Cover Sheet
Standard Operating Procedure

Operation Title: **Groundwater Sampling for Site Characterization and Long-Term Monitoring**

Originator Name: **Becky Blais**
Quality Assurance Coordinator
Maine Department of Environmental Protection
Division of Remediation

Approvals:

Division of Remediation Director:

Nick Hodgkins		4/22/2026
Print name	*Signature*	*Date*

Bureau of Remediation and Waste Management Director:

Susanne Miller		4/24/2026
Print name	*Signature*	*Date*

Distribution:

(x) Division of Remediation and Division of Technical Services
By: Becky Blais Date: 07/14/2026

1.0 Applicability

This Standard Operating Procedure (SOP) applies to all programs in the Maine Department of Environmental Protection's (MEDEP) Division of Remediation (DR). It may be utilized by other Divisions within MEDEP, as determined by the respective Division Directors or their designees.

This SOP is not a rule and is not intended to have the force of law, nor does it create or affect any legal rights of any individual, all of which are determined by applicable statutes and law. This SOP does not supersede statutes or rules.

2.0 Purpose

The purpose of this document is to describe the MEDEP/DR procedure for collecting groundwater samples at new and existing monitoring wells associated with site investigation/assessment (investigation) activities and/or long-term monitoring (LTM) programs.

The recommended method for groundwater sampling at LTM and investigation sites is almost always the low-flow purging and sampling method. Alternative sampling methods are sometimes necessary due to site conditions or site-specific Data Quality Objectives (DQOs). The procedures outlined in this SOP are intended to ensure groundwater samples are collected in a consistent, technically defensible manner.

Site-specific DQOs should be reviewed prior to sampling to confirm that the procedures and sampling methods described in this SOP are appropriate for the intended monitoring objectives, as groundwater sampling objectives may vary depending on site conditions and program goals.

At investigation sites, sampling is conducted to support site assessment, delineation, or remedial decision-making, and therefore DQOs do not require long-term monitoring of contaminant concentration trends. At LTM sites, DQOs require regularly scheduled sampling events (e.g., quarterly, semi-annual, annual, or biennial) using consistently documented procedures to evaluate groundwater quality trends over time. This SOP is intended to support both types of monitoring activities.

3.0 Key Definitions

Newly Installed Well: For the purpose of this SOP, a newly installed well is a well that has been installed for less than 48 hours. These wells typically have not yet developed a stagnation zone in the well riser pipe. These wells may also be temporary, being abandoned immediately after initial sampling.

Existing Monitoring Well: For the purpose of this SOP, an existing monitoring well is a well that has been in place for greater than 48 hours. These wells typically have developed a stagnation zone in the water column which may influence sampling methodology.

Low-Flow Purging: For the purpose of this SOP, Low-Flow Purging is defined as pumping a well at a rate equal to or less than the recharge rate of the formation such that a stable drawdown of the water level is achieved at a constant pumping rate.

Variable Speed Pump: A mechanical device specifically manufactured to have the capacity to adjust flow such that it can pump groundwater from a monitoring well at or below groundwater recharge rates. For the purposes of this SOP, it is limited to bladder or peristaltic type positive displacement pumps and submersible type rotodynamic pumps.

Reciprocating Type Positive Displacement Pump: All positive placement type pumps that rely on the use of a cylinder or piston arrangement with a foot valve to displace water. This includes all WaTerra™ inertial type pumps.

Bailer: A long narrow cylinder or bucket-like device with an open top and a check valve at the bottom that is used to remove water from a monitoring well.

Equipment Blank: A type of sample collected for QA/QC. Involves running de-ionized water through a piece of sampling equipment and collecting the water for analysis to determine if equipment may be a source of contamination.

Purging: The process of evacuating standing water from a monitoring well prior to sample collection.

Trip Blank: A type of sample collected for QA/QC. Involves placing de-ionized water in the appropriate containers under laboratory conditions, which is then transported along with site-specific samples obtained during a monitoring event.

Well riser pipe: A length of solid pipe, which extends from the screened interval of a monitoring well to the ground surface, where the well is accessed.

Site Assessment: The collection of environmental data to determine the presence, nature, and or extent of contamination at a site. Assessment activities can include installation and sampling of new groundwater wells, existing wells, and sampling of other environmental media. Sampling generally occurs to support the development of a robust conceptual site model, to evaluate potential receptors on and off site, and to determine if additional investigation work is needed.

Long Term Monitoring: A planned program of repeated sampling conducted over time. Generally, the goal of an LTM is to document contaminant and water quality trends to better understand plume stability, remedy performance, and/or to meet regulatory requirements. LTM work typically occurs after baseline site conditions are characterized via site assessment. An LTM occurs according to an established monitoring plan that usually includes consistent well locations, sampling methods, and analytical parameters.

4.0 Responsibilities

All MEDEP/DR Staff must follow this procedure when performing this task. All Managers and Supervisors are responsible for ensuring that their staff are familiar with and adhere to this SOP. MEDEP/DR staff reviewing data by outside parties should ensure that this SOP (or an equivalent) was followed, depending on the specific Data Quality Objectives (DQOs) of the task.

Other MEDEP SOPs may also apply when performing this task, including, but not limited to MEDEP/DR SOP *RWM-DR-014 - Development of a Sampling and Analysis Plan* (SAP). The SAP should consider quality assurance and quality control (QA/QC) samples and measures, the specifics of which will depend on the DQOs for the task. Types of QA/QC samples are discussed in more detail in the DR Quality Assurance Plan (QAP). SAP development includes provisions for creating a Health and Safety Plan (HASP) associated with the activity, including compliance with Dig Safe notifications when disturbing soil with powered equipment or tools (i.e., not hand tools). Dig Safe notification does not include public utility clearance requests which must be completed separately (e.g., sewer and water lines). These utility marking requests typically do not extend onto marking private property (i.e., they may only mark lines in the public right of way), so hiring a private utility marking company may be necessary, depending on site specifics. Fieldwork and data collection tasks must be properly documented in accordance with applicable MEDEP SOPs and policies.

5.0 General Information for all Groundwater Sampling Methodologies

5.1 Introduction

The goal in any groundwater monitoring activity is to collect groundwater samples that are representative of mobile organic and inorganic loads in the vicinity of the selected open well interval. Current research indicates that low-flow sampling (LFS) is the best available technique for: 1) obtaining the most consistently representative samples of groundwater from the formation surrounding the screened interval of a properly installed monitoring well; 2) eliminating variability introduced by sampling technique; and 3) providing a basis for evaluating appropriateness of long-term groundwater sampling data.

LFS includes both a purge option (Section 6) and a no-purge option (Section 7). Whenever possible, sampling should utilize the purge option. In low permeability formations or poorly installed monitoring wells it may not be possible to collect groundwater samples using the specified purge techniques. To evaluate whether the no purge option is necessary, see Attachment A.

The purge option for LFS involves pumping the well at a rate that minimizes drawdown in a well to reduce mixing of the riser water and groundwater in the aquifer. Field parameters, such as pH, dissolved oxygen, temperature, turbidity and conductivity are monitored during purging until readings have stabilized; at this point, groundwater entering the pump intake represents formation water and the sample is collected.

Collecting representative groundwater samples via LFS requires considerable experience. At least one experienced person in LFS should always accompany every sampling team.

5.2 Planning Considerations for Groundwater Sampling

5.2.1 Conceptual Site Model and Sampling and Analysis Plan

Except in rare emergency instances, groundwater sampling activities should be guided by a current Conceptual Site Model (CSM), whether sampling is for LTM or site investigation activities. The CSM summarizes the understanding of site conditions, including potential contaminant sources, hydrogeologic settings, migration pathways, and potential receptors. This understanding informs the selection of appropriate monitoring wells, sampling methods, analytical parameters, and DQOs.

The CSM and planned work should be documented in an approved Sampling and Analysis Plan (SAP) or equivalent work plan. The SAP should describe the groundwater sampling approach, including the selected sampling method, field measurements, sample handling procedures, and required quality assurance/quality control (QA/QC) samples. The SAP should also identify any deviations from the procedures described in this SOP and provide justification for the selected approach. Additional guidance on the development of Sampling and Analysis Plans is provided in MEDEP SOP-RWM-DR-014.

5.2.2 Health and Safety Planning

All work should follow the applicable Health and Safety Plan for the program or site. As monitoring wells may be contaminated above drinking water standards, protocol described in this SOP must be performed by personnel who are trained and certified to work on sites contaminated by hazardous substances. Appropriate personnel protective equipment must be used. Additional concerns to be aware of include, but are not limited to:

- Sealed monitoring wells may accumulate gases (e.g., methane, hydrogen sulfide, or site-related vapors) over time, which can create pressurized conditions and potential inhalation or fire hazards when opened. Stand upwind whenever possible when opening well caps and loosen them slowly to allow pressure to dissipate before proceeding. If strong odors, audible pressure release, or other signs of gas buildup are observed, the well should be allowed to vent prior to further work. A photoionization detector (PID) or 4-gas meter may be used to assess site conditions when Contaminant of Concern (COCs) suggest the potential presence of hazardous vapors or gases.

- Monitoring well casings may harbor insects, rodents, or other small animals. Use caution when opening well covers and avoid placing hands inside protective casings without visual inspection.

If insects or animals are present, allow them to disperse before proceeding

5.2.3 Long Term Monitoring-Specific Planning

Prior to conducting an LFS event, information regarding well construction, development, and water level records for each well to be sampled should be obtained and reviewed to determine the appropriate pump to be used, the depth of intake, and the potential groundwater recharge rate of the well. If this information is not available, a reconnaissance should be made prior to the actual sampling event to determine well depth, water level, length of screen, and a pump test to determine the recharge rate of the well. Note that if historical data is available for site wells, sampling should generally begin with the cleanest monitoring locations (least contaminated) and then proceed to the dirtiest monitoring locations (most contaminated). This decreases the possibility of cross-contamination between monitoring locations and can minimize or eliminate non-dedicated equipment decontamination in the field, although exact procedures may vary by site and COCs.

Additionally, wells that have not been sampled for two years or more should be redeveloped prior to conducting the actual sampling event. Redevelopment of monitoring wells is outlined in MEDEP/DR SOP RWM-DR-028 – Maintaining and Redevelopment of Inactive Monitoring Wells.

Where feasible, the Department recommends the use of dedicated sampling equipment for long-term monitoring programs to reduce the potential for cross-contamination and improve sampling efficiency.

5.3 General Equipment for Groundwater Sampling

The following list of equipment is typically required when performing LFS activities. Equipment is generally described using standard terminology rather than specific brand names. In some cases, commonly used trade names may be referenced where they are widely used to describe a material or component. Equipment with equivalent performance specifications may be used in place of the identified equipment (see MEDEP/DR SOP# RWM-DR-014 - Development of a Sampling and Analysis Plan).

A general list for groundwater sampling includes the following items:

- Pump and power supply (or alternate water retrieval device)
- Tubing
- Field parameter monitors
  Water level and flow measurement tools
- Previous well documentation (LTM) and supplies for documenting current condition and sampling event
- Decontamination supplies
- Miscellaneous supplies such as sample collection bottles and labels
- Containerization and treatment supplies, if required

It is important that DQOs are considered when choosing equipment and materials (e.g. tubing, bladders). See SOP No. RWM-DR-030 for additional protocol and considerations related to Per- and Polyfluoroalkyl Substances (PFAS) sampling.

5.3.1 Pump

Commonly used and acceptable pump types are peristaltic, bladder, and submersible pumps. The pump selected must have capabilities of adjusting the flow rate without the use of flow restrictors, as flow restrictors only slow discharge at the surface and not at the intake point and may create backpressure, turbulence, or unstable flow conditions that compromise representative sampling.

All pumps discussed in this section are appropriate for both site investigation and LTM events.

The Department recommends the use of dedicated equipment, where possible, for long-term monitoring. Pump selection should be based on DQOs, well construction, depth to water, power supply availability, and contaminants of concern being sampled.

Peristaltic Pumps

Peristaltic pumps can be used for sampling most wells where the depth to water does not exceed approximately 24 feet (based on suction lift limitations). These pumps are best used in wells where minimal drawdown can be maintained, and analytes are not highly volatile.

Submersible Pumps
Submersible pumps may be used in wells with deeper water levels and are appropriate for most analyte types when operated at low-flow rates. Flow rates must be adjustable to maintain minimal drawdown consistent with low-flow sampling procedures. Submersible pumps are generally too large to fit in small diameter wells.

Bladder Pumps
Bladder pumps are appropriate for low-flow sampling in wells with deeper water levels and are particularly suitable when sampling for volatile organic compounds (VOCs) because they minimize agitation and aeration. Bladder pumps are recommended where precise flow control and minimal disturbance of formation water are required. Bladder pumps come in a variety of diameters and bladder materials, and are generally the most reliable pumps when intake depth and/or depth to water are significant, especially when utilizing a drop tube assembly. If PFAS samples are collected, ensure that bladder material is PFAS-free.

5.3.1.1 Power Supply

The power supply options for the pumps include generators, deep cycle batteries, and compressed gas. If a gasoline generator or car battery is used, it must be located downwind and at a safe distance from the well so that the exhaust and/or tailpipe fumes do not contaminate the samples. If the operator of the generator has handled gasoline, then they should not risk cross-contamination by handling the sampling equipment or sample containers.

5.3.1.2 Tubing

High density polyethylene (LDPE) tubing is recommended for most situations. Examples of other situations include, but are not limited to:

- If PFAS samples are collected, high-density polyethylene (HDPE) should be utilized. See SOP

No. RWM-DR-030 for additional sampling protocol.

- Sites with low concentrations of certain petroleum related contaminants should consider the use of Polytetrafluoroethylene (Teflon™) lined tubing.
- Pump type and intended flow-rate are also important considerations when choosing tubing. Examples include:
- Peristaltic pumps typically use 1/4-inch or 3/8-inch outside diameter (OD) HDPE or LDPE tubing together with 3/8-inch OD silicone tubing.
- Submersible pumps typically have barbed fittings that accommodate 3/8-inch or 1/2-inch inner diameter (ID) LDPE tubing, depending on the pump manufacturer. Note that larger diameter tubing (1/4 inch ID or greater) is generally easier to install in monitoring wells equal to or greater than 2 inches in diameter.
- Bladder pumps require both air intake and water discharge lines

In particularly deep or wide diameter monitoring wells, it may be difficult to submerge tubing to the target intake depth. When this occurs, a tubing weight may be utilized. The type of weight and attachment method (i.e. zip ties) should not include prohibited materials and should be recorded on field data logs.

As in the case with pumps, the use of dedicated tubing, where possible, is recommended for long-term monitoring programs. When dedicated tubing is present, staff should ensure that tubing is in good working order and that the intake depth matches the DQOs for the sample collection event.

5.3.2 Indicator Parameter Monitoring Instruments

Site-specific DQOs should be used to select appropriate field parameters. It is highly recommended that a minimum subset of field parameters should be collected that includes pH, conductivity, and turbidity or dissolved oxygen. Field parameter options include, but are not limited to:

- pH (EPA Methods 150.1 or 9040),
- turbidity (EPA Method 180.1),
- specific conductance (EPA Methods 120.1 or 9050),
- temperature (EPA Method 170.1),
- oxidation reduction potential (ORP), and
- dissolved oxygen (EPA Method 360.1).

A flow-through cell is required for dissolved oxygen and ORP measurements

5.3.3 Water Level/Flow Measuring Tools

Water level and flow measurement are required for LFS. Several different water level meters are available to staff. Ensure that the water level meter is long enough to measure the depth to bottom of wells that are being sampled.

A graduated cylinder and stopwatch are used for measuring flow in mL/minute.

5.3.4 Documentation Supplies

This includes a field notebook for taking field notes, and the MEDEP LFS data sheet included in Attachment B or an approved equivalent.

A well's location, well construction, previous sampling data, and the site-specific quality assurance project plan (SSQAPP) or SAP or should accompany samplers in the field.

5.3.5 Miscellaneous Supplies

Miscellaneous supplies include tools and keys for opening wells, decontamination equipment and material, sample bottles, preservation supplies, sample tags and labels.

5.3.6 Contaminated Groundwater Management

Containerization requirements should be clearly stated in the work plan or quality assurance project plan dictating work, but it is important to note that conditions may change. When site conditions, expected COCs, or regulatory requirements indicate that ground surface discharge is not appropriate, groundwater should be containerized to minimize release into the environment and potential further contamination. Appropriate containers include drums, buckets, totes, or other suitable vessels that are structurally sound, compatible with the material being stored, and capable of being securely closed and labeled.

Always clearly label containerized material and stage it securely away from surface water, storm drains, public access, and any site traffic. Management may be necessary to prevent spills, leaks, or exposure. Dispose of groundwater following applicable MEDEP guidance, site-specific requirements, and any other applicable regulations.

For management of petroleum contaminated groundwater, see SOP No. RWM-PP-012.

6.0 Low Flow Purge and Sample Procedure

The following steps describe the general approach to purging via LFS and may not apply to every sampling event. Any significant modifications to this procedure should be addressed in the applicable SAP or SSQAPP. Deviations from the approved workflow shall be documented in daily field logs and summarized in the final sampling report.

If collecting samples via no purge sampling, please see Section 7.1.

Additionally, this procedure is not designed to collect samples from wells containing light or dense non-aqueous phase liquids (LNAPL or DNAPL). If monitoring wells have suspected or known NAPL contamination, see Section 7.2.

6.1 Field Procedure

6.1.1 Prior to Purging

Calibrate Monitoring Equipment. See SOP PP#008 for more information.

Confirm Correct Well: Prior to initiating LFS activities, personnel should confirm that they are accessing the correct monitoring well by verifying the well identification label against the field documentation and site plan. Where appropriate, well locations should also be confirmed using GPS coordinates and well depth to ensure accurate identification and prevent data misattribution. This is especially important when wells are nested within the same casing. When in doubt, confirm well ID by measuring the depth to bottom with a weighted tape and comparing it to installation records. However, it should be noted that this is not ideal as it may increase sediment in the water column that could bias sample concentrations.

Obtain Static Water Level: Measure and record the depth to water (to 0.01 ft) in the well to be sampled before inserting tubing or preparing to purge the well. Monitoring wells should be measured consistently by using the same measuring reference point for each sampling event. If the top of the well riser pipe is the selected reference point, a mark or notch in the well material should indicate where the measurement takes place. If no mark or notch is observed, the measurement should take place at the highest point of the well riser. Care should be taken to minimize suspension of any particulates attached to the sides or at the bottom of the well. If wells to be sampled are arranged in clusters (i.e. shallow/middle/deep), then depth to water readings should be collected from all wells in the cluster before purging.

Install Sampling Pump or Tubing: In most circumstances, the tubing intake point should be in the middle of the saturated screened interval. The use of dedicated sample tubing will reduce disturbance and water mixing in the well. In situations where dedicated equipment is not used, field staff will lower equipment (i.e. pump, safety cable, tubing and electrical lines) slowly into the well so that the pump intake is placed at the desired location of the saturated screened interval to avoid disturbing sediments in the bottom of the well.

6.1.2 Begin Purging

Purge well: Check previous data sheets to assist in well set-up, flow rates, and notes regarding gas presence in the sample tube. Turn the pump on and begin monitoring flow rate and water level (drawdown). Ideally, the flow rate should be between 100 mL and 500 mL and should be adjusted to pump at the fastest rate possible where there is no or minimal drawdown. When sampling for long term monitoring, an attempt should be made to replicate previous flow rates.

Monitor water level and pumping rate frequently during the first five minutes of purging. Once flow rate and drawdown are stabilized, connect the flow through cell.

If the recharge rate of the well is less than the minimum capability of the pump, then the water level will not stabilize. If a constant water level cannot be maintained at a flow rate of at least 100 mL/min., then the no-purge option should be evaluated (see Section 6.2 and then Section 7.1). Care should be used to avoid de-watering the screen or lowering the water level to the intake depth. It is helpful to calculate whether water being pumped is formation or stagnant, especially when water level is dropping.

Begin Parameter Monitoring: Once the water level has stabilized during purging, monitor field indicator parameters. For field indicator parameter readings collected from a flow-through cell (dissolved oxygen and ORP at a minimum), the pump's flow rate must be able to "turn over" at least one flow-through cell volume between each reading. Depending on the pump rate and flow-through cell volume, these readings are typically collected every three (3) to five (5) minutes. Samples for turbidity measurements should be obtained before water enters the flow-through cell to provide more accurate readings.

Monitor for Stability: Purging is complete and sampling may begin when all field indicator parameters are within the following limits after three (3) consecutive readings at the appropriate time interval:

- Turbidity: 10% for values at or above 5 Nephelometric Turbidity Units (NTU). If three (3) consecutive turbidity readings are less than 5 NTU, the values may be considered stabilized.
- Dissolved Oxygen: 10% for values at or above 0.5 milligrams per liter (mg/L. If three (3) consecutive dissolved oxygen readings are less than 0.5 mg/L, the values may be considered stabilized.
- Specific Conductance: 3%.
- Temperature: 3%.
- pH: ± 0.1 units

- Oxidation/Reduction Potential: ± 10 millivolts.

If the monitoring well has been purged for two hours and parameters have not stabilized, sampling can proceed, although it should be noted on the field data record for follow up and further assessment.

6.1.3 Collect Samples

Collect samples in appropriate containers as indicated by the laboratory conducting the analysis. Samples for laboratory analyses must be collected before the flow cell. This can be done by disconnecting the flow cell after reaching stabilization or using a sample port before the flow cell. Samples should never be collected after water has passed through a flow through cell. The flow rate should not be altered when filling sample bottles. LFS will help reduce turbidity caused by improper purge and sampling techniques. The need for filtering water samples will be reduced by using this method. However, if turbidity values equilibrate above 20 NTUs (or NTU threshold specified by the laboratory analyzing samples), one should consider the need to collect both a filtered and an unfiltered sample. An in-line 0.2-0.45 micron (um) particulate filter should be pre-rinsed with approximately 25 - 50 milliliters (mL) of groundwater prior to sample collection, or as per filter manufacturer's instructions. Note that filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations representative of total mobile loads.

6.1.4 After Sample Collection

Decontamination

Dedicated equipment will not need decontaminating. After collection of the samples, any tubing used may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Non-dedicated equipment should be cleaned prior to field work, after each sampling location, and upon return to the office from the field, as outlined in MEDEP/DR SOP# RWM-DR-017 – Equipment Decontamination Protocol. Specific procedures for cleaning submersible pumps, including support cable and electrical wires, are outlined below. Non-dedicated tubing should be discarded.

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump, or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is flushed out. The outside of the pump and the electrical wires must be rinsed with the decontaminating solutions as well. The procedure is as follows:

- Flush the equipment/pump with deionized or tap water. Flush the pump by allowing the pump to run with water for several minutes in a basin filled with water.
- Flush with non-phosphate detergent solution for several minutes.
- Flush with deionized water to remove all of the detergent solution. In some instances of high levels of contamination, it may be appropriate to use isopropyl alcohol in this step. The need for this will be determined in the Site-Specific Sampling and Analysis Plan (SAP) (See MEDEP/DR SOP# RWM-DR-014)
- Flush one final time with distilled/deionized water. If required (as determined in Site-Specific Sampling and Analysis Plan), collect equipment blank after final flushing.

Purge Water Treatment
If required, treat purge water prior to releasing it directly to the ground.

Secure Well and Site
Return dedicated equipment to the monitoring well or storage location. Replace the cap and lock the well casing or return bolts to flush mount wells. Ensure all debris and equipment are picked up and disposed of properly and that the Site is secure.

6.2 Procedure Evaluation

The purpose of the LFS purge option is to sample the groundwater from the surrounding aquifer. If the well is not receiving sufficient recharge from the formation, then the water level will drop as pumping continues. This means that the discharge water could contain a significant percentage of stagnant water from the well casing. As the percentage of casing water increases, the representativeness of the sample decreases. If the percentage of casing water is significant, an alternative sampling technique, such as the no-purge option, should be considered (see Section 6.3). A decision process for implementing low flow/no purge sampling can be found in Attachment A.

The second step in evaluating the viability of LFS for a potential no-purge well is to determine the volume of groundwater needed to fill the laboratory containers. Compare this volume to the volume of groundwater in the screened section of the monitoring well. If the volume of water contained in the screened zone is greater than the volume of sample required to fill the sample containers, then the no-purge option is appropriate for this well.

6.2.1 Calculating Formation/Stagnant Water Ratio

It is important to determine how much of the water being pumped is coming from the well and how much is coming from the aquifer. This is done by comparing the total volume being purged to the drawdown volume in the well. If the equilibrium flow rate is 150 mL/min or lower for a given well, the following evaluation should be followed:

- Calculate the total volume of water discharged for a given time interval.
- Measure the total drawdown of the water level in the well during that time interval.
- Calculate the total drawn-down volume in the well (see Table 1, Section 7.3 for mL/ft conversions of typical monitoring well sizes)

Compare the total volume of water discharged to the total drawdown volume. If the drawdown volume comprises 60% or more of the discharge volume, then any samples collected may not be representative of the surrounding groundwater aquifer and the well construction should be evaluated.

6.2.2 Well Construction Evaluation

Evaluate the well construction. Was the appropriate screen slot size selected? Was the appropriate filter sand selected? Is the depth to bottom accurate, or is the screen blocked by sediment? If inconsistencies are noted, they should be clearly documented and communicated to relevant project personnel.

If the well construction details are not appropriate for the formation, then consideration should be given to installing a replacement well that is properly designed. A poorly designed well will not yield representative samples no matter what purging procedure is utilized.

6.3 Procedure Modifications

The LFS procedure can be modified to meet the DQOs for the sampling event. Careful consideration should be given to the purpose of each parameter collected in the procedure. Each parameter has importance that extends beyond the measurement for equilibrium.

Examples of additional modifications that may be needed include, but are not limited to:

Weather considerations: extreme temperatures and barometric temperature shifts are not only health and safety considerations, but they can affect the accuracy and calibration of sampling equipment

Monitoring wells with recharge rates below 100 mL/min may not be capable of being pumped at a continuous rate. Therefore, low or no-purge options should be considered

When sampling exposed groundwater from an excavation, it is more appropriate to follow MEDEP/DR SOP RWM-DR-004 – Surface Water and Sediment Sampling methodology.

Alternative Sampling Approaches for Long-Term Monitoring

Whenever possible, groundwater samples should be collected via LFS for site assessment/investigation and long term monitoring. However, certain circumstances require a different approach to sampling.

Low Flow Permeability Formations and No-Purge Sampling

The theory of no-purge sampling, also known as grab sampling, is that the water in the screened zone is in equilibrium with the aquifer and the water in the riser portion of the well is not. The goal is to sample only the water in the screened zone and to minimize any mixing with the water in the riser.

In certain low permeability formations, it may not be possible to maintain a constant drawdown at low flow rates (100-500 mL/min.). In these formations, the only option may be to obtain a groundwater sample without purging.

If a monitoring well was previously pumped in an attempt to LFS, the well should ideally be allowed to recharge to at least 80% of the initial static water level depth prior to initiating no-purge sampling procedures.

6.3.1 No Purge Sampling Procedure

Dedicated equipment, or equipment that has been in the well for at least two weeks, is required to properly complete this procedure (to eliminate any additional mixing of the water in the riser with the water in the screen).

The pump intake must be at or slightly above the midpoint of the screen.

1. Calculate the volume of water standing in the discharge line.
2. Turn on the pump at the lowest possible flow rate.
3. Purge the volume of water that was standing in the discharge line.
4. Immediately begin sample collection after the discharge line is purged.
5. If volume remains, consider collecting water quality parameters if required by DQOs.

If equipment is not dedicated, install the pump or tubing and purge a volume of water equal to 1.5 times the volume required to fill the laboratory containers. Purging must be completed at the lowest setting possible (must be less than 100 mL/min). Then shut off the pump and allow the well to recharge until the water level returns to the static water level and proceed with the steps outlined above.

6.4 Collecting Groundwater Samples When Free Product is Present

Note: If significant free product is present, groundwater samples may not be representative of aquifer conditions and product recovery, or remedial actions should be evaluated prior to sampling.

Light and dense non-aqueous phase liquids (LNAPL/DNAPL) represent free product phases that do not mix uniformly with groundwater. LNAPL floats on the water surface, while DNAPL may accumulate at the bottom of the well. Because these liquids are immiscible with water, standard groundwater sampling techniques may draw product into the sample or disturb the NAPL layer.

Groundwater samples from wells containing NAPL should be collected using low-flow sampling techniques whenever possible to minimize disturbance within the well.

Prior to sampling, wells should be gauged with an interface probe to determine the presence and thickness of any product. If possible, remove product utilizing a bottom emptying bailer or absorbent pad prior to pumping.

Pumping rates and drawdown should be minimized to prevent agitation and entrainment of NAPL. When LNAPL is present, groundwater samples should be collected below the product-water interface without disturbing the floating product layer. When DNAPL is present (or suspected), the pump intake should be positioned above the bottom of the well to avoid drawing product into the sample.

The presence and thickness of any NAPL present, sampling depth, and any observations about product movement should be documented in field records. Any purge water should be containerized for treatment or treated on site.

6.5 Bailer Sampling Procedure

In modern groundwater investigations, bailer purging and sampling is much less frequent when compared to more reliable procedures like LFS. Bailer samples tend to be less representative and can disturb the well and surrounding aquifer. However, bailers can be helpful for LNAPL product recovery (Section 7.2), emergency sampling, very shallow wells, and other site-specific situations where pumps cannot be deployed.

Calculate Well Volume: Calculate the height of the water column by subtracting the height of water in the well from the total depth of the well, in feet (Formula 1). Then, use Formula 2 and the chart below to calculate well volume in gallons. Milliliters per foot are also included to help with drawdown calculations.

Equation 1:

Water Column Height (H) in feet
H = total well depth (ft) - depth to water (ft)

Equation 2:

Well Volume in Gallons
V= (gal/ ft of casing) x H

Table 1: Common Well Diameter Volumes

Well Inner Diameter (inches)	Gallons per foot	mL per foot
¾	0.163	618
1	0.041	154
1 ½	0.092	347
2	0.163	618
4	0.653	2470
6	1.469	5560

Purge the Well: At least three volumes should be purged from the well. When this is not possible, as in the case of purging a slow recharge well until dry, it is acceptable to sample the well as soon as enough water (assumed to be fresh groundwater) has entered the well to obtain a sample.

Attach clean line to the bailer and lower it into the well until it touches the bottom. Then, secure the end of the line or cord to an anchor on the well casing. This anchor will hold the bailer if it is accidentally dropped down the well.

Raise the bailer up through the water column as smoothly as possible. As line comes out, keep it off the ground to avoid cross-contamination. Empty the bailer water into a graduated bucket and repeat this procedure until the desired purge volume has been extracted.

Sample the Well: Once purged, the well may be sampled by lowering the bailer slowly below the water level and pouring the contents directly into the appropriate laboratory containers.

6.6 Reciprocating Positive Displacement Pumps

Reciprocating-positive displacement pumps, of which WaTerra™ is a specific example, produce the lowest quality sample due to the physical movement of the pump in the well and are better suited for well development. The reciprocating action disturbs the sediment in the bottom of the well, generates friction between the well materials and the pump, and partially mixes water in the screen zone with water in the well riser pipe. Additionally, the hydraulic forces exhibited by the pump disturb the equilibrium the aquifer has with the filter sand and acts to re-develop the equilibrium (re-develop the well) during the sampling event. The reason for using reciprocating-positive displacement pumps instead of variable speed pumps or bailers should be outlined in the SAP or SSQAPP developed for the specific activity. If this type of pump is used at a site, it should be used according to the manufacturer's instructions.

7.0 Documentation

All site visits, including groundwater sampling events, shall be documented as described in the MEDEP/DR SOP# RWM-DR-013 - *Documentation of Field Activities and Development of a Trip Report*. A field log must be kept each time groundwater monitoring activities are conducted in the field; the LFS Data Sheet in Attachment B is the approved form for use by staff. The field log should document the following:

- Well identification, condition of well
- Static water level
- Pumping rate or flow rate, including units
- Time of all measurements
- Water Level at the specified pumping rate
- Indicator parameter values
- Well sampling sequence and time of sample collection
- Types of sample bottles used and sample identification numbers
- Preservatives used
- Parameters requested for analysis
- Name of sample collector(s)
- Calibration information of meters

9.0 References

Backhus, D.A., Ryan, J.N., Groher, D.M., MacFarlane, J.K., Gschwend, P.M., 1993; Sampling Colloids and Colloid-Associated Contaminats in Ground Water; Ground Water, Vol 31, No. 3, pp. 466-479.

Barcelona, M.J., Wehrmann, H.A., Varljen, M.D., 1994. Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground-Water Sampling; Ground Water, Vol 32, No.1, pp. 12-22.

Garske, E.E., Schock, M.R., An Inexpensive Flow-Through Cell and Measurement System for Monitoring Selected Chemical Parameters in Ground Water. Groundwater Monitoring & Remediation, Summer 1986.

Herzog, B.L., Chou, S.J., Valkenburg, J.R., and Griffin R.A., 1988. Changes in Volatile Organic Chemical Concentrations After Purging Slowly Recovering Wells. Groundwater Monitoring Review, v.9, no.3, pp 93-99.

Kearl, P.M., Korte, N.E., Cronk, T.A., 1992. Suggested Modifications to Ground Water Sampling Procedures Based on Observations from Colloidal Borescope. Groundwater Monitoring & Remediation, Spring 1992, pp 155-161.

Powell, R.M., Puls, R.W., 1993. Passive Sampling of Groundwater Monitoring Wells Without Purging: Mulitlevel Well Chemistry and Tracer Disappearance. Journal of Contaminant Hydrology, Volume 12, pp 51-77.
Puls, R.W., Powell, R.M., 1992. Acquisition of Representative Ground Water Quality Samples for Metals. Groundwater Monitoring Review, v.12, no.2, pp 167-176.

Puls, R.W., Powell, R.M., 1992. Transport of Inorganic Colloids through Natural Aquifer Material. Environmental Science Technology, Vol 26, pp 614-621.
Puls, R.W., Powell, R.M., Clark, D.A., Paul, C.J., 1990. Facilitated Transport of Inorganic Contaminants in Ground Water: Part I, Sampling Considerations. Environmental Research Brief EPA-600-M-90-023

Puls, R.W., Powell, R.M., Clark, D.A., Paul, C.J., 1990. Facilitated Transport of Inorganic Contaminants in Ground Water: Part II, Colloidal Transport. Environmental Research Brief EPA-600-M-90-023

Puls, R.W., Barcelona, M.J., 1986. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. USEPA Ground Water Issue EPA-540-S-95-504.

Shanklin, D.E., Sidle, W.C., Ferguson, 1995. Micro-Purge Low-Flow Sampling of Uranium-Contaminated Ground Water at the Fernald Environmental Management Project. Groundwater Monitoring Review, Summer 1995.

USEPA Region 1, 2010. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Quality Assurance Unit, 11 Technology Drive North Chelmsford MA, EQASOP-GW001.

ATTACHMENT A
Decision Process for Implementing Low-Flow/No-Purge Sampling

Decision Process for Implementing LFS

1) Obtain well construction, development, and water level records for each well being sampled. Compile total depth, screened interval, water level, and available hydraulic conductivity information for field technician(s).

Continue to 2

2) Review available equipment. Make sure the pump is capable of variable speeds and can pump water at low rates without the use of mechanical flow restrictions. Reducing flow by altering the diameter of the discharge pipe is not acceptable for purposed of LFS. Make sure the chamber being used to collect field parameters is appropriate for the parameters being measured. For ORP and DO measurements with probes, the chamber must be an enclosed chamber that does not allow water to contact the atmosphere and does not impact the water quality. Additionally, the size of the chamber should be appropriate given the expected flow rates.

Continue to 3

3) The objectives of the sampling event should be reviewed to determine the important stabilization parameters as well as the important field parameters for geochemical analyses.

Continue to 4

4) Is the well being used as part of a long-term plan to monitor trends in groundwater chemistry?

Yes? Go to 5

No? Go to 6

5) Complete Well Performance Evaluation on Well prior to first sampling event

Continue to 6

6) Will water level (under pumping conditions) stabilize above the top of the screen?

Yes? Go to 11

No? Go to 7

7) Is the static water level above the top of the screen?

Yes? Go to 9

No? Go to 8

8) Will the stabilized water level reduce the volume of water in the well by greater than 10%?

Yes? Go to 12

No? Go to 11

9) Is there sufficient water in the well to purge and sample the well given the measured drawdown rate without dewatering any part of the screen?

Yes? Go to 10

No? Go to 12

10) Is the volume of water attributable to the change in water level greater than 20% of the volume of water being discharged during the same time period?

Yes? Go to 12

No? Go to 11

11) Complete the Standard Low Flow Sampling Procedure and collect groundwater samples once the selected stabilization parameters have equilibrated.

12) Evaluate the appropriate application of Reduced Purge Procedures for this well.

13) Is the sampling equipment (pump or sample tube) dedicated to the well and/or has it been installed for more than 2 weeks prior to sampling?

Yes? Go to 15

No? Go to 14

14) Install the pump or tubing and purge a volume of water equal to 1.5 times the volume required to fill the laboratory containers. Purging must be completed at the lowest setting possible (must be less than 100 mL/min). Then shut-off the pump and allow the well to recharge until the water level returns to the static water level.

Continue to 15

15) Set the pump rate to the lowest possible setting (must be lower than 100 mL/min) and purge a volume of water equal to the volume of water in the sample tube. Then immediately begin collection of laboratory samples at the same rate. Record the water level at the beginning of sample collection and at the end of sample collection. If field parameters are to be collected, they must be collected after laboratory samples are collected.

ATTACHMENT B
Low-Flow Data Sheet

Well# ____________________

Date ____________________

Initial Static Water Level ____________________

Begin Time of Purge ____________________

Sample Collection via Low Flow Methodology Field Data Record

Site Name ____________________

Total Depth __________ Well Diameter __________ Measuring Point __________

Screen Interval __________ Formation __________ Sample Device __________

Pg. ____ of ____

Time	Water Level	Flow	DO	Temp.	Cond.	pH	ORP	Turb.	Comments
Min.	Feet below MP	mL/Min	mg/L	Celcius		-log[H+]	mV	NTU	
Write Meter Number of Instrument Used									Comments
FINAL STABILIZED READINGS									

Equilibrium Goals

3 consecutive readings 3-5 min. apart[1]

Flow 1-2 mL/Min	Cond. +- 3%
Water Level +- 0.01	pH +- 0.1
DO +- 10%[2]	ORP +- 10 mV
Turb +- 10%[3]	Temp. +- 0.1

mL/Ft Information

3/4 in well = 87 mL/Ft

2 in well = 617mL/Ft

4 in well = 2470 mL/Ft

Record all instrument calibrations in Instrument Calibration Log Book or Field Book

Samplers: ____________________

Laboratory Sample Numbers

Analysis	Field Filtered?	Number

Eh Correction for Ag/AgCl probe:

Add 199 mV to ORP value

Date Revised 9/25/25 MSB

1: Readings should be collected at intervals which allow a full volume of water to be "turned over" in the flow-through cell.

2: Only applies to values at or above 0.5 mg/L. Stablization is achieved if three consecutive readings below 0.5 mg/L are recorded.

3: Only applies to values at or above 5 NTU. Stablization is achieved if three consecutive readings below 5 NTU are recorded.

Sample ID: ____________________

Sample Collection Time: ____________________

QC Samples Collected: ____________________

Notes

QCed by/ Date: ____________________

Sampler Signature/Date: ____________________