12.0 Soil Sampling for Analysis

12.1 Introduction

Soil samples are collected at FDGTI sites for two types of laboratory analysis:

1. chemical testing. i.e., the presence and concentration of specific chemical constituents such as petroleum hydrocarbons and metals, and
2. physical testing , i.e. the geologic and hydrogeologic properties of the soil such as particle size distribution and hydraulic conductivity.

Numerous methods, both mechanical and manual, exist for retrieving soil samples from the subsurface for analysis, and both sample retrieval and packaging methods will be dependent upon a number of project-specific factors. No matter which methods are chosen, standard protocols exist regarding sampling, preservation, transport, documentation and decontamination of equipment to assure that samples are valid representations of conditions at the site.

12.2 Purpose

The purpose of this document is to present standard procedures relating to the most common types of soil sampling methods employed by FDGTI where the samples will be laboratory analyzed. This SOP will discuss various sampling methods, QA/QC sampling protocol, proper packaging and preservation procedure, considerations regarding the transport of samples, necessary documentation procedure and standard decontamination procedure. Not all soil sampling methods are discussed in this document. Other sampling methods are presented in ASTM Standards presented in the references, below.

12.3 References

The following ASTM Standards were consulted in the preparation of this SOP:

C 998-90 Practice for Sampling Surface Soil for Radionuclides
C 999-90 Practice for Soil Sampling Preparation for the Determination of Radionuclides
D 1452-80(95) Practice for Soil Investigation and Sampling by Auger Borings
D 1586-84(92) Test Method for Penetration Test and Split-Barrel Sampling of Soils
D 1587-94 Practice for Thin-Walled Tube Sampling of Soils
D 3550-84(91) Practice for Ring-Lined Barrel Sampling for Soils
D 4220-95 Practices for Preserving and Transporting Soil Samples
D 4547-91 Practice for Sampling Waste and Soils for Volatile Organics
D 4687-87 Guide for General Planning of Waste Sampling
D 4700-91 Guide for Soil Sampling from the Vadose Zone
D 4840-88(93) Practice for Sampling Chain of Custody Procedures
D 4979-89 Test Method for Physical Description Screening Analysis in Waste
D 5088-90 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites
D 5451-93 Practice for Sampling Using a Trier Sampler
Z5734Z New Standard Guide for Selection of Soil and Rock Sampling Devices Used with Drill Rigs for Environmental Investigations

Note: an ASTM serial designation in bold type denotes a major reference used in the preparation of this SOP. Non-bold serial designations denote references useful in obtaining additional information pertinent to the subject matter.

12.4 Equipment

Take the following equipment to the field when soil sampling is planned:

- a field instrument for screening volatile organic vapors,
- hand augering and sampling devices, if appropriate,
- aluminum foil,
- plastic wrap,
- sample liners (i.e., brass or stainless steel rings) if appropriate,
- sterilized sampling jars with teflon liners, if appropriate,
- clean knife or stainless-steel spatula,
- shovel,
- tape measure,
- squeeze bottle of dilute HCl,
- non-phosphate detergent,
- a 10% nitric or hydrochloric acid wash, if appropriate,
- methanol, if appropriate,
- deionized water,
- 3 to 4 wash buckets,
- clean paper towels,
- plastic bags,
- sample labels,
- pen with water-proof ink,
- chain of custody records,
- disposable gloves,
- project field log, and
- site sampling plan.

12.5 Preparation for sampling

Prior to commencement of soil sampling, the following preparations must be completed:

Pre-determine the sampling strategy, including number and depth of samples and QA/QC sampling plan. This should be contained in a written work plan that has been approved by the customer. Be aware of any flexibility built into the sampling plan (e.g., the collection of extra samples if contaminated zones are encountered).

Prepare a site plan showing proposed sampling locations, if possible.

Notify the laboratory to schedule analyses and order glassware, blanks, etc. from them (see Section 12.9.1, below).

Coordinate with drilling or excavation subcontractor to assure that they bring the proper sampling devices and decontamination equipment;

prepare equipment to take to the site (see Section 12.4, above), and coordinate rental equipment and items that will be supplied by others (i.e., the drillers, the lab).

Set up field notes in advance, including a scheme for logging all essential sampling information in an orderly fashion. Pre-determine a sample numbering system (see Section 12.7.4, below, for a discussion on sample numbering).

Prepare sample containers (including preservatives and field blanks as necessary) and labels in advance, if possible.

Assure that all items that will be used for sampling such as sampling devices and sample containers are sterilized or have been decontaminated prior to collecting the first sample. Decontamination of drilling and sampling equipment at the site prior to commencement of drilling may necessary.

Assure that selected sampling equipment is chemically compatible with the expected contaminants and contaminant analyses (i.e., don't use brass sample liners for samples being analyzed for zinc).

12.6 Sample Retrieval Methods

Sampling subsurface soil involves inserting into the ground a device that retains and recovers a sample (except where soils are sampled from open pits using excavation equipment or a shovel). There are a number of ways to retrieve subsurface soil samples for laboratory analysis. The chosen method will depend on a number of factors, including:
the project goals;
the drilling (or excavation) method chosen for other reasons (e.g., well installation, tank pull);
subsurface geology and hydrogeology;
intended depth of sampling;
intended analyses, and
access (i.e., the terrain, on-site structures, overhead utilities, etc.)

Important criteria to consider when selecting a method for subsurface soil sampling include the following:
type of sample: encased or uncased soil sample, depth-specific representative sample, a sample according to the requirements of the analysis, etc.;
sample size requirements;
suitability of the method for sampling various soil types;
maximum sample length;
suitability of the method for sampling soils under various soil moisture conditions;
ability to minimize cross contamination;
accessibility to the sampling locations; and
personnel requirements.

Soil samples collected for laboratory analysis are generally referred to as either *disturbed* or *undisturbed*, depending on the sample retrieval method. The term "undisturbed" to describe a soil sample always has to be qualified because the sampling process inevitably results in some degree of disturbance. The following three general characteristics affect the degree of sample disturbance:

1. increasing sampler wall thickness increases disturbance;
2. increasing tube diameter decreases disturbance; and
3. increasing tube length increases disturbance.

Samples collected using a thin-walled sampler provide the least disturbed core samples in soft soils, yet the term "relatively undisturbed" is still considered a more appropriate description. Regardless of the sampling method, professional judgement is always required to determine whether a sample is undisturbed. That determination should be framed in the context of the sampling objectives.

Loss of volatiles during sample collection, handling, and shipping effects the concentrations detected by the laboratory. The losses can be significant. The principal mechanisms of loss are volatilization of the compounds and biodegradation. The choice of sample retrieval methodology (along with sample handling and preservation techniques) will directly affect the potential for losing volatiles.

Table 12-1, attached, presents the general criteria for selecting the most suitable soil sampling method. Sampling methods are discussed in detail, below.

12.6.1 Hand Auger Sampling

Hand auger borings often provide the simplest method of soil investigation and sampling. They may be used for any purpose where disturbed samples are to be collected, and are valuable in connection with shallow ground water level determination and indication of changes in strata, and for advancement of a hole for insertion of undisturbed sample collection devices. Equipment required is simple, relatively inexpensive and low-maintenance, easily transportable, and able to be used in confined areas. Hand augering is often used in places where drill rig access is poor.

Depths of auger investigations are limited and hand augering is generally slow as compared with a drilling rig. Ability to hand auger and achievable depth ranges are dependent on ground water conditions, soil characteristics, and the equipment used.

The structure of a cohesive soil is completely destroyed and the moisture condition may be changed by the auger. Also volatile gases in the soil will likely be lost so it is not advisable to collect samples for volatile organic analysis from auger cuttings. Soil samplers capable of retrieving undisturbed samples from the auger hole can be used if the hole does not collapse (see Section 12.6.3, below).

There are two general categories of hand augers:

1. hand-operated (i.e., non-powered), and
2. machine-driven.

Hand-Operated Augers:

The following types of hand-operated augers are available:

- *helical (screw-type) augers* - small, lightweight augers generally available in diameters ranging from 1 through 3 in. (25.4 through 76.2 mm). Types of helical augers:
  - *spiral-type auger* - consisting of a flat, thin metal strip, machine twisted to a spiral configuration off uniform pitch, having at one end a sharpened or hardened point.
  - *ship-type auger* - similar to a carpenter's wood bit. It is generally forged from steel, and provided with sharpened and hardened nibs at the point end and with an integral shaft extending through its length for attachment of a handle.

Figure 12-1, attached shows typical helical (screw-type) augers. Helical augers disturb soil and disrupt soil structures. Moreover, they tend to transport shallow soils downward when reentering a drill hole. They work better in wet, cohesive soil than in dry, loose soil. Also, if the soil contains gravel or rock fragments, their use may be inhibited.

- *open tubular augers* - ranging in size from 1.5 through 8 in. (38.1 through 203.2 mm) and having the common characteristic of appearing essentially tubular when viewed from the digging end. Types of open tubular augers:
  - *open-spiral (Dutch) type* - consisting of a flat, thin metal strip that has been helically wound around a circular mandrel to form a spiral in which the flat faces of the strip are parallel to the axis of the augered hole.
  - *closed-spiral type* - similar to the open-spiral type except that the pitch of the spiral is much less.
  - *barrel type* - consisting essentially of a tube having cutting lips or nibs hardened and sharpened on the cutting end.

An open-spiral (Dutch) type auger is shown in Figure 12-2, attached. This tool is best suited for sampling wet, clayey soils.

Typical barrel type augers are shown in Figure 12-3, attached. Barrel augers generally provide larger samples than screw-type augers. Barrel augers do not work well in gravelly soils, caliche, or semi-lithified deposits. Samples obtained are disturbed. Because the sample is retained inside the barrel, there is less chance of it mixing with soil from a shallower interval during insertion or withdrawal of the sampler. There are three types of barrel augers:

1. *regular barrel augers*, which are suitable for use in loam-type soils;
2. *sand augers*, with a specially-formed bit for retaining dry, sandy soils; and
3. *mud augers*, for sampling wet, clayey soils, is open-sided to facilitate sample removal.

- *post-hole augers* - generally 2 through 8 in. (50.8 through 203.2 mm), and having in common a means of blocking the escape of soil from the auger. Types of post-hole augers:
  - *clam-shell type* - consisting of two halves, hinged to allow opening and closing for alternately digging and retrieving. It is not usable deeper than about 3.5 ft. (1.07 m).
  - *Iwan (post-hole barrel) type* - consisting of two tubular steel segments, connected at the top to a common member to form a nearly complete tube, but with diametrically opposed openings. It is connected at the bottom by two radial blades pitched to serve as cutters which also block the escape of soil.

An Iwan (post-hole barrel) type auger is shown in Figure 12-4, attached. In stable, cohesive soils, Iwan augers can be advanced up to 25 ft. (7.62 m).

Machine-Driven Augers:

A typical hand-held power auger consists of a solid flight auger attached to and driven by a small air-cooled engine (Figure 12-5 is a drawing of a typical power auger). Two handles on the head assembly allow two operators to guide the auger into the soil. Throttle and clutch controls are integrated into grips on the handles. Augers are available with diameters ranging from 2 to 16 in. (5.08 to 40.64 cm). The auger sections are commonly 3 ft. (0.91 m) long. Disturbed soil samples can be collected from the surface as drill cuttings are brought up, or a sampling device can be lowered into the borehole after pulling the auger out of the hole. If the soil contains cobbles or boulders, power augering may not be possible.

12.6.2 Drilling Rig Sampling

Various drilling methods are available and are discussed in SOP No. 9. The most common drilling method used to penetrate unconsolidated sediments is hollow-stem auger drilling, though other methods are also used. During drilling, sampling devices such as a split barrel sampler can be lowered into the borehole at chosen depth intervals to retrieve undisturbed soil samples. These devices are typically driven (though sometimes pushed) into soils beneath the bottom of the borehole. Alternatively, sampling devices such as a rotating core sampler can be advanced with the drill string as drilling proceeds thus capturing a soil core as the borehole is deepened.

Core sampling devices for soil can be divided into four major categories:

1. thick-walled samplers,
2. thin-walled samplers, and
3. piston samplers.

Four major methods for advancing samplers are:

1. push,
2. drive,

3. rotation, and
4. vibration.

The following are the most common devices used to retrieve soil samples during drilling on FDGTI sites:

Split-barrel sampler:

The split-barrel sampler (also known as a split spoon sampler), is a thick-walled sampler that is generally advanced by driving with a hammer. The split-barrel sampler is the most common device used for down-hole sample retrieval in unconsolidated sediments. It consists of two split-barrel halves, a drive shoe, and a sampler head containing a ball check valve, all of which are threaded together.

A typical split-barrel sampler is constructed with the dimensions shown in Figure 12-6. The driving shoes are made of hardened steel and must be replaced or repaired when it becomes dented or distorted. A plastic or metal retainer basket, or a flap valve is often fitted into the drive shoe to prevent samples from falling out during retrieval. The head of a split-barrel sampler is vented to prevent pressure buildup during sampling and must be kept clean. A ball check valve is located in the head to prevent downward water pressure during sampling and sample retrieval. Removal of the water check valve often results in sample loss. A variation of the standard split-barrel sampler is the ring-lined barrel sampler which is specially designed to hold sample liners or rings. Most slit-barrel samplers used today however can also be fitted with sample liners, so the differences between the two types of samplers are not significant.

The procedure for retrieving soil samples using a split-barrel sampler is as follows:

1. Prior to sampling, the split-barrel sampler and related sampling equipment such as sample liners (also known as (brass or stainless steel) rings) and sampling spatula must be decontaminated following the procedure outlined in Section 12.11, below.

2. After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, Attach the split-barrel sampler (with or without sample liners) to the sampling rods and lower it into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

3. Conduct a standard penetration test following the procedure outlined in Section 10.6 of SOP No. 10.

4. Bring the sampler to the surface. To remove the sampler, apply two rotations to the drill rods to shear the soil at the bottom of the sampler. The hammer can be used to back tap the drill string to free the sampler, if necessary. Withdraw the strings slowly and detach the sampler from the drill rods.

5. Open the sampler and package the sample following the procedure in Section 12.9, below.

A number of drilling methods where split-barrel sampling can be performed are presented in SOP No. 9. Several drilling methods produce unacceptable borings for sampling and testing. The following methods are not permitted when sampling will be performed:
the process of jetting through an open-tube sampler and then sampling when the desired depth is reached;
the continuous-flight auger method for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure;
advancing casing below the sampling elevation prior to sampling;
advancing the boring with bottom discharge bits; and
advancing the boring for subsequent insertion of the sampler solely by means of previous sampling with the split-barrel sampler.

Rotating (Continuous) Core Samplers:

Rotating core samplers (also called continuous core samplers) are advanced during drilling of a borehole by cutting soil away from around the core using a circular cutting bit as the shoe of the inner stationary core barrel advances into the soil. In the case of a hollow-stem auger, the auger itself functions as the rotating outer barrel.

Where a rotating core sampler is used in conjunction with hollow-stem augers, high-quality soil cores can be obtained. The inner core barrel can be advanced using either drill rods or a wireline system.

Thin-Walled Samplers:

Thin-walled samplers are direct-push type samplers, and are fully described in Section 12.6.3, below. Thin-walled samplers (and other direct-push samplers such as piston samplers) can be used in conjunction with drilling by lowering the sampler into the borehole and advancing it into undisturbed soils at the bottom of the hole using the drill rods. Care must be taken not to use thin-walled samplers in soil that is exceptionally hard or containing large particles such as cobbles and boulders as the sampler could be damaged.

12.6.3 Direct Push/Drive Technologies

Various methods exist for driving sampling devices directly into the ground without rotation and with or without percussion. Such devices can be pushed or hammered by hand, or pushed or driven using portable hydraulic equipment or large rigs (e.g., a cone penetrometer platform). Certain of these devices, such as a ring-lined barrel sampler, can be used in conjunction with a hand augering device to retrieve an essentially undisturbed sample from a discrete depth in a hand-drilled borehole using extension rods (some sampling devices are interchangeable with the auger head).

Direct Push Hand Samplers:

Direct-push hand samplers, also known as tube-type samplers, generally have proportionally smaller diameters and greater body lengths than barrel-type hand augers. For sampling, these devices are or driven pushed into the soil causing the tube to fill with material from the interval penetrated. The assembly is then pulled to the surface and a sample can be collected from the tube. Since the device is not rotated, a nearly undisturbed sample can be obtained. Commercial units are available with foot lever attachments, a hydraulic apparatus, or drop-hammers to aid in driving the sampler into the ground. Vibratory heads have also been developed to advance tube-type samplers.

Tube type samplers are not as suitable for sampling in compacted, gravelly soils as are the barrel augers. They are preferred if an undisturbed sample is required. Commonly used varieties of tube type samplers include:
soil sampling tubes (Lord samplers),
Veihmeyer tubes (King tubes,
thin-walled tube samplers (Shelby tubes),
ring-lined barrel samplers, and
piston samplers.

Figure 12-7, attached, shows a soil sampling tube. This device consists of a hardened cutting tip, a cut-away barrel, and an uppermost threaded segment. The cut-away barrel allows textural examination and easy removal of soil samples. The sampler is pushed into the ground by leaning on the unit's handle. Once the sampler has reached the bottom of the sampling interval, it is twisted to break soil continuity at the tip then extracted. This sampler works best in soft, clayey, cohesive soils. Cobbles and rock fragments may inhibit the use of this sampler, and cohesionless soil will not be retained in the barrel.

Figure 12-8, attached, shows a Veihmeyer tube sampler. The Veihmeyer tube is a long, complete cylinder that can be from 4 to 16 ft. (1.22 to 4.88 m) long. It has a beveled cutting tip, the sampling tube and a drive head threaded into the upper end of the tube. A drop hammer which is on a guide rod that is slipped into the upper end of the rod, is used to pound the sampler into the ground. The sampler is then retrieved by pulling or jerking up on the hammer. Samples are extruded by forcing a rod through the tube.

A thin-walled sampler is shown in Figure 12-9, attached. They are available with 2, 3, and 5-in. (5.08, 7.62, and 12.70-cm) outside diameters and are commonly 30 in. (76.20 cm) long. The thin-walled tube is pushed into the soil by hand, with a jack-like system, or with a hydraulic piston. Samples are extruded from the tube with a hydraulic ram. Shelby tubes are best used in clays, silts and fine-grained sands. If soils are cohesionless, they may not be retained in the tube. If firm to very hard soils are encountered, driving (hammering) the sample may be required, but this should be avoided as the tube may be damaged by driving.

A ring-lined barrel sampler is shown in Figure 12-10. It consists of a on-piece barrel or two split barrel halves, a drive shoe, sample liners (i.e., sampling rings), and a sampler head. The sample liners are similar to identical to those used in split barrel samplers. In fact, the ring-lined barrel sampler is in effect, a small (about 6-in. long), hand-driven version of a split barrel sampler. The sampler is either pushed or hammered into the ground. Once retrieved, the soil-filled ring can be removed from the barrel and capped with plastic or teflon tape for transport to a laboratory with virtually no disturbance of the soil. The barrels can be driven into hard soils and soils containing sands and gravels that might damage thin-walled samplers. These samplers are preferred when “undisturbed” physical tests or contaminant analyses are to be performed.

Figure 12-11, attached, is a drawing of a typical piston sampler. Piston samplers are used to retrieve locally saturated or cohesionless soils and very soft soils and sludge that will not be retained in other types of samplers. The sampler consists of a sampling tube, an extension pipe, an internal piston, and rods connected to the piston and running through the extension pipe. The piston can be pushed unto the ground with the handle or driven with a drop hammer. As the tube is advanced, the piston is held stationary or pulled upward with the attached rods. Once the tube has been advanced through the sampling interval, it is rotated to break the suction of the soil and pulled to the surface keeping the piston rod fixed with respect to the extension pipe. The sample is extruded using the piston.

Samples taken from the backhoe bucket should be taken from the center of the material to prevent collecting soil contaminated by the bucket surface, and to prevent inclusion of materials that may have fallen from above the desired sampling interval.

Soil removed from pits using excavation equipment can be subsampled using a ring-lined barrel sampler to obtain a relatively undisturbed sample if the material in the bucket consists of relatively large blocks of cohesive soil. A subsample can also be collected by pushing a pre-cleaned metal

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ring into the soil by hand or driving it into the soil using a hammer and a block of wood.

CPT Rig Sampling:

A cone penetrometer testing (CPT) rig is used to advance electronic testing and sampling apparatus into the subsurface by direct push technology. The use of CPT rigs to obtain subsurface data is fully discussed in Section 9.3.8.1 of SOP No. 9. The advantage of using a CPT rig is that it can usually penetrate to greater depths than hand-operated direct-push devices. One disadvantage is that CPT boreholes are generally smaller diameter than boreholes using standard drilling methods, so the volume of soil obtainable at a given depth will be relatively smaller. Also, because the borehole is made by pushing a probe into the subsurface, the structure of the soil sample retrieved will likely be distorted which limits its usefulness for certain physical tests.

To sample soils using a CPT rig, it is necessary to first advance the hole to the desired sampling depth using the standard CPT electronic cone device. This device is then withdrawn from the hole and a push-type sampling device is lowered into the hole and pushed into soil at the bottom of the hole by the rig then withdrawn.

12.6.4 Excavation Sampling

Soils may be sampled from an excavated trench or pit. Excavation is usually performed by a backhoe and samples are collected with a knife, spatula, shovel or trowel. Occasionally samples are obtained from the sides or bottom of an excavation using a tube-type sampler. If a trench or pit is sufficiently deep to be classified as a confined space, the backhoe operator will be directed by the field scientist to retrieve a sidewall or bottom sample using the backhoe bucket. A sample will then be collected from the soil retrieved by the bucket.

Caution: FDGTI personnel and subcontractors are not allowed to enter confined spaces. Excavation should be sampled from the surface using sampling devices with extensions or using a backhoe bucket. Use extreme caution both around heavy machinery and around open excavations. Do not use a sampling method that requires standing at or leaning over the edge of the excavation. When directing a backhoe to retrieve samples, position yourself to give the operator plenty of room, allowing for the swing of the boom, and have the operator position the bucket a safe distance from the excavation before collecting the sample. Make sure that the operator sees you before approaching the bucket to take the sample.

Samples collected from the bucket of an excavator should be trimmed to remove contaminants from other waste or soil strata or to remove surface layers that may have already lost volatiles. The removal of surface layers can be accomplished by scraping the surface using a clean knife or spatula.

12.7 Selection of Samples for Analysis

12.7.1 General Sampling Protocol

A subsurface field investigation plan that includes a soil sampling plan must be prepared by FDGTI for a given site and approved by the client prior to commencement of field work. Section 5.6 of SOP No. 5 discusses the preparation of such a plan. The sampling plan is designed to locate sampling points so that suitable representative samples descriptive of pertinent site conditions (such as subsurface contamination) can be obtained. The proposed number and location of boreholes and/or test pits and the number of soil samples to be collected will be based on a number of site-specific parameters (see SOP No. 5) and on regulatory and customer requirements.

Typically, a soil sampling plan consists of collecting samples at prescribed depth intervals during the drilling of boreholes or in prescribed locations (sidewalls and floor) from an excavation pit. This prescribed plan may be altered during field work based on actual field conditions such as presence of contaminants or heterogeneities in the subsurface strata. The choice of representative samples is of particular concern in soils in which heterogeneities are significant. Interpretation of analytical data is generally improved if the individual(s) most familiar with subsurface conditions at the site (usually the field scientist) has some freedom to select samples to be analyzed by the laboratory. Therefore all sampling plans should be subject to reevaluation and revision as dictated by actual field conditions. No changes in the field sampling plan is allowed, however, without notification of the intended change to the project manager and the customer, and the approval of the changes by the customer.

When drilling, the boring is advanced incrementally to permit either intermittent or continuous sampling. Test intervals are normally stipulated by the project manager, or may be chosen by the field scientist based on field conditions. Typically, the intervals selected are 5 ft. (1.5 m) or less in homogenous strata with test and sampling locations at every change in strata. Sampling is often prescribed for soils immediately above the water table (or in the capillary zone) where ground water is encountered as contaminants will often be concentrated in this zone (sampling this zone also provides an indication of potential ground water contamination).

When sampling for contaminant concentrations, adjacent soils that have similar physical properties to the collected sample should at times be retained for physical analyses (such as particle size distribution) to determine or verify the field-interpreted characteristics of the sample.

When drilling to install a ground water monitoring well, soils may be sampled for chemical analysis at some depth within the saturated zone depending on the expected contaminants (i.e., light non-aqueous phase liquids vs. dense non-aqueous phase liquids). Soil samples should be collected from lithologically distinct layers within the saturated zone for particle size testing and other physical tests that will help define the hydraulic characteristics of the saturated zone.

12.7.2 Headspace screening

When sampling soils for detection of volatile subsurface contaminants, not all of the collected samples will be laboratory analyzed (this would be too costly). Headspace screening is a field method that has been devised to allow preliminary detection of the presence of volatile contaminants in collected soils. Headspace screening of soils can be used for a number of purposes, such as deciding whether a tank pit must be further over-excavated prior to collecting validation samples, or choosing the soil sample with the highest apparent contaminant concentration from a borehole for laboratory analysis.

When collecting soil samples in the field for volatile organic analysis, a portion of each sample will be subject to headspace screening, and a separate portion will be retained for potential laboratory analysis. That portion of soil used for screening should be discarded after the screening is completed, because the release of volatiles inherent in the screening procedure will render the sample invalid for laboratory analysis. When collecting soils from an 18-in. split barrel sampler, for example, the middle 6-in. Sample liner is retained for laboratory analysis while the soil in the bottom 6-in. liner is placed in a jar or a plastic bag for headspace screening.

For the collection of headspace samples, carefully place that portion of soil to be screened into a glass sampling jar (a sealable plastic bag can also be used). Seal the top of the sample jar with aluminum foil prior to screwing on the air tight lid. The procedure for conducting field headspace screening using a volatile gas analyzer is presented in Section 7.4.2 of SOP No. 7.

Headspace screening results

will be used by the field scientistto choose which s amples are sent to the laboratory for analysis of vola tile contaminants. Typically the following samples are chosen for laboratory analysis based on headspac e

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from each individual borehole, the vadose zone soil sample that yields the highest headspace reading; and

the first soil sample collected during over-excavation of a sidewall or floor of a contaminated pit that yields a headspace reading that is below a prescribed threshold such as 100 ppm. The headspace result will signal an end to over-excavation of that area and the sample will be laboratory analyzed as a validation sample.

Some or all of the soil samples that are not chosen for laboratory analysis should nevertheless be packaged, transported to the laboratory and placed on hold in case further additional analysis is warranted based on preliminary laboratory results.

12.7.3 Compositing of Samples

Several soil samples are sometimes composited (i.e., mixed) to form one sample in order to save on the cost of analysis. For example, five samples are collected, one at each five-ft. depth interval from a 25-ft. deep borehole and composited to form one sample to be tested for metals.

Compositing of samples that will be tested for volatile contaminants is not recommended because of the potential loss of volatiles during mixing. Field compositing of samples is not recommended because of the difficulty in assuring that the composited sample is properly mixed to form a sample that is uniformly representative of the component samples. If a composite sample is required, the individual samples from which the composite will be made should be collected and individually packaged using standard procedures. Written instruction should then be submitted to the laboratory (usually documented on the chain of custody record) with the samples directing the laboratory to composite the samples into one sample for requested analyses.

12.7.4 Sample Numbering

Sample identification numbers should generally consist, at minimum, of the following:

1. the type of hole, i.e., borehole: “BH,” monitoring well: “MW,” test pit: “TP,” etc.;
2. the numerical sequence of the hole, i.e., “1,” “2,” “3,” etc.;
3. the depth from ground surface at which the sample was taken, e.g., “4.5" for 4.5 ft. depth;
4. An indicator of sample orientation if necessary, e.g., “N” if the sample is taken from the north wall of an excavation.

For example, a sample taken at 3.5 ft. depth from a borehole into which the fifth monitoring well will be installed is labeled “MW5-3.5.” A sample collected from the southern wall of the second test pit at a depth of 6 feet would be labeled “TP2-6N.” An alternate method for labeling samples from open excavations is to number all samples from a given excavation sequentially and prepare a drawing and table in the field log noting where the samples were taken from: “TP2-1,” TP2-2,” “TP2-3,” etc.

Other sample numbering schemes are valid as long as they are logical and consistent and documented in such a way as to allow one to easily determine the exact location where each sample was collected. Customers sometimes have their own standard sample numbering protocols which must be used on their sites.

12.8 QA/QC Sampling

A project’s QA/QC sampling protocol is pre-determined during work scope preparation, and will depend on a number of factors including project goals, level of detail, and cost constraints. The customer may already have a specific protocol for QA/QC sampling which may or may not include all of the samples recommended below. However, QA/QC sampling is essential to lending validity to the sampling program and analytical results. The QA/QC protocol presented here is taken from relevant ASTM standards and so is considered the industry standard protocol. State or local regulations may require a protocol that differs from the one presented here. If the customer’s requested QA/QC sampling protocol varies significantly from either the state/local protocol or the one presented here (whichever is relevant to the project), the project manager should inform the customer of this discrepancy and advise him/her of the potential consequences.

Four types of quality control samples relate to the quality assurance of field sampling:

1. Field blanks,
2. Split samples,
3. Field rinsates, and
4. Field spikes.

The selection of the types of quality control samples to be used should be made prior to the sampling event and included in the site sampling plan.

12.8.1 Field Blanks

Field blanks are samples prepared in the laboratory using reagent water or other blank matrix and sent with the sampling team. These samples are exposed to the sampling environment and returned with the samples to the laboratory for analysis. The purpose of the field blank is to verify that none of the analytes of interest measured in the field samples resulted from contamination of the samples during sampling.

The sampling plan should normally include a minimum of **one field blank for each procedure for each sampling event**. These samples can be submitted blind to the laboratory to challenge their analytical system or can be shipped with the instruction to hold them unless there is a reason to suspect sample contamination. The submission of blind field blanks would normally be reserved for those situations where the competency of the analytical laboratory was unproven.

12.8.2 Split Samples

Split samples are used to challenge the analytical laboratory performance. Split samples are also used when two different parties are sampling the same site and verification of analytical results is necessary. A split sample is prepared by subsampling a homogenous sample into two or more portions and submitting each portion separately to the analytical laboratory.

Homogenous split soil samples cannot be prepared for samples that will be analyzed for volatile organics. In such a case, the split will consist of packaging two “side-by-side” portions of undisturbed sample (e.g., two adjacent sections of a sample core). For all other soil samples, a sufficient quantity of soil is collected and mixed sufficiently with clean utensils to assure that stratification of analytes is avoided, and subsampled.

Split samples are treated as separate study samples and are submitted to the analytical laboratory without distinguishing identification (i.e., label each sample so as not to indicate that it is a split). Split samples are an indication of the precision of the analytical procedures.
Where feasible, each sampling event should include a minimum of **one split sample for each type of media or location sampled**. Where the data are intended for demonstration of data quality to an outside agency, splits should be included at a greater frequency, **up to 10% of the total number of samples collected**.

12.8.3 Field Rinsates

Field rinsates are samples collected in the field by filling a sample collection vessel that has just been decontaminated (such as a split-barrel sampler) with reagent water or other blank matrix, and then transferring this water to the proper sample bottles. The purpose of a field rinsate is to ensure that sampling equipment cleaned in the field is not cross contaminating samples through improper cleaning techniques. These types of samples should be taken **at least once for each procedure for each sampling event when field cleaning is performed**. If only one such sample is taken it should be collected just prior to the last sample.

12.8.4 Field Spikes

Field spikes are samples collected in the field and spiked with compounds of interest or related compounds. These samples are used to check on the potential for loss of analyte on shipping and for recovery of analytes from a particular medium. The field spike is prepared by adding a known amount of the spiking material to a known amount of the matrix and mixing thoroughly prior to closing and sealing the sample container.

Field spikes are normally not required but may be desired where preservation techniques are in question and the integrity of analytes at the laboratory is not known, when there is a question concerning matrix effects, and when the results from the analytical laboratory for a particular analyte or class of analytes are in question.

Field spikes should be submitted blind to the laboratory in the same manner as outlined for the split samples. These samples should be carried through all stages of the sampling and sample handling process as the actual study samples to ensure that they truly indicate the integrity of the samples collected.

12.8.5 QA/QC Samples for Decontamination Procedure

It is important to document the effectiveness of the decontamination procedure (see Section 12.11, below). Therefore the project's QA/QC program should include provisions for the collection of samples to evaluate the completeness of the decontamination procedure. This could include:

Collection of rinse or wipe samples before the initial equipment decontamination prior to its use for sampling to establish a base line level of contaminants residing on or in the equipment;

Collection of final rinse or wipe samples after equipment decontamination following its use; and

The frequency of sampling to demonstrate the completeness of equipment decontamination is dependent upon objectives of the project as they relate to QA/QC. At a minimum it is recommended after every ten decontamination washings.

12.9 Preserving and Transporting Samples

12.9.1 Laboratory Notification

Prior to scheduled sample collection, the sample shipment and analysis requirements must be discussed with the laboratory. Turnaround time, holding time, report contents and pricing requirements must be discussed with the laboratory prior to sample shipment.

Notify the laboratory in advance of any laboratory blanks or sample containers that must be supplied by the laboratory. Confirm the minimum amount of sample required for specific analyses, types of containers, preservatives (soil samples do not generally require preservatives), etc. prior to sample collection.

12.9.2 Sample Packaging

Soil samples will be packaged into sample containers for shipment to the appropriate laboratory. The method of sample handling and containment is dependent on the method to be used in the laboratory for analysis of specified physical or chemical parameters. The following general rules apply to the preservation of the validity of a sample:
the sampling procedure should be completed in a minimum amount of time, with the least possible handling of the sample before it is sealed in a container;
rough trimming of the sample should be considered prior to packaging if cross-contamination of the surface of the sample from other soil strata is likely to occur during sample collection (this could happen using certain hand augering methods). Potential losses of volatiles should be considered however before trimming;
If possible, the sample (or soil adjacent to the sample) should be inspected visually and its characteristics logged;
All packaged samples should be placed immediately into a secure storage container that is out of direct sunlight, away from heat-generating sources and away from potential sources of cross-contamination such as car exhaust;
samples that will be analyzed for chemical constituents must be immediately placed on ice or other cooling source that will sustain a temperature no greater than 4^{o} C (39^{o} F);

The following types of sample containers should be used to package soil samples:

Sample Liners:

Also known as sample rings, these liners are typically constructed of 6-inch long thin-wall cylinders of brass or steel with an inner diameter that allows the liner to fit snugly inside a split barrel sampler. Clear plastic liners of varying lengths which can be cut with a knife are also available to fit inside continuous core samplers. Sample liners should be used for retrieval of undisturbed samples that require minimal handling (i.e., for analysis of volatile contaminants or “undisturbed” physical testing such as hydraulic conductivity) because the sample can be left in the liner, its ends sealed, for shipment to the laboratory. Sample liners are also acceptable for other types of analyses, but brass liners should not be used where the components of the brass might affect metals analysis. Also, the manufacturing process could leave contaminant residues on the liners, so decontamination is recommended prior to use.

To package a soil sample that has been collected in a sample liner:

- Remove the sample liner that is chosen for laboratory analysis (usually the middle 6-in. long liner in an 18-in. long sampler) from the sampler (or, if the liner is a long plastic sleeve, slice out the section to be laboratory analyzed with a knife).

- with minimal handling, seal the liner with plastic caps designed to fit snugly over the liner’s ends (pre-cut pieces of teflon sheeting can be used to cover the liner’s ends or the sample can be entirely wrapped in a sheet of aluminum foil if plastic caps are not available). Tape the ends of the caps or teflon sheeting snugly to the liner with duct tape or tightly wrap the foil covering around the liner with tape.

- **Caution:** never allow the adhesive tape to come in contact with the sample as it could introduce contaminants to the sample.

- Affix a completed sample label directly to the sample liner or write the label information directly onto the liner using a water-proof marker.

- Log appropriate sampling information onto the chain of custody record (see Section 12.10, below) and into the field log.

- Clean off the outside of the liner and place the liner in a plastic bag. Tape the bag shut and immediately store the sample in a cooler with ice (samples for physical analysis do not have to be kept cool).

- Laboratory analysis for volatiles should not be performed on lined samples where the recovery is poor due to the potential losses of volatile compounds into the headspace of the liner. Similarly, laboratory analysis for “undisturbed” physical properties should be avoided on liners that are only partially filled with non-cohesive soils as the soils may shift in the ring.

Glass Jars or vials:

Wide-mouthed jars with lids lined with teflon seals, commonly ½ pt. (250 mL), 1 pt. (500 mL), and 1 quart-sized (1,000 mL) are commonly used to hold soil samples. Glass jars are acceptable containers where disturbed samples can be used (e.g., non-volatile chemical analysis and particle-size testing) but should not be used for physical testing such as hydraulic conductivity where an undisturbed sample is required. Glass jars are not the recommended for packaging samples for analysis of volatile components unless methanol is first added to the jar. A preferred method is to collect the sample into a 40-mL (1.35 oz.) glass vial with a teflon septum.

To package a soil sample into a glass jar or vial:

- For collection of samples into glass jars for analysis of volatiles, the jar must contain 100 mL (3.4 oz.) of an appropriate grade of methanol (this method should be first discussed with the laboratory).

- for soil cores that must be pushed out of a core barrel, first lay out a sheet of clean aluminum foil or plastic wrap, then push the soil core out onto it.

- Select that portion of the sample that will be packaged for analysis (usually the middle section of a sample core). Quickly remove that portion of the sample by cutting it with a knife or spatula and gently lifting it out of the sampler. Select a sufficient portion of sample to fill the jar as completely as possible, particularly if analysis of volatiles will be performed. If a disturbed sample is being collected (i.e., from a hand auger or a backhoe bucket) choose that portion of the retrieved sample that appears least disturbed, if possible, while attempting not to bias the sample according to grain size, structure, etc.

- Place the sample in the jar, with the least disturbance possible if sampling for volatile analysis. If volatiles are not a concern, the sample can be pressed into the jar to completely fill it. Avoid getting soil on the threads of the jar. If the sample is placed into a 40-mL vial, extrude it into the vial with as little disturbance as possible and fill the vial as completely as possible.

- Immediately place the cap on the jar or vial (double check that the lid's teflon seal is in place before using it). Affix the cap tightly to the jar.

- Affix a completed sample label to the jar or vial or write the label information directly onto the lid of the jar or onto the side of the jar or vial using a water-proof marker.

- Log appropriate sampling information onto the chain of custody record (see Section 12.10, below) and into the field log.

- Clean off the outside of the jar or vial and place it in a plastic bag. Tape the bag shut and immediately store the sample in a cooler with ice (samples for physical analysis do not have to be kept cool).

Plastic Bags:

Plastic bags (commercially available sealable storage bags or sample bags available from sampling equipment suppliers) can be used to package soil samples that will be subjected to physical tests where a disturbed sample is acceptable (e.g., particle size analysis or dry weight). Plastic bags **cannot** be used to hold samples that will be analyzed for chemical components, nor can they be used when physical testing must be performed on undisturbed samples.

To package a soil sample into a plastic bag:

- Select that portion of the sample that will be packaged for analysis (usually the middle section of a core) and cut the selected section from the core with a knife or spatula. The selected portion of soil must be sampled in its entirety, i.e., package the entire portion of the sample between the selected cuts so as not to bias the testing.

- Remove the selected sample from the sampler and place it into a plastic bag that is sufficiently large to hold the sample and still be properly sealed.

- Seal the bag by placing the sample into the bottom of the bag then tightly roll the empty portion of the bag around the sample, expelling air from the bag as it is rolled. It should be roughly cylinder shaped when sealed.

- Place duct tape tightly around the cylindrical sample at each end.
- Tape a completed label onto the sample bag or write the label information directly onto the bag or the duct tape using a water-proof marker.

- Log appropriate sampling information onto the chain of custody record (see Section 12.10, below) and into the field log.

- Clean off the outside of the bag and place it into an appropriate container for safe keeping (the sample does not have to be kept cool).

Note: Always wear latex or neoprene gloves when handling samples due to the potential for contaminants to be present. Check with the laboratory in advance regarding the minimum amount of sample needed for requested analyses as well as restrictions regarding sample containers and packaging methods.

12.9.3 Sample Labeling

Identify each collected and packaged sample by attaching a water-proof tag or label to the container prior to sampling or immediately thereafter. Tags or labels must be completed using permanent, waterproof ink. They should be protected against detachment from the individual sample containers if they get wet. Each tag or label must include, at a minimum, the following information:
a sample number that uniquely identifies that sample (usually composed of the borehole ID and the depth, for example “MW3-4.5");
company name (i.e., FDGTI);
the FDGTI project number;
the project name or site name;
the name, signature or initials of the person who collected the sample;
date and time of sample collection;
sample orientation, if applicable; and
preservative added.

If space exists on the tag or label, the requested analysis should also be recorded (this is important if the sample is collected into several different containers each having unique preservatives for specific laboratory analyses). Additional information that should be recorded at the time of sample labeling (either in the field notes or on the COC) includes:
place of sample collection;
whether composite or grab sample;
observations and remarks pertinent to the sample collection; and
storage temperature if the sample is stored in a refrigerator.

12.9.4 Sample Preservation

Soil samples do not generally require the addition of preservatives in the sample container. However, they do require that the sample container be tightly sealed to prevent the escape of vapors or introduction of vapors or moisture to the sample, and they should be subjected to minimal disturbance (i.e., agitation) after collection, particularly if the samples will be analyzed for volatile contaminants or “undisturbed” physical tests. Upon collection, the handling of each sample should be minimized. All collected samples should be immediately placed into a secure, light-proof storage container which is kept out of direct sun and away from any source of excessive heat or potential contaminated vapors (e.g. car exhaust).

Samples collected for chemical analysis or moisture content must be kept chilled to at least 4^{o} C (39^{o} F). To assure this, the samples, when being placed in the storage container (usually a cooler), should be packed in (i.e., surrounded by) ice or cold packs. Do not just place the samples on top of the ice as they may not stay cold enough. Also, assure that the sample integrity will not suffer from becoming wet from the ice or cold packs (i.e., labels or tape coming off). If necessary, place sample containers into individual sealable plastic bags as an extra protective measure.

12.9.5 Transporting Samples

When transporting samples from the site to either the office or the laboratory, they must be kept inside a secure storage container at all times the inside of which which, if necessary, is kept chilled. The storage container should not be subjected to excessive heat or potential sources of contamination (e.g.,, car exhaust). **Do not store or transport samples in the trunk of a car**.

If samples are relinquished by the sampler to another person for transport to the laboratory, proper chain of custody transfer documentation must be followed (see Section 12.10, below). **Custody of the samples should only be transferred to persons who are qualified to handle or transport them** (i.e., FDGTI technical personnel, certified couriers, or laboratory personnel).

Some samples are legally classified as hazardous substances because of the contaminants they contain, and as such they are under the control of federal regulations that govern the transport and handling of hazardous materials. It is the responsibility of FDGTI personnel to be aware of all regulations regarding the transport of samples containing specific contaminants and to conform to those regulations. If in doubt as to the legality of shipping a batch of samples, consult the FDGTI legal department **before arranging shipment**.

For information about legal requirements for packaging and shipping petroleum oils and other hazardous materials, refer to U.S. Postal Service Publication 52, “Acceptance of Hazardous, Restricted, or Perishable Matter,” the Domestic Mail Manual, Part 124, “Nonmailable Matter - Articles and Substances; Special Mailing Rules,” and the packaging requirements listed in the Domestic Mail Manual, part 121.

12.10 Chain of Custody Procedures

12.10.1 Importance

The purpose of chain of custody (COC) procedures is to permit traceability from the time samples are collected until all data has been generated. The procedures are intended to document sample possession from the time of collection and disposal. This practice provides documentation during each step, that is, during shipping, storage, and during the process of analysis. A COC is necessary if there is any possibility that analytical data or conclusions based upon analytical data will be used in litigation. This possibility is assumed to exist on **every** FDGTI project. Therefore sampling COC procedures **must** be followed during every sampling event, and the information contained on the COC must accurately represent the sample collection information and the associated analytical requests.

12.10.2 Field Custody Procedures

As few people as possible should handle samples.

The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred.

Labels or tags should be firmly attached to the sample containers and made of waterproof paper. Use waterproof ink to label the sample.

The field supervisor (i.e., the lead FDGTI person on site) determines whether custody procedures are being followed during the field work and decides if additional samples are required (the project manager must be notified immediately if the pre-planned sampling protocol is to be changed).

12.10.3 Chain of Custody Record

A blank copy of a typical COC record is included as Figure 12-12, attached. All laboratories and some customers furnish blank COC records, and they are all essentially the same as the one shown in Figure 12-12. All information listed below that is required to be recorded must be recorded on the COC form. If a place does not exist on the form for the recording of any of the required information, then that information should be recorded in an existing “comments” or “remarks” section on the record or, at least, in the project field notes. A completed example of a completed COC for is presented as Figure 12-12 for reference.

As with all other field data, COC information should be recorded when the sampling is taking place. **Record all COC sampling data while on site.** Any errors on COC documents should be corrected by drawing a single line through the error. The error and the correction should be initialed and dated. If uncorrected errors are noted by the laboratory staff, the corrections must be made in writing by the project manager and submitted to the laboratory. These documents will also become part of the project file and must be dated and signed by the project manager.

The COC record accompanies the samples. When transferring possession of samples, the individuals relinquishing, the shipper, and the receiver of the samples are to sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in a laboratory. Document any opening or closing of sample storage containers (i.e., coolers) on the COC record.

12.10.4 Required Information

The following instructions describe the information required on the COC record. The numbers correspond to sections on the blank COC record shown in Figure 12-12, attached.

(1) *Project Manager*: Print the name of the project manager or the name of the person who should receive the laboratory report. **Note:** - the example COC does not have a space for recording the name of the company (i.e., FDGTI). Therefore, the company name should follow the project manager's name in this section.

(2) *Address*: Enter the address of the project manager or the address of the person who should receive the report.

(3) *Project #*: Enter the FDGTI project number.

(4) *Phone #*: Enter the telephone number where the project manager or other contact person can be reached.

(5) *Fax #*: Enter the facsimile telephone number where preliminary laboratory results should be sent.

(6) *Site Location*: Enter the city and state where samples were collected.

(7) *Project Name*: Enter the name of the project.

(8) *Sampler Name*: Print sampler's name and the sampler should initial any existing statement regarding field sampling procedures.

(9) *Field Sample ID*: Enter one sample ID per line per matrix. Print the ID which will identify the sample, it should be identical to the sample ID on that sample's label. The ID must be limited to 8 characters.

(10) *Source of Sample*: This information is optional and is used to describe where the sample was taken from (e.g., "drum" or "sump").

(11) *Lab #*: For Lab Use Only. Do not write in this space.

(12) *# Containers*: Enter the total number of containers, regardless of analysis or preservation type, for the sample ID listed on that line.

(13) *Matrix*: Put a check in the appropriate box to describe the sample matrix. If the matrix is "Other" specify what it is in the *Remarks* section.

(14) *Method Preserved*: Put the number of containers in the box which describes the type of preservation used. If ice is used, put a check in that box. Describe "Other" types of preservation in the *Remarks* section.

(15) *Sampling Date*: Enter the date (month, day, year) the sample was collected.

(16) *Sampling Time*: Enter the time (military) the sample was collected.

(17) *Analysis Request*: Choose a method by putting a check in the box(es) in the appropriate column(s). Most COCs list the most common methods requested plus have several blank columns where you can request analytical methods that are not already listed by writing the method(s) in the heading (note the three blank columns on the attached record). Contact the laboratory's customer service

is you have any questions regarding the type of method to choose or to schedule special analysis requests.

(18) *Special Handling*: Request special handling of the analysis and report by putting a check in the appropriate box(es). If you have been given a quote number, it should be recorded in this section.

(19) *Special Detection Limits*: Specify special detection limits if they are required. For example, if your sample is from a municipal water supply you may need to specify drinking water detection limits.

(20) *Special Reporting Requirements*: Specify any special reporting requirements.

(21) *Remarks*: Any additional information regarding samples, analyses requested, or special considerations must be noted here. Samples which are known to be highly contaminated can be noted in this section. Enter the method of shipment, courier's name(s) and other pertinent shipping information in this section. Additional project identifiers should be specified in this section (site location, site number, code, etc.).

(22) *Lab Use Only/Storage Location/Lot #/Work Order #*: Do not write in this space.

(23) *Relinquished by Sampler*: To be signed by the sampler at the time the samples are relinquished by the sampler to the carrier for shipment, or to any other authorized person.

(24) *Relinquished by/Received by Date*: The date is entered by the relinquisher at the time custody of the samples is relinquished to another person.

(25) *Relinquished by/Received by Time*: The time is entered by the relinquisher when custody of the samples is relinquished to another person.

(26) *Received by*: To be signed by each person who receives custody of the samples prior to the laboratory taking custody.

(27) *Relinquished by*: The final acknowledgment of transferral is signed by the person who relinquishes custody of the samples to the laboratory.

(28) *Relinquished by/Received by Date*: The final date is entered by the person who relinquishes custody of the samples to the laboratory.

(29) *Relinquished by/Received by Time*: The final time is entered by the person who relinquishes custody of the samples to the laboratory.

(30) *Received by Laboratory*: To be signed by laboratory log-in person at the time of sample receipt by the laboratory.

(31) *Waybill #*: The shipping waybill number will be entered in this box at the time of receipt of the samples by the laboratory.

Reminders: To best achieve project objectives, all samples should be scheduled at least 48 hours prior to shipment. In order to insure that holding time are met, all samples should be shipped the day of collection. All changes on the chain of custody document must be initialed by the project manager or sampler.

A separate COC record must accompany each separate shipment of samples. The sample storage containers (i.e., coolers) should be padlocked or sealed with tape or other sealing material prior to shipment to the laboratory.

Alternative procedures can be used to establish a new COC form or document whenever a transfer of custody is made. In these cases, both the transferer and the transferee should keep a signed receipt of such a transfer. Note these procedures in the field log.

The original COC record must accompany each shipment to identify its contents. A copy of the COC record is retained by the FDGTI project manager. If sent by mail, register the package with return receipt requested. Freight bills, post office receipts, and bills of lading should be retained as part of the permanent documentation.

12.10.5 Sample Seals

Sample seals are sometimes used to detect unauthorized tampering of samples following collection up to the time of analysis. Use waterproof adhesive paper seals for this purpose. If a seal is used, add the date and the sealer to the COC record or on the seal itself. Each seal must be attached in such a way that it is necessary to break the seal to open the sample container. Seals must be affixed to containers before the samples leave the custody of the sampling personnel. Each split sample must have its own seal.

12.11 Decontamination of Sampling Equipment

An appropriately developed, executed and documented equipment decontamination procedure is an integral and essential part of environmental site investigations. The benefits of its use include:
minimizing the spread of contaminants within a study area and from site to site;
reducing the potential for worker exposure by means of contact with contaminated sampling equipment; and
improved data quality and reliability.

The following reagents will be used to decontaminate equipment in the field:
a non-phosphate detergent solution;
an inorganic desorbing agent consisting of a 10% nitric or hydrochloric acid solution made from reagent grade nitric or hydrochloric acid and deionized water (1% is applied to low-carbon steel equipment);
an organic desorbing agent consisting of a pesticide grade isopropanol, acetone, or methanol solvent rinse;
control rinse water, preferably from a water system of known chemical composition; and
organic-free, reagent grade deionized water.

Prior to initiating a field program that will involve equipment decontamination, a site specific decontamination protocol should be prepared. Information in the protocol should include:
site location and description;
statement of the sampling program objective and desired precision and accuracy;

summary of available information regarding soil types, hydrogeology and anticipated chemistry of the materials to be sampled,;
listing of the equipment to be used for drilling/sampling, and materials needed for decontamination;
detailed step-by-step procedure for equipment decontamination for each piece or type of equipment to be used and procedures for rinse fluids containment and disposal as appropriate;
summary of QA/QC procedures and QA/QC samples to be collected to document decontamination completeness including specific type of chemical analyses and their detection limit; and
outline of equipment decontamination verification report.

Equipment associated with soil sampling can be put into one of two categories:

1. non-sample contacting equipment, i.e., equipment associated with the drilling or sampling effort that does not directly contact the equipment, or
2. sample contacting equipment, i.e., equipment that comes in direct contact with the sample or portion of sample that will undergo chemical analyses or physical testing.

Both of the above types of equipment are used during soil sampling. Non-sample contacting equipment generally consists of drilling rig, hand auger, or direct push components used to reach the required depth of sampling (drill rods, augers, push rods, etc.). Sample contacting equipment includes the sample retrieval devices such as split barrel samplers and hand auger sampling heads.

The general procedure for decontaminating **non-sample contacting equipment** is as follows:

Clean the equipment with a portable power washer or steam cleaning machine. Alternatively, hand wash with a brush using a non-phosphate detergent solution.

Rinse equipment with control water (i.e., water having a known chemistry).

The more rigorous decontamination procedures for sample contacting equipment may be employed if necessary to meet sampling or QA/QC objectives.

The general procedure for decontaminating **sample contacting equipment** is as follows:

Wash with detergent solution, using a brush made of inert material to remove any particles or surface film.

For equipment that, because of internal mechanism or tubing cannot be adequately cleaned with a brush, the decontamination solutions should be circulated through the equipment.

Rinse thoroughly with control water.

Rinse with an inorganic desorbing agent (i.e., acid rinse). This step may be deleted if the samples will not undergo inorganic chemical analysis.

Rinse with control water.

Rinse with an organic desorbing agent (i.e., solvent rinse). This step may be deleted if the samples will not undergo organic chemical analysis.

Rinse with deionized water.

Allow equipment to air dry prior to next use.

Wrap equipment for transport with inert material (aluminum foil or plastic wrap) to prevent direct contact with potentially contaminated material.

Sample containers such as jars and vials are generally assumed to be pre-sterilized by the manufacturer or supplier. This should be confirmed prior to their use. Some sample contacting equipment such as sampler liners (i.e., brass and stainless steel sample rings) may be expected to contain residues from the manufacturing process, such as cutting oils. Any equipment whose cleanliness is not confirmed should be decontaminated using the above process prior to use.

Depending on site conditions, it may be appropriate to contain spent decontamination rinse fluids. If this is the case, the appropriate vessel for fluid containment (i.e., a drum approved by the Department of Transportation or similar container suitable for this purpose) should be used depending on the ultimate disposition of the material.

Depending on site conditions, it may be desirable to perform all equipment decontamination at a centralized location as opposed to the location where the equipment was used. If this is the case, care must be taken to transport the equipment to the decontamination area such that the spread of contamination is minimized.

TABLE 12-1 CRITERIA FOR SELECTING SOIL SAMPLING METHOD

Type of Sampler:	Obtains Core Sample		Most Suitable Core Types		Operation in Stoney Soils		Most Suitable Soil Moisture Conditions			Access to Sample Sites During Poor Soil Conditions		Relative Sample Size		Labor Requirements	
	Yes	No	Coh.	Coh'less	Fav.	Unfav.	Wet	Dry	Inter.	Yes	No	Sm.	Lg.	Singl.	2/More
A. Drill Rig Samplers:															
1. Multipurpose Drill Rig															
2. Split Barrel Drive Sampler															
3. Thin-Walled Tube Sampler															
4. Piston Sampler															
5. Continuous Sample Tube System															
B. Hand Operated Samplers:															
1. Hand-Held Power Auger															
2. Screw-Type Auger															
3. Barrel Auger:															
a. Post-Hole Auger															
b. Dutch Auger															
c. Regular Barrel Auger															
d. Sand Auger															
e. Mud Auger															
4. Tube-Type Sampler:															
a. Soil Sampling Tube:															
(1) Wet Tip															

(2) Dry Tip							
b. Veihmeyer Tube							