



Standard Guide for Sampling and Analysis of Residential and Commercial Water Supply Wells in Areas of Exploration and Production (E&P) Operations¹

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1. Scope

1.1 This guide presents a methodology for obtaining representative groundwater samples from domestic or commercial water wells that are in proximity to oil and gas exploration and production (E&P) operations. E&P operations include, but are not necessarily limited to, site preparation, drilling, completion, and well stimulation (including hydraulic fracturing), and production activities. The goal is to obtain representative groundwater samples from domestic or commercial water wells that can be used to identify the baseline groundwater quality and any subsequent changes that may be identified. While this guide focuses on baseline sampling in conjunction with oil and gas E&P activities, the principles and practices recommended are based on well-established methods that have been in use for many years in other industrial situations. This guide recommends sampling and analytical testing procedures that can identify various chemical species present including metals, dissolved gases (such as methane), hydrocarbons (and other organic compounds), as well as overall water quality.

1.2 This guide provides information on typical residential and commercial water supply well systems and guidance on developing and implementing a sampling program, including determining sampling locations, suggested purging techniques, selection of potential analyses and laboratory certifications, data management, and integrity. It also includes guidance on personal safety. The information included pertains to baseline sampling before beginning any activities that could present potential risks to local aquifers, periodic sampling during and after such work, and ongoing monitoring relating to known or potential groundwater constituents in the area. This guide does not address policy issues related to frequency or timing of

sampling or sampling distances from the wellhead. In addition, it does not address reporting limits, sample preservation, holding times, laboratory quality control, regulatory action levels, or interpretation of analytical results.

1.3 These guidelines are not intended to replace or supersede regulatory requirements and technical methodology or guidance nor are these guidelines intended for inclusion by reference in regulations. Instances where this guide is in conflict with statutory or regulatory requirements, practitioners shall defer to the latter. These guidelines are intended to assist in developing sampling programs to meet project goals and objectives. However, site-specific conditions, regulatory requirements, site-specific health and safety issues, technical manuals and directives, and program data quality objectives should be evaluated and consulted along with the information contained in this guide for each individual site and sampling program.

1.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document 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 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 of this document means only that the document has been approved through the ASTM consensus process.

1.5 Users are responsible for investigating and identifying all the legal and regulatory requirements that are applicable for the location where the sampling is being performed.

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

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.26 on Hydraulic Fracturing.

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2. Referenced Documents

2.1 *ASTM Standards:*²

- D511 Test Methods for Calcium and Magnesium In Water
 D512 Test Methods for Chloride Ion In Water
 D516 Test Method for Sulfate Ion in Water
 D653 Terminology Relating to Soil, Rock, and Contained Fluids
 D858 Test Methods for Manganese in Water
 D888 Test Methods for Dissolved Oxygen in Water
 D1067 Test Methods for Acidity or Alkalinity of Water
 D1068 Test Methods for Iron in Water
 D1125 Test Methods for Electrical Conductivity and Resistivity of Water
 D1246 Test Method for Bromide Ion in Water
 D1293 Test Methods for pH of Water
 D1687 Test Methods for Chromium in Water
 D1976 Test Method for Elements in Water by Inductively-Coupled Argon Plasma Atomic Emission Spectroscopy
 D2330 Test Method for Methylene Blue Active Substances (Withdrawn 2011)³
 D2908 Practice for Measuring Volatile Organic Matter in Water by Aqueous-Injection Gas Chromatography
 D2972 Test Methods for Arsenic in Water
 D3082 Test Method for Boron in Water
 D3223 Test Method for Total Mercury in Water
 D3557 Test Methods for Cadmium in Water
 D3559 Test Methods for Lead in Water
 D3648 Practices for the Measurement of Radioactivity
 D3859 Test Methods for Selenium in Water
 D3920 Test Method for Strontium in Water
 D4191 Test Method for Sodium in Water by Atomic Absorption Spectrophotometry
 D4192 Test Method for Potassium in Water by Atomic Absorption Spectrophotometry
 D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
 D4382 Test Method for Barium in Water, Atomic Absorption Spectrophotometry, Graphite Furnace
 D4658 Test Method for Sulfide Ion in Water
 D5673 Test Method for Elements in Water by Inductively Coupled Plasma—Mass Spectrometry
 D5907 Test Methods for Filterable Matter (Total Dissolved Solids) and Nonfilterable Matter (Total Suspended Solids) in Water
 D5980 Guide for Selection and Documentation of Existing Wells for Use in Environmental Site Characterization and Monitoring
 D7315 Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode
 D7678 Test Method for Total Petroleum Hydrocarbons (TPH) in Water and Wastewater with Solvent Extraction using Mid-IR Laser Spectroscopy

2.2 *EPA Standards:*⁴

- EPA 160.1 Total Dissolved Solids (TDS)
 EPA 300.0 Determination of Inorganic Anions by Ion Chromatography
 EPA 300.1 Determination of Inorganic Anions in Drinking Water by Ion Chromatography
 EPA 310.1 Ortho-Phosphorus, Dissolved Automated, Ascorbic Acid
 EPA 310.2 Alkalinity (Colorimetric, Automated, Methyl Orange)
 EPA 325.1 Chloride (Colorimetric, Automated Ferricyanide AAI)
 EPA 425.1 Methylene Blue Active Substances (MBAS)
 EPA 900.0 Gross Alpha and Beta Activity in Water, Official Name: Gross Alpha and Gross Beta Radioactivity in Drinking Water
 EPA 903.1 Radium-226 in Drinking Water, Official Name: Radium-226 in Drinking Water (Radon Emanation Technique)
 EPA 906.0 Tritium in Drinking Water EPA 908.0 Uranium in Drinking Water-Radiochemical Method
 EPA 9030B Acid-Soluble and Acid-Insoluble Sulfides: Distillation
 EPA 9034 Titrimetric Procedure for Acid-Soluble and Acid-Insoluble Sulfides
 EPA 9056A Determination of Inorganic Anions by Ion Chromatography
 RSKSOP-175 Sample Preparation and Calculations for Dissolved Gas Analysis in Water Samples Using a GC Headspace Equilibration Technique (Advisory)
 SW846 8015D Nonhalogenated Organics Using GC/FID
 SW846 8260C Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)
 SW846 8270D Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)
 SW846 6010D Inductively Coupled Plasma-Atomic Emission Spectrometry
 SW846 6020B Inductively Coupled Plasma-Mass Spectrometry
 SW846 7470A Mercury in Liquid Waste (Manual Cold-Vapor Technique)

2.3 *Federal Standard:*⁵

- 40 CFR Part 136 Guidelines Establishing Test Procedures for the Analysis of Pollutants

2.4 *Other:*

- ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories⁶
 PA DEP 3686 REV 1 Light Hydrocarbons in Aqueous Samples via Headspace and Gas Chromatography with Flame Ionization Detection (GC/FID)

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.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, <http://www.epa.gov>.

⁵ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

⁶ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology **D653**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cistern, n*—receptacle for the collection or storage of groundwater or rainwater.

3.2.2 *groundwater spring, n*—place where groundwater flows naturally from underground onto the land surface or into a body of surface water.

3.2.2.1 *Discussion*—The occurrence of a groundwater spring depends on the nature of geologic formations, especially permeable and impermeable strata, on the position of the water table, and on topography.

3.2.3 *pitless adaptor, n*—device located below the ground surface used to connect the submersible pump in a water supply well to a pressure tank or other form of water storage.

3.2.3.1 *Discussion*—This device serves to protect the well-head from freezing conditions and may center the submersible pump in the well.

3.2.4 *point-of-entry treatment (POET) system, n*—or whole house or building treatment systems, treats all water entering the building.

3.2.4.1 *Discussion*—These systems are typically situated in the basement of a home or building or in a vault within proximity to the home or building.

3.2.5 *point-of-use (POU) system, n*—treats water at the point where it is used.

3.2.5.1 *Discussion*—These systems are typically situated under kitchen or bathroom sinks or both or in closets/cabinets in proximity to kitchens or bathrooms.

3.2.6 *pressure tank, n*—closed vessel used to store water from a supply well or spring under pressure for use within a home or building.

3.2.6.1 *Discussion*—Typically “bladder” pressure tanks are used in association with supply wells and springs; these tanks contain a rubber bladder filled with air that is used in association with a pressure switch to regulate the pressure of the water in the tank.

3.2.7 *water softener, n*—water treatment system that substitutes sodium ions for ions that cause water to be “hard,” in most cases, calcium and magnesium ions and having a cation resin in the sodium form that removes cations such as calcium and magnesium from water and releases another ion such as sodium.

3.2.7.1 *Discussion*—Water softeners are also used to remove iron, manganese, some radiological materials, nitrate, arsenic, chromium, selenium, and sulfate.

4. Significance and Use

4.1 A supply well provides groundwater for household, domestic, commercial, agricultural, or industrial uses.

4.2 Using a standardized protocol based on an existing industry standard or approved regulatory methods and procedures to collect water samples from a supply well is essential to obtain representative water quality data. These data can be critical to efforts to protect water uses, and human health, and

identify changes when they occur. Use of this guide will help the project team to design and execute an effective water supply sampling program.

4.3 It is important to understand the objectives of the sampling program before designing it. Water supplies may be sampled for various reasons including any or all of the following:

- (1) baseline sampling before an operation of concern,
- (2) periodic sampling during such an operation,
- (3) investigative responses to perceived changes in water quality, or
- (4) ongoing monitoring related to known or potential groundwater constituents of concern in the area.

Sampling programs should be based on these objectives and be developed in coordination with the prospective laboratory(ies) to ensure its procedures, capabilities, and limitations meet the needs of the program, protect human health and fulfill regulatory requirements.

5. Well Purging and Sampling Requirements

5.1 *Sampling Equipment:*

5.1.1 Gas or multiple meters to provide, at a minimum, information on lower explosive limits for combustible gases and oxygen levels to be used for atmospheric screening;

5.1.2 Sample containers, made of compatible materials, preservatives appropriate for the sampling to be performed, labels, and chain-of-custody forms (COCs).

5.1.3 Field notebook, preferably with waterproof, numbered pages or electronic equivalent such as a tablet.

5.1.4 Schedule and contact information for the properties (locations) to be sampled and contact information for laboratory and carrier/shipping company (if used).

5.1.5 Area maps, including GPS coordinates of well(s).

5.1.6 Large cooler and bagged ice for storing all samples and a mini cooler that can be brought inside the home/building to put samples directly on ice after collection and gallon and quart size zip-lock bags in which to put sample containers, ice, and COC, and trash bags for site-derived waste.

5.1.7 Intrinsically safe flashlight or headlamp (sample ports are commonly located in low light areas).

5.1.8 Pan or other secondary containment system to catch any water that may have dripped during sampling. Make sure cleanup is performed after sampling is complete.

5.1.9 Safety equipment including: gloves (work and latex or nitrile), safety glasses, shoes with slip resistant soles, clean rags or towels, pails and buckets, basic tool kit, first aid kit, and fire extinguisher.

5.1.10 Specific health and safety plan.

5.1.11 Watch or wristwatch with second hand, or a digital timer, and graduated container to calculate flow rate and volume.

5.1.12 Supplies need to include apparatus used to measure field parameters such as pH, turbidity, specific conductance, and dissolved oxygen.

5.1.13 Digital Camera.

5.2 *Field Visit and Sample Collection*—After arrangements with the property owner or responsible party have been made, the following steps should be taken: