundwater sample collection methods will be consistent with the following description.

Groundwater samples from the two monitoring wells will be collected using a peristaltic pump and disposable polyethylene tubing consistent with previous groundwater sample collection methodology at the Former Husky Service Station (Hydrometrics, 2018). The general sequence of procedures for groundwater sampling will be as follows:

1. Collect water level.
2. Wells will be purged to remove stagnant water using a low-flow rate of 0.1 to 0.5 liters per minute, if achievable and Site conditions allow, until field parameter stabilization or three well volumes have been removed. Field parameters used to determine well stabilization include dissolved oxygen (DO), oxidation/reduction potential (ORP), pH, specific conductance (SC), and water temperature. Purge water generated during sampling and decontamination will be disposed of on the ground near the monitoring site unless free product is apparent.
3. After well stabilization parameters have been met or three well volumes have been removed, a groundwater sample will be collected and poured directly into laboratory prepared bottles. In addition, field parameters will be recorded at each well at the time of sample, including pH, SC, DO, water temperature, and ORP.

In the event that insufficient water is observed within a well for field parameter stabilization prior to sample collection, an attempt will be made to sample the first water to the surface. Field parameters will then be recorded from any remaining water in the well.

The samples will be properly preserved in the field and hand delivered to Energy Laboratories in Helena, Montana. Samples will be analyzed for VPH as required by the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases (MDEQ, 2024). One field duplicate and deionized (DI) water trip blank (provided by Energy Laboratories, Helena Laboratory) will be collected and submitted for quality control purposes. Sample containers, preservation methods, and holding times for the requested laboratory analytical parameters will be in conformance with Table 3-1. Sampling of monitoring wells for VPH will be performed in accordance with Hydrometrics' SOPs in Appendix A.

TABLE 3-1. SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Matrix	Parameter	Container	Preservation	Holding Time
Water	VPH	2 - 40 mL glass vials	Zero headspace; HCL; cool to 4°C	14 days

3.2 DATA VALIDATION

All laboratory analytical data will be validated using DEQ's Data Validation Summary Form (DVSF).

4.0 PROJECT REPORTING

Following completion of the spring 2026 groundwater monitoring event, an Interim Data Report will be prepared. The Interim Data Report will include a discussion, data, tables, figures as described in MDEQ's Montana Groundwater Monitoring Work Plan and Report Guidance for Petroleum Releases (MDEQ, 2021). A discussion of the results will take place with the MDEQ project manager following report submittal.

A Groundwater Monitoring Report will be prepared following the second annual monitoring event to describe both groundwater monitoring events, in accordance with the above referenced guidance, and the next steps toward closure of this Site. The report will include findings from groundwater monitoring described in this Work Plan and specifically include:

- A discussion of methods, deviations from the approved work plan, conclusions, and recommendations.
- A discussion and data that demonstrates whether the groundwater plume is or is not stable or decreasing in concentration.
- Data tables with cumulative groundwater level, field, and analytical results.
- An updated Release Closure Plan (RCP).
- Appendices for monitoring field forms, laboratory reports, and completed DVSFs.

Reports will be submitted to the MDEQ Project Manager electronically using the MDEQ File Transfer Service.

5.0 SCHEDULE

The below schedule depicts the estimated completion dates for each task.

Task 1.	Ground monitoring event (high water)	**May/June 2026**
Task 2.	Receive Analytical Results (Event 1)	**Approximately 1 month following monitoring event**
Task 3.	Prepare Interim Data Submittal	**September 2026**
Task 4.	Discuss work plan tasks and monitoring results with MDEQ's project manager.	**As needed; September 2026**
Task 5.	Ground monitoring event (high water)	**May/June 2027**
Task 6.	Receive Analytical Results (Event 2)	**Approximately 1 month following monitoring event**
Task 7.	Prepare and submit a Groundwater Monitoring Report and the Release Closure Plan (RCP).	**September 2027**

6.0 REFERENCES

Hydrometrics, Inc., 2006. Petroleum Release at August Habits' Property, Corner of Highway 44 and Montana Street Valier, MT Initial Remedial Investigation Work Plan. June 2006.

Hydrometrics, Inc., 2007. Initial Remedial Investigation for Petroleum Release at Former Husky Service Station, Corner of MT Highway 44 and Montana Street Valier, Montana. May 2007.

Hydrometrics, Inc., 2008. Petroleum Release at Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, MT 2008 Remedial Investigation Work Plan. May 2008.

Hydrometrics, Inc., 2009. 2008 Remedial Investigation for Petroleum Release at Former Husky Service Station, Corner of MT Highway 44 and Montana Street Valier, Montana. January 2009.

Hydrometrics, Inc., 2010. 2009 Annual Groundwater Monitoring For Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana. January 2010.

Hydrometrics, Inc., 2012a. Abbreviated Groundwater Monitoring CAP for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT. September 2012.

Hydrometrics, Inc., 2012b. Standardized Groundwater Monitoring Report AR-01 for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT. November 2012.

Hydrometrics, Inc., 2013a. Abbreviated Soil Boring and Monitoring Well Installation CAP for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197, Work Plan 7271. May 2013.

Hydrometrics, Inc., 2013b. Abbreviated Soil Boring and Groundwater Monitoring Well Installation Report for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197, Work Plan 7271. November 2013.

Hydrometrics, Inc., 2014a. Abbreviated Groundwater Corrective Action Plan for Petroleum Release at Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197, Work Plan 8641. August 2014.

Hydrometrics, Inc., 2014b. Abbreviated Groundwater Corrective Action Report for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197, Work Plan 8641. December 2014.

Hydrometrics, Inc., 2016a. Abbreviated Groundwater Corrective Action Activities Report for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197. May 2016.

Hydrometrics, Inc., 2016b. Abbreviated Groundwater Corrective Action Activities Report for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197. December 2016.

Hydrometrics, Inc., 2018. Abbreviated Groundwater Corrective Action Activities Report for Petroleum Release At Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Pondera County, MT; DEQ Facility ID #56-13802, Release #3197. January 2018.

Hydrometrics, Inc., 2020. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Groundwater Monitoring Report; DEQ Facility ID #56-13802, Release #3197, Work Plan #10882. January 2020.

Hydrometrics, Inc., 2021. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Remedial Investigation Report; DEQ Facility ID #56-13802, Release #3197, Work Plan #34092. October 2021.

Hydrometrics, Inc., 2022. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Cleanup Work Plan #34456; DEQ Facility ID #56-13802, Release #3197. February 2022.

Hydrometrics, Inc., 2023a. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Cleanup Report; DEQ Facility ID #56-13802, Release #3197. August 2023.

Hydrometrics, Inc., 2023b. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Groundwater Monitoring Work Plan #34771; DEQ Facility ID #56-13802, Release #3197. October 2023.

Hydrometrics, Inc., 2023c. Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, Groundwater Monitoring Interim Data Report under Work Plan #34771; DEQ Facility ID #56-13802, Release #3197. December 11, 2023.

Hydrometrics, Inc., 2024. Groundwater Monitoring Report for the Petroleum Release at the Former Husky Service Station, Corner of Highway 44 and Montana Street Valier, Montana, under Work Plan #34771; DEQ Facility ID #56-13802 (TID 30489), Release #3197, Work Plan 34771. August 1, 2024.

Montana Department of Environmental Quality (MDEQ), 2021. Montana Groundwater Monitoring Work Plan and Report Guidance for Petroleum Releases. March 2021.

Montana Department of Environmental Quality (MDEQ), 2024. Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases. February 2024.

Montana Department of Environmental Quality (MDEQ), 2025. Personal Correspondence Re: Work Plan Requested to Monitor Petroleum-Contaminated Media at the Former Husky Service Station, Corner of Highway 44 and Montana Street, Valier, Pondera County, Montana; Facility ID 56-13802, (TID 30489), Release 3197, Work Plan 35104. November 10, 2025.

APPENDIX A

HYDROMETRICS, INC.
STANDARD OPERATING PROCEDURES

HYDROMETRICS, INC.

STANDARD OPERATING PROCEDURES

Standard Operating Procedure	Date Revised	Title of Standard Operating Procedure
HSOP-004	10/2010	Chain-of-Custody Procedures, Packing, and Shipping Samples
HSOP-006	4/2012	Field Measurement of pH, Dissolved Oxygen, Conductivity, ORP, and Temperature Using a Multi-Meter
HSOP-029	6/2004	Labeling and Documentation of Samples
HSOP-031	6/2004	Field Notebooks
HSOP-105	9/2020	Low Flow/Minimal Drawdown Groundwater Sampling for Monitoring Wells
HSOP-110	4/2020	Water Level Measurement with an Electric Tape

STANDARD OPERATING PROCEDURE

HSOP-004

CHAIN-OF-CUSTODY PROCEDURES, PACKING, AND SHIPPING SAMPLES

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1.0 SCOPE AND APPLICATION

HSOP-004 presents procedures to be followed when shipping samples of environmental media (e.g., air, water, soil, waste material) to a laboratory for analysis. All samples submitted should be accompanied by chain-of-custody documentation.

2.0 SUMMARY OF METHOD

Samples of environmental media submitted to laboratories for analysis are often shipped via commercial carrier. Samples are packed in shipping containers to minimize the potential for container breakage or leaking. Each shipment will be accompanied by sample documentation, including chain-of-custody forms and a list of required analytical parameters, methods, and detection limits. Samples are cooled with ice during transport, to maintain temperature at approximately 4°C (±2°C). Shipments of hazardous materials must conform to International Air Transport Association (IATA) Dangerous Goods regulations and/or Department of Transportation (DOT) regulations, as well as any carrier-specific requirements.

3.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

- Care should be exercised when handling samples of hazardous or potentially hazardous waste. Personal protective equipment (PPE) should be utilized (gloves, safety glasses, coveralls) as appropriate.
- Glass sample containers should be handled with extreme care to avoid breakage, loss of sample, and possible injury.

4.0 INTERFERENCES

Not Applicable

5.0 PERSONNEL QUALIFICATIONS

Personnel should be familiar with the project work plan and objectives, and with the operation of equipment listed in Section 6.0 below. Personnel should also familiarize themselves with the schedule of the shipping location to be used for shipping samples. For projects involving hazardous materials, consult the project work plan, courier regulations, and any state and federal air or ground shipping regulations for details on shipping hazardous material.

6.0 EQUIPMENT AND SUPPLIES

- Shipping container (metal or plastic cooler);
- Packing material (bubble wrap, Styrofoam peanuts);
- Absorbent material (clay absorbents, rock wool);
- Shipping tape;
- Shipping strap;
- Custody seals;
- Chain-of-custody (COC) forms;
- Heavy-duty or contractor grade garbage bags or similar plastic bags;
- Ziploc bags; and
- Ice.

7.0 CHAIN-OF-CUSTODY PROCEDURE

1. Chain-of-custody involves ensuring that samples are traceable from the time of collection until received by the analytical laboratory. The laboratory is responsible for custody during processing and analysis. A sample is under custody if:
    - It is in your possession;
    - It is in your view, after being in your possession; or
    - It was in your possession and you then placed it in a designated secure or locked area to prevent tampering.
2. When ready to ship samples, set out samples in a clean, secure area to complete chain-of-custody forms. Chain-of-custody forms may be obtained from the project laboratory, or from Hydrometrics' Data Quality Department. An example COC form is shown in **Attachment 1**. Each sample should be identified on the form by its sample number, date and time of collection, and analysis requested. Check sample labels against information recorded in field notebook and on chain-of-custody to ensure consistency and guard against transcription errors (**HSOP-029**). It is usually best to use one chain-of-custody form per shipping container, covering the samples included in the container. When shipping multiple coolers to the laboratory, label chain-of-custody forms as "Cooler 1 of 3," "Cooler 2 of 3," etc. While chain-of-custody forms obtained from various sources may differ, certain information regarding sampling dates and times, sample identification, contact information, and requested parameters for analysis should be included on all acceptable forms. Complete all fields on the chain-of-custody form, as applicable

to the particular sampling event. Examples of typical COC information to be completed are as follows:

a) **Company Name:** Enter "Hydrometrics, Inc."

b) **Project Name:** Enter the project name and Hydrometrics' project number.

c) **Report Mail Address:** Enter the name, address, and e-mail address of the person who should receive the laboratory report.

d) **Contact Name:** Enter the name of the project manager, sampling personnel, or other responsible contact.

e) **Phone/Fax:** Enter the phone and fax number of the contact person for the project.

f) **E-mail:** Enter the e-mail address for the contact person.

g) **Sampler:** Print the name of the person who collected the samples.

h) **Invoice Address:** Enter the address where the invoice should be sent.

i) **Invoice Contact and Phone:** Enter the name and phone number of the person responsible for approving the invoice.

j) **Purchase Order:** Enter the Hydrometrics' Purchase Order number for the sample order.

k) **Quote/Bottle Order:** Enter the laboratory quote number for the project or bottle order number provided with the sample bottle order.

l) Note any special reporting requirements or formats.

m) **Sample Identification:** Enter the unique sample number assigned to the sample.

n) **Collection Date:** Enter the date each sample was collected. Do not use ditto (") marks, arrows or lines to represent the same date.

o) **Collection Time:** Enter the time each sample was collected. Do not use ditto (") marks, arrows or lines to represent the same time.

p) **Number of Containers and Matrix:** Enter the number of bottles the sample is contained in followed by a dash and then a letter representing the type of sample matrix (i.e., A=Air, W=Water, S=Soil/Solid, V=Vegetation, B=Bioassay, O=Other).

q) **Analysis Requested:** Write the analysis to be performed on each sample and check the box for each sample you want to receive this analysis. Also include an analytical parameter list.

r) **Remarks:** Use this field to make notes or comments to the laboratory.

(Note: If a laboratory-provided COC form is used, be sure to follow any additional instructions included from the laboratory.)

3. Record shipping information (tracking numbers, name of courier, other pertinent information) on chain-of-custody form. Sign and date chain-of-custody form, and retain one copy of form for project file.

8.0 PACKING AND SHIPPING PROCEDURE

1. Seal drain holes in bottom of shipping cooler (inside and out) to prevent leakage. Check sample container lids to ensure they are tightly sealed.
2. Line bottom of cooler with packing material (bubble wrap). Open and place two heavy-duty plastic bags in cooler (one inside the other).
3. Seal samples within individual plastic or bubble wrap bags, as necessary. All glass containers (VOAs, amber glass bottles, glass soil jars) should be placed in individual bubble wrap bags. Place sealed sample containers in shipping cooler, inside double plastic bags. In most instances, a labeled temperature blank should be included with the samples to allow the laboratory to check the sample temperature upon arrival. The temperature blank is generally a small vial or bottle filled with tap water and labeled "Temperature Blank." Ensure that temperature blank meets temperature requirements upon receipt by laboratory.
4. Cover samples with ice, inside double plastic bags.
5. Close and seal double plastic bags, by knotting or with shipping tape. Fill any empty space in cooler with additional packing material or absorbent material.
6. Record shipping information (tracking numbers, name of courier, other pertinent information) on chain-of-custody form. Sign and date chain-of-custody form, and retain one copy of form for project file.
7. Place original chain-of-custody, sample parameter list, cover letter, and any other documentation needed by the laboratory into a plastic Ziploc bag. Seal Ziploc bag and tape to the inside of the shipping container lid.
8. Label outside of shipping container with sampling organization name, address, and phone number, laboratory destination name, address, and phone number, and any required DOT shipping labels.
9. Place custody seals on front and back of cooler (see **Attachment 2**) and tape in place with shipping tape to avoid accidental breakage. Wrap cooler securely in at least two places with a minimum of three wraps of shipping tape. Shipping strap may also be used to provide additional insurance against the cooler opening during shipment.
10. Deliver sample containers to the shipping location. Since samples should reach the laboratory as soon as possible to protect sample integrity, **overnight shipping is required,** unless unavailable at the shipping location. Retain copies of shipping receipts for the project file. Shipping receipts and tracking numbers serve as chain-of-custody documentation during sample transport from the sampler to the laboratory.
11. Additional guidance may be found in the EPA's *Contract Laboratory Program Guidance for Field Samplers* (EPA, 2004). More stringent shipping requirements may apply to samples collected under CLP protocols. The project work plan should be consulted to determine any special requirements.

9.0 DATA AND RECORDS MANAGEMENT

The following documents generated during sample packing and shipping will be retained in the project file:

- Chain-of-custody form;
- Analytical parameter list;
- Cover letter; and
- Shipping receipts.

10.0 QUALITY CONTROL/QUALITY ASSURANCE

- Field personnel should cross-reference information on sample labels, in the field notebook, and on sample chain-of custody forms during the sample packing and shipping process.
- Data quality review will include checking of sample documentation to ensure consistency.
- Temperature blank measurements by the laboratory upon arrival of samples will document that samples were maintained at the appropriate temperature during shipping.

11.0 REFERENCES

Hydrometrics' HSOP-029: Labeling and Documentation of Samples

EPA, 2004. Contract Laboratory Program Guidance for Field Samplers (Draft Final). EPA 540-R-00-003. January 2004.

12.0 APPROVED

Approved By	Title	Signature	Date
Michael Wignot	Principal/Senior Engineer		06/2004

Attachment 1. Example Chain-of-Custody Form

CHAIN OF CUSTODY RECORD

Hydrometrics, Inc.
3020 Bozeman Ave. • Helena, MT 59601 • (406) 443-4150

Attachment 1
Example Chain-of-Custody Form

PROJ. NO.	PROJECT NAME
SAMPLERS: *(Signature)*	

DATE	TIME	COMP	GRAB	SAMPLE NUMBER	NO. OF CON-TAINERS	Commons UF / RAW	Nutrients UF / H_2SO_4	Diss. Metal F / HNO_3	CN UF / NaOH	Total Metals UF / HNO_3	Total Recoverable Metals UF / HNO_3	BTEX	TPH								REMARKS

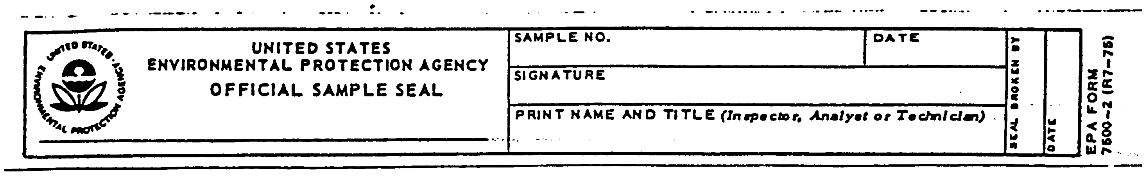
Relinquished by *(Signature)*	Date / Time	Received by *(Signature)*	Lab	P.O. #	Shipped via: Bus FedEx UPS Other ____ Air Bill # ____
Relinquished by *(Signature)*	Date / Time	Received by *(Signature)*	Remarks		
Relinquished by *(Signature)*	Date / Time	Received for Laboratory by *(Signature)*	Date / Time	Enclosed: ❑ Parameter sheet w/detection limits ❑ QA / AC standard mixing instructions ❑ Cover letter ❑ Other ____	

Split Samples: ❑ Accepted ❑ Declined ____ Signature

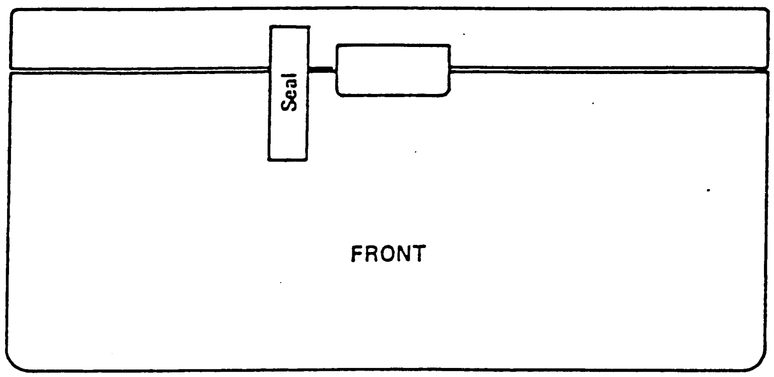
Return results & electronic copy to: QA / QC Dept. at address at top of page

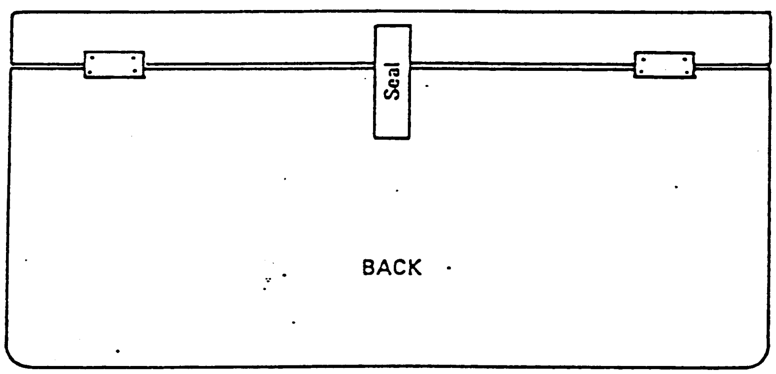
HFORM-1 07/11
TNO 406-443-8550

Attachment 2. Example of Custody Seals and Placement


UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
OFFICIAL SAMPLE SEAL

SAMPLE NO.
DATE
SIGNATURE
PRINT NAME AND TITLE *(Inspector, Analyst or Technician)*
SEAL BROKEN BY
DATE
EPA FORM 7500-2 (R7-75)





STANDARD OPERATING PROCEDURE

HSOP-006

FIELD MEASUREMENT OF pH, DISSOLVED OXYGEN, CONDUCTIVITY, ORP, AND TEMPERATURE USING A MULTI-METER

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

This procedure will allow field personnel to collect pH, conductivity, dissolved oxygen (DO), temperature, and oxidation reduction potential (ORP) parameters of groundwater/surface water with a single meter.

2.0 SUMMARY OF METHOD

A multiple parameter meter (multi-meter) is calibrated and subsequently used to gather field water quality parameters for groundwater and surface water samples.

3.0 HEALTH AND SAFETY WARNINGS

Standards used for calibration of the multiple parameters of the meter may present a hazard to personnel performing calibration or handling solutions. Care should be taken to minimize the risks of spills. Minimum personal protective equipment (PPE) to be worn during calibration procedures should consist of latex or nitrile gloves. For calibration in the field at the project site rather than the lab, additional PPE may be required by the work plan or project specific Health and Safety plan. Material safety data sheets (MSDS) for all substances used for calibration should be available during calibration.

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

4.0 INTERFERENCES

The primary potential interference during use of the multi-meter comes from damage to the meter or its various probes. The meter should be handled with care to limit potential damage to the probes. Damaged probes should be repaired or replaced according to the manufacturer's instructions.

5.0 PERSONNEL QUALIFICATIONS

Personnel should be familiar with the usage and operation of the multi-meter being used. It is recommended that manufacturer's documentation on use and storage be reviewed prior to operation.

6.0 EQUIPMENT AND SUPPLIES

- YSI Model 556 Multi-meter (or similar);
- Standard/buffer solutions (Conductivity, pH, ORP); and
- Latex or nitrile gloves.

7.0 PROCEDURE

7.1 CALIBRATION

7.1.1 Conductivity and pH

1. From the main menu, select **Calibrate**.
2. Place the correct amount of calibration standard into a clean, dry or pre-rinsed calibration cup.
3. Immerse the probe into the solution, making sure the sensor to be calibrated and the temperature probe are adequately covered.
4. Allow at least one minute for temperature to stabilize.
5. Select the sensor to be calibrated. For conductivity, a second menu will offer the option of calibrating in **specific conductance, conductivity,** or **salinity**. Calibration of any one option automatically calibrates the other two. For pH, a second menu will appear offering the choice of a 1-, 2-, or 3-point calibration. Always perform a 3-point calibration.
6. Enter the value of the standard being used. (For pH, always calibrate in the 7 buffer first.) Be certain that the units are correct and press **Enter**. The current values of all enabled sensors will appear.
7. Observe readings and when they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate if the calibration has been accepted.
8. Press **Enter** again to return to the Calibrate screen, or, for pH, to continue with the second point of the calibration.

7.1.2 Oxidation – Reduction Potential (ORP)

1. Place the correct amount of a solution with known ORP value into a clean, dry, or pre-rinsed calibration cup.
2. Immerse the probe into the solution, making sure the sensor to be calibrated and the temperature probe are adequately covered.
3. Allow at least one minute for temperature to stabilize.
4. Read the ORP value and compare to the known value. Note that ORP values vary with temperature.

5. If ORP value is within ±20 mV of known value, record ORP value and temperature on calibration form.
6. If ORP value exceeds ±20 mV of known value, selected Calibrate from main menu, select ORP sensor, and enter known ORP value.
7. Observe readings and when they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate if the calibration has been accepted.
8. Corrections of ORP to E_H are typically calculated for individual samples based on temperature, due to the variability of reference electrode potentials with changing temperature.

7.1.3 Dissolved Oxygen

1. Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup. Screw the transport/calibration cup onto the probe, engaging only 1 or 2 threads to ensure venting to the atmosphere. **Make sure the DO and temperature sensors are NOT immersed in water.**
2. Turn the instrument on to the Run mode and wait 10 minutes for the DO sensor to stabilize.
3. From the main menu, select **Calibrate**, then **Dissolved Oxygen**, then **DO%**.
4. Observe the readings and when they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate if the calibration has been accepted.
5. Press **Enter** again to return to the DO Calibration screen.

7.2 TAKING READINGS

1. Power the instrument on, or select **Run** from the Main Menu.
2. Insert probe into the sample to be measured. Continuously move the probe through the sample until the readings on the screen stabilize. If using a flow through cell, insert and connect the probe to the flow through cell and wait until readings stabilize, according to **HSOP-049**.
3. Record the sample readings in the sample field book and on sample specific sample forms (if used).
4. If recording readings in the meter's electronic memory, use the arrow keys to highlight **Log one sample**, or select **Start logging** to record a series of data. Press **Enter**.
5. The Enter Information screen should appear. Use the keypad to enter a file name and description. Press Enter.
6. Highlight **OK** and press **Enter** to confirm the data was successfully logged.

8.0 DATA AND RECORDS MANAGEMENT

Field readings will be documented in the field notebook which is maintained in accordance with **HSOP-031**, and on sample specific sample forms (if used). Sample forms will be maintained in the project file as noted in **HSOP-029**.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

Field personnel should cross reference recorded readings with the display on the meter. If at any time during the use of the meter erroneous readings are suspected, buffer solutions should be used to check calibration and recalibrate if necessary. Notes of the calibration check or calibration should be made in the field book. The project work plan and QAPP should be reviewed for project-specific directions regarding use of a multi-meter to gather and record water quality parameters.

10.0 REFERENCES

Hydrometrics' HSOP-029: Labeling and Documentation of Samples

Hydrometrics' HSOP-031: Field Notebooks

Hydrometrics' HSOP-049: Use of a Flow Cell for Collecting Field Parameters

11.0 APPROVED

Approved By	Title	Signature	Date
Michael Wignot	Principal/Senior Engineer	Michael W. Wignot	4/2012

STANDARD OPERATING PROCEDURE

HSOP-029

LABELING AND DOCUMENTATION OF SAMPLES

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

HSOP-029 describes typical procedures used to label sample containers, to ensure that information on the label is complete and correct, and to document the number and type of samples collected at a particular site. Samples must be thoroughly documented so that analytical data received from the laboratory can be correlated to the correct sampling site.

2.0 SUMMARY OF METHOD

Hydrometrics uses unique sample codes to identify individual samples. Sample codes are distinct from site identification codes, to ensure that the laboratory is unaware of the sample source, and whether the sample is a quality control (QC) or routine sample. Sample codes and other pertinent information are written on adhesive labels affixed to the sample container, or directly on the sample container in some cases. Sample documentation includes recording information in the field notebook (and on sampling forms if required), and completing chain-of-custody documentation for sample storage and shipping.

3.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

4.0 INTERFERENCES

Some common problems with sample labeling and documentation might include the following:

- Use of incorrect sample numbers;
- Transcription errors during sample labeling or recording information in the field notebook; and
- Duplication of sample numbers.

These errors may be avoided by having an additional member of the sampling team check the labeling and documentation during the field event. If one person is conducting the sampling event, information entered on the sample label and in the field notebook should be double-checked for accuracy.

5.0 PERSONNEL QUALIFICATIONS

Labeling and documentation of samples should be conducted by personnel familiar with the project work plan and the proposed sample numbering scheme.

6.0 EQUIPMENT AND SUPPLIES

- Sample ID tag or label;
- Permanent marker;
- Container seals;
- Chain-of-custody form;
- Sampling forms; and
- Field notebook.

7.0 PROCEDURE

1. Determine appropriate sample number to be assigned to the sample. Hydrometrics' numbering convention is as follows:

   XXXX-YYMM-ZZZ

   where: XXXX=three- or four-letter project prefix;
   YYMM=last two digits of year followed by month (e.g., 0407 for July 2004);
   ZZZ=sequential numbers, starting with 100.

   This convention may be modified as necessary; most Quality Assurance Project Plans (QAPPs) contain information on sample numbering to be used for a particular project. For some projects, sample numbers for each site to be sampled may be pre-assigned by Hydrometrics' Data Quality Department, to facilitate sample entry into the project database.

2. Fill out information on sample ID tag or label. ID tags are typically serially numbered, and may be used for samples that are likely to be the subject of litigation, or as mandated by EPA, other agency, or work plan requirements. Sample labels are similar to ID tags, but are not numbered.

3. Waterproof permanent markers (such as Sharpie pens) should be used to complete sample ID tag or label information. Information to be included on the sample ID tag or label **must** include:
   - Date and time (24-hour style, e.g., 1400 for 2:00 p.m.);
   - Unique sample number;
   - Sample processing and preservative (whether the sample has been field-filtered, whether a preservative has been used, and the type of preservative); and
   - Sampling personnel names or initials.

Optional information that may also be included on the sample label or tag as warranted could include the type of analysis requested, or whether the sample is a grab or composite. In no case should a QC sample (blank, duplicate, or blind performance evaluation sample, used to evaluate lab performance with a standard of known concentration) be identified as such on the sample label. QC samples are assigned sample numbers in the same manner as other samples.

4. When multiple sample containers are used at the same site due to differing preservation requirements or additional volume requirements, the same sample numbers should be used on each container.
5. Due to requirements for cooling samples and field conditions, sample containers often become wet. If possible, it is advisable to place clear shipping tape over the label to ensure that it stays on the container. In addition, some sample information may be written on the sample lid, to aid in sample identification should the label become separated from the container.
6. If required by the project, signed and dated seals may be placed over the container lid to prevent opening without breaking the seal.
7. Sample information is recorded in the field notebook, including the same information recorded on the sample label (date and time, sample number, etc.), as well as identifying information for the sampling site, and QC sample information (see **HSOP-031**). If desired, sampling forms may also be used to record sampling information.
8. On large projects, with multiple field sampling activities occurring at the same time, multiple field notebooks may be used to document sampling activities. Each notebook should clearly state in the initial entry what tasks will be recorded in the particular book.
9. After collection and documentation, samples should be handled in accordance with standard chain-of-custody procedures (see **HSOP-004**).
10. Any corrections made to sample labels, field notebooks, or chain-of-custody documentation should be made by crossing out the incorrect information with a single line, entering the correct information, and signing and dating the correction.

8.0 DATA AND RECORDS MANAGEMENT

Copies of all sample documentation, including field notebooks, sampling forms, and chain-of-custody forms will be maintained in the project file. Sampling crews are responsible for submitting this information to the Data Quality Department for filing at the completion of each sampling event.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

- At the conclusion of the sampling event, field personnel should collate and review all sampling documentation materials for accuracy, prior to submitting the information to the Data Quality Department.
- Sample codes and associated sampling sites will be cross-referenced during data review and validation procedures stipulated by the project work plan and QAPP.
- Field samplers should ensure that complete documentation of samples has occurred prior to the close of sampling activities each day, by counting the number of samples collected and checking the field notebook for entries related to each sample.

10.0 REFERENCES

Hydrometrics' HSOP-004: Chain-of-Custody Procedures, Packing, and Shipping Samples

Hydrometrics' HSOP-031: Field Notebooks

11.0 APPROVED

Approved By	Title	Signature	Date
Michael Wignot	Principal/Senior Engineer	Michael Wignot	6/2004

STANDARD OPERATING PROCEDURE

HSOP-031

FIELD NOTEBOOKS

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

HSOP-031 presents general guidance on recording field activities in a dedicated project notebook. Field books are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the implementation of the project. In legal proceedings, field notes are typically admissible as evidence and subject to cross-examination.

2.0 SUMMARY OF METHOD

Bound notebooks with sequentially numbered pages are used to record observations, sampling information, weather conditions, and other pertinent information during field activities. Entries are made in permanent ink, and signed and dated at the bottom of each page. Both original notebooks and copies of field notes are retained as part of the project file.

3.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

4.0 INTERFERENCES

The primary potential problem with recording information in field notebooks is dealing with incorrect entries. In no case should erasures be made or information be obliterated or made illegible. Errors should simply be crossed out with a single line, dated, and initialed by the person making the original entry.

5.0 PERSONNEL QUALIFICATIONS

No specific qualifications are necessary for recording information in field notebooks. Personnel should be familiar with the scope and objectives of the project in order to record more meaningful field observations.

6.0 EQUIPMENT AND SUPPLIES

- Bound notebook with water resistant, sequentially numbered pages; and
- Pen (indelible ink).

7.0 PROCEDURE

1. New field notebooks should be labeled with the project title and number on the cover. Inside the front cover, write Hydrometrics' address and phone number as contact information, in case the notebook is lost. Multiple field notebooks may be required for large or ongoing projects; these should be assigned sequential numbers or labeled on the cover with the inclusive dates of observations recorded in the notebook (e.g., Project X, May 2002 through May 2004).
2. Notebook entries should begin on a fresh page for each day during a field event. While specific entry formats may vary with personal preference, the intent of the field notebook is to provide a daily record of significant events, observations, and measurements, as well as sampling information. All entries should be accompanied by date and time. Examples of information to be recorded in the field notebook includes:
    - Weather conditions;
    - Personnel on-site, including arrival and departure times and identities of visitors and observers;
    - Purpose of daily activities;
    - Site sketch maps;
    - Health and safety briefing information;
    - Field meter calibration information;
    - Identification and description of sampling sites (see **HSOP-002**);
    - Descriptions of photos taken;
    - Communication logs;
    - Documentation of deviation from methods; and
    - Sampling instrument decontamination records.

    Sampling-specific information should include (see also **HSOP-029**):

    - Sample number, date, and time;
    - Site identifier;
    - Description of sample containers, preservation, and sample collection method;
    - Sample tag number (if applicable);
    - Field parameter measurements and water calibration (static water level, total well depth, pH, specific conductance, water temperature, turbidity, color, odor, etc.); and
    - Soil depth intervals and descriptions.

    This list is not meant to be exhaustive, and other pertinent information should also be recorded in the field notebook as determined by field personnel.

3. The field notebook will be used to record communication with individuals on-site and on the phone that could result in a deviation from the SAP or that could impact the quality of the data being collected as part of the investigations.
4. Observations and measurements should be recorded in indelible ink, at the time they are made.
5. If erroneous entries are recorded, corrections should be made by deleting incorrect information with a single line, and dating and initialing the deletion in the notebook. Do not erase or obliterate incorrect entries, or remove pages from the notebook.
6. Blank and unused portions of notebook pages should be crossed out with a single line.
7. At the conclusion of the field event, review notebook entries, sign and date each page (if not already done), and photocopy notebook pages for inclusion in the project file. Original notebooks may be maintained in the project file, or in the files of individual field personnel at the discretion of the project manager.

8.0 DATA AND RECORDS MANAGEMENT

Copies of field notes are retained in the project file. Original field notebooks are maintained in the project file, or in the files of individual field personnel at the discretion of the project manager. Completed (filled) notebooks should be placed in the project files or the Data Quality Department notebook library, at the discretion of the project manager. Copies of field notebooks should be updated in project files at the end of each field event.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

Standard procedure requires review of field notes by a person other than the person who recorded the field notes, prior to entering the information into the project files, to check for inaccurate, incomplete, or unclear entries, blank pages, or other problems with documentation. Peer review of notebook entries should also be conducted at least once per day during field activities.

10.0 REFERENCES

Hydrometrics' HSOP-002: Determination, Identification, and Description of Field Sampling Sites

Hydrometrics' HSOP-029: Labeling and Documentation of Samples

11.0 APPROVED

Approved By	Title	Signature	Date
Michael Wignot	Principal/Senior Engineer	Michael M. Wignot	6/2004

STANDARD OPERATING PROCEDURE

HSOP-105

LOW FLOW/MINIMAL DRAWDOWN

GROUNDWATER SAMPLING FOR MONITORING WELLS

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

Collection of representative groundwater samples requires the use of appropriate standard procedures, using equipment and methods that will maintain the chemical, physical, and biological integrity of the water sample and therefore accurately represent the characteristics of groundwater within the aquifer. Typically, groundwater samples are collected using a “standard purge procedure,” where a minimum number of well volumes are purged from the well while monitoring field parameters for stabilization, and samples are collected after removal of the required volume of water has occurred and stabilization of parameters has been demonstrated (USGS, 2006). In certain circumstances, however, use of an alternative low flow/minimal drawdown purging and sampling technique is warranted. HSOP-105 presents guidelines for implementing the low flow/minimal drawdown purging and sampling method for groundwater sampling.

The methods described in HSOP-105 are based primarily on the *Groundwater Sampling Guidance* developed by the Montana Department of Environmental Quality (DEQ, 2018). This guidance was prepared to assist responsible parties, environmental professionals, and DEQ technical staff in performing appropriate groundwater sampling activities, including low flow sampling. The U.S. Environmental Protection Agency has also prepared useful documents including *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells from September 19, 2017* (USEPA, 2017). The EPA SOP reference should be consulted for additional suggestions and guidance on performing low-flow sampling. The purpose of this procedure is to provide a sampling method that will (1) minimize the potential impact of purging on groundwater chemistry, and (2) minimize the volume of purge water requiring disposal.

Implementation of the low-flow purging and sampling procedure will usually be specified in project planning documents (work plans, field sampling plans, and/or quality assurance plans). In general, HSOP-105 should be implemented at monitoring wells with a screen length of ten feet or less. While dedicated equipment is preferred to minimize potential disturbances due to placement of pumping equipment, the method may also be employed using non-dedicated equipment. Groundwater samples for the full spectrum of chemical constituents may be collected using the low-flow purge technique, including metals and other inorganics, and organic compounds (e.g., volatile, semi-volatile, PCBs, pesticides, herbicides).

This method is not generally applicable to water supply wells, which usually include dedicated pumps without the ability to accurately control purge rates. The low-flow method should not be used when non-aqueous phase liquids (NAPLs) are present within the well.

When performing low flow sampling in Montana, these procedures should be compared to the DEQ's Groundwater Sampling Guidance (DEQ, 2018). The intent of this SOP is to confirm to this DEQ Guidance; however, in the unlikely event of discrepancies in procedure, the DEQ guidelines should be followed.

2.0 SUMMARY OF METHOD

The low-flow purging and sampling method consists of the following steps:

- Measurement of the depth to groundwater;
- Installation of pumping equipment (if non-dedicated equipment is used) so that the pump intake is located at an appropriate location within the screened interval;
- Purging of the well at a low flow rate to maintain less than 0.3 feet of drawdown;
- Monitoring of field parameters at regular intervals (3 to 5 minute intervals are recommended for typical flow rates) to ascertain stabilization; and
- Collection of groundwater samples after field parameter stabilization has occurred.

Note that stable drawdowns of less than 0.3 feet, while desirable, are not mandatory (EPA, 2017).

3.0 HEALTH AND SAFETY WARNINGS

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of project-specific health and safety plans, along with site-specific and/or organization-specific safety requirements and training.

Hazards specific to groundwater sampling may include electrical shock hazards during operation of generators, pump control boxes, batteries, etc.; lifting hazards encountered during setting and retrieval of pumps; contact with groundwater and associated organic or inorganic contaminants; and contact with chemical preservatives. Appropriate personal protective equipment should be used at all times during field activities. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc. Good field practice also includes setting aside time prior to, during, and following field activities to consider potential health and safety issues and their resolution (e.g., "tailgate" safety meetings).

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

4.0 INTERFERENCES

Problems with the low-flow purging and sampling procedure may occur with extremely low-yield/low recharge wells, when drawdown of less than 0.3 feet cannot be maintained even at very low pumping rates. In general, these wells should be identified prior to field sampling, and a different purging/sampling technique should be utilized such as the use of special pumps capable of maintaining very low pumping rates (bladder, peristaltic). However, if low-yield conditions are encountered in new wells or wells where the situation has not occurred before, or the well is dewatered during sampling using the low-flow method, the EPA SOP (USEPA, 2017) gives the following recommendations:

> *the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.*

It is also recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

5.0 PERSONNEL QUALIFICATIONS

Personnel should be familiar with the project planning documents (work plans, field sampling plans, and quality assurance plans), as well as the overall project objectives. Review of well logs and previous sampling documentation regarding well total depths, screened intervals, pump intake depths, pumping rates, field parameter measurements, and other pertinent information should be reviewed prior to field activities. Personnel should also be proficient with the operation of equipment listed in Section 6.0 below. Site safety and training requirements (including HAZWOPER training) must also be met as necessary.

6.0 EQUIPMENT AND SUPPLIES

Minimum equipment requirements for implementing the low-flow method for purging and sampling groundwater include the following:

6.1 DOCUMENTS

- SAP/QAPP;
- HASP;
- Field data from previous events;
- Location maps, directions, site access requirements, phone numbers, etc.;
- Sampling documentation materials (field notebook, field sampling forms or data sheets, chain-of-custody documentation); and
- Relevant associated SOPs.

6.2 EQUIPMENT

- Water level probe for measuring depth to water.
- Device for measuring well total depth (steel tape and weight or other device), if total depth measurement is required.
- Sampling pump and associated equipment (submersible, bladder, or peristaltic pump and tubing, power supply). Pumps and tubing should be constructed of inert materials appropriate for the target analytical constituents, such as stainless steel, high-density polyethylene, Teflon®, or similar materials. Pump tubing should be graduated to allow for accurate placement of the pump intake at a specified depth.
- Flow measurement equipment, such as an inline flowmeter, calibrated bucket and stopwatch, or graduated cylinder.
- Field parameter meters (multiple single-parameter type, or multiparameter meters). Indicator parameters for groundwater sampling typically include pH, specific conductance (SC), dissolved oxygen (DO), and water temperature. Turbidity measurements and oxidation-reduction potential (ORP) may also be monitored. The list of required field parameters will usually be included in the project planning documents.
- Flow-through cell. The flow-through cell should be relatively small ($\leq$ 1 liter), and a manufactured and completely closed (threaded) cell is preferred. The discharge line to the flow-through cell should be separate from the discharge line used for collection of samples using the necessary fittings (usually tees and valves).
- Power source(s) for computer, pump, etc. (non-petroleum powered power source preferred, otherwise additional sampling precautions should be taken to prevent sample interference for sampling for SVOCs and hydrocarbons).
- Resource grade GPS (as necessary).

6.3 MATERIALS AND SUPPLIES

- Sample collection supplies (e.g., bottles, labels, preservatives, filters, coolers, nitrile gloves);
- Pens, markers sample tape etc.;
- Decontamination supplies;

- Chain of custody forms; and
- Ice for preserving laboratory samples.

7.0 PROCEDURE

1. Position vehicles for sampling such that any vehicle or generator exhaust is produced downwind of the sampling area.
2. Remove well cap and measure depth to groundwater from the designated measuring point (and total well depth, if required). Total well depth may also be obtained from well logs or previous measurements. Record information in field notebook and on field forms. Occasional re-measurement of depth to water is recommended to confirm initial measurement, and the reproducibility of the depth to water measurements.
3. Calculate one casing volume (volume of water in the casing) using the formula V=0.0408 x (TD-SWL) x (D^2), where TD is the well total depth (feet below measuring point), SWL is the depth to water (feet below measuring point), and D is the well casing inner diameter (inches). Record information in field notebook and on field sampling form.
4. For sampling with non-dedicated equipment, place the pump and tubing slowly and carefully into the well to avoid agitating the water or generating turbidity, setting the pump intake at the pre-determined location within the well screen interval, or at approximately the center of the screened interval if no location is specified. For dedicated systems, the pump will already be installed with the intake at the desired depth.
5. For sampling with non-dedicated equipment, remeasure the depth to water after the pump has been placed in the well, and record in field notebook and on field form. The water level probe or measuring device should be left in place at this time to allow for measurement of drawdown during the purging/sampling procedure.
6. Connect pump tubing to discharge line and flow-through cell line. Make electrical connections to allow operation of pump. Direct discharge line and flow-through cell waste line into containers to contain purge water, if required by the project sampling plan. Alternatively, direct purge water to the ground away from the well head and from electrical equipment.
7. Begin pumping at a low rate while monitoring drawdown using water level probe. Records from previous monitoring events may also provide guidance on appropriate pumping rates for a particular well. Slowly increase pump rate while maintaining drawdown of less than 0.3 feet. Record pump rates and associated water level measurements on field documentation. In addition to minimizing drawdown, the final pumping rate should be low enough to avoid producing excessive turbulence or high levels of turbidity within the well. However, higher purge rates may be used for larger diameter wells, or if field parameter measurements, historic data, and/or drawdown measurements suggest that higher pumping rates do not compromise the representativeness of groundwater samples.
8. Estimate one "tubing volume" (volume of water in the pump, tubing, and flow through cell) using approximate length and inner diameter of pump tubing and volume of flow cell. After a minimum of one tubing volume has been purged, begin recording field parameter measurements (pH, SC, DO, water temperature, and, if indicated, turbidity and/or ORP) at three- to five-minute intervals. Water level measurements and pumping rate measurements (if varied) should also be recorded at this time. Note that the interval between field parameter measurements should allow sufficient time for the volume of water in the flow-through cell to

be completely replaced by fresh groundwater, so modifications to the three- to five-minute rule of thumb may be necessary.

9. Stabilization criteria are based on three successive readings of field parameters that agree to within the stabilization criteria given in Table 1. Criteria for turbidity and ORP are included in Table 1, although these parameters are less frequently included as required field parameters for groundwater monitoring projects. The USGS does not consider ORP a "routine field measurement" due to difficulties associated with the accurate measurement and interpretation of the data. This SOP specifies stabilization over three successive measurements during low-flow purging and sampling as adequate for the majority of applications.

Table 1. Low-Flow Groundwater Sampling Field Parameter Stabilization Criteria

Parameter	Stabilization Criteria[1]
water temperature	±0.2°C
specific conductance	±3% (SC>100) ±5% (SC<100)
dissolved oxygen	±0.2 to 0.3 mg/L
pH	±0.1 to 0.2 pH units
turbidity	±10%
ORP	±10 mV[2]

[1]Criteria from USGS (2012) unless otherwise noted.
[2]Criteria from DEQ (2018).

10. When stabilization criteria have been met, record final field parameter measurements and depth to water, and collect the groundwater sample. Maintain or slightly reduce the pumping rate for collection of samples, and collect the samples directly from the discharge port of the pump (i.e., do not collect samples after water has passed through the field parameter flow through cell, inline flow meters, or other equipment). Rinse sample containers three times with sample water prior to filling (the rinsing step may be ignored if bottles are provided "pre-preserved," with preservatives already placed in the container). Sample containers should be filled by allowing water to gently flow down the inside of the container, minimizing turbulence.
11. If field-filtered samples are required, an in-line filter should be placed at the end of the pump discharge tubing. A small quantity of sample water (250 to 500 mL) should be allowed to pass through the filter prior to rinsing of sample bottles and collection of samples. Filters are single-use only; discard filters after collecting a sample and do not reuse.
12. Preserve groundwater samples as appropriate for the analysis required, tightly cap containers, and place in coolers with ice for storage and transport.
13. Shut off pump and complete sample documentation (field notebook and field sampling forms). For non-dedicated equipment, disconnect electrical and pump tubing connections, and decontaminate equipment as required by the project planning documents.
14. Close and lock well.

8.0 DATA AND RECORDS MANAGEMENT

Copies of all field notes and documentation collected during the low-flow purging and sampling procedure will be maintained in a project file (hard copies) and/or on the network directory dedicated to the project (electronic files). Field documentation should include notes regarding any difficulties encountered during implementation of the procedure, and any modifications to or deviations from this procedure or any other prescribed methods outlined in the project planning documents.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

Quality control and quality assurance for low-flow groundwater sampling is similar to standard procedures for any type of water sampling, including adherence to methods stipulated in project planning documents, and collection and analysis of field quality control (QC) samples. Field QC sample types may include blanks (equipment rinsate blanks, trip blanks, bottle blanks, or other types), field duplicates, and standards (samples with known concentration) obtained from third-party vendors. The project sampling plan or quality assurance plan should be consulted to verify the frequency of field QC sample collection and to provide additional details concerning collection of these samples. In many cases, field blank and duplicate samples are collected at a frequency of 1 per 20 samples or 1 per day, whichever is more frequent.

10.0 REFERENCES

DEQ, 2018. Groundwater Sampling Guidance. March 6.

USEPA, Region I. 2017. Low Stress (low-flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells. Quality Assurance Unit, North Chelmsford, MA. Revised September 19.

USGS, 2006. Collection of Water Samples (v. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapter A4, National Field Manual for the Collection of Water-Quality Data.

USGS, 2012. Use of Multiparameter Instruments for Routine Field Measurements (v. 1.1). Chapter A6. Field Measurements, Section 6.8, National Field Manual for the Collection of Water-Quality Data. March.

USGS, 2013. Dissolved Oxygen (v. 2.0). Chapter A6. Field Measurements, Section 6.2, National Field Manual for the Collection of Water-Quality Data. September.

USGS, 2019. Specific Conductance Chapter A6. Field Measurements, Section 6.3, National Field Manual for the Collection of Water-Quality Data. February.

11.0 APPROVED

Approved By	Title	Signature	Date
Michael Wignot	Principal/Senior Engineer	Michael Wignot	9/2020

STANDARD OPERATING PROCEDURE

HSOP-110

WATER LEVEL MEASUREMENT WITH AN ELECTRIC TAPE

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

HSOP-110 presents guidance for collecting water level measurements with an electric tape. Measurements are typically collected as depth to water at groundwater monitoring locations (monitoring wells, water supply wells, piezometers), but may also be collected at surface water monitoring locations instrumented with stilling wells, or other locations where the water level distance from an established measuring point is of interest. The most accurate readings (±0.01 foot) are obtained at depths less than about 200 feet; at greater depths, the effects of tape stretching increasingly affect accuracy.

Manual groundwater level measurements may be used to calculate groundwater elevations and potentiometric surfaces, to estimate groundwater flow directions and gradients. They may also be collected during aquifer testing to monitor changes in water levels (drawdown and recovery), often in association with water levels recorded with pressure transducers as a check on the transducer data. In addition, groundwater level measurements are routinely used in conjunction with well depths during groundwater sampling activities to determine appropriate purge volumes, and are monitored during low-flow purging and sampling to ensure that water level drawdown is maintained within the specified range.

2.0 SUMMARY OF METHOD

This method uses a decontaminated graduated electric tape with a weighted probe and sensor on the end, marked with feet, tenths, and hundredths of a foot for the entire length. The tape is stored on a reel to allow efficient extension and retrieval; the reel also includes a battery to power the unit and a visual and/or audible signal to indicate when contact is made with the water surface. The weighted probe is lowered slowly into the well (or other measurement structure) until the visual/audible signal occurs. The tape is slightly raised and lowered several times to determine as accurately as possible when contact is made with the water surface. At the point of contact, the depth to water is read to 0.01 foot directly from the graduated tape, referenced to a permanent measuring point marked on the well casing or other structure. If the tape is graduated in intervals other than 0.01 foot, the distance from the contact point to the nearest gradation is measured with a 0.01-foot graded engineer's tape measure, and the depth to water calculated by addition or subtraction.

The depth to water, measurement date, and measurement time are recorded on the appropriate field documentation. The tape is then retrieved and decontaminated prior to use at another location; if multiple measurements are to be collected in a short period of time at the same location (e.g., during aquifer testing or well purging), the tape may be retrieved a short distance above the water level and left suspended in the well using a brake on the reel.

3.0 HEALTH AND SAFETY WARNINGS

Minimum personal protective equipment (PPE) to be worn during collection of water level measurements procedures consists of safety glasses/goggles and protective gloves (leather or fabric, and/or chemical-resistant gloves such as nitrile). Additional PPE may be required by the site-specific hazard assessment, Work Plan or Health and Safety plan, based on site conditions or known hazardous constituents present in site groundwater or other media. Personnel should be also aware of potential abrasions from well casings, which are often sharp or jagged, and biohazards such as venomous spiders.

In many cases, water level measurements are recorded at an extensive network of wells in as short a time period as practical, to ensure that data are collected under similar conditions to the extent feasible; thus, the water level measurement task can become repetitive and steps should be taken to minimize the potential for repetitive motion injuries. Personnel should use the shortest electric tape necessary for the depths to be measured, to minimize the weight of the equipment. When raising and lowering the water level probe, it is important that personnel have good footing, use proper posture and engage core muscles. Staying mentally focused on the measurement procedure will help prevent immediate and gradual (chronic) injuries. Throughout the day it is a good technique to switch arms occasionally or when fatigued from operating the reel. For deeper wells requiring longer reeling times, allow time to rest if needed. Injuries to the back, neck, shoulders, and arms are more likely if proper procedures are not practiced each and every time. At sites requiring frequent water level measurements (i.e., multiple daily or several times per week), automated water level recording should be considered, especially when depths to water exceed 50 feet.

Field personnel should be aware of the health and safety precautions to be followed during any field event, and should be familiar with any project-specific hazards. This may include review of task-specific Hazard Assessments (HAs), Job Safety Analysis (JSAs), project-specific health and safety plans (HASPs), site-specific and/or organization-specific safety requirements and training.

4.0 INTERFERENCES

The following potential interferences should be considered during water level measurement activities:

- Very low conductance (dilute) water may cause inaccurate readings, as the probe signals are based on completion of an electric circuit through the water.
- Material on the water surface such as light non-aqueous phase liquid (LNAPL) or other contaminants may interfere with obtaining consistent readings; for these situations, an interface probe specifically designed for such conditions should be used.
- Non-static conditions (pumping wells, cascading wells) may complicate or prevent accurate water level measurement. These conditions should be documented in field notes.

- Areas with tidal influence may experience unstable water levels over the period required to collect measurements at multiple wells. Careful documentation of measurement times and the relationship to tidal schedules is important in these situations.
- Some time for groundwater level equilibration may be required after removal of tightly-sealed well caps or plugs. Refer to project planning documents and field notes from previous measurement events, or collect multiple water level measurements to assess water level stability.
- Water supply wells or monitoring wells with dedicated pumps installed for sampling will often have tubing, wire, or other equipment within the well casing. Water level tapes may become entangled and difficult to lower or retrieve. Use stilling wells or dedicated water level measurement ports if present; if these are not present, use extra caution when lowering and raising probe.

5.0 PERSONNEL QUALIFICATIONS

Personnel collecting water level measurements should be familiar with the function and operation of the water level measurement equipment, and with the objectives of the measurement activities as outlined in the project guidance documents (such as a Work Plan or Sampling and Analysis Plan). Familiarity with the well locations and conditions will increase the efficiency of measurements; when assigning personnel to a water level measurement task at a new or unfamiliar site, budget additional time for field activities.

6.0 EQUIPMENT AND SUPPLIES

- Electric water level tape continuously graduated to 0.01 foot (graduation in other intervals will also require use of a 0.01-foot graded engineer's tape to complete measurements to 0.01 foot);
- Extra batteries;
- Well access tools (wrenches, pliers, etc.) and keys;
- Field notebook and/or field forms;
- Record of previous water level measurements;
- Decontamination supplies (may include spray bottles, deionized (DI) water, non-phosphate detergent, organic solvents, paper towels); and
- PPE (protective gloves, eye protection).

7.0 PROCEDURE

1. Inspect the electric tape prior to using it in the field, checking for wear, kinks, frayed electrical connections, and battery function. Replace battery if necessary. Check correct operation of the electric tape with testing button, and/or by lowering the probe into tap water, confirming that the visual/audible signal operates correctly when the probe contacts the water surface.
2. In the field, remove well cap and allow water level to equilibrate. Determine the measuring point (MP) from which the water level is to be measured. The MP should be documented in field records, and in most cases consists of a permanent mark on the top of a well casing. If no mark is apparent or documentation is missing or unclear, personnel should measure both the total

well depth and the water level from a selected point, mark this measuring point, and note this procedure in the field documentation.

3. Using appropriate PPE and taking care not to touch the probe or tape to the ground surface, lower the probe slowly into the well until the visual/audible signal indicates contact with the water surface. Avoid running the tape across the edge of the well casing, as this may cause excessive wear on the tape. Do not lower the probe any deeper into the water than necessary to determine the water level.
4. Slightly raise and lower the probe across the water surface several times to carefully check the contact point. Read the depth to water at the MP directly from the tape, or pinch the tape at the MP when contact is made and read the depth at this point.
5. If the electric tape is graduated in intervals other than 0.01 foot, measure the distance from the contact point to the nearest gradation with a 0.01-foot graded engineers tape, and calculate the depth to water by addition or subtraction as appropriate.
6. Record the date, time, and depth to water to the nearest 0.01 foot on field forms and/or in the field notebook. Compare the current measurement to previous measurements at the same location for consistency. If an unusually large discrepancy is noted, recheck water level to confirm. Multiple measurements should also be made periodically throughout the day, even at locations where current measurements agree with previous measurements, as a check on the reproducibility of the procedure.
7. If multiple readings are to be collected as part of aquifer testing, well purging, or similar activities, retrieve the probe a short distance above the water level and leave the tape suspended in the well using the brake on the reel.
8. After completing measurements, retrieve the probe slowly onto the reel, again taking care not to run the tape across the edge of the well casing. Decontaminate the probe and any section of the tape that was submerged in the water, using the decontamination procedures specified in the project planning documents. In most instances, thoroughly rinsing with deionized (DI) water and drying with paper towels is sufficient for locations where inorganic constituents are of concern. Non-phosphate detergent and/or organic solvents such as acetone, followed by a DI water rinse may be used where organic constituents are of concern.
9. At some locations, bacterial growth, rust, or other foreign materials may necessitate additional decontamination of the entire tape length that was lowered into the well. Dilute bleach solution may be used for bacterial decontamination, while detergent and DI rinses should be sufficient for rust.
10. Electric water level tapes should be stored clean, dry, and fully reeled.

8.0 DATA AND RECORDS MANAGEMENT

Water level measurements and procedures, including the measurement value, date, time, MP identification, and any other pertinent field information will be recorded on field forms and/or in field notebooks. Original field documentation should be scanned into electronic format and originals archived in the project file when field activities are complete.

Calibration log books for electric water level tapes are maintained in each Hydrometrics office, in a location near where the equipment is stored.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

- Electric water level tapes should be calibrated annually, at a minimum, with calibration results recorded in a dedicated log book. Calibration consists of comparing the electric tape to a similarly-marked (0.01 foot) reference steel tape, maintained in the office for calibration purposes, as follows:
  - The distance from the probe sensor to the nearest foot mark on the tape is checked to ensure that this distance corresponds to a sensor position of zero feet.
  - The electric tape and steel tape are stretched out straight on the ground, and the length/distance marks are compared.
  - Water level measurements in a convenient well made with the electric tape may be compared to those made with the reference steel tape (or with a second electric tape that was recently calibrated against the steel tape). Measurements should agree to within ± 0.03 feet.
  - If the electric tape appears to be inaccurate based on calibration, it should be replaced; correction factors may be developed but their use is not recommended.
- Use of spliced or otherwise repaired electric water level tapes is discouraged. If such equipment is to be used, careful calibration of the electric tape and full documentation of any correction factors is required.
- Measuring points used for referencing water level measurements should be surveyed to a sufficient level of vertical accuracy to allow calculation of water elevations to ±0.01 foot, or as outlined by the project planning documents. Survey data may be tied to an established vertical datum (i.e., North American Vertical Datum or NAVD 88), or to a local arbitrary datum as dictated by project needs.
- Total well depths should be verified periodically by lowering a weighted tape to the bottom of the well and noting the depth where the weight is felt resting on the well bottom. Some electric well tapes are not rated for submersion, so steel tapes are preferred over electric tapes to measure total well depths. If electric tapes are used to measure total well depths, note that the measurement may need to be corrected for the length of the probe beneath the water level sensor (if the sensor is not at the end of the probe), since the tape distance markings are referenced to the sensor electrode.

10.0 REFERENCES

United States Geological Survey, 2006. National Field Manual for the Collection of Water-Quality Data. Chapter A4 – Collection of Water Samples. Appendix A4-B: Instructions related to measuring water levels at wells and a sample USGS ground-water-quality field form. September 2006.

United States Environmental Protection Agency, 2016. Region 4 Science and Ecosystem Support Division Operating Procedure SESDPROC-105-R3: Groundwater Level and Well Depth Measurement. November 2016.

11.0 APPROVED

Approved By	Title	Signature	Date
Robert Anderson	Principal / Senior Hydrogeologist	Rut e ll	4/6/2020