Low-flow purging is purging using a pumping mechanism that produces low-flow rates [less than 1 liter per minute (lpm) or less than 0.26 gallon per minute (gpm)] that cause minimal drawdown of the static water table and usually employs a flow cell in which geochemical parameters are continuously monitored. These parameters may include dissolved oxygen content, oxidation-reduction potential (redox), conductivity, turbidity, and/or pH.

The intent of this sampling protocol is to collect a representative sample from the monitored groundwater zone. A representative sample may be obtained when all the monitored chemical parameters have stabilized, thus qualitatively demonstrating that the groundwater being purged is in equilibrium (refer to Table 3). Samples are collected directly from the pumping mechanism with minimum disturbance to the aquifer groundwater. The low-flow/low volume purging method (purging to parameter stability) tends to isolate the interval being sampled, which provides more accurate water quality measurements and reduces the volume of purge water generated. This method has an advantage in that it can limit vertical mixing and volatilization of volatile organic compounds in solution within the well casing or borehole as compared to high-flow purging and sampling.

Table 1

Purging Methods		
Method	**Low-flow (< 1 lpm)**	**High-flow (> 1 lpm)**
Peristaltic Pump	1	2
Centrifugal Pump	3	3
Submersible Impeller Pump	1	3
Bailer	X	2
Bladder Pump	3	2
Vacuum Truck	X	1
1 - Not recommended, better methods exist **2** - Useful with limitations **3** - Recommended method **X** - Unacceptable		

Depending on the purging method to be used, there are specific equipment limitations. Table 1 provides a description of the various methodologies and their applicability.

The proper selection of sampling devices or pumps is critical to the quality and representation of the sampling results. The following table provides a summary of the acceptable sampling methods for the various compounds of concern.

Table 2
Acceptable Sampling Methods for Compounds of Concern

Analytical Sampling						
Method	**VOCs**	**Semi-VOCs**	**Metals and Inorganics**	**Petroleum Hydrocarbons**		**General Chemistry**
				C3-C16	**C16+**	
Peristaltic Pump	X	1	3	X	1	2
Centrifugal Pump	2	3	3	2	2	3
Submersible Impeller Pump	2 3 IF LOW FLOW	3	3	2	3	3
Bailer	2	2	2	2	2	2
Bladder Pump	3	3	3	3	3	3
Bladder Pump	2	2	3	2	3	3
Vacuum Truck	X	X	X	X	X	X
DPIS	3	3	2	2	2	2
Diffusion Sampler	2	2	X	2	2	X
Grab Sampler	2	2	2	2	2	2

1 - Not recommended, better methods exist **2** - Useful with limitations **3** - Recommended method
X - Unacceptable **Note**: Centrifugal pump—assumed at a low-flow rate (no greater than 1 lpm)

Purge Well

The well must be purged with a device that does not compromise the sample by cross contamination, aeration, or other negative effects. Refer to Table 1 for the acceptable purging devices for this method.

Low-flow Purging and Sampling Method Protocol

The low-flow purging and sampling method has been described in groundwater monitoring literature since the mid-1980s with a defined methodology being accepted by the U.S. EPA in 1995. An overview of this methodology is presented in an U.S. EPA Ground Water Issue paper titled *" Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures"* by Robert Puls and Michael J. Barcelona dated April 1996.

Low-flow purging and sampling is appropriate for collection of groundwater samples for all groundwater contaminants, including inorganic compounds, metals, pesticides, PCBs, volatile and semi-volatile organic compounds (VOCs and SVOCs), other organic compounds, radiochemical and microbiological constituents. This method is not applicable to the collection LNAPL or DNAPL.

Low-Flow refers to the velocity of the water entering the pump intake. Low-flow purging also results in limited drawdown. This method can be applied to wells that meet the following criteria: The well will be purged at a constant low-flow rate of 0.1 to 1.0 liters per minute (lpm), with an overall goal of less than 0.10 meter or 0.33 foot of drawdown in the well during purging.

1. FLOW RATE

The flow rate used during purging must be low enough to avoid increasing the water turbidity. The following measures should be taken to determine the appropriate flow rate:

- The flow rate shall be determined for each well, based on the hydraulic performance of the well.
- The flow must be adjusted to obtain stabilization of the water level in the well as quickly as possible.
- The maximum flow rate used should not exceed 1 liter per minute (0.26 gpm).
- Once established, this rate should be reproduced with each subsequent sampling event.
- If a significant change in initial water level occurs between events, it may be necessary to re-establish the optimum flow rate at each sampling event.

2. MEASUREMENT OF WATER AND DRAWDOWN

Measurement of the water level in the well during purging is important when establishing the optimum flow rate for purging. The goal is to achieve a stabilized pumping water level as quickly as possible with minimal drawdown, to avoid stressing the formation and mobilizing solids and to obtain stabilized indicator parameters in the shortest time possible.

3. MEASUREMENT OF INDICATOR PARAMENTERS AND TURBIDIDTY

Continuous monitoring of water quality indicator parameters is used to determine when purging is competed and sampling should begin. Stabilized values, based on selected criteria listed in Table 3 should be met prior to sampling. The use of an in-line flow cell (closed) system is recommended for measuring indicator parameters, except for turbidity. Indicator parameter collection is more important when low-flow purging is used and additional parameters are needed as compared to the high-flow purging method.

Generally measurements are taken every 3 to 5 minutes and water chemistry parameters are considered to be stable when they are within the following ranges for three (3) consecutive readings:

Table 3
Stability Criteria for Low-Flow Purging

Constituent	Criteria
Dissolved Oxygen Content (DO)	± 0.2 mg/L
Oxidation-Reduction Potential (redox)	± 20 mv
Turbidity	± 10 % (optional depending on instruments)
Specific Conductance	± 03-05% of reading
Temperature	± 3% of reading (min. of ± 0.2 C)
PH	± 0.2 units, minimum

4. EQUIPMENT REQUIREMENTS

Because the methodology requires that disturbance to the water column in the well be minimized, the same pumping device used for purging should be used for sampling (i.e. the pump should be left in place after purging). Refer to Table 1 and Table 2 for the proper pumping equipment for the low-flow method.

a. Dedicated and Portable Systems

Studies have shown that the installation of any device into a well disturbs the stratification typically exhibited in a well due to laminar flow of groundwater in the well. Insertion also potentially mobilizes suspended solids in the water column due to disturbance of settled and adhered solids in the casing and agitation of water in the filter pack. Therefore, low-flow purging and sampling techniques are more accurate when dedicated systems are used. Dedicated systems result in lower initial turbidity values and lower purge volumes to achieve stabilized indicator parameter readings, and should be considered when a well will be sampled multiple times.

If portable systems are used, they must be placed carefully into the well and lowered into the screen zone as slowly as possible. Placement of the portable pump can disturb the groundwater flow conditions resulting in non-equilibrium conditions. As a result, longer purge times and greater purge volumes may be necessary to achieve indicator parameter stabilization. In general, this may require that after installation, the portable pump should remain in place for a minimum of 1-2 hours to allow settling of solids and re-establishment of horizontal flow through the screen zone. If initial turbidity readings are excessive (>50 NTU), pumping should cease and the well should rest for another 1-2 hours before initiating pumping again. In wells set in very fine-grained formations, longer waiting periods may be required.

b. Water-Level Measurement Equipment

Continuous water-level measurement devices are preferred, such as down-hole pressure transducers, but electronic water-level tapes can be used. The devices used must be capable of measuring to 0.01-foot accuracy.

c. Indicator Parameter Equipment

Measurement of indicator parameters (dissolved oxygen content, redox potential, specific conductance, temperature and pH) is required. This is most easily performed using an in-line flow cell (closed) system attached directly to the pump discharge tubing. For turbidity measurement, a separate field nephalometer should be used.

5. COLLECT SAMPLES

After the monitoring well has been properly purged using the low-flow method, use step #12 of the Low-Flow Sampling Method SOP (WRAD-SOP-GW-03) (where appropriate) for groundwater sample collection. However, when using this method it is of utmost importance to collect the groundwater samples using the same pump or device used for low-flow purging without moving it or causing disturbance to the well.

Benefit of Compliance to Instruction:

- Ensures consistency in all readings
- Compliance with Regulatory guidelines
- Provides proper QA/QC for all wells sampled
- Allows for a consistent, reliable, historical record of analytical results
- Identifies impacts to groundwater

Consequence of Non-Compliance to Instruction:

- Inaccurate readings
- Useless data that must be sampled again
- Re-sampling and analysis cost overruns
- Disciplinary action
- Impacts to groundwater not identified in timely fashion

Environmental Management System (EMS) –ISO 14001 *PROCESS MAP #*: N/A

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