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Standard Guide for Field Filtration of Ground-Water Samples¹

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1. Scope

1.1 This guide covers methods for field filtration of ground-water samples collected from ground-water monitoring wells, excluding samples that contain non-aqueous phase liquids (either Dense Non-Aqueous Phase Liquids (DNAPLs) or Light Non-Aqueous Phase Liquids (LNAPLs)). Methods of field filtration described herein could also be applied to samples collected from wells used for other purposes. Laboratory filtration methods are not described in this guide.

1.2 This guide provides procedures available for field filtration of ground-water samples. The need for sample filtration for specific analytes should be defined prior to the sampling event and documented in the site-specific sampling and analysis plan in accordance with Guide D 5903. The decision should be made on a parameter-specific basis with consideration of the data quality objectives of the sampling program, any applicable regulatory agency guidelines, and analytical method requirements.

1.3 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide 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 guide be applied without consideration of the many unique aspects of a project. The word “Standard” in the title of this guide means only that the guide has been approved through the ASTM consensus process.

1.4 *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:

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids²
- D 5088 Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites²
- D 5092 Practice for Design and Installation of Ground-Water Monitoring Wells in Aquifers²
- D 5903 Guide for Planning and Preparing for a Ground-Water Sampling Event³
- D 6089 Guide for Documenting a Ground-Water Sampling Event³
- F 740 Terminology Relating to Filtration⁴

3. Terminology

- 3.1 *filter, v*—to pass a fluid containing particles through a filter medium whereby particles are separated from the fluid. (F 740)
- 3.2 *filter, n*—a device for carrying out filtration which consists of the combination of the filter medium and suitable hardware for constraining and supporting it in the path of the fluid. (F 740)
- 3.3 *filter medium*—the permeable material used for a filter that separates particles from a fluid passing through it. (F 740)
- 3.4 *filter preconditioning*—the process of preparing a filter medium for filtration
- 3.5 *filter system*—the combination of one or more filter with all the associated process hardware required for filtration. (F 740)
- 3.6 *filtrate*—the fluid that has passed through the filter. (F 740)
- 3.7 *filtration*—the process by which particles are separated from a fluid by passing the fluid through a permeable material. (F 740)
- 3.8 *filtered sample*—a ground-water sample which has passed through a filter medium.
- 3.8.1 *Discussion*—This type of sample may also be referred to as a “dissolved” sample. An unfiltered sample containing dissolved, sorbed, coprecipitated and all suspended particles may be referred to as a “total” sample.

¹ This guide 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.

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

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

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

3.9 *particle*—a small discrete mass of solid or liquid matter.
(F 740)

4. Significance and Use

4.1 A properly designed, installed and developed ground-water monitoring well, constructed in accordance with Practice D 5092, should facilitate collection of samples of ground water that can be analyzed to determine both the physical and chemical properties of that sample. Samples collected from these wells that require analysis for dissolved constituents should be filtered in the field prior to chemical preservation and shipment to the laboratory for analysis.

5. Purpose of Ground-Water Sample Filtration

5.1 Ground-water samples may be filtered to separate a defined fraction of the sample for analysis.

6. Timing of Ground-Water Sample Filtration

6.1 Ground-water samples should be filtered immediately upon collection and prior to chemical preservation of the sample. (1)⁵ Filtration should be completed in as short a time as possible while minimizing sample aeration, agitation, pressure changes, temperature changes and prolonged contact with ambient air.

NOTE 1—The pressure change that occurs when the sample is brought to the surface may cause changes in sample chemistry which include losses of dissolved gases and precipitation of dissolved constituents such as metals. When handling samples during filtration operations, additional turbulence and mixing of the sample with air can cause aeration and oxidation of dissolved ferrous to ferric iron. Ferric iron rapidly precipitates as amorphous iron hydroxide and can adsorb other dissolved trace metals (2).

7. Ground-Water Sample Filtration Procedures

7.1 *Preparation for Ground-Water Sample Filtration*—The ground-water sample filtration process consists of three phases: selection of filtration method; selection and pretreatment of filter media; and ground-water sample filtration prior to transfer into the sample container.

7.1.1 *Filtration Method Selection Criteria*—A wide variety of methods are available for field filtration of ground-water samples. In general, filtration equipment can be divided into positive pressure filtration and vacuum (negative pressure) filtration methods, each with several different filtration medium configurations. Ground-water samples undergo pressure changes as they are brought from the saturated zone (where ground water is under pressure greater than atmospheric) to the surface (where it is under atmospheric pressure), resulting in changes in sample chemistry. Vacuum filtration methods further exacerbate pressure changes. For this reason, positive pressure filtration methods are preferred. Table 1 presents equipment options available for positive pressure and vacuum filtration of ground-water samples. Fig. 1 presents examples of common filter characteristics and applications.

7.1.2 When selecting a filtration method, the following criteria should be evaluated on a site-by-site basis:

TABLE 1 Examples of Equipment Options for Positive and Negative Pressure Filtration of Ground Water Samples

Positive Pressure Filtration Equipment:

- In-line capsules
 - attached directly to a pumping device discharge hose
 - attached to a pressurized transfer vessel
 - attached to a pressurized bailer
- Free-standing disk filter holders
- Syringe filters
- Zero headspace extraction vessels

Negative Pressure Filtration Equipment:

- Glass funnel support assembly

7.1.2.1 Effect on sample integrity considering the potential for the following to occur:

7.1.2.2 Sample aeration (Note 2),

7.1.2.3 Sample agitation (Note 2),

NOTE 2—Sample aeration and increased agitation may result in sample chemical alteration.

7.1.2.4 Change in partial pressure of sample constituents resulting from application of negative pressure to the sample during filtration,

7.1.2.5 Sorptive losses of components from the sample onto the filter medium or components of the filtration equipment (for example, flasks, filter holders etc.); and

7.1.2.6 Leaching of components from the filter medium or components of the filtration equipment into the sample.

7.1.2.7 Volume of sample to be filtered;

7.1.2.8 Chemical compatibility of filter medium with ground water sample chemistry;

7.1.2.9 Anticipated amount of suspended solids and the attendant effects of particulate loading (reduction in effective filter pore size);

7.1.2.10 Time required to filter samples (Note 3);

NOTE 3—Short filtration times are recommended to minimize the time available for chemical changes to occur in the sample.

7.1.2.11 Ease of use;

7.1.2.12 Availability of an appropriate medium in the desired filter pore size

7.1.2.13 Filter surface area;

7.1.2.14 Use of disposable versus non-disposable equipment;

7.1.2.15 Ease of cleaning equipment if not disposable;

7.1.2.16 Potential for sample bias associated with ambient air contact during sample filtration; and

7.1.2.17 Cost, evaluating the costs associated with: equipment purchase price, expendable supplies and their disposal, time required for filtration, time required for decontamination of non-disposable equipment and quality control measures.

7.1.2.18 The filtration method used for any given sampling program should be documented in the site-specific sampling and analysis plan and should be consistent throughout the life of the sampling program to permit comparison of data generated. If an improved method of filtration is determined to be appropriate for a sampling program, the sampling and analysis plan should be revised and implemented in lieu of continuation of the existing filtration method. In this event, the effect on comparability of data needs to be examined and quantified to allow proper data analysis and interpretation (Note 4).

⁵ The boldface numbers given in parentheses refer to a list of references at the end of the text.

Media ¹	Analytes						Filter EFA ² (Diameter in mm)							Pore Size (µm)					Filter Type					
	Major Ions	Minor Ions	Trace Metals	Nutrients	Organic Compounds	Dissolved/Suspended Organic Carbon	17 cm ² (47 mm)	20 cm ² (50 mm)	64 cm ² (90 mm)	158 cm ² (142 mm)	250 cm ²	800 cm ²	700 cm ²	770 cm ²	0.1	0.2	0.45	1.0	5.0	Flat Disc	Capsule	Syringe Filter	Funnel	Zero Headspace Extractor (ZHE)
Acrylic Copolymer	X		X	X			X	X	X			X				X	X	X	X	X	X	X		
Glass Fiber					X		X	X	X							X	X	X	X	X	X	X	X	X
Mixed Cellulose Esters				X			X	X	X					X	X	X	X	X	X			X		
Nylon			X				X	X				X				X	X	X	X	X	X	X		
Polycarbonate	X	X	X	X			X	X						X	X	X	X	X	X	X	X	X	X	X
Polyethersulfone	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Polypropylene	X	X	X	X								X				X	X	X		X				
Silver					X		X									X			X					

¹ Other media maybe appropriate for specific analytes of interest

² EFA - Effective Filtration Area

FIG. 1 Examples of Common Filter Characteristics and Applications

NOTE 4—Statistical methods may need to be implemented to determine the significance of any changes in data resulting from a change in filtration method.

7.1.3 *Filtration Equipment Materials of Construction*—Filtration equipment and filtration media are available in a wide variety of materials of construction. Materials of construction should be evaluated (e.g. by contacting manufacturers, conducting leach tests or collecting equipment blanks) to minimize sample bias:

7.1.3.1 Potential for negative bias due to adsorption of constituents from the sample (2);

7.1.3.2 Potential for positive bias due to desorption or leaching of constituents into the sample (3-6);

7.1.3.3 Reduction of the effective filter pore size caused by clogging when filtering water containing suspended particles; (6) and

7.1.3.4 Aeration of the sample leading to precipitation of some constituents (for example, ferric hydroxide) (3).

7.1.4 *Selection and Pretreatment of Filter Media*—Filtration media are manufactured with specific pore size diameters designed to permit particles of a selected size to be retained by the filter medium. Filtration media must be selected after considering filter pore size, and materials of construction. Ground-water samples requiring field filtration must be filtered using a medium with a pore size that meets the requirements of the approved sampling and analysis plan.

7.1.5 *Preconditioning of the Filtration Medium:*

7.1.5.1 Filter media require preconditioning prior to sample filtration (7). Purposes of filter preconditioning include: to minimize positive sample bias associated with residues that may exist on the filter surface or constituents that may leach from the filter; and to create a uniform wetting front across the entire surface of the filter to prevent channel flow through the filter and increase the efficiency of the filter surface area. Preconditioning the filter medium may not completely prevent sorptive losses from the sample as it passes through the filter medium.

7.1.5.2 In most cases, filter preconditioning should be done at the wellhead (Note 5) immediately prior to use. Some manufacturers prerinse filters prior to sale. These filters are typically marked “prerinsed” on filter packaging and provide directions for any additional field preconditioning required prior to filter use.

NOTE 5—Some filters require preconditioning procedures that can only be done in the laboratory (for example, GF/F filters must be baked prior to use).

7.1.5.3 The procedure used to precondition the filter medium is determined by the following: the design of the filter (that is, filter capsules, or disks), the material of construction of the filter medium, the configuration of the filtration equipment, and the parameters of concern for sample analysis. Filtration medium manufacturers’ instructions should be followed prior to implementing any filter preconditioning protocols in the field to ensure that proper methods are employed and to minimize potential bias of samples being filtered.

7.1.5.4 The volume of water used in filter preconditioning is dependent upon the surface area of the filter and the medium’s ability to absorb liquid. Many filter media become fragile when saturated and are highly subject to damage during handling. Therefore, saturated filter media should be handled carefully and are best preconditioned immediately prior to use.

7.1.6 *Preconditioning of Disk Filters*—Disk filters (also known as plate filters) should be preconditioned as follows:

7.1.6.1 Hold the edge of the filter with filter forceps constructed of materials that are appropriate for the analytes of interest (Note 6);

NOTE 6—Manufacturers often use colored parchment paper disks (for example, yellow or blue) to separate filter disks and these should not be confused with the filtration medium.

7.1.6.2 Saturate the entire filter disk with water (Note 7) (while holding the filter over a containment vessel (not the sample bottle or filter holder) to catch all run-off, then;