



Standard Practice for Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations¹

This standard is issued under the fixed designation D 6640; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This practice covers procedures for obtaining soils from core barrel samplers for chemical and physical analysis, with an emphasis on the collection and handling procedures that maintain the representativeness of the chemical contaminants of concern. Core barrel samplers are initially empty (hollow) until they are pushed into the ground to collect and retrieve a cylindrical soil sample with minimal disturbance. The selection of equipment and the sample handling procedures are dependent on the soil properties, the depth of sampling, and the general properties of the chemical contaminants of concern, that is, volatile organic compounds, semi-volatile organic compounds, and inorganic constituents. The sampling procedures described are designed to maintain representative concentrations of the contaminants regardless of their physical state(s), that is, solid, liquid or gas.

1.2 Four general types of core barrel samplers are discussed in this practice: split-barrel, ring-lined barrel, thin-walled tube, and solid-barrel samplers.

1.3 This document does not cover all the core barrel devices that are available for the collection of soil samples.

1.4 The procedures described may or may not be applicable to handling of samples for assessing certain geotechnical properties, for example, soil porosity.

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:

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids²
- D 1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils³
- D 1587 Standard Practice for Thin-Walled Tube Geotechni-

- cal Sampling of Soils³
- D 3550 Standard Practice for Ring-Lined Barrel Sampling of Soils³
- D 3694 Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents⁴
- D 4547 Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds⁵
- D 4687 Guide for General Planning of Sampling⁵
- D 4700 Standard Guide for Soil Sampling from the Vadose Zone³
- D 5088 Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites³
- D 5784 Standard Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices²
- D 5792 Standard Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives⁵
- D 5875 Standard Guide for Use of Cable-Tool Drilling and Sampling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices²
- D 5876 Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices²
- D 6051 Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities⁵
- D 6151 Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling²
- D 6169 Standard Guide for Selection of Soil and Rock Sampling Used With Drill Rigs for Environmental Investigations²
- D 6232 Standard Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities⁵
- D 6282 Standard Guide for Direct Push Soil Samplings for Environmental Site Characterization²
- D 6286 Standard Guide for Selection of Drilling Methods

¹ This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.03 on Sampling Equipment.

Current edition approved Feb. 10, 2001. Published April 2001.

² *Annual Book of ASTM Standards*, Vol 04.09.

³ *Annual Book of ASTM Standards*, Vol 04.08.

⁴ *Annual Book of ASTM Standards*, Vol 11.02.

⁵ *Annual Book of ASTM Standards*, Vol 11.04.

for Environmental Site Characterization²

3. Summary of Practice

3.1 Obtaining soil samples from the surface and subsurface for chemical and physical analysis often involves the advancement of a core barrel sampler into the ground. A core barrel sampler can be operated by hand or mechanically, and it may be of a closed or open design (D 6282). Once the core barrel has been filled, the sampler is recovered from the bore hole and the soil sample is handled appropriately for the chemical constituents of concern.

3.2 This practice describes collection and handling procedures used with four types of core barrel samplers. The standards related to data quality objectives (D 5792), equipment specifications (D 6232, D 6169 and D 4700), their limitations and advantages (D 6282), and the site-specific geological and hydrological data should be reviewed to determine the soil coring equipment that is best suited for a specific project.

4. Significance and Use

4.1 Often during environmental investigations, soils are analyzed after being collected from the surface, the vadose zone (D 653) and sometimes from below the ground water table to identify and quantify the presence of a chemical contaminant. A contaminant is a substance that is typically hazardous and either is not normally present or that occurs naturally but is of an uncharacteristically high concentration (D 4687). A three-dimensional spatial array of samples can often provide information as to the source and route(s) of migration of the contaminant. The resultant information is used to direct remedial and corrective actions or can be used for monitoring purposes. Obtaining a soil sample with a core barrel sampler involves driving this device into the ground and then retrieving it for sample processing. Several methods for advancing a core barrel are generally acceptable (e.g., D 1586, D 1587, D 3550, D 4700, D 5784, D 5875, D 5876, D 6151, D 6282, and D 6286). Drilling methods that use drilling fluids (liquids or air) should be avoided because they are more susceptible to cross-contamination (See section 5.1.6).

5. Equipment Selection Criteria

5.1 Important criteria to consider when selecting a core barrel sampler for soil sampling are:

5.1.1 The materials that come into direct contact with the soil sample (barrel or barrel liner) should be compatible with the chemical or physical properties of the contaminant(s) of concern and the chemical properties of the soil. As a general rule samples obtained for semi-volatile organic compound analysis can be obtained within a core barrel or core barrel liner that is composed of stainless steel, steel, or brass. When only inorganic constituents are of concern, a plastic core barrel liner would be more appropriate than the previously cited materials. All of these materials are suitable for volatile organic compounds as long as the contact time is minimized. Often all of the above samples (semi-volatile organic, inorganic, and volatile organic compounds) are obtained from a single soil core. In this situation, soils should be taken from the interior of the soil core to avoid potential interferences between the contaminants of concern and the surface of the core barrel that is in direct

contact with the sample.

5.1.2 The design of the core barrel sampler should allow for easy access to the sampled substrate for all subsequent handling procedures.

5.1.3 Core barrel size requirements depend on the type and number of chemical constituents of concern. For example, more soil is needed for the collection of samples intended for semi-volatile organic compound analysis than for the analysis of volatile organic compounds or inorganic constituents or both. Typically, a 250-mL (8-oz) bottle is filled for the analysis of semi-volatile organic compounds, a 125-mL (4-oz) bottle for inorganic constituents, and only 5-g subsamples are taken for volatile organic compounds.

5.1.4 Sampling depth (see D 6286, for selection of drilling method).

5.1.5 Suitability for soil type, that is, grain size, cohesion properties, and moisture content. For example, when sampling non-cohesive materials or when sampling below the water table, a core catcher (basket) should be used to limit the loss of sample and ground water during retrieval (D 4700 and D 6282).

5.1.6 The spreading of contamination between sampling depths should be minimized. Sealed hollow-barrel samplers (section 6.1.4) or cased bore holes and proper advancement techniques should be used to limit cross-contamination between sampling depths in the vadose zone. Although a cased bore hole does not guarantee that contamination will not be spread from one sampling depth to another, it lowers the possibility and eliminates the potential for bore hole collapse and side wall slough that can compromise the integrity of the samples removed from uncased bore holes. When there is standing ground water in the bore hole, a sealed sampler system should be used.

5.1.7 Site accessibility.

5.1.8 Time constraints.

5.1.9 Appropriate equipment availability.

6. Sampling Equipment

6.1 The types of core barrel samplers discussed in this practice are the split-barrel, ring-lined barrel, thin-walled tube, and solid-barrel samplers. These samplers are part of equipment that is either manually or mechanically powered, are designed to excavate a bore hole to the sampling depth, and may remain in the bore hole during the sample collection activity (i.e., cased bore hole or dual-walled casing).

6.1.1 *Split-Barrel Sampler*—As described in Methods D 1586 and D 4700, the split-barrel sampler is composed of a core barrel cut in half along the length of the barrel, a hardened metal drive shoe (cutting tip) and a sample head that vents (e.g., a ball check valve) to allow air to be displaced as it is filled (see Fig. 1). The shoe and the head thread onto opposite ends of the split barrel and hold the two halves together. A common barrel size is 5.08 cm (2 in.) outside diameter and 3.81 cm (1.5 in.) inside diameter. The drive shoe used with this particular barrel size has an inside diameter of 3.49 cm (1.375 in.). If fitted with a liner for encasing the sample, the inside diameter of the core barrel liner should not be less than the drive shoe. Several other sizes of split-barrel samplers are available, with inside diameters ranging from 2.5 to 10 cm. A

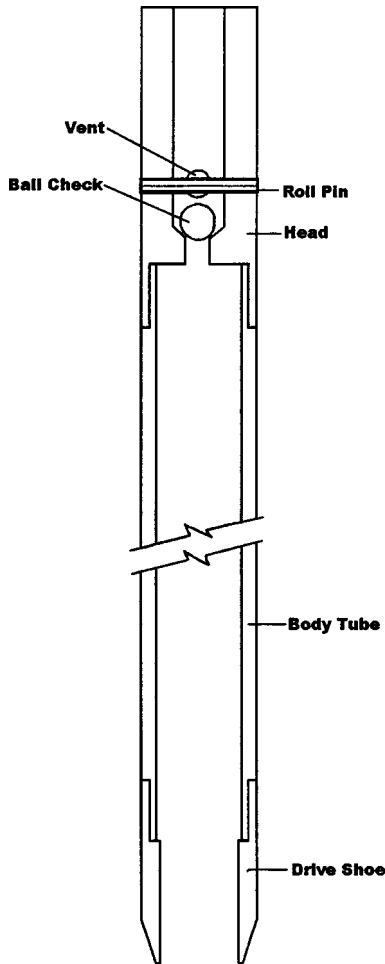


FIG. 1 Split Barrel Sampler

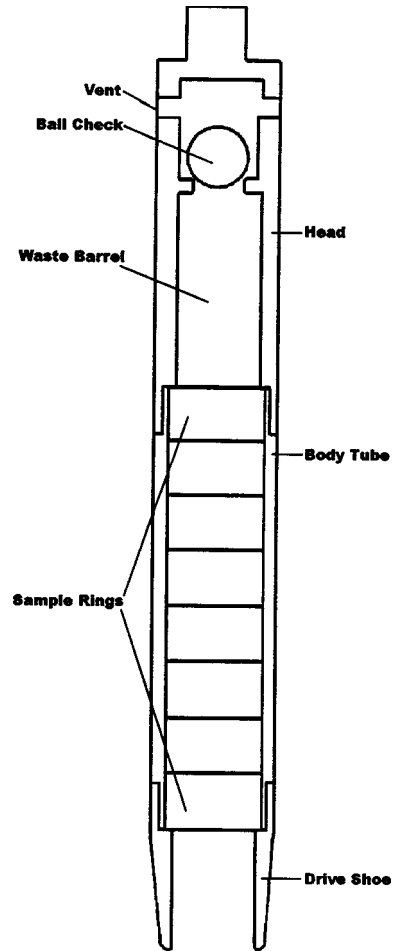


FIG. 2 Ring-Lined Barrel Sampler

core barrel catcher (basket) can be used with this type of sampler to help retain non-cohesive materials. The split-barrel sampler is often used in conjunction with hollow-stem continuous-flight augers or an equivalent drilling or direct-push probe system (D 4700 and D 6282).

6.1.2 *Ring-Lined Barrel Sampler*—As described in Methods D 3550 and D 4700, the ring-lined barrel sampler consists of an intact barrel or two split-barrel halves, a drive shoe, rings, a waste barrel, and a sampler head that vents (e.g., a ball check valve) to allow air to be displaced as it is filled (Fig. 2). The rings, which come in various lengths and are made of several different materials, should fit snugly within the barrel. The inside diameter of the rings should not be less than that of the drive shoe opening. The lengths of the rings will depend on the sampling plan so as to either allow quick access to a cross section of the soil core at a depth of interest or allow the appropriate size sample to be collected (see section 8.1.2). The waste barrel section allows the rings to be filled with undisturbed soil by leaving space to contain the disturbed soil that often is present at the bottom of a hole. A core catcher (basket) can be used with this type of sampler to help retain non-cohesive materials. This sampler is often used in conjunction with hollow-stem continuous flight augers, or an equivalent drilling or direct-push probe system (D 4700 and D 6282).

6.1.3 *Thin-Walled Tube Sampler*—As described in Methods

D 1587 and D 4700, the thin-walled tube sampler consists of a core barrel attached to a head (Fig. 3). The head connects to standard drill rods and contains a vent (e.g., a ball check valve) to allow air to be displaced as it is filled. This sampler description is unique to the Shelby tube, which is available with outside diameters of 5.08, 7.62, and 12.70 cm (2, 3, and 5 in.), and a length of approximately 0.91 m (36 in.). In all cases the drive end of the thin-walled tube sampler has a slightly smaller diameter than the inside of the tube. A core barrel catcher (basket) cannot be used with this type of sampler; therefore, non-cohesive materials may be lost during retrieval. These samplers are often used in conjunction with hollow-stem continuous-flight augers or an equivalent drilling or direct-push probe system (D 4700 and D 6282).

6.1.4 *Solid Barrel Sampler*—The solid-barrel sampler is similar in design to the thin-tube sampler, with some important exceptions; the walls are thicker and they often can be equipped with a liner(s) and a core catcher (Method D 6282, see Figs. 4 and 5). Most of the core barrel samplers in D 6282 are designed to be a closed chamber until the depth of interest is reached, then either the entire sampler or an inner barrel is driven to a greater depth, without advancing or after retracting the drive point or piston tip. The open chamber (no drive point or piston tip) sampler design is often used for near-surface sampling equipment (Fig. 5).

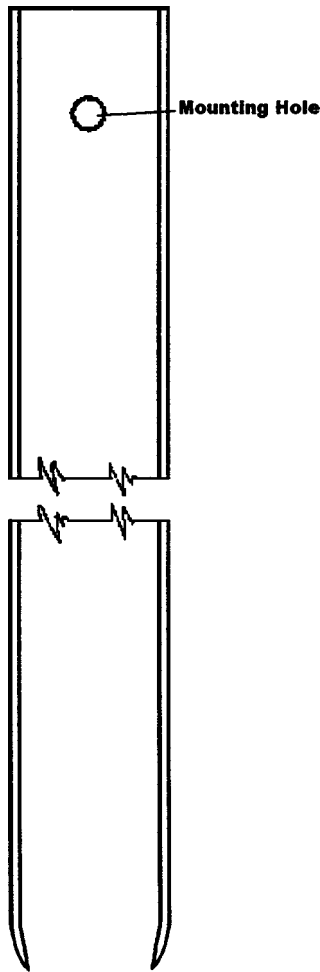


FIG. 3 Thin-Walled Tube Sampler

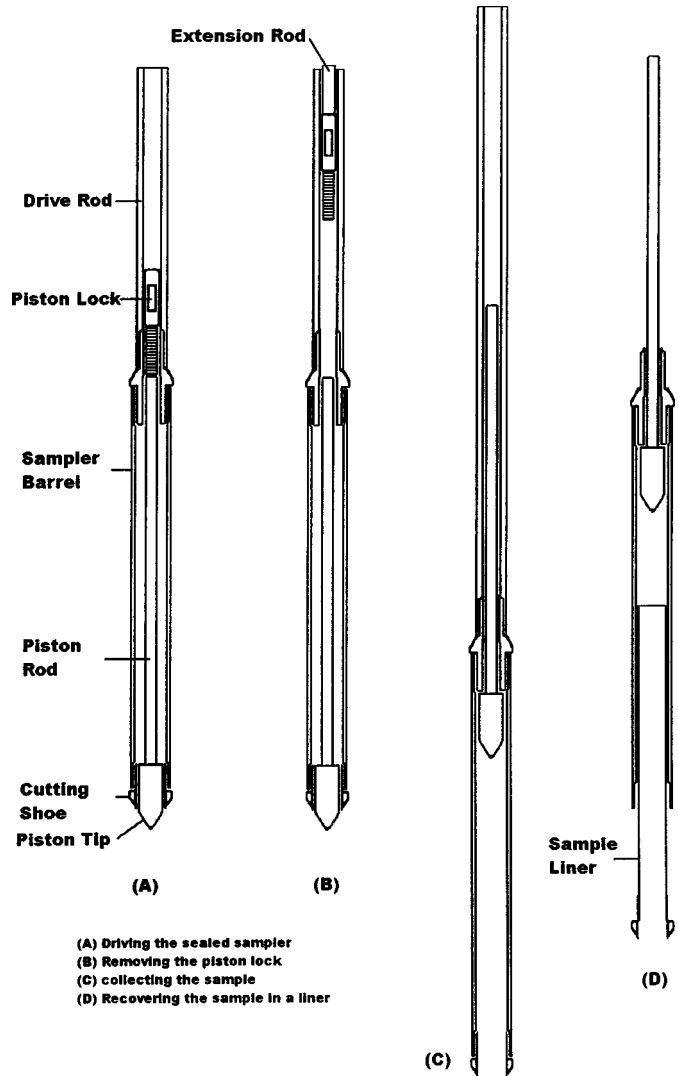


FIG. 4 Direct Push, Single Tube Sampler

7. Pre-Sampling

7.1 The pre-sampling activities are:

7.1.1 Equipment that comes into direct contact with the sample should be steam cleaned, washed with a detergent solution, and rinsed with contaminant-free water, desorbing agents, and deionized water (D 5088). The other pieces of equipment should be either steam-cleaned or washed with a detergent solution and rinsed with contaminant-free water.

7.1.2 The cutting tip or shoe should have a sharp edge. Once dulled, the cutting tip or shoe should be sharpened or replaced.

7.1.3 A work station should be set up for capping the core barrel sampler or when opening to remove subsamples. This work station should consist of a flat clean surface and be set up in a location which provides protection from extreme weather conditions and that is upwind of any local emission sources.

7.1.4 When sampling for volatile organic compounds or when subsampling on-site for constituents that are subject to oxidation or rapid biodegradation, the vessels used for transportation, the on-site sample storage chamber, and the equipment used for obtaining subsamples should be prepared for immediate use. For example, when using an on-site chemical or physical method of sample preservation, it is necessary to perform all of the steps leading up to the transfer of soil subsample from the sampler to the sample container. This may involve adding a solvent or acid solution to a vessel and

recording a tared weight or having a chamber available that is capable of maintaining the appropriate refrigeration temperature.

8. Sampling

8.1 *Sampling Method*—A core barrel sampler can be used at the surface or threaded onto extension rods and lowered to the bottom of a cased or uncased bore hole or pushed as a single unit (direct push D 6282) to the depth of interest. The core barrel sampler is then driven into the soil manually or by some mechanical means to a depth that does not exceed the length of the core barrel. The filled sampler is then pulled out as smoothly (minimizing vibration) as possible to retain a maximum amount of soil in the sample chamber. Depending on the chemical and physical characteristics of the contaminants of concern, either the collection of subsamples should be initiated immediately or the sampler or barrel liner(s) should be capped and preserved in preparation for storage and transportation. The core barrel sampler should be handled by personnel wearing a fresh pair of gloves, and if opened on site, this operation should be performed on a clean surface that is positioned upwind of any local emission sources.

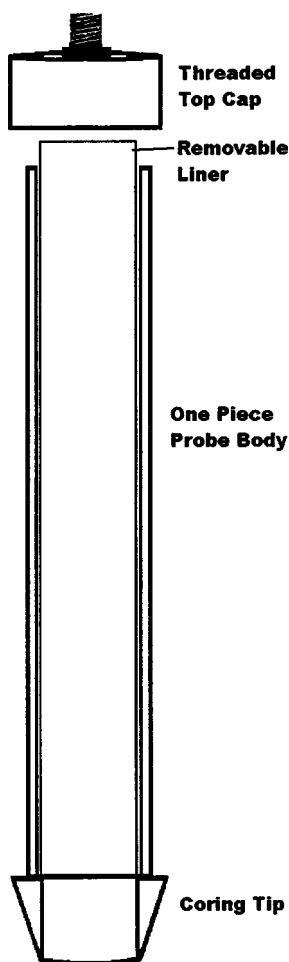


FIG. 5 Open Chamber Sampler

8.1.1 *Sampling for Volatile Organic Compounds*—Volatile organic compounds often simultaneously exist in three physical phases, that is, gas, liquid and solid. In general, the loss of volatile organic compounds from the gas phase presents the greatest challenge to intrusive sampling protocols. To minimize losses of volatile organic compounds, subsurface soils should be retrieved and subsampled as quickly as possible, taking special care to limit exposure and disaggregation of the soil's physical structure. Therefore, the core barrel should not be removed from the borehole until the sampling personnel are prepared, and the collection of subsamples for volatile organic compounds analysis should be the first activity performed (i.e., pre-empting even the logging of core barrel sample recovery and other soil core characteristics) once a core barrel has been opened.

8.1.1.1 When removing the drive shoe or drive head or both, care should be taken not to disaggregate (vibrate) the sample. The ends should be removed using the appropriate wrenches while the sampler is held in a vise. In the case of a split-barrel sampler without a liner, once the two ends (shoe and head, Fig. 1) have been removed, the sample is exposed by removing one half of the barrel. For a ring-lined barrel sampler, after removing the ends the rings should be gently pushed out of the barrel as a single piece, if possible. Once removed, the rings should be separated using a flat-bladed knife to create a flat

cross-sectional surface. When a single core barrel liner is used to encase the entire sample and the length sampled is greater than 15 cm (6 in.), a plastic liner should be used. Thin-walled plastic liners can easily be cut open using a hand saw or razor knife to allow access at any location. When a 15-cm or longer metal liner is used, special sampling tools that allow smaller diameter cores of soil to be removed from well within the liner should be used (see D 4547). For all of these samplers, once a fresh soil surface is exposed, the collection of samples for volatile organic compound analysis should be initiated immediately. Subsamples of 5 to 25 g should be obtained with a rigid, thin-walled, small coring tool (D 4547). For example, coring tools for the purpose of transferring a subsample can be made by cutting off the front end of a disposable plastic syringe. These smaller coring tools help to maintain the sample structure during collection and transfer to the sample bottle, as do their larger counterparts, i.e., the core barrel samplers (see sections 6.1.1-6.1.4). A more complete description of the sampling tools, containers, and general procedures that should be used for the collection, handling, and preservation of samples taken for the analysis of volatile organic compounds can be found in D 4547. Lastly, if the surface has been exposed for more than a minute or two because of an unforeseen delay, a fresh surface in the soil core should be created just prior to sampling.

8.1.1.2 For the characterization of volatile organic compounds in soil, the sampling plan should specify the collection of either a discrete subsample (i.e., approximately 5 g of soil, D 4547) or one that is representative of the sampling interval. When a discrete subsample is specified, only a single location in the soil core is sampled for analysis. Typically, the highest reading established by a field-portable instrument capable of continuously measuring the total concentration of detectable volatile organic compounds, in the vapor phase adjacent to the surface of the soil core, is used to select the sampling location. Traditionally, only a single subsample has been taken from a soil core for the analysis of volatile organic compounds because most homogenization techniques fail to maintain representative concentrations for this class of constituents. A sample that is more representative of the concentration of volatile organic compounds over the sampling interval can be obtained by composite sampling (D 6051). For volatile organic compounds this could be performed by placing several (at least 3 per 30 cm [1 ft] of vertical distance, evenly spaced) subsamples into a vessel containing a solvent (D 4547) or by obtaining several subsamples and averaging the concentration for the soil core by either combining extracts when an organic solvent is used for extraction or after performing the analysis of several discrete subsamples.

8.1.1.3 To limit loss of soil gases, small (< 2.5-cm) diameter hollow-barrel samplers (large sample surface area to volume ratio) or ones that require that the sample be extruded from the core barrel (compaction) are not recommended for obtaining soils for volatile organic compound characterization.

8.1.1.4 Core barrel and core barrel liners are not recommended for storage and transportation since sheets of polytetrafluoroethylene or aluminum foil do not serve as a hermetic barrier for volatile organic compounds, sealing waxes readily

sorb volatile organic compounds, and many adhesives contain volatile organic compounds of interest (D 4547).

8.1.2 *Sampling for Semi-Volatile Organic Compounds and Inorganic Constituents*—When sampling for contaminants that have low vapor pressures and that are not rapidly affected by oxidation or biodegradation, the sample handling does not have to be as careful or as expeditious as for volatile organic compounds. In general the same handling procedures stated above for the different soil core barrel samplers should be used (see section 8.1.1.1). One major difference is that samples can be removed from the core barrel or core barrel liner using a clean stainless steel spatula or similar plastic device, depending on the constituents of concern. However, since many semi-volatile organic compounds are susceptible to biodegradation, they should be preserved if not analyzed immediately. Preservation methods and the preparation of sample containers for many of the compounds that fall under the general classification of organic constituents can be found in D 3694.

8.1.2.1 For the characterization of semi-volatile and inorganic constituents in soil cores, sampling plans often specify that the subsample be representative of the sampling interval. Therefore, sample compositing and mixing schemes should be used prior to removing a representative sample for analysis. D 6051 describes procedures that could be used to homogenize the soil obtained from a core barrel that could either be used in the field or in a laboratory setting prior to removing a subsample for analysis. When oxidation or rapid biodegradation is a concern, practices similar to those cited above (see 8.1.1.2) for handling several discrete or composite samples for the characterization of volatile organic compounds should be used. That is, the entire sampling process should be performed

as quickly as possible from the point of filling the core barrel sampler to the point where subsampling is performed. When removing subsamples for chemical analysis, care should be taken to limit exposure to the atmosphere and, if not analyzed immediately, they should be appropriately preserved. If subsampling is performed off-site, the ends of the core barrel or core barrel liner should be sealed with the appropriate materials and the entire soil core preserved by placing it in a refrigerated container.

8.1.2.2 Larger samples are usually collected for the analysis of semi-volatile organic compound than for either volatile organic compounds or inorganic constituents (see section 5.1.3). When sampling plans specify an 240-mL (8-oz; approximately 400-g) bottle be filled to capacity for the collection of a sample for semi-volatile organic compound analysis, a small-diameter (< 2.5-cm) hollow-barrel sampler would not be recommended.

9. Post-Sampling

9.1 The core barrel sampler and metal core barrel liners and the rest of the down-hole equipment should be decontaminated in accordance with D 5088 (see 7.1.1).

9.2 Nonreusable equipment (that is, plastic core barrel liners and baskets) should be disposed of properly.

9.3 The sample handling table should be properly decontaminated between subsampling activities.

10. Keywords

10.1 contaminants; core barrel samplers; split-barrel, ring-lined barrel; subsurface soil sampling; thin-walled tube

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