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# Standard Practice for Low-Flow Purging and Sampling Used for Groundwater Monitoring[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 describes the method of low-flow purging and sampling used to collect groundwater samples from wells to assess groundwater quality.

1.2 The purpose of this procedure is to collect groundwater samples that represent a flow-weighted average of solute and colloid concentrations transported through the formation near the well screen under ambient conditions. Samples collected using this method can be analyzed for groundwater contaminants and/or naturally occurring analytes.

1.3 This practice is generally not suitable for use in wells with very low-yields and cannot be conducted using grab sampling or inertial lift devices. This practice is not suitable for use in wells with non-aqueous phase liquids.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are approximate mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.5 *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 only that the document has been approved through the ASTM consensus process.*

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5092/D5092M Practice for Design and Installation of Groundwater Monitoring Wells
D5521/D5521M Guide for Development of Groundwater Monitoring Wells in Granular Aquifers
D5608 Practices for Decontamination of Sampling and Non Sample Contacting Equipment Used at Low Level Radioactive Waste Sites
D5903 Guide for Planning and Preparing for a Groundwater Sampling Event
D5978/D5978M Guide for Maintenance and Rehabilitation of Groundwater Monitoring Wells
D6089 Guide for Documenting a Groundwater Sampling Event
D6452 Guide for Purging Methods for Wells Used for Ground Water Quality Investigations
D6517 Guide for Field Preservation of Ground Water Samples
D6564/D6564M Guide for Field Filtration of Groundwater Samples
D6634/D6634M Guide for Selection of Purging and Sampling Devices for Groundwater Monitoring Wells
D6725/D6725M Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers

[1] These test methods are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

D6911 Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis
D7069 Guide for Field Quality Assurance in a Groundwater Sampling Event
D7929 Guide for Selection of Passive Techniques for Sampling Groundwater Monitoring Wells

## 3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms about soil and rock and the fluids contained in them, refer to Terminology in D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *artifactual turbidity*—particulate matter that is not naturally mobile in the groundwater system and can be introduced to the subsurface during drilling or well construction, sheared from the target monitoring zone during purging of the well, or produced by exposure of groundwater to atmospheric conditions (abbreviated definition from D653).

3.2.2 *blank-riser pipe water*—water in the riser pipe interval of a monitoring well above or below the well screen that is assumed to not represent formation quality water because it is less susceptible to ambient well flushing and is potentially stagnant.

3.2.3 *drawdown [L]*—vertical distance the ambient (non-pumping) water level is lowered due to continuous removal of water from the well.

3.2.4 *flow-through cell*—vessel through which purge water is transported in order to contact sensors for continuous measurement of indicator and operational parameters.

3.2.5 *flow-weighted average concentration*—single analyte value that reflects a mixture proportional to the flow rate and respective concentrations of groundwater entering the screen interval.

3.2.6 *indicator parameters*—chemical properties (oxygen, oxidation-reduction potential, specific conductance, and pH) measured to determine when the discharge water is considered to represent a flow-weighted average concentration of the formation water.

3.2.7 *operational parameters*—physical properties (water level, turbidity, and temperature) measured to determine whether pumping operations have introduced potential sampling biases.

3.2.8 *optimum pumping rate* $[L^3/T]$—well-specific pump rate used to minimize the purge time required before sampling while also minimizing changes to the ambient groundwater flow conditions and operational parameters.

3.2.9 *pumping water level [L]*—free or unconfined water elevation during purging and sampling.

3.2.10 *screen volume* $[L^3]$—quantity of water contained in the screened interval of a monitoring well.

3.2.11 *stabilization*—condition that occurs when changes in indicator and operational parameter values are maintained within a specified range over a selected number of consecutive readings and it appears the readings will continue to remain within that specified range during subsequent readings.

## 4. Summary of Practice

4.1 *General Objective*—Under ambient conditions, the amount of groundwater flow through a monitoring well screen is dependent on the local hydrogeological conditions and well design (for example, well diameter, screen length, sand pack). If a well is constructed, developed, and maintained properly, hydraulic communication normally exists between the formation and well under ambient conditions (**1**).[3] With adequate hydraulic communication and ambient aquifer flow, the composition of the formation water and pre-pumping well water may be very similar (Guide D7929). However, purging methods are commonly applied to assure the collection of formation-quality water. Indicator parameters (for example, dissolved oxygen and specific conductance) can be monitored to assess changes in the composition of the discharge water as formation water is drawn into the well, mixes with existing well water, and displaces the pre-existing water in the screened interval during purging. If the well is purged at a rate that results in substantial changes (that is, stress) to the ambient flow conditions, as can be shown by increases in operational parameters (drawdown and turbidity), the quality of formation water entering the well screen can be altered. The low-flow purging and sampling method was developed to collect reproducible samples that are considered to represent a flow-weighted average of the formation water while minimizing changes to the ambient flow conditions (**2**).

4.2 *Minimizing Hydraulic Stress*—Pumping that induces excessive drawdown and/or groundwater inflow velocities through the well screen can result in sampling biases associated with screen dewatering, water column aeration, artifactual turbidity, and/or mixing of blank-riser pipe water into the screened interval. The magnitude of these effects at a given pumping rate are dependent on the well design and near-well hydrogeological conditions (for example, gradient and hydraulic conductivity). Since the amount of hydraulic stress and related sampling biases that can occur at a given pumping rate varies for each well, the overall goal of low-flow purging and sampling is to minimize hydraulic stress by reducing the pumping rate to the extent practical. Typically pumping rates on the order of 0.1 to 1.0 L/min can be used to minimize changes to ambient flow conditions while preserving the quality of formation water entering the well (**2**), although higher rates can be used if appropriate.

4.3 *Sample Composition*—Groundwater samples collected by this method are considered to represent a flow-weighted average of the formation water entering the screened interval based on the stabilization of indicator parameters (**3-7**). The vertical distribution of the inflow rate through the well screen varies according to the vertical distribution of permeable materials in the surrounding formation and the presence of vertical head gradients (if any). Some degree of vertical mixing often occurs within the well under ambient flow conditions (**4, 8**). During pumping, the mixed pre-pumping well water is incorporated with groundwater that enters the well screen and

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

advances toward the pump intake. The purge time needed to achieve stabilization of indicator parameters is dependent on the well design, the degree of in-well mixing, vertical heterogeneity of surrounding formation materials, and stratification of the formation water quality (if any) entering the well screen. These factors control the volume of water to be purged. Where the composition of formation water entering the well screen interval is relatively homogenous and/or is similar to the pre-pumping well water (as signaled by the stabilization of indicator parameters), a sample collected by low-flow purging and sampling reflects an acceptable mixture of the formation and pre-pumping well water (**3**, **4**).

## 5. Significance and Use

5.1 *Method Considerations*—The objective of most groundwater sampling programs is to obtain samples that are similar in composition to that of the formation water near the well screen. The low-flow purging and sampling method uses the stabilization of indicator parameters to determine when the pump discharge is considered to represent a flow-weighted average of the formation water. Measurements of operational parameters are used to determine potential sampling bias (for example, artifactual turbidity and increased temperature) that may have been introduced by pumping operations and to ensure that the sample is representative of formation water. The low-flow purge rate minimizes lowering of the ambient groundwater level and thereby minimizes potential entrainment of blank-riser pipe (and potentially stagnant) water above or below the screen into the screened-zone of the well. This sampling method assumes that the well has been properly designed and constructed as described in Practices D5092/D5092M and D6725/D6725M, adequately developed as described in Guide D5521/D5521M, and has received proper well maintenance and rehabilitation as described in Guide D5978/D5978M (see Note 1).

NOTE 1—This Standard is not intended to replace or supersede any regulatory requirements, standard operating procedure (SOP), quality assurance project plan (QAPP), ground water sampling and analysis plan (GWSAP) or site-specific regulatory permit requirements. The procedures described in this Standard may be used in conjunction with regulatory requirements, SOPs, QAPPs, GWSAPs or permits where allowed by the authority with jurisdiction.

5.2 *Applicability*—Low-flow purging and sampling may be used in a monitoring well that can be pumped at a constant low-flow rate without continuously increasing drawdown in the well (**2**). If a well cannot be purged without continuously increasing drawdown even at very low pumping rates (for example, 50 – 100 mL/min), the well should not be sampled using this sampling method as described in this standard; a passive sampling method, as described in Guide D7929, may be considered as an alternative.

5.3 *Target Analytes*—Low-flow purging and sampling can be used to collect samples for all categories of aqueous-phase contaminants and naturally-occurring analytes. It is particularly well suited for use where it is desirable to sample aqueous-phase constituents that may sorb or partition to particulate matter, because the method minimizes the potential for artifactual turbidity compared with high flow/high volume purging using a pump, bailer, or inertial-lift device (**9-12**).

## 6. Benefits and Limitations of Low-Flow Purging and Sampling

6.1 *Benefits:*

6.1.1 Purging and sampling at a low-flow rate provides more accurate and reproducible samples of the formation-quality water than high flow/high volume purging and sampling methods by minimizing hydraulic stresses on the ambient flow conditions that may introduce one or more of the following biases to the sample (**12**, **13**):

6.1.1.1 *Artifactual Turbidity*—Artificially elevated turbidity levels induced by pumping rates that entrain colloidal sized particles that are immobile under ambient flow conditions can result in increased concentrations of contaminants that are sorbed or partitioned on those colloids (for example, metals and some organics);

6.1.1.2 Artificial aeration, or oxygenation, of the water column from percolation and/or cascading of water down the sand pack and well screen, respectively, when the well is rapidly dewatered. Water column aeration can also result from agitation by the sampling device. These processes can result in the loss of volatile organic compounds and dissolved gases, as well as chemical changes associated with oxygenation; and

6.1.1.3 Entrainment of blank-riser pipe (and potentially stagnant) water from drawdown or excessive agitation of the water column.

6.1.2 Purging and sampling at a low-flow rate can provide more cost and well-maintenance benefits than other purge and sampling methods by:

6.1.2.1 Reducing purge-water volume, resulting in reduced exposure of field personnel to potentially contaminated purge water;

6.1.2.2 Reducing well maintenance (for example, redevelopment) through reduced pumping stress on the well and formation, resulting in greatly reduced movement of fine sediment into the filter pack and well screen;

6.1.2.3 Reducing purge-water volume, resulting in savings of costs related to purge water handling and disposal or treatment; and

6.1.2.4 Potentially reducing purge time, particularly when using dedicated pumps (**14**), resulting in labor cost savings.

6.2 *Limitations:*

6.2.1 Low-flow purging and sampling is generally not suitable for use in very low-yield wells (those that will not yield sufficient water without continuously increasing drawdown while pumping at very low rates (for example, 50 – 100 mL/min) over time).

6.2.2 As with any sampling method, low-flow purging and sampling is not suitable for sampling in wells known to contain light or dense non-aqueous-phase liquids (NAPL), because it may misrepresent the risk to human health and may complicate data interpretation.

6.2.3 Low-flow purging and sampling cannot be performed using grab sampling devices (for example, bailers) or inertial-lift devices, because these devices can severely agitate the water column in the well, and this typically results in aeration, excessive mixing of the water column, and artifactual turbidity (see Guide D6634/D6634M).