DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF PETROLEUM STORAGE SYSTEMS
PETROLEUM CLEANUP PROGRAM

STANDARD OPERATING PROCEDURES PCS-004

SOIL ASSESSMENT AND SAMPLING METHODS FOR FLORIDA BUREAU OF PETROLEUM STORAGE SYSTEM SITES

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EXECUTIVE SUMMARY

Proper soil sampling and analytical procedures are critical to obtaining data necessary for fully assessing and remediating petroleum contaminated sites. Because of this, the Bureau of Petroleum Storage Systems (BPSS) is clarifying the procedures necessary to obtain reliable and usable soil data. This memo clarifies proper field collection and preservation practices, phases out the use of EnCore™ samplers, discusses strategies for the collection of representative volatile organic soil samples, and clarifies when Soil Cleanup Target Levels apply. This memo also clarifies the soil classification system that should be used to describe the lithologies on a boring log (the Unified Soil Classification System), and some issues concerning Synthetic Precipitation Leaching Procedure (SPLP) testing and speciation of Total Recoverable Petroleum Hydrocarbons (TRPHs).

This memo is intended as procedural guidance to be followed for all petroleum contaminated sites, regardless of whether the site is eligible for cleanup funding assistance from the Inland Protection Trust Fund (IPTF). However, inclusion of some considerations of IPTF funded cleanups was unavoidable. Therefore, certain provisions of this guidance are concerned with the appropriate scope of activities that should be conducted at a cleanup site.

INTRODUCTION

The soil assessment requirements and procedures mandated by the United States Environmental Protection Agency (EPA) and the 1997 revision of Chapter 62-770, Florida Administrative Code (F.A.C.) have sometimes been confusing or misinterpreted. In the past three years, there have been additional changes or clarifications as to where to collect samples, the number of samples to be collected, how samples are to be collected, preserved, and analyzed, and how to interpret the data. Consultants and contractors working on petroleum projects must be familiar with the following three guidance documents related to soil assessment which are available on the BPSS web site (www.dep.state.fl.us/dwm/programs/pcp/default.htm).

1. "Guidelines for Assessment and Source Removal of Petroleum Contaminated Soil," dated May 1998.

2. "Chapter 62-770, F.A.C. Table IV Interpretation," dated July 13, 1998.

3. "New Soil Sampling Procedures and Recommended EPA Methods (per changes to USEPA SW-846) and other Quality Assurance Issues for the Division of Waste Management," dated July 15, 1998.

This memorandum does not replace or supersede the above guidance documents but is intended to enhance and better clarify the procedures.

One of the most commonly misunderstood procedures relates to collecting the soil samples for laboratory analyses. Chapter 62-770, F.A.C. mandates the collection of confirmatory soil lab analyses for a minimum of three vadose zone soil samples per source area representing high, medium, and low screening results for Gasoline Analytical Group (GAG) and/or Kerosene Analytical Group (KAG) discharges. The establishment of Method 5035 during the revision of EPA's SW846, which changed the way soil samples should be collected, prepared, and analyzed to reduce volatilization, caused some degree of confusion because it requires a high level and/or low level laboratory analysis (depending on the concentration of contaminants in the sample) of each sample collected. Assessments at petroleum impacted sites in Florida must satisfy both of these regulatory documents whether there are one or multiple source areas, whether the water table is shallow or deep, whether the discharge is old or new, and in a variety of lithologies. Soil sampling may also be necessary in the smear zone and/or saturated zone to obtain further data to assist in remedial decisions.

DEFINITIONS OF VADOSE ZONE, SMEAR ZONE, CAPILLARY FRINGE, AND SATURATED ZONES FOR BPSS SITES

When screening a petroleum contaminated site with an Organic Vapor Analyzer (OVA), certain observations must be made as soil is collected to differentiate between vadose zone soil contamination, smear zone contamination, volatilization from the water table, and capillary fringe effects. For the purpose of describing soil sampling strategy in Florida's petroleum cleanup program, the following definitions for the different soil zones should be used.

The **vadose zone** is the area between the land surface and the water table. Since the water table fluctuates, the thickness of the vadose zone varies with the water table. Due to the nature of contamination migration in the soil matrix, soil contamination in the vadose zone is generally restricted to the source area locations.

The **saturated zone** is defined as the area below the water table. The top of the saturated zone will vary depending upon the seasons and is sometimes difficult to distinguish from the capillary zone during the drilling event. For this reason, soil borings should be completed to a depth of at least one to two feet into the water table to ensure that the borings are completed into the saturated zone (unless a variance to this policy has been approved by the BPSS).

The **capillary fringe** is described as the area directly above the water table where moisture "wicks" upward due to capillary forces, leaving small amounts of water in the pore spaces above the water table. The thickness of the capillary fringe zone is dependent primarily on the type of soils.

The **smear zone** is the area of soil contamination that may exist, at varying extents, within the zone of water table fluctuations that have occurred since the time of the petroleum release. Petroleum product floating on top of the water table can become sorbed onto the soils within this zone as the water table fluctuates, potentially leaving a large amount of petroleum product mass that has adhered to the soil grains. This product can remain trapped below the water table as the water table rises. Soil Cleanup Target Levels (soil CTLs) generally apply to the vadose zone (above the water table), but due to water table fluctuations the soil CTLs may or may not apply to the smear zone samples and a case-by-case determination is necessary (for a detailed discussion, see the Smear Zone Sampling Strategy section on pages 12 and 13). It is important to determine whether there is a smear zone and to define the smear zone boundaries as part of a site assessment to allow proper decisions regarding the need for, and scope of, remedial action and the proper placement of the top of well screens (because apparent smear zones, as indicated by elevated OVA readings as the water table is approached, can help estimate historical water table fluctuations at a site).

CHAPTER 62-770, F.A.C. REQUIREMENTS, INTERPRETATIONS, AND ACCEPTABLE ALTERNATIVES

All petroleum site assessments must have laboratory analyses performed on representative vadose zone soil samples from areas suspected of being contaminated by petroleum products. Chapter 62-770, F.A.C. allows field soil screening techniques for soil assessment to complement limited soil lab data, and the soil laboratory analytical results from the vadose zone need to be compared to soil CTLs for each site. Soil samples obtained for the purpose of comparison with soil CTLs must be:

1. Grab samples (not composited) which are collected during field soil screening activities;

2. Collected in the vadose zone above the seasonal high water table; and

3. Collected at least once during the site assessment (although additional sampling may be required depending on the age of the soil screening and OVA data and on the horizontal and vertical extent of soil contamination).

The criteria to determine which subsamples of the field-screened samples should be collected for laboratory analyses are listed below.

1. At each GAG or KAG source area, when there are positive corrected hydrocarbon measurements (above background) during soil screening activities, at least three vadose zone soil samples for laboratory analyses should be collected as follows:

    a. One sample should be taken at a soil screening location with a relatively **high** corrected hydrocarbon measurement compared to other measurements taken at the site. If several screening results exceed the instrument's detection capability, the sample should be collected close to the suspected source area. It should be noted that if the corrected hydrocarbon measurements are undetermined due to a high methane content, then subsequent sampling events must utilize a screening instrument that has a measuring limit of at least 5,000 ppm;

    b. One sample should be taken at a soil screening location with a **medium** range corrected hydrocarbon measurement; and

    c. One sample should be taken at a soil screening location with a relatively **low** positive corrected hydrocarbon measurement (the value should be above background, generally above 10 to 20 ppm).

2. At each GAG or KAG source area, when there are no positive responses above background during soil screening activities, only one soil sample for laboratory analyses should be collected from the suspected source area. If information is not available regarding the depth of the suspected discharge, or if there was a suspected surface spillage (based on the eligibility information), then the sample should be collected from within two feet of the ground surface. In the case of aboveground storage tanks, the sample should be collected next to the tank if a containment area is not present, or at the location where the containment area drain valve discharges if a containment area is present. However, if the discharge is suspected to have occurred at depth (such as a ruptured line or fuel tank), then the soil sample should be collected at the depth suspected of having been most impacted. If laboratory analyses indicate that there is petroleum contamination in the soil, then soil assessment should proceed on the assumption that the screening method may not be able to resolve the extent of the soil contamination (see 3, below).

3. At sites where soil contamination has been confirmed from laboratory results, but it has been demonstrated that soil contamination is not detected by field soil screening devices, then the extent of the soil contamination will need to be defined by laboratory analyzed samples. The sampling locations and the number of samples needed to define the extent of soil contamination exclusively with laboratory analyses should be determined on a site-by-site basis. Consideration can also be given to the use of field screening methods other than the OVA. A proposal for an alternative method should be made to the BPSS prior to using the technique. If TRPHs are the only contaminants detected (a common situation for old diesel fuel discharges) and the area of contamination is expected to be large, it may be desirable to complement the lab analytical data with a field testing kit (it also may be appropriate to speciate the TRPHs, as discussed later in this guidance).

4. Laboratory soil samples should be obtained from the perimeter of new excavation areas, during or immediately after excavation, to confirm that the contaminated soil has been removed (usually a minimum of one soil sample collected from the north, south, east and west sides of the excavation). The samples should be collected at the depth where the soil was most impacted. At least one soil sample should also be obtained from the bottom of the excavation if the water table was not intersected.

5. Additional laboratory samples may be required or recommended in cases where:

    a. There are large areas of soil contamination (to ensure that at least 5% of the positive soil screening readings are analyzed as appropriate, see "Guidelines for Assessment and Source Removal of Petroleum Contaminated Soil," dated May 1998);

b. There is a deep water table that requires the use of a rig and the cost of completing additional borings later to obtain more samples for lab analyses greatly exceeds the cost of collecting and analyzing extra samples during the initial boring event;

c. Contamination is located in complex lithologies which could result in heterogeneous distribution of contamination that might easily be missed with only three samples per source area;

d. There is poor correspondence between soil screening results and laboratory results;

e. The age of the spill suggests that any contamination remaining may consist of non-volatile contaminants;

f. The site is suspected to have been impacted by different types of petroleum products; or

g. A substantial remediation activity (e.g.-excavation) is anticipated that could greatly benefit in terms of scope and cost of the activity by better defining the extent and degree of soil CTL exceedances.

The selection of sample locations for lab analyses does not need to be based on any particular exact percentage of the range of field screening results. The objective is to obtain a sample that represents a high screening result, one with a low screening result that is above background, and one with a result as close to the midpoint of screening results as possible. The goal should be to collect the high from within 10% of the highest screening result, the low from within 10% of the lowest screening result, and the medium from approximately halfway between these. However, this goal can be adjusted based on the need for the data and the appropriateness of the sampling strategy. In many cases, obtaining a high in the top 25% and a low in the bottom 25% may be sufficient and more practical. For subsequent sampling events, the goal of the soil sampling event may be to obtain one or more high, medium, or low soil samples that better determine the OVA threshold value indicating the soils are contaminated above the Soil CTLs, or one or more extra high soil samples to assist in making remedial decisions. The high, medium, and low soil samples should normally be obtained from separate borings, but on rare occasions (such as when the water table is deep) from different depths in the same boring depending on the nature and extent of the soil contamination. The best strategy is to vary the depths and locations of soil samples as appropriate to obtain data representative of the extent of contamination.

The following describes the laboratory analytical procedures to utilize and how the results are to be applied:

1. For GAG and KAG discharges, each sample should be analyzed for BTEX plus MTBE and Polycyclic Aromatic Hydrocarbons (PAHs) using appropriate approved EPA methods, and TRPHs using FL-PRO. Unless a different source area is identified during the initial sampling event, subsequent soil sampling events should be restricted to the contaminants identified during the initial sampling event. For used oil discharges, generally only one soil sample is collected from the most visibly stained area and the sample should be analyzed for the contaminants of concern listed in Table C of Chapter 62-770, F.A.C.

2. Vadose zone laboratory analytical results should be compared to the soil CTLs (Direct Exposure Residential and Leachability Based on Groundwater Criteria columns) specified in Table II of Chapter 62-777, F.A.C. For a detailed description of how to use the soil lab data obtained to make cleanup decisions, see the memo titled "Chapter 62-770, F.A.C., Table IV Interpretation," dated July 13, 1998.

3. Owners of petroleum contaminated sites with Remedial Action Plans or Monitoring Only Plans that have been approved and implemented have the option to adhere to the site rehabilitation completion requirements stipulated in the version of Chapter 62-770, F.A.C. that was in effect at the time of the plan approval (as long as the approved active remediation or monitoring is continued to present or completion). If they elect to use a pre-September 23, 1997 version of Chapter 62-770, F.A.C., these sites are not required to have soil samples collected for laboratory analyses. If the site owner chooses not to utilize the current version of Chapter 62-770, F.A.C., the reports that are submitted to the Department should clearly state which version of Chapter 62-770, F.A.C. is being used for the assessment and remediation of the site. The versions of Chapter 62-770, F.A.C. where Cleanup Target Levels for soil and/or groundwater have changed are:

    a. Chapter 17-70, F.A.C., new 11-1-87,
    b. Chapter 17-70, F.A.C., amended 2-21-90,
    c. Chapter 62-770, F.A.C., amended 9-23-97,
    d. Chapter 62-770, F.A.C., amended 8-5-99.

Tabular summaries of soil analytical results should be presented along with the screening results in reports submitted to the BPSS. The contaminant concentrations should be listed adjacent to the filtered, unfiltered and corrected hydrocarbon screening measurements.

EPA's SW846 REVISION and PROPER FIELD COLLECTION TECHNIQUES

The EPA determined that a significant percentage of VOCs might be lost (mainly by volatilization) from soil samples during traditional sampling and analysis procedures. In the last SW846 revision, the EPA established Method 5035, which was created, for the most part, to reduce volatilization of a soil sample from the time it is collected in a sample container through the time it is analyzed. A new "closed loop" analytical method was created to help reduce volatilization in the lab, and new field preservation methods were established. The field preservation is aimed at minimizing biodegradation and volatilization of constituents between the time the soil is put into a sample container in the field until the time the sample is prepared for analysis. However, a large part of the volatilization is taking place from the time the soil is taken from its natural setting to the time it is preserved in a sample container. Transfer of the sample into the container requires proper field collection techniques to minimize losses by volatilization.

Proper soil sampling and analyses have been discussed previously in the guidance memo "New Soil Sampling Procedures and Recommended EPA Methods (per changes to USEPA SW-846) and other Quality Assurance Issues for the Division of Waste Management," dated July 15, 1998. However, the following modification to that procedure is now a requirement by the BPSS:

1. Effective six months from the date of issuance of this guidance (April 1, 2002), EnCore™ samplers (or equivalent) will no longer be an allowable device for transporting samples to the laboratory.

2. Soil samples (approximately 5 g or 3 cm^3) must be collected with a coring device such as a disposable plastic syringe (or other appropriate coring device) and immediately transferred into three VOC vials having a Teflon-lined lid which were prepared and weighed at the laboratory with approximately 5 mL of an appropriate preservative. The appropriate preservative for one of the vials (on which the lab will run their high level analyses to detect VOCs above approximately 200 ug/kg) is methanol and/or polyethylene glycol. The appropriate preservative for two of the vials (on which the laboratory will run a low level analysis if VOCs were not detected on the high level analysis) is organic-free reagent-grade water. (NOTE: Do not confuse the Chapter 62-770, F.A.C. requirement for sample collection from the high, medium, and low screening results with EPA's high and low level laboratory procedures. They are not related.)

It is imperative that the soil from the collection device (e.g., hand extraction tools, split spoon samplers, Direct Push Technology [DPT] sampling liners) be transferred using the coring device (i.e., syringe) into the VOC vial and other lab and/or screening containers as fast as possible (within 1 minute), with as little disturbance and disaggregation of the sample as possible. Disturbing and disaggregating the soil while extracting it from its natural setting and transferring it to laboratory and/or screening containers causes increased volatilization and therefore should be kept to a minimum. Of the allowable sample collection methods, hand extraction causes the most disturbance of the sample, but since it is a requirement for at least the top four feet of a boring, care must be taken to keep the sample as undisturbed as is practical before collecting it with a corer and while transferring the soil into the lab vials and/or screening jars quickly. When transferring the soil sample from the coring device into the VOC vial, care should be taken to prevent splashing the preservative out of the VOC vial. The order of sample collection should be VOC vials first, followed by filling OVA unfiltered and filtered screening jars, and then filling the soil bulk jar last.

Some of the field procedures currently in use today for soil collection and transfer to the laboratory and screening containers are improper. The following are examples of inappropriate soil sampling procedures:

1. It is not appropriate to open a sampling device, half fill and cover the OVA sampling jar, wait the required 5-15 minutes for the sample to equilibrate with the jar headspace, obtain the OVA results, and then decide whether or not to fill the lab sample containers from soil left in the sampler device or soil screening jar.

2. It is improper to fill a jar (or plastic bag) with soil, place it (or the sampling device) in a sample cooler on ice, and wait until later to decide whether or not to collect the lab samples from the jar, plastic bag, or sampling device.

3. Obtaining soil samples from auger flights is also not permitted due to mixing of soils and volatilization of the contaminants due to excessive exposure to air.

For split spoon or direct push soil tube sampling, the sample collection device must be immediately opened after the soil has been retrieved, and the soil must be immediately transferred to the sample containers. When using a coring device, this means that as the sample collection tool is opened, the coring devices must be immediately filled with soil and the soil transferred to the VOC vials and other containers (within 1 minute), before the OVA screening results are obtained. Hypothetically, the previous discussion would indicate that you were collecting soil lab samples before you knew from where to collect them (since your goal is to obtain soils from the high, medium, and low screening results to send to the lab), however, in many cases enough is known about a site to make good estimates as to the locations of the source areas and the extent of soil contamination. Often, previous investigations or the nature of the discharge will indicate the best locations and depths to collect the lab samples. However, the BPSS encourages the collection of extra soil samples while in the field when there are not enough data to estimate the optimum soil lab sampling points. The strategy for collecting the high, medium, and low screening samples for lab analyses is discussed in the next section.

VADOSE ZONE SOIL SAMPLING STRATEGIES

The rationale for where and how to collect the soil analytical samples and how many to collect is discussed below. Each site will have its own strategy based on its site-specific characteristics, but a few generalities are inherent.

Two different strategies that may be used to collect the soil samples are described below:

Strategy 1: The consultant should bring to the site extra sample containers for all sample parameters (for example, bring double the amount of sample containers that are required for that field event). This way extra samples can be collected at the time the soil borings are advanced. The consultant should utilize their best judgment and knowledge about the location(s) of the source area(s) in the placement of soil borings and should collect extra high, medium, and low soil samples during the screening process. This way, when the screening event has been completed, a good selection of samples will be available from which to select those samples corresponding to high, medium, and low screening results to send to the lab without the need for additional borings. Once appropriate samples are selected to send to the laboratory, the extra samples will be discarded. Since it is not necessary for samples corresponding to any particular numeric value representing exact high, medium, and low soil screening samples to be submitted to the lab, it is not necessary or cost-effective to collect "continuous" soil lab samples, just a representative number. Below are examples of when Strategy 1 may be appropriate:

- For sites with a deep water table where there are insufficient data to preselect soil lab sampling locations, and because of the cost associated with installing deep soil borings, Strategy 1 may be the most cost-effective approach.

- For sites that have a shallow water table but have excessively thick or reinforced concrete that must be removed with a core drill prior to hand augering, this may add to the time necessary to obtain a sample and simply collecting extra soil lab samples during the soil screening process may be more cost-effective.

- If borings are being completed in the vicinity of a gasoline distribution line or some other hazard, then the sampling strategy of collecting extra soil samples at the time of the advancement of the borings would be preferred so that another boring does not have to be completed in the area to collect the sample for lab analyses.

Strategy 2: After the extent of soil contamination has been sufficiently delineated through soil screening, the depths and locations to collect the high, medium, and low soil samples can be determined. Then, additional soil borings can be located adjacent to the original borings to obtain the lab samples. It is important to also collect samples for OVA screening to confirm the previous OVA readings at this interval. Below are examples of when Strategy 2 may be appropriate:

- This option may be considered for sites which have a shallow water table (and do not have excessively thick or reinforced concrete) because they are generally quick to hand auger, and don't require a drilling rig to collect soil samples above the water table.

- This option may be considered for some DPT investigations with an intermediate depth to water where difficult drilling conditions are not present. In such areas where the depth to water and lithology allow for efficient DPT boring advancement, Strategy 2 may be the most cost-effective approach.

- This strategy may also be appropriate for sites where the source areas are not known. However, if enough information is available to estimate the locations of the tanks, integral piping, and dispensers, Strategy 1 may be more appropriate.

The two strategies given above are not mutually exclusive and there can be an overlap of methods on a site-specific basis. The cost-effectiveness of installing additional borings versus collecting extra soil sample containers must be considered for each site, and for preapproval sites must be agreed to by the consultant and FDEP site manager prior to field activities.

For sites where the general extent of soil contamination has already been determined (for example, sites where assessment work was halted in March 1995), it is usually not necessary to reassess the entire site. Rather, a few new borings should be placed around each source area and the soil plume perimeter at locations and depths predetermined (using historical data) to obtain approximate high, medium, and low samples. If the previous soil screening and/or lab data are old, samples should be collected for field screening and lab analyses to reevaluate the extent of soil contamination that still exists by comparing the new data with previous results. That procedure will help determine if any redistribution or natural attenuation of petroleum in the soils has occurred.

SMEAR ZONE SAMPLING STRATEGY

The previous discussion on sampling strategy has focused mainly on vadose zone sampling for general assessment considerations. Other sampling procedures must be considered for determining the distribution of petroleum products in the smear and saturated zones.

While collecting and screening soil in the field, attention must be paid to the changes in OVA responses as the boring depth approaches the water table. An elevated OVA response just above the water table may indicate product in the smear zone, or simply lesser amounts of dissolved petroleum from the capillary fringe and/or vapors from petroleum present in the groundwater. This may help explain why there is often poor correlation between field screening and laboratory analyses. Determinations of the distribution of petroleum mass and the development of remedial decisions can be affected by determining which of these phenomena is present. To evaluate which is present, a combination of field observations and lab analyses of the soil is necessary.

A boring placed in a source area where a discharge occurred close to the surface might result in high OVA responses from the surface down to below the water table. A boring placed outside of the area where a surface discharge occurred may result in negligible OVA responses in the vadose zone, but increased OVA responses as the water table is approached and reached, indicating smear zone, capillary fringe, and/or volatilization off the water table. As the distance from the source is increased, soil screening in borings may result in elevated OVA responses only in the saturated zone, indicating groundwater contamination. Fluctuations in the water table complicate this evaluation. During a high water table, the smear zone may be completely below the current water table. Lab analyses of soil samples collected at various locations and depths will help clarify this situation. Collection of vadose zone samples from above the smear zone was discussed earlier in this document, but collection of soil samples near the water table may be necessary to determine the amount of contamination present and whether it is smear zone product or just a consequence of the dissolved or volatized component in the groundwater. During a low stand of the water table, such as in the drought in effect prior to the issuance of this guidance, samples just above the water table are often sufficient to characterize the smear zone. However, during a higher stand of the water table, samples above and below the water table may be appropriate.

Typically, lab analyses of soil samples collected in the vadose, smear, or saturated zones are used for determining the distribution of petroleum products and for making remedial decisions, whereas lab analyses of soil samples collected above the water table are also used to compare to soil CTLs. It is necessary to consider the factors described above and apply judgement on a case-by-case basis in determining whether to collect soil samples from the smear zone for lab analyses and how many samples to collect. At the time that Site Rehabilitation Completion is proposed, the soil CTLs will not apply to smear zone samples unless the smear zone is also part of the vadose zone. However, the smear zone can have a profound effect on the duration of time and cost to achieve site rehabilitation completion, either by active remedial action or natural attenuation monitoring. Lines of evidence of the likely significance of the smear zone need to be considered and the additional cost of soil sample collection and analysis from the smear zone weighed against the possible implications of the smear zone source mass to the cleanup time and cost if it is not assessed and addressed effectively by the remediation strategy.

BORING LOG REQUIREMENTS

A boring log must be completed for all borings to document, at a minimum, the following:

1. lithologies;
2. moisture content;
3. depth to groundwater;
4. OVA measurements;
5. presence of odors (if observed);
6. soil discoloration;
7. free product;
8. the start and finish date(s) and time(s) of the boring;
9. the name of the person (preferably a geologist) completing the log;
10. sampling information, including the sampling interval and percent of sample recovered, and;
11. boring completion method (hand auger, direct push, etc.).

For each soil boring that is completed or each well that is installed, a separate soil boring log should be prepared and submitted to the Department.

The lithologies must be described and then classified according to the Unified Soil Classification System (USCS). This is a change from previous guidance (October 1998 SAR Guidance Preparation memorandum) which only recommended the use of the USCS. Mandating the use of the USCS will standardize the lithology descriptions. (Note: Field personnel must be cautious as to the use of the "grading" concept used in the USCS, which is the opposite of the "sorting" concept that many geologists are accustomed to. Grading refers to the degree of mixing, whereas sorting refers to the degree of similarity.)

Moisture content (typically categorized as dry, moist or damp, wet, or saturated) must be included for every sample collected (for example, at one to two foot intervals). Detailed logging of even slight lithologic variations and/or moisture content may help locate potential seasonal perched zones which may be inhibiting the movement of groundwater and/or petroleum products, and may assist in development of an appropriate remedial strategy.

SPLP SOIL SAMPLING

Synthetic Precipitation Leaching Procedure (SPLP, USEPA Test Method 1312) extractions and analyses of the leachates are performed when there is a question of whether the contamination in the soil at a site will leach to the groundwater at concentrations in excess of groundwater CTLs. The SPLP should only be considered in situations where Direct Exposure soil CTLs are not exceeded but one or more leachability soil CTLs are exceeded. A description of the SPLP testing procedure is outlined in the Department's May 1998 "Guidelines for Assessment and Source Removal of Petroleum Contaminated Soil."

SPLP tests should not be performed routinely at every site if the leachability-based soil CTLs are exceeded for a soil sample. For example, if the site has a shallow water table and the groundwater is impacted by petroleum hydrocarbons at levels above the groundwater CTLs then it stands to reason that the contamination in the soil is leaching to the water table (the exception would be when soil contamination sufficient to leach to the groundwater existed in the past, but the soils have since naturally attenuated to a point they are no longer contributing to groundwater contamination). SPLP tests should generally be performed for sites where the groundwater is not impacted at levels above the groundwater CTLs, but the leachability-based soil CTLs are exceeded.

When costing in the SPLP analyses in a work order, two separate costs for the SPLP analyses should be included for each SPLP sampling location. The first cost that should be included is for the extraction of the leachate from the soil (EPA Method 1312) and the second cost is for analysis of the leachate by the laboratory (EPA Method 602, 8310, etc., depending on which contaminants were previously detected in the soil above leachability-based soil CTLs). It is important that the laboratory uses a water analysis method capable of achieving the groundwater CTLs for the SPLP leachate test. The results of the SPLP analyses should be compared to the groundwater CTLs and not the leachability-based soil CTLs for each constituent analyzed.

As discussed in the Executive Summary, this guidance document is intended to be followed for all petroleum contaminated sites, regardless of whether the site is eligible for cleanup funding assistance or not. This section discusses a provision that SPLP analysis of soil samples should not be conducted unless direct exposure soil CTLs are not exceeded but leachability soil CTLs are exceeded in the soils at the site, which can only be ascertained after sending soil samples for laboratory analyses. This is a required procedure for IPTF funded site assessments and is good advice for any site. However, if a responsible party for a non-eligible site or his consultant wishes to do a greater scope of activities than suggested by this guidance (e.g., performing SPLP analysis prior to knowing whether either of the Leachability or Direct Exposure Soil CTLs are exceeded) they should have that level of discretion.

SPECIATION OF TRPHs

In Section IV (D) of the Technical Report entitled "Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-777, F.A.C." (available on the BPSS web site) it is stated that if the default soil CTLs are exceeded for TRPHs, then alternative soil CTLs may be established by performing an additional laboratory analysis that identifies the TRPH class (aromatic or aliphatic), the fractions present for each class, and the concentrations measured for each class. This additional analysis should only be performed if TRPHs are the only contaminant of concern detected above the soil CTLs.

If this analysis is to be performed, then two (split) soil samples should be collected from the previous sampling location and depth interval that indicated the TRPH exceedance. One sample should be analyzed using FL-PRO. The second (split) sample should be analyzed for TRPHs using either the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) method or the Massachusetts Department of Environmental Protection (MADEP) method. [Note: Although we are currently including both the Extractable Petroleum Hydrocarbons (EPH) and the Volatile Petroleum Hydrocarbons (VPH) portions of the MADEP method, it is anticipated that data will show that volatile organics will not be a concern; if that is the case, in the future the FDEP will restrict MADEP analyses to the EPH portion]. The purpose of collecting split samples is so that the laboratory can first analyze the samples for TRPHs using the FL-PRO method to verify the samples collected are representative of the location of previous TRPH exceedance. Based on the concentration of TRPHs detected during the FL-PRO analysis, a decision can then be made as to whether it is necessary to run the more expensive TPHCWG or MADEP methods.

The concentrations obtained during FL-PRO analyses should be compared to the direct exposure and leachabiltity-based soil CTLs. The concentrations for the TPHCWG method should be compared to each of the TRPH classes and fractions that are listed in Table C4 of the Technical Report "Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-777, F.A.C." A revision to this document is expected next year and will also include a table with which to compare the concentrations for the MADEP method (until then, a copy of the table can be obtained from the BPSS).