

Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations¹

This standard is issued under the fixed designation D6282/D6282M; 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 guide addresses direct push soil samplers, which may also be driven into the ground from the surface or through prebored holes. The samplers can be continuous or discrete interval units. Samplers are advanced by static push, or impacts from hammers, or vibratory methods, or a combination thereof, to the depth of interest. Both single tube and dual (double) tube systems may be advanced for soil sampling with direct push methods. Direct push methods are most often used to collect geo-environmental soil samples. These soil samples are used for soil classification (Practice D2488) and lithologic/hydrostratigraphic logging as well as being sub-sampled for contaminant and chemical analyses.

1.2 Other drilling and sampling methods may apply for samples needed for engineering and construction applications. This guide does not address single sampling events in the immediate base of the drill hole using rotary drilling equipment that employ cuttings removal as the sampler is advanced. Other sampling standards, such as Test Method D1586, Practices D1587 and D3550, and summarized in Guide D6169 apply to rotary drilling activities (Guide D6286). The guide does not cover open chambered samplers operated by hand such as augers, agricultural samplers operated at shallow depths, or side wall samplers.

1.2.1 While Sonic Drilling is considered a direct push method this standard may not apply to larger equipment addressed in Practice D6914.

1.3 Guidance on collection and handling of samples, are given in Practices D4220 and D6640. Samples for chemical analysis often must be subsampled and preserved for chemical analysis using special techniques such as Practice D4547, D6418, and D6640. Additional information on environmental sample preservation and transportation is available in other references (1, 2, 3, 4, 5, 6)². Samples for soil classification may

be preserved using procedures given in Practice D4220 similar to Class A. In most cases, a direct push sample is considered as Class B in Practice D4220 but is protected, representative, and suitable for chemical analysis. The samples taken with this practice do not usually produce Class C and D (with exception of thin wall samples of standard size) samples for laboratory testing for engineering properties, such as shear strength and compressibility. If sampling is for chemical evaluation in the Vadose Zone, consult Guide D4700 for any special considerations.

1.4 Insertion methods described include static push, impact, percussion, other vibratory/sonic driving, and combinations of these methods using direct push equipment adapted to drilling rigs, cone penetrometer units, and specially designed percussion/direct push combination machines. Hammers providing the force for insertion include drop style, hydraulically activated, air activated and mechanical lift devices.

1.5 Direct push soil sampling is limited to soils and unconsolidated materials that can be penetrated with the available equipment. The ability to penetrate strata is based on hammer energy, carrying vehicle weight, compactness of soil, and consistency of soil. Penetration may be limited or damage to samplers and conveying devices can occur in certain subsurface conditions, some of which are discussed in 5.6. Successful sample recovery also may be limited by the ability to retrieve tools from the borehole. Sufficient retract force must be available when attempting difficult or deep investigations.

1.6 This guide does not address the installation of any temporary or permanent soil, groundwater, vapor monitoring, or remediation devices.

1.7 The practicing of direct push techniques may be controlled by local regulations governing subsurface penetration. Certification, or licensing requirements, or both, may need to be considered in establishing criteria for field activities.

1.8 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 Groundwater and Vadose Zone Investigations.

Current edition approved May 1, 2014. Published July 2014. Originally approved in 1998. Last previous edition approved in 2005 as D6282-98(2005), which was withdrawn in January 2014 and reinstated in May 2014. DOI: 10.1520/D6282-14.

² The boldface numbers in parentheses refer to a list of references at the end of this standard.



1.9 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.

1.10 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.

2. Referenced Documents

2.1 ASTM Standards:

- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D1452 Practice for Soil Exploration and Sampling by Auger Borings
- D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
- D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
- D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D3694 Practices for Preparation of Sample Containers and for Preservation of Organic Constituents
- D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4220 Practices for Preserving and Transporting Soil Samples
- D4547 Guide for Sampling Waste and Soils for Volatile Organic Compounds
- D4700 Guide for Soil Sampling from the Vadose Zone
- D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
- D5092 Practice for Design and Installation of Groundwater Monitoring Wells
- D5299 Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
- D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
- D6001 Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization
- D6067 Practice for Using the Electronic Piezocone Penetrometer Tests for Environmental Site Characterization
- D6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
- D6286 Guide for Selection of Drilling Methods for Environ-

mental Site Characterization

- D6418 Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis
- D6640 Practice for Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations
- D6724 Guide for Installation of Direct Push Groundwater Monitoring Wells
- D6725 Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers
- D6914 Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
- D7242 Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers
- D7648 Practice for Active Soil Gas Sampling for Direct Push or Manual-Driven Hand-Sampling Equipment

3. Terminology

3.1 *Definitions*—For definitions of common terminology terms used within this guide refer to Terminology D653. Definitions for additional terms related to direct push water sampling for geoenvironmental investigations are in accordance with Guide D6001.

3.1.1 *assembly length, n*—length of sampler body and riser pipes.

3.1.2 *direct push sampler, n*—sampling devices that are advanced into the soil to be sampled without drilling or borehole excavation.

3.1.3 *extension rod, n*—hollow steel rod, threaded, in various lengths, used to advance and remove samplers and other devices during direct pushing boring. Also known as drive rod. In some applications, small diameter solid extension rods are used through hollow drive rods to activate closed samples at depth.

3.1.4 *incremental drilling and sampling, n*—insertion method where rotary drilling and sampling events are alternated for incremental sampling. Incremental drilling often is needed to penetrate harder or deeper formations.

3.1.5 *push depth, n*—the depth below a ground surface datum to which the lower end, or tip, of the direct-push sampling device is inserted.

3.1.6 *sample interval, n*—defined zone within a subsurface strata from which a sample is gathered.

3.1.7 *sample recovery, n*—the length of material recovered divided by the length of sampler advancement and stated as a percentage.

3.1.8 *soil core, n*—cylindrical shaped specimen recovered from a soil sampler of soil, sediments, or other unconsolidated accumulations of solid particles produced by deposition or the physical and chemical disintegration of rocks and which may or may not contain organic matter.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *closed barrel sampler, n*—a sampling device with a piston or other secured device that



movement of material into the barrel until the blocking device is removed or released. Liners are required in closed barrel samplers. Also may be referred to as a protected type sampler.

3.2.2 *impact heads/drive heads*, *n*—pieces or assemblies that fit to top of the above ground portion of the direct push tool assembly to receive the impact of the hammering device and transfer the impact energy to sampler extensions or drive rods.

3.2.3 *open barrel sampler*, *n*—sampling barrel with open end allowing material to enter at any time or depth. Also may be referred to as an unprotected type sampler.

3.2.4 *piston lock*, *n*—device to lock the sampler piston in place to prevent any entry of a foreign substance into the sampler chamber prior to sampling.

3.2.5 *single tube system*, *n*—a system whereby single extension/drive rods with sampler attached are advanced into the subsurface strata to collect a soil sample.

3.2.6 *solid barrel sampler*, *n*—a soil sampling device consisting of a continuous or segmented tube with a wall thickness sufficient to withstand the forces necessary to penetrate the strata desired and gather a sample. A cutting shoe and a connecting head are attached to the barrel.

3.2.7 *split barrel sampler*, *n*—a soil sampling device consisting of the two half circle tubes manufactured to matching alignment, held together on one end by a shoe and on the other by a connecting head.

3.2.8 *dual tube systems*, *n*—a system whereby inner and outer tubes are advanced simultaneously into the subsurface strata to collect a soil sample. The outer tube is used for borehole stabilization. The inner tube for is used sampler recovery and insertion.

4. Summary of Guide

4.1 Direct push soil sampling consists of advancing a sampling device into subsurface soils by applying static pressure, by applying impacts, or by applying vibration, or any combination thereof, to the above ground portion of the sampler extensions until the sampler has been advanced to the desired sampling depth. The sampler is recovered from the borehole and the sample removed from the sampler. The sampler is cleaned and the procedure repeated for the next desired sampling interval. Sampling can be continuous for full depth borehole logging or incremental for specific interval sampling. Samplers used can be protected type for controlled specimen gathering or unprotected for general soil specimen collection.

5. Significance and Use

5.1 Direct Push Soil Sampling is used extensively in environmental site characterization of soils below ground surface and can also be used for subsurface geotechnical site characterization (3, 7, 8, 9-12, 13). Limited early studies have been done using Direct Push Soil Sampling for environmental investigations (14, 15, 16). These methods are preferred for environmental site characterization over rotary drilling sampling methods (D6169, D6286) because they are minimally intrusive (less disruptive to the soil column) and they do not generate soil cuttings which could be contaminated and require

characterization and safe disposal. Direct Push soil samplers are grouped into two categories; Single Tube and Dual (Double) Tube systems.

5.1.1 *Dual Tube Systems*—Dual tube soil sampling systems are preferred for use because the bore hole is protected and sealed by the outer casing during operations. However, in some conditions when sampling below the groundwater, a sealed single tube sampler (5.1.2) must to be used to avoid sample cross contamination. Figure 1 shows how a Double Tube system is used. The outer tube stays in place to protect and seal the borehole and prevents potential cross contamination of the boring and the soil sample. Dual tube systems allow for rapid continuous sampling both above and below the water table. When sampling is not required, a sealed inner drive point can be locked in for driving through zones not targeted for sampling or through obstructions or difficult to sample formations.

5.1.1.1 Dual tube systems facilitate deployment of other testing and sampling systems (Test Method D1586 and Practice D1587) and sensors, groundwater sampling (D6001), water testing (D7242), and even monitoring well installations (D6724, D6725). Well installations may require use of specially designed expendable tips that facilitate well construction.

5.1.1.2 In larger Dual Tube systems with inside diameters of at least 75 mm the Standard Penetration Test (D1586) is often conducted in the bottom of the boring. Reliable SPT N values can be obtained in most soil formations that are not disturbed by the driving of the casing. Cohesionless sands and very soft clays may be disturbed during advancement of the Dual System to the test depth and should be evaluated or flagged if suspect. Reliable N values may not be obtained if there is evidence of heave or borehole instability from the base of the borehole to the inside the casing.

5.1.1.3 Dual tube systems are easily grouted and sealed for completion because the outer casing keeps an open sealed borehole for insertion of grout tubes.

5.1.1.4 As shown on Fig. 1, continuous sampling is done with an opening left at the bottom of the outer casing during the sampling process. This is fine as long as the formation is stable between sampling events. If there are heaving conditions into the outer casing the outer casing may be retracted to set the sampler barrel in position. The instability can be improved by maintaining a water level balance in the outer casing and using slower retraction of the sampler string during withdraw. If the material stability is a problem then one must deploy a sealed single tube piston sampler (5.1.2) into the boring to retrieve samples.

5.1.1.5 A constant outer tube diameter of the Dual Tube system generally has more friction than some Single Tube rod driven samplers so may require larger equipment capable of higher more percussion and push forces. Dual Tube systems approaching 100 to 150 mm outside diameter have been developed and require larger direct push equipment.

5.1.2 *Single Tube Systems*—Sealed single tube samples assure that the soil sample is not cross contaminated by other soils or fluids inside the bore hole so they are preferred sampling method to use below groundwater and in soil

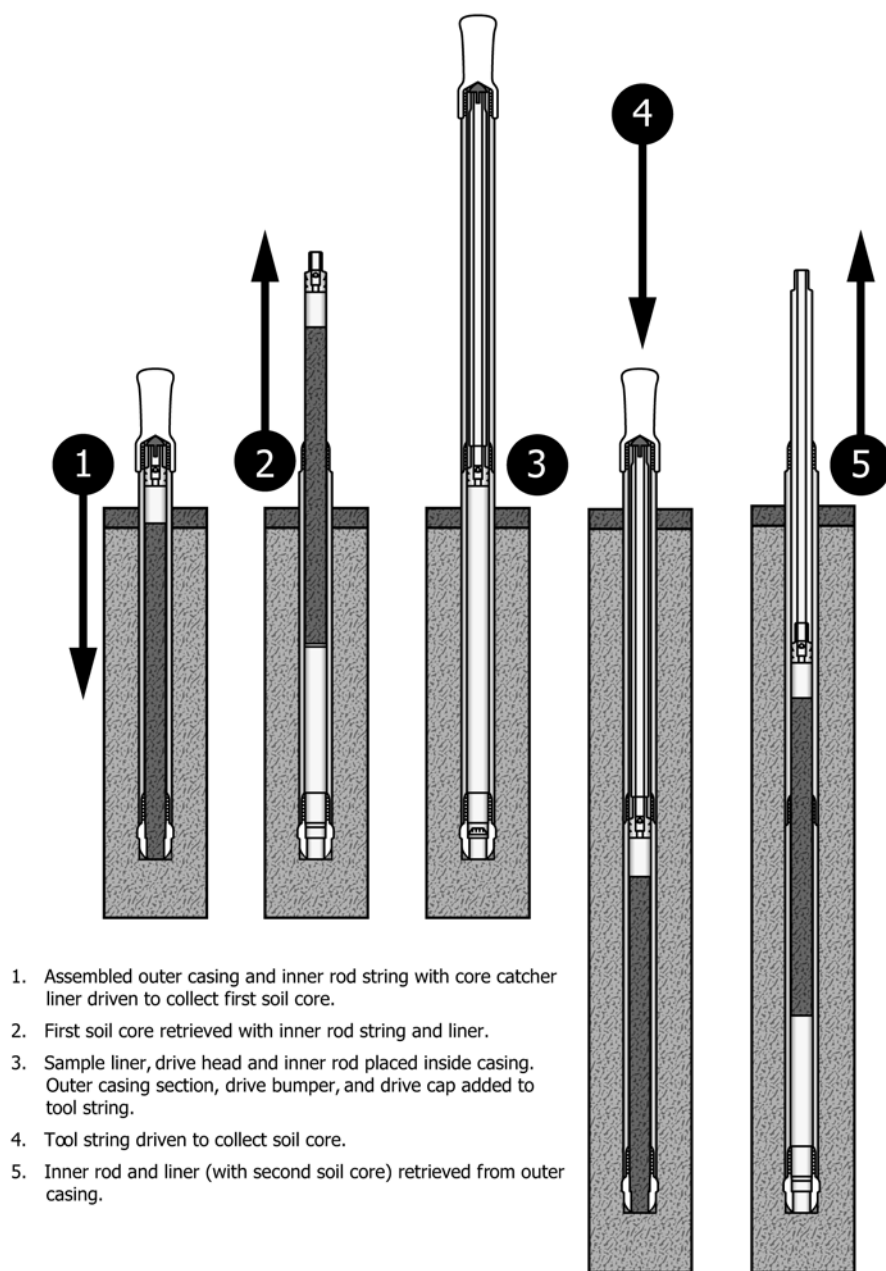


FIG. 1 Dual Tube Direct Push Soil Sampler Operation

sampling systems are most often used for single incremental discrete soil sampling events but can also be used in continuous sampling modes with limitations listed below. Sealed piston type samples assure the best preservation of sample and assure no cross contamination of the soil. Figure 2 shows the basic operation of a single tube sampler. The sampler includes a sealed piston point to prevent soil intrusion during advancement to the target sample depth. The piston is then unlocked using various mechanisms and the sample is pushed to the design length. The complete sampler tube and drive rods are removed from the ground to retrieve the sample leaving an open hole after sampling.

5.1.2.1 The disadvantage to single tube sampling is that the hole left in the ground may not stay open and it would be difficult to grout if required. If positive proof of grouting is required it may be necessary to push a re-entry grout tube to the sample depth to grout the hole (D6001). Another disadvantage is possible travel of contaminants down the open hole. If cross contamination is a concern than a dual tube sampler system should be used.

5.1.2.2 Many single tube systems use drive rods of smaller diameter than the sampler body. The use of smaller diameter drive rods raises two concerns when sampling. First the soil above the sampler body may cave on the sampler and cause

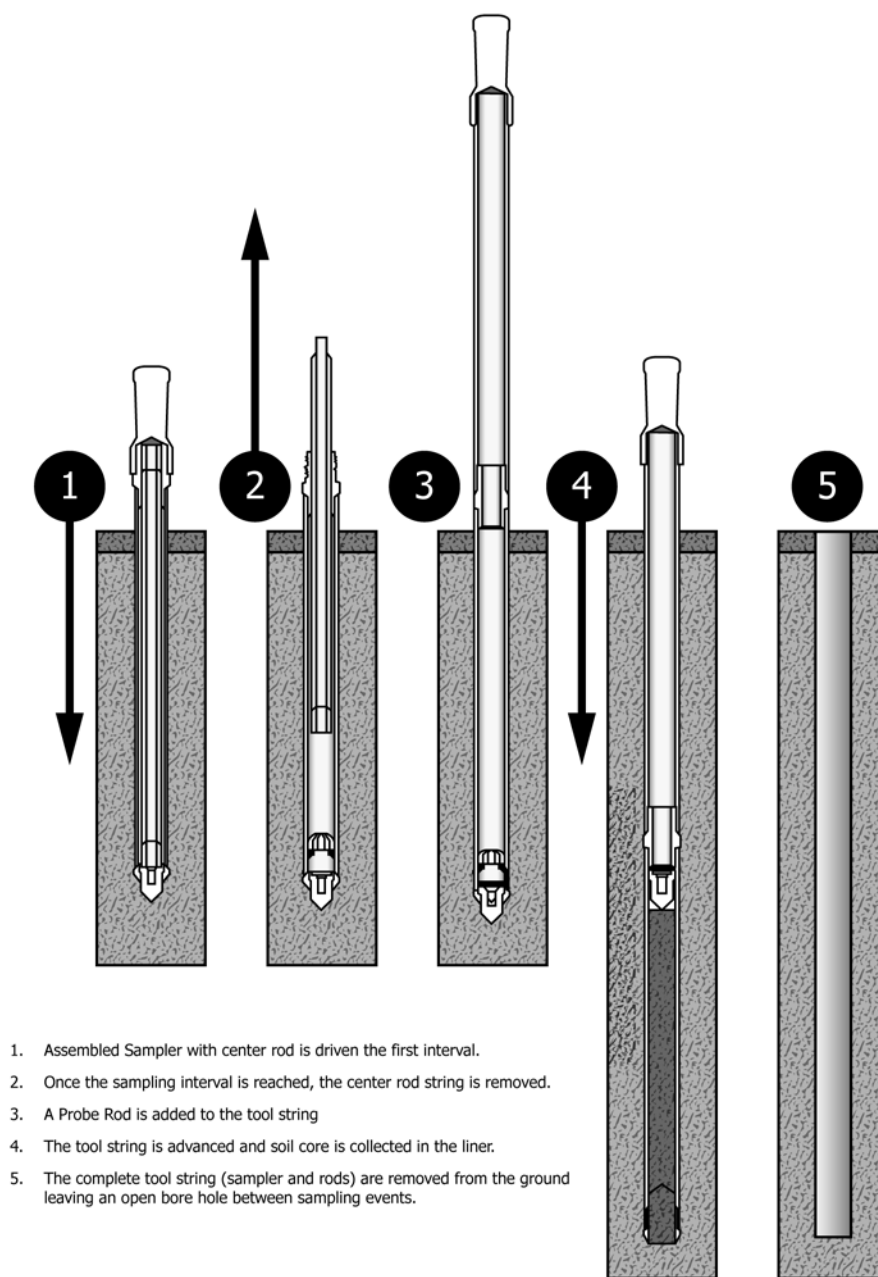


FIG. 2 Single Tube Direct Push Soil Sampler Operation

retraction problems. Second, if chemical analysis is required and the sampler will penetrate and cross contaminated zones there is concern that fluids from layers up above may run down the open annulus above the sampler causing cross contamination.

5.1.2.3 Single tube piston samplers are sometimes used in conjunction with Cone Penetrometer Testing (CPT) (D6067) and can be used in other geotechnical drilling (D6169) in the base of a drill hole.

5.1.2.4 Continuous Sampling operations may be conducted in the same hole with limitations. Using the sealed piston sampler, consecutive samples can be obtained in the same hole by re-driving the sealed piston sampler to a deeper target depths.

5.1.2.5 Open tube samplers without a piston (Fig. 3) should not be used except in rare cases. Use of an unsealed open barrel sampler without a sealed piston multiple times in the same sampling hole will result in cross contamination of samples from the hole wall, cave, and heaving. Continuous soil sampling using an open barrel is sometimes performed above the water table where boreholes are very stable. This sampling mode should never be used below the water table. A sealed sample is required to assure no cross contamination.

5.2 Direct push methods of soil sampling are used for geologic investigations, subsurface soil matrix contamination studies, and water quality investigations. Examples of a few types of investigations in which direct push sampling may be

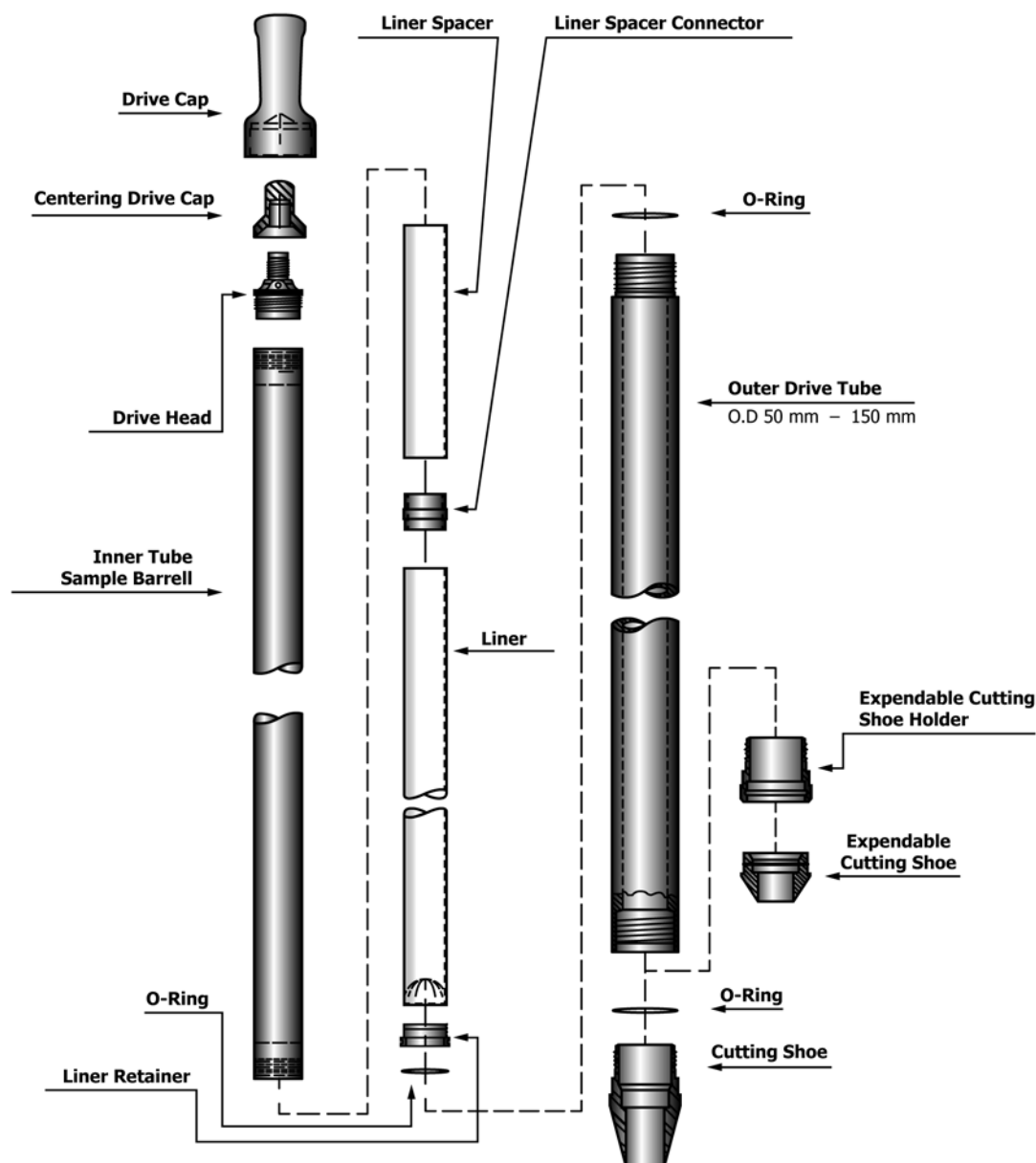


FIG. 3 Dual Tube Soil Sampler with Solid Inner Barrel and Liner

used include site assessments, underground storage tank investigations, and hazardous waste site investigations (17-19). Continuous sampling is used to provide a lithological detail of the subsurface strata and to gather samples for classification and index tests or for chemical testing. These investigations frequently are required in the characterization of hazardous waste sites. Samples, gathered by direct push methods, provide specimens necessary to determine the types and concentration of contaminants in soils and sediments, and in most circumstances, the contained pore fluids (7, 8, 9, 10, 11, 12, 13). Procedures for soil core handling for chemical testing are given standard D6640. Sampling for Volatile Organic Compounds (VOC) is addressed in Guide D4547 and often the core may be rapidly subsampled on site using other methods such as D6418 or other similar small hand core samplers. Samples for other chemical characterization generally require subsampling

into glass or plastic jars or vials and preserved with refrigeration (See EPA test methods in SW-846 (4)). Verify containers and preservation requirements meet the data quality objectives as specified by the lead regulatory agency, in the project work plan, and with the selected analytical laboratory.

5.3 Direct push methods can provide accurate information on the characteristics of the soils encountered and of the chemical composition if provisions are made to ensure that discrete samples are collected, that sample recovery is maximized, and that clean decontaminated tools are used in the sample gathering procedure. For purposes of this guide, “soil” shall be defined in accordance with Terminology D653. Using sealed or protected sampling tools, cased boreholes, and proper advancement techniques can assure good representative samples. Direct push boreholes may be constructed as a