



Olympus Technical Services, Inc.

September 30, 2026

Edvard Melesh
Environmental Project Officer
Montana Department of Environmental Quality
Petroleum Tank Cleanup Section
P.O. Box 200901
Helena, MT 59620-0901

Re: Work Plan Requested to Monitor Petroleum-Contaminated Media at Schiller's Service
319 E Main Street, East Helena, Lewis and Clark County, Montana;
Facility ID 25-01316 (TID 23410), Release No. 0735; DEQ Work Plan ID No. 35245
Olympus Work Order No. A1031

Dear Mr. Melesh:

Olympus Technical Services, Inc., (Olympus), on behalf of Mr. Gary Schiller, is submitting this Groundwater Monitoring Work Plan for the above-referenced facility (Site). The Montana Department of Environmental Quality (DEQ) Petroleum Cleanup Section requested a work plan in correspondence dated August 26, 2026. The purpose of the work is to assess and redevelop the existing well network, monitor groundwater conditions, prepare a Groundwater Monitoring Report, and to evaluate remedial actions necessary for closure of the release.

Site Description

The Site is located at 319 East Main Street in East Helena, Montana. The Site occupies a portion of the southeast $\frac{1}{4}$, southeast $\frac{1}{4}$, southwest $\frac{1}{4}$, of Section 25, Township 10 North, Range 3 West, Principal Meridian Montana. A Site location map is shown on Figure 1 and a Site layout map is shown on Figure 2. The Site historically operated as a gasoline service station since the early 1970s, but fuel service operations ceased prior to November 1989 when the fuel dispenser pumps located north of the facility building were removed. In March 1990, the underground storage tanks (USTs) located west of the building were removed, followed by the dispenser piping located north and west of the building removed in May 1991. The former station building is currently used for storage.

Previous Site Investigations

The release was discovered in May 1991 when petroleum-impacted soil was encountered during UST piping removal at the gasoline dispenser island and reported to the Montana Department of Health and Environmental Sciences (DHES). One 4,000-gallon unleaded gasoline UST (installed in 1971) and one 10,000-gallon regular gasoline UST (installed in 1974) were removed from the Site in March 1990. One soil sample collected at a depth of approximately 12 feet indicated gasoline-range impacts, though the results were not available for review. Approximately 7 cubic yards of impacted soil was transported to a landfarm for treatment. The excavation was approximately 5 feet wide by 12 feet long and approximately 6 feet deep. The impacts with highest volatile organic carbon (VOC) response were reportedly observed in a clay-sand layer at approximately 4 feet below ground surface (bgs). The landfarm was sampled in October 1998 and was non-detect for gasoline constituents.

In April 1996, a Phase I Remedial Investigation (RI) was conducted at the Site using a hollow-stem auger. Several soil borings near the dispenser island area had refusal on alluvial cobbles and boulders in the subsurface before the groundwater interface was encountered. The field work was postponed to September 1998 and a soil boring was advanced to a total depth of 30 feet bgs using air rotary drilling and completed as monitoring well M1. No soil samples were collected for laboratory analysis. Field screening indicated petroleum impacts between 15 to 20 feet bgs near the dispenser island. A groundwater sample was collected and analyzed for MTBE, benzene, ethylbenzene, toluene, and total xylenes (MBTEX) and all constituents exceeded RBSLs established at that time. The Phase I RI recommended additional Site characterization.

A Phase II RI was conducted in March and April 1999 and included installation of three monitoring wells, M2, M3, and M4 via air rotary methods. No soil samples were collected for laboratory analysis. The wells were completed at a depth of 27 feet bgs. Well M4 was installed upgradient of the former fuel system, and M2 and M3 were installed north and northwest (assumed downgradient). Groundwater samples collected from wells M1 and M3 contained MBTEX concentrations exceeding the Human Health Standards (HHS) at that time, while the samples collected from wells M2 and M4 were non-detect for all MTBEX analytes. The groundwater flow direction was determined to be north to northeast, and installation of additional downgradient wells to the northeast was recommended.

In November 1999, hydraulic conditions at the Site were assessed with a slug test. In March 2000, a soil vapor extraction (SVE) system began operating on the north end of the Site, and well M1 was converted to a vapor extraction well. Performance sampling of the SVE system occurred weekly during the first month of operation, then monitoring frequency was reduced to monthly. VOC concentrations consistently exceeded 1,000 parts per million (ppm). Tedlar bags were used to collect air samples from the system and were analyzed at an analytical laboratory for MBTEX and gasoline-range organics (GRO). Monthly SVE monitoring between March and December 2000 displayed a decreasing trend for hydrocarbon concentrations analyzed by the laboratory. Approximately 750 lbs of gasoline was calculated to have been extracted from well M1 in 2000. Approximately 1,676 lbs of gasoline was calculated to have been extracted from well M1 in May 2001, and 2,362 lbs of gasoline was calculated to have been extracted from well M1 in October 2001. By February 2002, an estimated 2,493 lbs of gasoline had been extracted from well M1.

A Phase III RI was conducted in May 2000 and included installation of one downgradient monitoring well, M5. Groundwater samples collected from wells M3, M5, and an onsite water supply well. MBTEX was not detected in the groundwater sample collected from the water supply well. The sample collected from M3 exceeded the HHS for MBTEX, and the sample collected from M5 exceeded the benzene HHS only.

In December 2002, monitoring well M6 was installed east of well M3 to delineate the boundaries of gasoline impacts in groundwater. Wells M2 through M6 were sampled for volatile petroleum hydrocarbons (VPH). The groundwater sample collected from well M3 contained VPH analytes exceeding HHS/risk-based screening levels (RBSLs) for all VPH analytes except toluene.

Groundwater monitoring and SVE system O&M conducted between June 2003 and February 2004 indicated approximately 2,784 lbs of gasoline had been extracted from well M1, and VPH impacts were present in well M3.

DEQ requested a work plan for continued groundwater monitoring and SVE system O&M; however, Olympus had recommended modifying the system to include air sparge for wells M1

and M3. Discussions between DEQ, Olympus, and the property owner did not result in an approved work plan.

A work plan request was issued by DEQ on August 26, 2026 to locate and assess the condition of groundwater monitoring wells, redevelop existing wells, and conduct one year of semi-annual groundwater monitoring to characterize current Site conditions. If major well repairs or replacement needs are identified during the well assessment, the change in scope as well as request for additional funding will be submitted by a Form 8.

Scope of Work

Site Assessment and Well Redevelopment

Multiple construction projects have been completed in the vicinity of the Site since the six onsite monitoring wells were last sampled in February 2004, including Main Street resurfacing and City Hall facility upgrades in 2007. Olympus proposes a Site Assessment to be conducted before the groundwater monitoring event, to include locating, collecting fluid level measurements, and redevelopment of all six monitoring wells. This will ensure that any missing or damaged wells can be evaluated and arrangements can be made to repair or replace wells if needed prior to the first groundwater monitoring event. If any existing monitoring wells are not located, or have been damaged since 2004, Olympus will discuss possible repairs or installing replacement wells with the DEQ project manager.

All Site wells will be redeveloped using a development pump and surge block. Each well will be surged a minimum of three times and purged until the water appears clear. Since the wells have been out of use for more than 20 years, excessive sediment may have accumulated at the bottom of the well. Olympus will attempt to remove as much sediment as possible during redevelopment activities. Purge water will be disposed of according to DEQ's *Disposal of Untreated Purge Water from Monitoring Wells* Guidance. Disposal costs are not included in this estimate since purge water has historically been discharged to the surface, per DEQ's guidance. Groundwater sampling will not be conducted for at least one week following development.

Groundwater Sample Collection and Analyses

Semi-annual groundwater monitoring events will be conducted at the Site during approximate low and high groundwater conditions in 2027 (anticipated May/June and October/November). Groundwater monitoring will include measuring static water levels (SWLs) using an electronic water level probe. The SWL data will be used to develop a potentiometric map of the groundwater table.

Groundwater samples will be collected from all Site monitoring wells using a bladder pump operating under low-flow steady state conditions. Field parameters will be measured in 3-5 minute intervals during groundwater purge, including dissolved oxygen (DO), oxygen reduction potential (ORP), pH, specific conductivity (SC), temperature, turbidity, and pumping water levels. Upon groundwater parameter stabilization, groundwater samples will be collected into laboratory supplied containers, preserved, stored on ice, and submitted under chain-of-custody procedures to Energy Laboratories (Energy) in Helena, Montana. The samples will be analyzed for VPH and extractable petroleum hydrocarbons (EPH) screen. Groundwater samples exceeding DEQ's fractionation limit of 1,000 micrograms per liter ($\mu\text{g/L}$) for EPH screen may be further analyzed for EPH fractions upon review of the analytical results. During the first groundwater monitoring event, groundwater samples will also be analyzed for lead scavengers of 1,2-Dichloroethane (DCA) and 1,2-Dibromoethane (EDB). Lead scavengers will only be included in subsequent events if analytes are detected at concentrations above the HHS.

Quality assurance/quality control (QA/QC) procedures will be followed to test for the provision of reliable, accurate, and defensible data. QA/QC samples will be collected to verify the precision and accuracy of the laboratory generated data. One duplicate groundwater sample will be collected per event to test for precision related to sampling methods. Field duplicates will be analyzed for VPH and EPH only.

Release Closure Plan Update

The Release Closure Plan (RCP) developed by Northwind Portage in August 2020 will be updated for the Site based on results of all investigative and remedial activities conducted to date. The RCP will be included with the Groundwater Monitoring Report, and will include discussion and results of all investigative, post-investigative, and corrective action, as well as evaluation of the conceptual site model, exposure pathways, possible data gaps, and remedial alternatives.

Groundwater Monitoring Report

Olympus will present the results of the 2027 groundwater monitoring events in one Groundwater Monitoring Report. The summary report will include a discussion of groundwater monitoring results, site maps, tabulated analytical data, groundwater sample information forms, analytical laboratory reports, data validation summary, time trend graphs, and conclusions and recommendations based on the monitoring results.

Cost Estimate

Work Plan development, groundwater monitoring and sample collection, and report preparation will be invoiced at unit cost rates approved by the Petroleum Tank Release Compensation Board (PTRCB). Project management will be invoiced on a time and materials basis. A unit cost worksheet for groundwater monitoring is attached to this work plan.

Schedule

Olympus appreciates the opportunity to assist you with this project. Site work will commence upon approval of the work plan by DEQ and obligation of mutually agreed upon funds by PTRCB. The groundwater monitoring event is tentatively scheduled for May-July 2027. Please contact me at (406) 443-3087 or dtackett@olytech.com with comments or questions regarding the proposed scope of work or the project.

Sincerely,

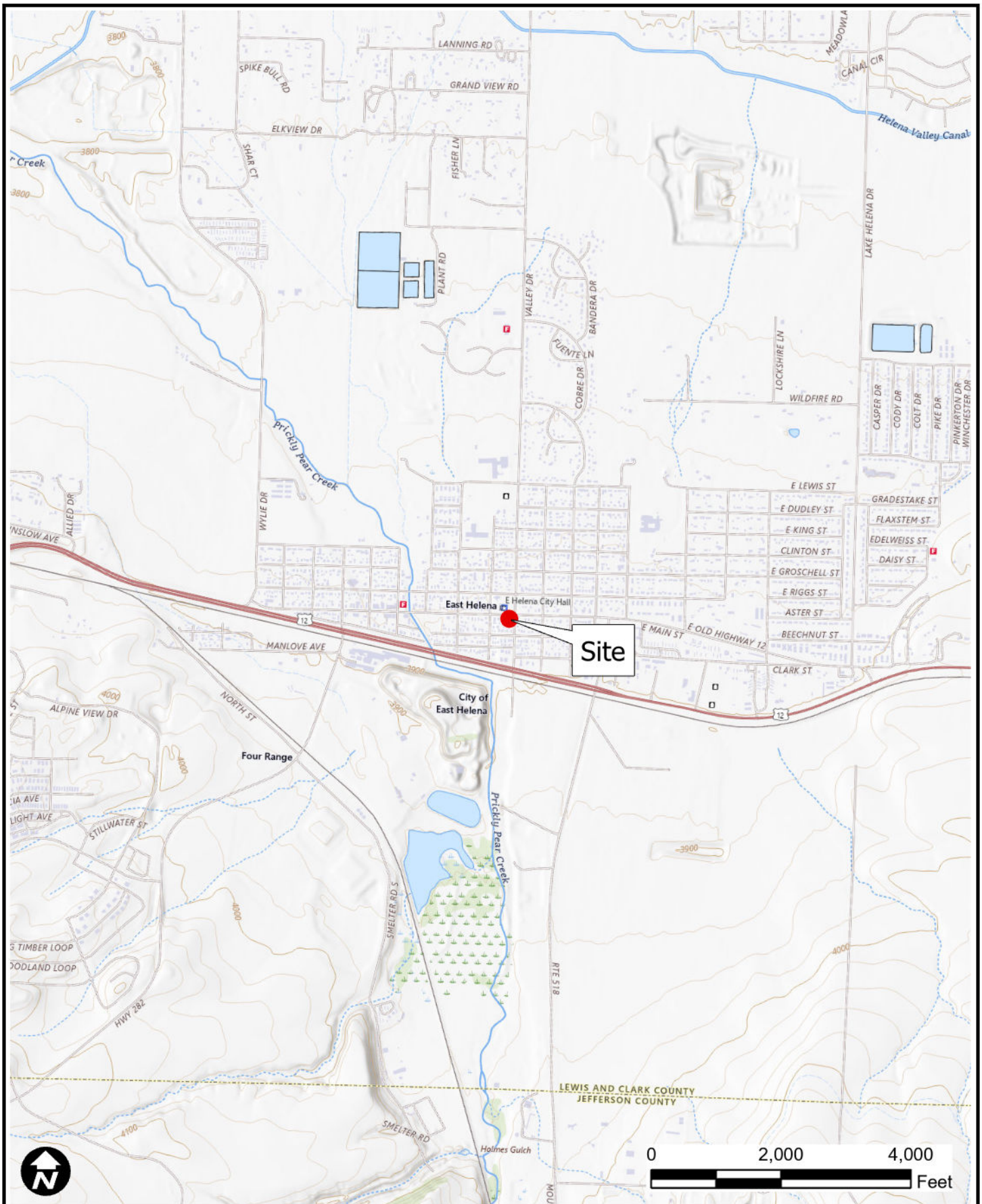
Olympus Technical Services, Inc.



Diane Tackett, PG
Project Geologist

Attachments: Figures 1 & 2, Detailed Cost Estimate, and Groundwater Monitoring and Sampling Unit Cost Worksheet, Olympus' Standard Operating Procedures

cc: Mr. Gary Schiller, owner



Olympus Technical Services, Inc.

Site Topographic Map
Former Schiller's Service
East Helena, Montana

**FIGURE
1**



Olympus Technical Services, Inc.

Site Features Map
Former Schiller's Service
East Helena, Montana

**FIGURE
2**

Olympus Technical Services, Inc. Cost Estimate**Date:** 9/23/2026**Client:** Gary Schiller**Project Name:** Former Schiller's Service**Olympus Project/Proposal No.:** A1031**ODC** 7%

Task	Quantity	Unit
Task 1 - Work Plan		
Standardized Groundwater Monitoring	1	Each
Task 2 - Project Management		
Project Geologist	8	Hours
Task 3 - Mobilization		
Tech III - Well Locate and Redevelopment, 1 Trip	10	Mile
Tech III - Groundwater Monitoring, 2 Trip	20	Mile
Task 4 - Well Locate and Redevelopment		
Tech III - Well Locate and Redevelopment	6	Each
Metal Detector	1	Day
Task 5 - Groundwater Monitoring		
Fieldwork		
GWM Setup	2	Each
Groundwater Monitoring (2 events)	12	Well
Duplicate Sample Modifier	2	Each
Task 6 - Laboratory Analytical Fees		
VPH	14	Each
EPH Screen	14	Each
EPH Fractionation	6	Each
EDB	6	Each
DCA	6	Each
Laboratory Disposal Fee	14	Each
Sample Fee	14	Each
Task 7 - Release Closure Plan		
Update RCP	1	Each
Task 8 - Data Validation		
Data Validation	2	Each
Task 9 - Reporting		
Groundwater Monitoring Report	1	Each

Comments/Notes:

- 1.
- 2.
- 3.

STANDARD OPERATING PROCEDURE

Groundwater Sampling (GW-1)

This Standard Operating Procedure (SOP) covers multiple volume purge and low-flow methods of groundwater sampling from a well.

1.0 Equipment:

Purge Water Containment*	Bailers with Line*
Five Gallon Bucket	Tubing*
Electronic Water Level Probe or	Filter(s) and accessories*
Oil-Water Interface Probe*	Sample Containers
Meters: pH, Specific Conductivity, Dissolved	Preservatives*
Oxygen (DO), Oxidation-Reduction	Decontamination Supplies
Potential (ORP), Turbidity (low flow)	Coolers with Ice
Pump (Peristaltic, Bladder)	Field Sampling Forms
Compressor or Compressed air cylinder for	Field Notebook
bladder pump	Chains-of-Custody
Power Supply (for pump)	Indelible Ink Pen(s)
Graduated cylinder or other calibrated	Personal Protective Equipment
container for measuring flow rate	Sampling and analytical plan (SAP)

*As required by site-specific SAP or Site conditions

2.0 Groundwater Sampling Sequence

The sampling sequence within a specific site should begin with the well containing the lowest anticipated analyte concentration. Successive samples will be obtained from wells anticipated to have increasing analyte concentration. If the relative degree of suspected concentrations cannot be reasonably assumed, wells will be sampled in order of increasing proximity to the suspected analyte source area, preferably from the perimeter towards the center of the site, and, if the groundwater flow direction is known, preferably in the order of up-gradient, cross-gradient, down-gradient, then in the vicinity of the suspected analyte source.

3.0 Instrument Calibration

Calibrate instruments at the beginning and end of each day following the appropriate SOP. Document calibration procedures in the field notebook.

4.0 Decontamination

All reusable sample equipment that comes into contact with groundwater shall be decontaminated prior to use at each well following the procedures in the site-specific SAP. This includes but is not limited to the static water level probe/cable and bladder pump barrel.

Decontamination is typically conducted using a phosphate-free soap (e.g. Alconox) water wash, distilled water rinse, isopropyl alcohol wash, nitric acid wash (if metals analysis is to be conducted) and final distilled water rinse procedure.

5.0 Water Level Measurements

Measure static water levels in the wells prior to sample collection and prior to installing the pump and tubing (if a dedicated pump is not already in place). If the well is equipped with a dedicated pump, then measure the static water level prior to purging. Because water levels may fluctuate on a short-term basis, measure the static water levels in all site wells within a relatively short period of time.

If non-aqueous phase liquid (NAPL) is suspected to be present, use an oil-water interface probe to test for its presence. Follow the meter-specific operating instructions for the measurement.

If NAPL is not suspected to be present, utilize an electronic water level probe. Check the operation of the meter by turning on the indicator signal switch and pressing the test button on the side of the reel. The buzzer should sound, and the indicator light should illuminate. If the water-level indicator signal(s) is not functioning properly, replace the batteries and/or use a different meter.

Holding the device atop the casing, lower the cable gradually into the well or piezometer until the indicator contacts the water surface. Contact with the water surface is indicated by a buzzer sound and illumination of the indicator light. Stop lowering the cable. Note the point on the graduated cable that corresponds to the measuring point at the top of the casing when the electronic circuit is first completed. If the measuring point is not designated on the well casing, then use the north side of the casing. Draw the cable at least one foot above the water level, then lower it until the indicator contacts the water surface. If the readings differ by more than 0.02 feet, then repeat until the measured readings stabilize. Record the water level to the nearest 0.01 feet.

6.0 Purging

Sampling can be performed via multiple volume or low flow methods, depending on the SAP requirements. Record all field measurements in a field notebook or field sampling form. Example field sample forms are attached to this SOP.

Multiple Volume Purging Procedure

- a) Before purging each well, measure and record the depth to water from the designated measuring point on the well casing to the nearest 0.01 foot using an electronic water level meter.
- b) Purge a minimum of three well volumes using a pump or bailer. The following equations can be used to calculate one well volume. The first equation gives the results in cubic feet (V1), and the second equation gives the results in gallons (V2):

$$V1 = 0.0057 * (d*d) * W$$

$$V2 = 0.043 * (d*d) * W$$

Where:

d = the well casing diameter in inches (in); and

W = the depth of water in the well casing measured in feet, calculated by subtracting the measured depth to water in the well from the total well depth.

Example: Monitoring well diameter = 4-in diameter
 Water level = 25.5 ft below ground surface (bgs)
 Well depth = 36.0 ft bgs

Therefore, the well has 10.5 ft of water column.

Using equation 1:

$$V1 = 0.0057 (4\text{in} * 4\text{in}) * 10.5\text{ft}$$

$$V1 = 0.92 \text{ cubic ft}$$

Or using equation 2:

$$V2 = 0.043 (4\text{in} * 4\text{in}) 10.5\text{ft}$$

$$V2 = 7.2 \text{ gallons}$$

Therefore, 3 well volumes = 3 x 0.96 cubic ft = 2.86 cubic ft

or

3 well volumes = 3 x 10.5 gallons = or 21.5 gallons

would be the minimum three well casing volumes that need to be purged from the well.

- c) When using a downhole down-hole DO meter, lower the DO meter into the well to the approximate level of the pump intake and start the meter.
- d) The well will be purged and samples will be collected using a disposable hand-bailer, a peristaltic pump, a positive displacement (bladder) pump and/or a disposable polyethylene or Teflon-lined polyethylene tubing. If pump and tubing are not dedicated to the well, the bladder pump will be decontaminated and new tubing or bailers will be used for each subsequent well location. The pump intake should be placed within the well screen and near the middle of the water column. Field parameters (typically DO, pH, temperature, ORP, and specific conductance) should be measured at 1, 2, and 3 well volumes to ensure that all stagnant water has been removed from the well and that water quality parameters have stabilized.

Note: If a well is evacuated during purging, it will be allowed to recharge until the water level has recovered to 80 percent of the static level or for a period not exceeding 24 hours before sampling. If it has not recovered sufficiently to allow sampling after 24 hours, this well will be noted as "dry" during the sampling event.

- e) Purge water will be handled in accordance with the site-specific SAP and SOP G-6.

Low Flow Purging Procedure

- a) Samples will be collected with a peristaltic (for inorganics only) or bladder (for any analytes) pump. Use new disposable tubing and bladders for collection of each sample.
- b) Non-disposable equipment that comes into contact with the sampled water (e.g. bladder pump body) must be decontaminated prior to collection of each sample.
- c) Slowly lower the pump or disposable polyethylene tubing into the well until the pump intake is located approximately the midsection of the saturated screened interval. The depth interval of the well screen will be provided in the site-specific SAP. For wells with screens longer than 10 feet, the primary flow zones and target depth for the pump intake should be identified in the site-specific SAP.
- d) The well will be pumped at a rate of 100 to 500 milliliters per minute and the water level monitored approximately every five minutes. A steady flow rate will be maintained that results in a stabilized water level, ideally with a drawdown of 0.3 feet or less. Monitor water levels at a minimum of 5-minute intervals and record the measurement on the field sampling form or in the field notebook.
- e) Place meters in the flow through cell prior to initiating pumping and record every parameters at a minimum of 5-minute intervals; including, turbidity, pH, oxidation-reduction potential (ORP), temperature, specific conductance (SC), and dissolved oxygen (DO). Record the parameters in a data logger, on the field sampling form, or in the field notebook. The well will be considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:
 - <10 NTU (turbidity) for three consecutive readings or three consecutive readings within 10% of each other
 - ±0.1 S.U. for pH
 - ±3% for specific conductivity
 - ± 10 millivolts ORP and
 - ± 10% dissolved oxygen or three consecutive values less than 0.5 mg/L

Depending on site conditions, parameters may not stabilize during pumping. If parameters do not stabilize, contact the project manager to select an appropriate course of action. Actions recommended by Montana DEQ include:

- Purge the well for a minimum of four hours prior to sampling if the static water level was stable prior to pumping, or
- Purge three well volumes from the well prior to sampling, or
- Discontinue purging and do not collect a sample.

Lack of stabilization of parameters shall be documented in the field logbook.

7.0 Groundwater Sample Collection

- a) Label each sample container with sample identification, date, time collected (military time), and preservative.
- b) Don latex or nitrile gloves prior to collecting sample. Without moving or turning off the pump, groundwater samples should be collected in order from most to least volatile analytes directly from the pump discharge tubing into laboratory supplied sample containers (do not collect sample downstream from any inline-flow device/meter). The pump rate may be decreased for sample collection in order to fill sample containers (sometimes necessary to fill volatile organic compound (VOC) sample vials) but the pump rate may not be increased. Samples collected using a bailer will be poured directly from the bailer into the sample jar. Preserve samples according to analytical requirements in attached table or site-specific SAP.
- c) Samples collected for volatile organic compounds (VOCs) are typically collected in 40-ml vials. Fill each sample bottle completely so the water forms a convex meniscus at the top to ensure that no air is trapped when sealing the sample container. No air bubbles should pass through the sample as the bottle is filled or be trapped in the sample when the bottle is sealed. Invert the sample container after it is preserved and sealed to verify the absence of air bubbles. If air bubbles are present, uncap the sample bottle, add more sample and repeat procedure. If air bubbles are still present, discard the bottle and re-sample. If air bubbles continue to be present in the sample bottle, it may be caused by the preservative reacting with alkaline water. In that case the sample may be collected without a preservative, but must be analyzed within 7 days of collection. For non-preserved samples, notify the laboratory as soon as possible that the samples will be delivered to them in an unpreserved condition and need to be analyzed within 7 days of collection. The laboratory will indicate when they will need to have the samples delivered by.
- d) Collect filtered samples by attaching the in-line filter directly to the sample discharge tubing and pump the sample through the filter directly into the sample container.

- e) Store samples on ice and submit for laboratory analysis according to chain of custody procedures specified in SOP G-4.

A list of common analytes and preservative requirements are described below.

Analysis	Number of Containers	Container Type	Preservation	Maximum Holding Time
VOCs	2	40 ml glass	4° C & HCL	14 days
SVOCs	2	1 liter glass	4° C	7 days
VPH	2	40 ml glass	4° C & HCL	14 days
EPH	2	1 liter glass	4° C & H ₂ SO ₄	14 days
Metals	1	500 ml Plastic	4° C & HNO ₃	6 months, 28 days Hg
Nutrients	1	500 Plastic	4° C & H ₂ SO ₄	Varies (contact lab)
Common Ions	1	1 liter Plastic	4° C	7 days

STANDARD OPERATING PROCEDURE GW-4

WELL DEVELOPMENT

Standard Operating Procedure Well Development (GW-4)

The monitoring wells, pumping wells, and piezometers shall be developed after construction is completed. The purpose of the development is to remove any remnants of drilling fluid and fine-grained material and to restore the natural permeability of the screened formation. At a minimum, the following development techniques shall be available to develop the wells.

1. Surging with plunger
2. High velocity jetting
3. Airlift pumping
4. Overpumping and backwashing with submersible pump
5. Bailing

The development methods will be selected in the field by the supervising hydrogeologist. This decision will be based primarily on the condition of each well after construction. A description of the methods is provided below.

The duration of the development process will be determined by the supervising hydrogeologist. The amount of turbidity in the discharge water will be used as a guide to determine that development is complete. In addition to turbidity, physical parameters including temperature, pH, and specific conductivity will be measured. Use of the field test equipment will be found in SOP H-3 for conductivity, SOP H-1 for temperature and SOP H-2 for pH. These parameters should be stabilized or changing by less than 10 percent between readings at the end of development. Visual observation may be used to determine that the discharge water is clear. Water produced during development will be discharged in accordance with the site-specific SAP. Personnel will wear protective clothing and use equipment specified in the site-specific Health and Safety Plan.

All procedures used and measurements taken during development will be recorded in the field logbook. This information will include time required, volume of water removed, turbidity readings, pumping rate, and observations made during the development process.

All development equipment must be decontaminated in accordance with SOP G-5.

SURGING WITH PLUNGER

The surging shall be done by solid surge plunger. The belting discs shall be cut to form a free fit in the casing.

Before starting to surge, water should be bailed or pumped from the well to make sure that some water will flow into the well. For operation, the surge plunger shall be lowered into the casing about 15 feet below the water level. The plunger shall be operated up and down in the well casing to exert equal or approximately equal force on the inward and outward movement of the water through the screen. A surge plunger should not be run in a plugged well. In no case shall the surge plunger be operated below the top of the screen. The surging shall be started slowly at first and the speed increased as the work progresses until it reaches the fastest limit at which the tools will drop and rise without excessive slap of the cable. Periodically, the plunger will be removed and the amount of fines accumulated at the bottom of the well will be measured using a weighted steel tape. If fines have been drawn into the well and have blocked 10

percent or more of the total screen length, the well shall be bailed or otherwise cleaned to the bottom between the surge plunger runs. The bottom of the well should be cleaned by bailer or air lift after surge development is completed.

HIGH-VELOCITY JETTING

This method should be used at the beginning of well development, so that any water introduced into the formation during jetting would be removed during later stages of the development. Development of the well shall be accomplished by high-velocity horizontal jetting with potable water of known chemistry. The jetting shall proceed from the bottom of the screen to the top. The outside diameter of the jetting tool shall be one inch less in diameter than the screen inside diameter. The maximum exit velocity of the jetting water at the jet nozzle shall be 150 feet per second. The jetting tool shall be rotated at a speed of less than one revolution per minute. It shall be positioned at one level for not less than two minutes and then shall be moved to the next level, moving more than 6 inches upward from the preceding jetting level.

AIR LIFT PUMPING

Development of the well shall be conducted by utilizing an air line and an air and water eductor pipe. The air line will be placed inside the eductor pipe with the end of the line near, but not extending below, the end of the pipe. Discharge of air from the air line shall always occur within the eductor pipe to prevent clogging of the filter pack and/or formation with air bubbles. Air lift development procedures should begin by determining that ground water can flow freely into the screen. Application of too much air volume in the well when the formation is clogged can result in a collapsed screen. To minimize the initial pumping rate, the air line and eductor pipe should be placed at shallow submergence. Once uninhibited flow to the screen has been established, the air line and eductor pipe should be lowered to approximately 5 feet above the bottom of the screen. Air will then be pumped through the air line causing displacement of the water in the eductor pipe and flow of water into the well. Development will continue by raising the air line/eductor pipe at approximately 5-foot intervals until the entire screen length has been pumped.

For the piezometers, which are not foreseen for sampling ground water, an alternate method of air lift may be used because of the small casing diameter. This method uses only an air line, and the well casing acts as the eductor pipe. The air line shall be placed at least 5 feet above the screen, or at the bottom of the well within the sump. At no time during development should the air line be moved within the screen area. Maintaining the air line above or below the screen prevents charging the filter pack and/or formation with air, which can cause clogging.

The compressors, air lines, hoses, fittings, etc. shall be of adequate size to pump the well by the air lift method. Pressurized air from air compressor(s) needs to be specifically filtered so that oil from the compressor does not contaminate the well.

Air lift pumping development produces best results when the submergence ratio of the air line is about 60 percent for wells 200 feet or less in depth (Ground Water and Wells, Johnson, 1972). The percent pumping submergence can be calculated as follows:

$$\text{percent pumping submergence} = \frac{\text{length of airline below pumping water level}}{\text{total length of well airline}} \times 100$$

The desirable drawdown is from static water level to the top of screen. The pumping rate will be estimated from available drawdown and pumping submergences.

OVERPUMPING AND BACKWASHING WITH SUBMERSIBLE PUMP

The pumping shall be done with a submersible pump capable of pumping at rates up to two times the estimated well capacity (well yield per unit drawdown). The pumping should be carried out in at least five steps including pumping rates of 0.25, 0.5, 1, 1.5, and 2 times the estimated well capacity. Pumping shall be conducted in five-minute cycles and shall continue until acceptable standards as explained at the beginning of SOP are attained.

BAILING

Where the nature of the formation and/or well construction make development of the well infeasible using pumps or air lift, bailers shall be utilized to evacuate water and fine sediments and/or fine formation particles from the well. Bailers should be of diameter allowing free-fall inside the well casing and should be equipped with a check valve at the bottom. The frequency of bailing trips shall depend on the ability of the well to recover.