Designation: D6771 – 02

Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations[1]

This standard is issued under the fixed designation D6771; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the method for purging and sampling wells and devices used for ground-water quality investigations and monitoring programs known as low-flow purging and sampling. This method is also known by the terms minimal drawdown purging or low-stress purging. This method could be used for other types of ground-water sampling programs but these uses are not specifically addressed in this practice.

1.2 This practice applies only to wells sampled at the wellhead.

1.3 This practice does not address sampling of wells containing either light or dense non-aqueous-phase liquids (LNAPLs or DNAPLs).

1.4 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "standard" in the title means that the document has been approved through the ASTM consensus process.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well) [2]

D5088 Practice for Decontamination of Field Equipment Used at Waste Sites [2]

D5092 Practice for Design and Installation of Ground Water Monitoring Wells [2]

D5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers [3]

D5903 Guide for Planning and Preparing for a Groundwater Sampling Event [3]

D6026 Practice for Using Significant Digits in Geotechnical Data [3]

D6089 Guide for Documenting a Ground-Water Sampling Event [3]

D6452 Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations [3]

D6517 Guide for Field Preservation of Ground-Water Samples [3]

D6564 Guide for Field Filtration of Ground-Water Samples [3]

D6634 Guide for the Selection of Purging and Sampling Devices for Ground-Water Monitoring Wells

3. Terminology

3.1 *drawdown (low-flow purging and sampling), n*—lowering of the water level in a well caused by pumping the well.

3.2 *entrance velocity, n*—the velocity with which formation pore water passes through a well screen during pumping of the well. This velocity should be controlled (held to less than 0.10 ft/s or 3.0 cm/s) to avoid turbulent flow through the screen and to minimize or eliminate deleterious effects on water chemistry and on well construction materials.

3.3 *low flow, n*—refers to the velocity that is imparted during pumping to the formation pore water adjacent to the well screen. It does not necessarily refer to the flow rate of water discharged by a pump at the surface.

4. Summary of Practice

4.1 Low-flow purging and sampling is a method of collecting samples from a well that, unlike traditional purging methods, does not require the removal of large volumes of water from the well. Low-flow purging differs from traditional methods of purging (as described in Guide D6452) in that its

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground-Water and Vadose Zone Investigations.

Current edition approved Feb. 10, 2002. Published March 2002. DOI: 10.1520/D6771-02.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

use is based on the observations of many researchers that water moving through the formation also moves through the well screen. Thus, the water in the screen is representative of the formation water surrounding the screen. This assumes that the well has been properly designed, constructed, and developed as described in Practice D5092 and Guide D5521. In wells in which the flow through the screen or intake zone is limited by hydraulic conductivity contrasts (for example, borehole smearing, residual filter cake, filter pack grain size, or well screen open area), the head difference induced by low-flow pumping provides an exchange of water between the formation and the well. Low-flow purging involves removing water directly from the screened interval without disturbing any stagnant water above the screen. This is done by pumping the well at a low enough flow rate to maintain minimal drawdown of the water column within the well as determined through water-level measurement during pumping. The objective is to pump in a manner that minimizes stress to the ground-water system to the extent practical, taking into account site sampling objectives. Pumping at low rates, in effect, hydraulically isolates the column of stagnant water in the well and negates the need for its removal prior to sample collection. Typically, flow rates on the order of 0.1 to 0.5 L/min are used; however, this is dependent on site-specific and well-specific factors (**1**). Some very coarse textured formations have been successfully purged and sampled in this manner at flow rates up to 1 L/min. Pumping water levels in the well and water-quality indicator parameters (such as pH, temperature, specific conductance, dissolved oxygen and redox potential) should be monitored during pumping, with stabilization indicating that purging is completed and sampling can begin. Because the flow rate used for purging is, in most cases, the same or only slightly higher than the flow rate used for sampling, and because purging and sampling are conducted as one continuous operation in the field, the process is referred to as low-flow purging and sampling.

5. Significance and Use

5.1 The objective of most ground-water sampling programs is to obtain samples that are representative of formation-quality water. Wells used in ground-water quality investigations or monitoring programs are generally purged of some amount of water in an attempt to obtain a representative sample. For traditional methods of purging (for example, well-volume purging), purging is done to minimize bias associated with stagnant water standing in the casing of the well (above the well screen), which generally does not accurately reflect ambient ground-water chemistry. To use low-flow purging and sampling, a pump intake is set within the well screen and the pump is operated at a low flow rate (generally less than or equal to the natural recovery rate of the well), minimizing drawdown in the well and thus hydraulically isolating the water in the screened zone from the water in the casing. Water pumped in this way comes directly from the screened interval of the well. This obviates the need to purge the stagnant water in the well prior to collecting samples. Access to formation-quality water is confirmed by monitoring water quality parameters to the point at which they stabilize as described in Guide D6452.

5.2 Low-flow purging and sampling may be used in any well that can be pumped at a constant rate of 1.0 L/min or less without continuous drawdown of the water level in the well (**1**). It is feasible to implement low-flow purging and sampling in wells in which the water level is always above the top of the well screen, and in wells that are constructed so that the water level is always within the well screen.

5.3 Low-flow purging and sampling can be used to collect samples for all categories of aqueous-phase contaminants and naturally occurring analytes, including volatile and semi-volatile organic compounds (VOCs and SVOCs), metals and other inorganics, pesticides, PCBs, other organic compounds, radionuclides and microbiological constituents. It is particularly well suited for use where it is desirable to sample aqueous-phase constituents that may sorb or partition to particulate matter. It is not applicable to sampling either light or dense non-aqueous-phase liquids (LNAPLs or DNAPLs).

6. Benefits and Limitations of Low-Flying Purging and Sampling

6.1 Purging and sampling at a low flow rate offers a number of benefits over traditional methods including:

6.1.1 Improved sample quality and reduced (or eliminated) need for sample filtration, through minimized disturbance of the well and the formation, which results in reduced artifactual sample turbidity and minimization of false positives for analytes associated with particulate matter;

6.1.2 Improved sample accuracy and precision and greatly reduced sample variability as a result of reduced stress on the formation, reduced mixing of the water column in the well and dilution of analytes, and reduced potential for sample agitation, aeration and degassing or volatilization;

6.1.3 Samples represent a smaller section or volume of the formation, representing a significant improvement in the ability to detect and resolve contaminant distributions, which may vary greatly over small distances in three-dimensional space;

6.1.4 Overall, improved sample reproducibility, especially when using dedicated pumps;

6.1.5 Improved ability to directly quantify the total mobile contaminant load (including mobile colloid-sized particulate matter) without the need for sample filtration;

6.1.6 Increased well life through reduced pumping stress on the well and formation, resulting in greatly reduced movement of fine sediment into the filter pack and well screen;

6.1.7 Greatly reduced purge-water volume, (often 90 to 95 %) resulting in significant savings of cost related to purge water handling and disposal or treatment, and reduced exposure of field personnel to potentially contaminated purge water; and

6.1.8 Reduced purging and sampling time (much reduced at sites using dedicated pumps), resulting in savings of labor cost, depending on the time required for water-quality indicator parameters to stabilize.

6.2 Though the application of low-flow purging and sampling will improve sampling results and produce significant technical and cost benefits at most sites, not all sites, and not all individual wells within a site, are well suited to this approach. Limitations of the method include the following:

6.2.1 On a practical basis, low-flow purging and sampling is generally not suitable for use in very low-yield wells (those that will not yield sufficient water without continued drawdown with pumping over time). This limitation is largely a function of the limitations of discharge rates of available pumps and the volume of the flow cell (if used) for indicator parameter measurement;

6.2.2 The need to use a variable flow-rate pump capable of pumping within the desired flow-rate range. Low-flow purging cannot be performed using grab sampling devices, such as bailers, or inertial lift devices, which severely agitate the water column in the well, resulting in significant mixing of the water column and release of considerable sediment, which shows up as increased turbidity in samples.

6.2.3 For some applications, the need to use a flow-through cell, which may increase capital costs, lead to slightly greater set-up time in the field, and add one piece of field equipment.

7. Equipment Requirements for Low-Flow Purging and Sampling

7.1 A variety of pumps capable of pumping at low flow rates may be used for low-flow purging and sampling. Continuous discharge and cyclic discharge pumps work equally well as long as the pump has adjustable flow rate controls and is capable of being run at a low enough flow rate to avoid causing continuous drawdown in the well. Because the purging and sampling processes are joined together into one continuous operation, the pump selected (see Guide D6634) should be appropriate for use both in purging and sampling the analytes of interest. For example, if VOCs or other pressure-sensitive parameters (for example, dissolved oxygen, carbon dioxide, trace metals) are analytes of interest, peristaltic and other suction-lift pumps should be avoided because they may cause loss of VOCs, degassing and redox and pH changes (**2-5**).

7.2 Dedicated pumps (those that are permanently installed in the well) are preferred over portable pumps because they eliminate disturbance to the water column in the well resulting in lower turbidity values, shorter purge times and lower purge volumes to achieve stabilized indicator parameter measurements. However, portable pumps can be used if care is taken to minimize disturbance to the water column during pump installation and some time is allowed prior to pump operation for any fines agitated in the water column to settle.

7.3 Grab sampling devices, such as bailers and kemmerer samplers, and inertial-lift devices, cannot be used for low-flow purging and sampling because of the disturbance they cause to the water column in the well and the attendant effects of mixing and increased sample turbidity.

7.4 A volume measuring device (for example, graduated cylinder) and a time piece capable of measuring in seconds will be necessary to calculate the flow rate from the discharge tube from the pump.

7.5 Low-flow purging and sampling requires continuous or periodic water-level measurements (see Test Method D4750). Any water-level measurement equipment that does not disturb the water column in the well may be used, as long as it provides the accuracy required by the sampling program (generally ±0.01 ft [3 mm]).

7.6 Low-flow purging and sampling requires continuous or periodic measurement of selected water-quality indicator parameters (and, possibly, turbidity) to determine when purging is complete and sampling can commence. Continuous monitoring in a closed flow-through cell of known volume generally provides the most consistent and reliable results, especially for dissolved oxygen and redox potential, and is the preferred method of measuring indicator parameters. However, individual instruments designed to measure the most common water-quality indicator parameters (temperature, pH, and conductivity or specific conductance) may also be used. Dissolved oxygen and redox potential measurements made after the purged water is exposed to atmospheric conditions, however, will not accurately reflect in-situ conditions. All instruments used to measure indicator parameters should be properly calibrated and maintained in accordance with manufacturers' instructions at the well head at the start of each day of sampling and calibration should be checked periodically throughout the sampling event.

7.7 Other equipment and supplies that may be used in low-flow purging and sampling include those items specified by the site-specific sampling and analysis plan (for example, decontamination supplies, sample bottles, filtration media and equipment, preservation supplies, wellhead screening instruments [PID, FID, OVA, combustible gas indicators], sample shipping containers, and field documentation materials [for example, field notebook, field data sheets, chain-of-custody forms, sample bottle labels, shipping documents]).

8. Description of the Procedure

8.1 *General*:

8.1.1 "Low flow" refers to the velocity with which water enters the pump intake and that is imparted during pumping to the formation pore water adjacent to the well screen. This velocity must be minimized to preclude the entrainment of artifactual particulate matter in the water to be collected as a sample. Low-flow does not necessarily refer to the flow rate of water discharged by a pump at the surface, which can be affected by valves, restrictions in the discharge tubing or flow regulators. Some researchers refer to the method as "low-stress" purging, where "low-stress" refers to the impact of pumping the well on the formation. Water-level drawdown provides a measurable indicator of the stress on a given formation imparted by a pumping device operated at a given flow rate. The objective of low-flow purging is to pump in a manner that minimizes stress (drawdown) or disturbance to the ground-water flow system to the extent practical.

8.2 *Preparation for Low-Flow Purging and Sampling*:

8.2.1 Prior to conducting the initial sampling event, the sampling team should prepare themselves and any equipment and materials to be used in the event in accordance with Practice D5903. Any equipment used in the sampling program that could contact the water in the well, the water collected during field parameter measurement, or the water collected as a sample should be properly cleaned before each use (see Practice D5088). The clean equipment should not be allowed to contact the ground or other surfaces that could impart contaminants. An effort should be made to closely match the length of the tubing used for portable pumps with the depth at