ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SPILL PREVENTION AND RESPONSE
CONTAMINATED SITES PROGRAM

Draft Field Sampling Guidance

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I. Introduction

The purpose of the Contaminated Sites Program *Draft Field Sampling Guidance* is to provide fundamental guidelines and present methods and equipment options for sample collection at contaminated sites and leaking underground storage tank sites. This guidance document updates and expands the sampling procedures currently found in the Underground Storage Tank (UST) Procedures Manual, adopted by reference in the 18 AAC 78 regulations. Alternatives to the procedures and equipment contained in this guidance may be proposed in project work plans on a site specific basis.

The Alaska Department of Environmental Conservation (ADEC) is requesting that staff and third party consultants use the field sampling procedures, tables, web links and appendices in this *Field Sampling Guidance* in place of the *Underground Storage Tank Procedures Manual.* Because this effort is continually evolving and adapting to meet the needs of a broad environmental community, users of this document should verify they have the most recent version of any referenced document.

The *Field Sampling Guidance* is also useful for the development of the site characterization work plan under 18 AAC 75.335; the cleanup work plan (including sampling and analysis) under 18 AAC 75.360; and the corrective action plan (including sampling and analysis) under 18 AAC 78.250. All three plans, if applicable, must be reviewed and approved by ADEC.

The *Field Sampling Guidance* is not designed to be a stand-alone manual. In addition to the information herein, the *Field Sampling Guidance* provides web links to a number of relevant internal and external resources, thereby creating a comprehensive system of tools to guide the environmental professional.

Additional ADEC guidance documents integral to work plan development and sampling design and procedures include the following:

- *Conceptual Site Model Policy Guidance* (2005)
- *Biogenic Interference and Silica Gel Cleanup Technical Memorandum* (2006)
- *Cumulative Risk Guidance* (2008)
- *Total Organic Carbon Technical Memorandum* (2008)
- *Arsenic Technical Memorandum* (2009)
- *Draft Guidance on Multi Increment Soil Sampling* (2009)
- *Draft Vapor Intrusion Guidance* (2009)
- *Ecoscoping Guidance* (2009)
- *Monitoring Well Guidance (2009)*
- *Risk Assessment Procedures Manual* (2009)
- *Site Characterization Work Plan and Reporting Guidance for Investigation of Contaminated Sites* (2009)

Other applicable sources of technical regulatory guidance include:

- Interstate Technology and Regulatory Council (ITRC) http://www.itrcweb.org/
- Environmental Protection Agency (EPA) http://www.epa.gov/quality/qa_docs.html#g-4
- ASTM International http://www.astm.org/

The initial release of the *Field Sampling Guidance* focuses on soil and groundwater. Additional guidelines for sampling other media are under development. More specialized material may be added in the future as input from staff and the regulated community is received.

Suggestions on how ADEC can improve the *Field Sampling Guidance* may be sent to Denise Elston at Denise.Elston@Alaska.gov.

The use of trade names is for descriptive purposes only and does not constitute endorsement of these products by the State of Alaska, the Department of Environmental Conservation, or the Division of Spill Prevention and Response.

II. Sampling Work Plan

Before field work begins it is important that the sampling objectives and intended data use be identified in order to support the pertinent site-specific decisions. Site-specific information must be gathered to ensure that the sampling design is logical and that it meets the required objectives that are stated in the work plan. The person(s) designing the work plan should be familiar with the site-specific conditions and be familiar with the work plan contents. Those implementing the work plan must adhere to it unless a field deviation is approved and documented by ADEC.

The 2002 EPA document G*uidance on Choosing a Sampling Design for Environmental Data Collection* at http://www.epa.gov/quality/qs-docs/g5s-final.pdf provides detailed information on a number of basic and innovative sampling designs that may be applied to a particular site or support the data use objectives. Different approaches may be applicable to sites with multiple source areas or to account for contaminant type, fate and transport considerations, or other factors.

The work plan should describe sampling procedures in detail so the project objectives can be met and the work plan adequately evaluated by ADEC. ADEC will review and approve the work plan based on 18 AAC 75 and 18 AAC 78 regulatory criteria, the intended data use, and site decisions that are expected as a result of the investigation.

Refer to ADEC's *Site Characterization Work Plan and Reporting Guidance* at http://www.dec.state.ak.us/spar/csp/guidance/site-characterization-wp&r.pdf for further guidance on general work plan elements. These may vary on a site-specific basis. Other ADEC guidance documents to be referenced during the work plan design phase are ADEC's *Conceptual Site Model Policy Guidance* at http://www.dec.state.ak.us/spar/csp/guidance/csm05_draft.pdf, and *Ecoscoping Guidance* at http://www.dec.state.ak.us/spar/csp/guidance/ecoscoping.pdf.

The environmental professional should notify the ADEC project manager prior to mobilizing for field activities and obtain approval prior to implementing any field modifications. If working in a remote location where communication with ADEC is not possible, document all work plan modifications and decision rationale in the field notebook and the final report. Site-specific field modifications not approved by ADEC may result in the rejection of site data, use of the site data as estimated, and/or a requirement that additional supplemental data be collected. While in the field it is advisable to retain a reference copy of the approved work plan and ADEC written approval.

III. Soil Sampling

Under Alaska regulation 18 AAC 75.990(127) surface soil is defined as soil that extends to two feet below the ground surface. Subsurface soil is defined at 18 AAC 75.990(123) as soil that is more than two feet below the surface.

A. General Guidelines

The soil sampling methodology must be stated in the work plan, support data use and intended site decisions, and be approved by ADEC. Unless approved by the ADEC project manager on a site specific basis, all laboratory soil samples must be discrete samples and may not be composited before analysis, except when required by federal regulations, e.g. Toxic Substances Control Act (TSCA) for Polychlorinated Biphenyls (PCBs) or Resource Conservation and Recovery Act (RCRA) waste disposal characterization.

Judgmental sampling involving the collection of discrete analytical samples based on field screening results is the most common sampling approach for contaminated sites in Alaska. Field sampling guidelines and procedures relevant to judgmental sampling are therefore emphasized in this guidance.

Although a number of different statistical sampling methods are possible, systematic random sampling is one of the more common statistical sampling approaches. A general guideline for a systematic random sampling design is to collect a minimum of 20 -30 samples from each decision unit in order to adequately perform statistical analysis, such as a derivation of a 95% upper confidence limit (UCL).

For regulated underground storage tank investigations analytical samples must be collected in accordance with 18 AAC 78.090.

Collect soil samples for all applicable contaminants of concern using the method specifications listed in Appendix D.

All soils collected for parameters other than VOC analysis should be homogenized in-situ or in a decontaminated stainless steel bowl or tray.

If soil contamination has the potential to extend to seasonal high groundwater, install temporary or permanent monitoring wells to assess potential groundwater contamination (see groundwater section). Collect soil samples, as necessary, below the water table and immediately above the water table.

The creation of a preferential pathway during site work may impact groundwater. As necessary, implement precautionary measures to assure the groundwater will be protected (i.e. grouting boreholes and compacting soil). If groundwater is encountered, grout soil borings in accordance with ADEC's *Monitoring Well Guidance.*

Soil sampling waste should be managed in a manner that does not contribute to further environmental degradation or pose a threat to public health or safety. On-site disposal may be approved by ADEC if:

- soils are deemed to be non-hazardous waste under the RCRA hazardous waste definition,
- there is no potential for off-site contaminant migration, and
- the potential to create a human health or ecological hazard through all exposure pathways is not suspected.

B. Field Screening

Field screening supports and is used in conjunction with a judgmental sampling approach. Field screening is useful to segregate excavated soils, identify release points, and estimate the extent of contamination. The proposed field screening method(s) and frequency must be stated in the work plan and support the data use objectives. If instruments or other field observations indicate contamination, soil must be separated into stockpiles based on apparent degrees of contamination.

If applicable, include minimum field screening device detection/quantitation levels and possible interferences in the work plan.

ADEC recommends that a correlation study between on-site field screening and site-specific analytical laboratory results be evaluated and reported where variable field screening results are common or expected.

It is important to remember that these tables are provided as a general guide to some of the available field screening methods and for each field screening method cited in Table 1 and in Appendices B and C, there may be several sources of field screening equipment, methods, or test kits available. For example, there are numerous companies that manufacture and sell petroleum hydrocarbon immunoassay test kits. Each manufacturer currently uses similar methods but different techniques to detect and measure petroleum hydrocarbons. Additional guidance on the methods available may be found in SW846 or through ASTM. These differences may be important to you when selecting a field screening technology for your site.

Table 1 – Field Screening Methods Guide[1,2]

Type	Use	Contaminants of Concern
Warm water sheen test, shovel sheen test	Soil/sediment	Hydrocarbons
Field test kits (Hach®,etc)	Soil /Water	Metals, PCB, TPH, Organics
Ultra Violet Fluorescence (siteLAB®, etc.)	Soil/Water/ Sediment	PAH, DRO, GRO, TPH, PCB
Hanby® Diesel Dog®	Soil/Water	Hydrocarbons, aromatics
Dexsil®-Petroflag®	Soil	Hydrocarbons
Immunoassay (EnSys, EnviroGard™, RaPID Assay, etc.)	Soil/water	PCB, PAH, BTEX, TPH, Pesticides, Pentachlorophenol (PCP)
Colorimetric Gas Tube Detectors	Air/Soil Water	Target Specific
Direct Reading Devices (PID, FID)	Soil	VOCs, GRO, DRO
UV/ROST technology	Soil	TPH, PAH
X-Ray Fluorescence	Soil/Sediment	Metals
Field gas chromatography	Soil/Water	Hydrocarbons, VOCs, SVOCs
Infrared Field Analyzer (Wilks Enterprises)	Soil/Water	TPH

[1] The ADEC does not endorse or recommend any specific brand test kit for use. While Table 1 provides methods available at the time this document was written, it's important to note that new and/or improved methods may come available and should be considered in the work plan design phase of the project.

[2] Some field screening procedures have an associated EPA approved method.

Use Table 2A to determine the minimum number of screening and laboratory analytical samples to collect from excavated soils at contaminated sites. This table was originally developed for petroleum contaminated sites; however, it is also being recommended for sites with other types of contaminants. For non-petroleum contaminants, ADEC may require a different frequency of screening and analytical samples depending on data use, contaminant type, site management decisions, remediation goals, and other site-specific factors. Sample frequency and collection procedures for all contaminated sites should be proposed in the site specific work plan submitted to the department for review and approval.

If field screening is conducted from the excavator equipment bucket only, collect a sufficient number of screening samples to ensure that all areas and locations of the excavation are adequately evaluated for potential contamination.

Table 2A – Excavated Soil Sample Collection Guide:

By Volume (cubic yards)	Number of Screening Samples	Associated Number of Laboratory Samples
0-10	5	1
11-50	5	2
51-100	1 per 10 cy	3
More than 100	1 per 10 cy, or as the ADEC determines necessary	3 samples, plus one (1) sample for each additional 200 cubic yards, or portion thereof or as the ADEC determines necessary.

Table 2A applies to all excavated soils removed from the ground including soils placed into stockpiles, drums, or other containers. Overburden soils would need to be sampled as excavated soil unless it has been demonstrated that the overburden soils are clean and was approved in a site-specific work plan.

Excavated soils taken to an ADEC approved treatment facility are excluded from the field screening and laboratory sampling frequency in Table 2A. Pre-treatment laboratory sampling may be required to establish that the contaminants are acceptable and suitable for treatment at the selected facility.

Surface and sub-surface field screening samples should be collected directly from an excavation area, the center of the excavation equipment bucket, or by using direct push or split spoon methods. Field screening samples should be collected in a manner that minimizes the loss of VOCs.

Use Table 2B to determine the minimum number of screening and laboratory analytical samples to collect from excavated soils at contaminated sites. This table was originally developed for petroleum contaminated sites; however, it is also being recommended for sites with other types of contaminants. For non-petroleum contaminants, ADEC may require a different frequency of screening and analytical samples depending on data use, contaminant type, site management decisions, remediation goals, and other site-specific factors. Sample frequency and collection procedures for all contaminated sites should be proposed in the site specific work plan submitted to the department for review and approval.

Table 2B – Surface/ Excavation Base and Excavation Sidewall Soil Sample Collection Guide

By surface area (square feet)	Number of Screening Samples	Associated Number of Laboratory Samples
0-50	5	1
51-124	5	2

125-250	1 per 25 sq ft	2
More than 250	10 plus 1 per additional 100 sq ft, or as the ADEC determines necessary	2 samples, plus one sample for each additional 250 square feet, or portion thereof; or as the ADEC determines necessary.
Excavation sidewalls	For each excavation sidewall, 1 per 10 linear feet, or portion thereof, with field screening sample collection focused on soil horizon(s) demonstrated as most likely to be contaminated.**	Minimum 1 per 20 linear feet, or portion thereof at the highest field screening reading in all soil horizons; or as the ADEC determines necessary. (i.e. a 20’x20’ excavation [80 linear feet total] would require 4 laboratory side wall samples. A 4’x4’ excavation [16 linear feet total] would require 1 laboratory side wall sample).**

** Field screening samples and laboratory samples are to be collected within a soil horizon at the area most likely to be contaminated, such as on top of confining layers, at the base of more porous layers, at the groundwater interface, or along any other preferential pathways identified in the field.

Conduct field screening and confirmation sampling at aboveground and underground storage tank locations as follows:

Tank Area:

- Below the tank, as per Table 2B.
- Adjacent to and below all fill and vent pipes.
- Excavation sidewalls, as per Table 2B.
- For an in-place assessment, no more than five (5) feet from the tank.
- Other areas of suspected contamination.

Piping Run and Dispensers:

- Within two (2) feet below piping joints, elbows, connections, and damaged piping components; if these locations are unknown then screening must occur within two (2) feet below original level of piping at a minimum frequency of one field screening sample for every ten (10) foot length of piping.
- Adjacent to and within two (2) feet below all dispensers.
- Other areas of suspected contamination.

Absence of positive field screening results or those field screening results below an arbitrary threshold cannot be used alone as justification for not taking the associated number of laboratory analytical samples.

1. Petroleum Hydrocarbon Field Screening Methods

A. PID and FID

Two commonly used field instruments for detecting organic vapors at petroleum sites are photoionization detectors (PIDs) and flame ionization detectors (FIDs).

Heated headspace organic vapor monitoring involves the measurement of volatile organics emitted from soil samples in a sealed container. The container is typically warmed and then tested for volatile organic vapors using photo- or flame-ionization techniques. The results generated by this method are qualitative to semi-quantitative and are limited to compounds that readily volatilize.

Conduct headspace analysis in glass jars or re-sealable polyethylene bags. If using re-sealable polyethylene bags, a blank sample should be tested prior to field screening to account for potential interferences caused by the bags themselves. In addition, the presence of moisture may interfere with instrument readings. Results should be presented in the report.

The following heated headspace field screening procedure must be used:

- Calibrate PID and FID field instruments according to the manufacturer's specifications and requirements.
- Partially fill (one-third to one-half) a glass jar or re-sealable polyethylene bag with the sample to be analyzed. Total capacity of the jar or bag may not be less than eight ounces (approximately 250 ml), but the container should not be so large as to allow vapor diffusion and stratification effects to significantly affect the sample.
- If the sample is collected from a split spoon, transfer it to the jar or re-sealable polyethylene bag for headspace analysis immediately after opening the split-spoon.
- Collect the sample from freshly uncovered soil if is collected from an excavation or soil stockpile.
- If a jar is used, quickly cover the top with clean aluminum foil or a jar lid. Use screw tops, strong rubber bands, or other methods that will tightly seal the jar. If a re-sealable polyethylene bag is used it must be quickly sealed shut.
- From the time of collection, allow headspace vapors to develop in the container for at least 10 minutes but no longer than one hour.
- Shake or agitate containers for 15 seconds at the beginning and end of the headspace development period to assist volatilization. Temperatures of the headspace must be warmed to at least 40° F (approximately 5° C).
- After headspace development, insert the instrument sampling probe to a point about one-half the headspace depth. The container opening must be minimized and care must be taken to avoid uptake of water droplets and soil particulates.
- After probe insertion, record the highest meter reading. This normally will occur between two and five seconds after probe insertion.
- Complete headspace field screening within one hour from the time of sample collection.
- Document all field screening results in the field record or log book.

If approved by ADEC, expedited field screening using a PID or FID may be conducted to determine where to collect laboratory samples from direct push or split spoon soil cores using the following procedure.

- Immediately after removing the soil core, expose fresh soil by making small divots or cracks at six inch intervals along the length of the core.
- Place the PID or FID probe above the freshly exposed divot or crack being careful not to touch the sample.
- Document all field screening results in the field record or log book.

B. Immunoassay

Immunoassay field screening involves the detection and the measurement of petroleum hydrocarbons using specific binding characteristics of antibodies and antigens. The antibodies form antibody/antigen compounds with molecules of specific organic compounds present in the petroleum hydrocarbon mixtures such as gasoline, diesel fuel, and motor oils. Most immunoassay test kits use an enzyme-linked immunosorbent assay (ELISA) process. In this process, the samples being tested are combined with a labeled enzyme that then competes for binding antibody sites. The process requires incubation prior to separation of bound and unbound antibodies. The bound antibodies are then quantified using secondary processes.

The immunoassay methods generate quantitative and semi-quantitative results. Most of these methods have been designed to measure the presence and concentration of a variety of petroleum hydrocarbon mixtures. Concentration determinations are based upon a relative response to specific types of organic compounds or molecular structures present in all hydrocarbon mixtures. Therefore, it is possible to monitor for gasoline, diesel, and other hydrocarbon mixtures using immunoassay methods.

Immunoassay methods require methanol extraction of a known mass of soil containing petroleum hydrocarbons. The methanol extract is then introduced to the antibody/antigen reaction to focus the testing process on the appropriate target compounds. Once the antibody/antigen reaction has been terminated, colorimetric or turbidimetric processes are used to quantify the petroleum hydrocarbon mixture present in the soil.

C. Infrared Spectrophotometry

Infrared spectrophotometry (IRS) is typically used to measure the carbon-hydrogen bonds (C-H bonds) present in all petroleum hydrocarbon mixtures. IRS field screening techniques recommend the addition of silica gel to a known mass of petroleum hydrocarbon impacted soil prior to extraction using a suitable solvent. The soil extract is then analyzed directly following calibration of the infrared spectrophotometer adjusted to the appropriate wavelength to measure the C-H bond emissions. The quantitative results are prepared using the extraction solvent and appropriate petroleum hydrocarbon target analyte. The concentrations are determined based on project specific data quality objectives and require an understanding of basic chemistry for proper preparation.

D. Colorimetric Wet Chemistry

Colorimetric test methods employ visible monitoring techniques to identify and quantify the presence of petroleum hydrocarbons. The methods require visual observation and quantification using visual comparison or spectrophotometric equipment. These methods usually employ organic wet chemistry techniques for determination of petroleum hydrocarbons on a qualitative, semi-quantitative, or quantitative basis.

Colorimetric wet chemistry methods require mixing soil containing petroleum hydrocarbons with coloring reagents. The presence of petroleum hydrocarbon mixtures are then determined through visible wavelength spectrophotometry or by visual observance of color in the reaction vessel.

E. Physical Screening Methods

Physical screening methods, such as visual and olfactory screening, are qualitative and can provide only basic information related to the presence or absence of petroleum hydrocarbons. However, these should be reported if observed. Physical screening methods require little or no preparation prior to a direct visual observation to evaluate the presence of petroleum hydrocarbons.

2. Selection Criteria

Petroleum hydrocarbon field screening methods use different technologies to measure or respond to the presence of petroleum hydrocarbons. These methods can react differently under similar conditions. To select a field screening method that will provide the user with the desired results, several criteria must be considered and evaluated during the selection process. These criteria include:

- Determination of the target analytes (volatile, semi-volatile, or relatively non-volatile petroleum hydrocarbons),
- Estimation of the target analyte concentration ranges (generally comparable to applicable cleanup standards),
- Determination of the data quality objectives, such as the need for quantitative, semi-quantitative or qualitative data,
- Required expertise to perform the screening analysis and,
- An understanding of the capabilities and limitations of the screening methods.

These criteria are discussed in greater detail in the following sections:

A. Target Analytes

Each field screening method has been designed to respond to various petroleum hydrocarbon mixtures or classes of organic compounds. Some screening methods are capable of testing only for volatile organics, while others are capable of measuring higher molecular weight petroleum hydrocarbons. To select an appropriate field screening method, the user should first try to identify the petroleum hydrocarbon mixture in the soil being tested. This is typically established using fixed laboratory analyses and/or prior knowledge of the source of contamination.

B. Multiple Petroleum Hydrocarbon Mixtures

The presence of multiple petroleum hydrocarbon mixtures complicates the use of field screening methods. The field screening methods are based on the detection of a variety of hydrocarbon mixtures or a combination of the petroleum fractions (GRO, DRO, and RRO). Without knowing which petroleum hydrocarbon mixture(s) are present, a range of field screening methods may need to be used to adequately estimate concentrations.

Field screening methods have limitations concerning the applicable ranges of concentrations they can detect. The concentration ranges are different for each field screening method. The screening method user should identify project specific data quality objectives and identify the field screening method that can meet those objectives. Field screening methods alone are not capable of generating results that correspond directly to the analytical methods required for GRO, DRO and RRO (AK 101, 102 and 103). Instead, the field screening methods are capable of detecting multiple ranges or varying portions of these hydrocarbon mixtures. The user should be familiar with information provided by various equipment and test kit manufacturers to ensure the selected screening method will evaluate the desired petroleum hydrocarbon ranges or mixtures.

C. Required Training and Expertise

Operation of the various field screening methods requires different levels of personnel training and expertise. Some of the simpler field screening methods can easily be completed after reviewing general procedures and becoming familiar with the operation of instrumentation and equipment. Other field screening methods require various levels of training and/or support from the experienced personnel, test kit manufacturers, and trained chemists. It is important that the operator responsible for the direct reading of instrumentation, test kits, and field-adapted laboratory equipment fully understand the principles used to measure and quantify target analytes. This knowledge allows the operator to maximize the reliability and usability of the data being generated.

D. Method Capabilities and Limitations

It is important to know the specific capabilities and limitations of the various methods when selecting an appropriate field screening method. It is also important to consult with the equipment/method manufacturers to further investigate the capabilities and limitations for application to particular projects. Various factors affecting the applicability of each field screening method are listed below, along with an example of the limitation.

- **Moisture in soil** may interfere with the operation of direct reading instruments, which may result in erroneous data.
- **Natural organic matter** in the soil may bias screening results due to the contribution of organic compounds similar to those present in refined petroleum hydrocarbons of concern.
- **Soil types** may interfere with testing procedures and results. Examples are: moist, dense, plastic, clay that is not easily broken apart may limit the generation of headspace hydrocarbon vapors for monitoring using a direct reading instrument; organic peat lithologies can introduce significant quantities of natural organics

causing high bias in immunoassay screening results; gravel and rock lithologies may decrease the accuracy of all screening methods due to limited sample surface areas, increased sample mass, and the limited sample size required by most screening methods.

- **Low temperature and high altitudes** may limit or preclude the operation of some direct reading instrument.
- **Temperature fluctuations** may alter the response from field screening instrumentation and equipment requiring frequent calibration.
- **Electrical power source stability** is required for operation of some field screening method equipment. Continuous power with limited voltage and current fluctuations is typically required when using electrical equipment requiring an alternating current (AC) power supply.

E. Other Technology Selection Criteria

- **Logistical concerns** require attention when shipping United States Department of Transportation (USDOT) hazardous substances such as methanol, hexane, isobutylene, or other chemicals or compressed gases to project sites. Some immunoassay methods require low temperature preservation during shipment and storage prior to use.
- **Timeframe for testing** must be considered. Some of the field screening methods will allow the user to test hundreds of samples per day, while others will be limited to fewer than 40.
- **Cost** will play an important role. The number of samples to be tested and the usability of the data will have a direct bearing on cost feasibility. It is suggested that the user perform a cost-benefit analysis prior to selecting field screening methods.

Selecting Appropriate Petroleum Hydrocarbon Field Screening Methods

Appendix B provides general information for each field screening method category described in this guide. It should be used as a preliminary or initial guide to select the field screening technologies or categories that meet your site specific target analytes, DQOs, and approximate concentration ranges you wish to evaluate.

Once the selection criteria in Appendix B are understood, Appendix C can be used to identify the field screening method category or categories most appropriate for your site. Appendix C further elaborates on the technical and logistical criteria important to selecting a field screening method. Factors affecting accuracy and precision are noted for each category. A relative comparison of the training and desirable expertise for the field operator is noted. General causes of interference and the associated effects on the screening results are described for each category. Finally, other logistical considerations such as, waste byproducts, transportation, storage, and shelf life are briefly compared. The task of selecting “the best fit” field screening method can be difficult and is dependent upon site-specific technical and logistical data.

C. Soil Laboratory Analytical Sample Collection

1. General Guidelines

Sample holding times must conform to the specifications in the required analytical method (see Appendix D). Special considerations should be given to sampling frozen soils, as the equipment and techniques described in the following sections may or may not apply.

For regulated underground storage tank investigations analytical samples must be collected in accordance with 18 AAC 78.090. For example, one analytical soil sample per dispenser area and one analytical soil sample along areas of piping most likely to be impacted.

2. Volatile Soil Sampling Procedure

Do not use a soil collection device for VOC sample collection that causes mixing or unnecessary disturbance of the soil in an effort to minimize volatilization. Core type samples are preferred to reduce the loss of volatiles during sampling Core samplers used for VOC sample collection must be constructed of non-reactive materials that will minimize loss of VOCs in the sample and should be of adequate size to obtain the minimum required soil mass. A large coring device or multiple core samples may be required to obtain the necessary soil mass, e.g. 25-50 grams Certain soil types and/or site conditions are not amenable to core type devices and sampling procedures. In such cases, a spoon or scoop type sampling method may result in less soil disturbance, more immediate soil field preservation, and, therefore, less volatile loss.

While soil core samplers are the preferred method for collecting VOC soil samples other sampling tools may also be acceptable with ADEC approval. Therefore, detailed sampling procedures should be included in the site work plan submitted to the ADEC for review and approval.

Collect and preserve AK101 and VOC soil samples as follows:

- Collect a minimum of 25 grams of soil with minimum disturbance directly into tared 4-oz or larger jar with a Teflon® -lined septum fused to the lid. Interim storage/containers (e.g. re-sealable polyethylene bags) are not allowed.
- Immediately after collection, carefully add 25-mL aliquot of methanol (methanol must include a surrogate for method AK101) until the sample is submerged. This step must be completed as quickly as possible, within approximately10 seconds of placing the soil in the sample jar. If an extended time period between soil collection and preservation is necessary due to site conditions or safety concerns, this must be specified in an approved work plan, recorded in the field notes and documented in the final report.
- Do not place tape, including evidence tape, on the sample container directly.
- Cool and retain samples at 4° C ±2° C.
- Collect a sample of the same material from the same location in an unpreserved jar for percent moisture determination.

- Collect appropriate field and laboratory quality control samples (see Table 3).
- Collect sample parameters in the following order:
    - Volatile Organic Compounds (VOCs, AK101 GRO, BTEX),
    - Semi-volatiles organic compounds (SVOCs); including pesticides herbicides, DRO, RRO, and PCBs,
    - Total Organic Carbon (TOC), and
    - Metals.
- Soils that are frozen in-situ (< -7 ^{o}C) may not be required to be preserved immediately for VOC analysis as specified above. In these cases, the soil must be maintained frozen (< -7 ^{o}C) in appropriate containers and sub-sampled and preserved as soon as practical. The soil should not be thawed prior to sub-sampling and preservation. Sub-sampling and preservation should follow the procedure specified above. The collection, maintenance of frozen soil at temperature, and sub-sampling/preservation procedures must be detailed in a site specific work plan submitted to the ADEC for review and approval.
- If volatile samples are not being collected, alternate sampling procedures may be approved on a site specific basis.

3. Excavated Soil (Stockpiles)

Segregate excavated soils into different stockpiles based on field screening results. If instruments or other field observations indicate contamination, soil must be separated into stockpiles based on apparent degrees of contamination. At a minimum, soil suspected of contamination must be segregated from soil observed to be free of contamination.

For each stockpile, use Table 2A to determine the appropriate number of field screening and laboratory analytical samples.

Field screening and associated laboratory analytical samples must be collected at different depths and locations to adequately represent soil contaminant heterogeneity and be of sufficient quantity to ensure representativeness.

Field screening samples must be collected at least 18 inches beneath the exposed surface of the stockpile unless additional shallower field screening samples are needed to represent soil contaminant heterogeneity. Petroleum contamination can be persistent near the bottom of long-term stockpiles, so it is important that some field screening samples be collected near the base.

Laboratory analytical samples must be collected from all excavated soils unless otherwise approved by ADEC.

Stockpile soils to be taken to a ADEC approved treatment facility are excluded from the field screening and laboratory sampling frequency. Pre-treatment laboratory sampling may be required to establish that the contaminants are acceptable and suitable for treatment at the selected facility.

4. Excavations

For volatile samples, remove 2-6 inches of soil immediately before sample collection. Furthermore, if the excavation has been open for longer than one hour, remove 6-12 inches of soil immediately before collection. Do not collect samples from disturbed soil that has fallen into the bottom of the excavation pit.

For non-volatile samples (metals, PCBs, DRO, RRO and PAHs) it may not be necessary to expose fresh soil by removing any overburden, prior to collection.

If excavation depth precludes safely collecting samples from the bottom of the excavation, samples may be collected from the center of a excavation bucket by first removing 4-6 inches of soil immediately, prior to collection.

5. In-Situ (sub-surface) Soils

The frequency and location of field screening and laboratory analytical samples must be proposed in the work plan submitted to ADEC for approval.

Typically, two laboratory samples should be collected from each boring. Collect one sample from the interval that is most impacted based on field screening and observations. If applicable, collect a second laboratory sample from the saturated soils just above the water table where contaminants are most likely to migrate, unless sampling objectives dictate otherwise.

6. Multi-Increment Soil Sampling

A multi-increment sampling approach must adhere to ADEC's *Draft Guidance on Multi Incremental Soil Sampling* at http://www.dec.state.ak.us/spar/csp/guidance/multi_increment.pdf.

7. Total Organic Carbon

Refer to ADEC's *Guidelines for Total Organic Carbon (TOC) Sample Collection and Data Reduction for Method Three and Method Four* for requirements at http://www.dec.state.ak.us/spar/csp/guidance/TOC-tech-memo-sept-2008.pdf.

8. Sampling Requirements for Naturally Occurring Compounds

Naturally occurring inorganic compounds may be found in concentrations above the regulatory cleanup level in 18 AAC 75.341 Table B1. The presence of inorganic compounds may be considered naturally occurring if no known or suspected anthropogenic inorganic contaminant sources are present. See ADEC's technical memorandum, *Arsenic in Soil* (March 2009), for additional information. Although the focus is on naturally occurring arsenic, the principles apply to all naturally occurring inorganic compounds. The technical memorandum is available for reference at http://www.dec.state.ak.us/spar/csp/guidance/tm-arsenic.pdf.

ADEC recommends the use of EPA's *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (EPA 540-R-01-003, September*

2002), for sampling and proposing site-specific background concentrations. The guidance is available at http://www.epa.gov/oswer/riskassessment/pdf/background.pdf.

Naturally occurring organic material is present in many Alaskan soils. Biogenic interference is the term that is used to describe the naturally occurring organic material that is quantified and reported as DRO and/or RRO in accordance with the AK 102 and AK 103 methods. For more information see ADEC's technical memorandum, *Biogenic Interference and Silica Gel Cleanup* at http://www.dec.state.ak.us/spar/csp/guidance/tm_biogenics.pdf.

D. Soil Sampling Equipment

1. Scoop/Trowel/Stainless Steel Spoon

Figure 1. Stainless Steel Scoop. (Photograph by D.Dibblee)

A trowel, scoop (Figure1), or stainless steel spoon may be used to collect soil samples. They can also be used for homogenizing soil or for collecting a variety of other waste samples. Scoops come in different sizes and makes. Some are coated with chrome paint, which can peel off and get into the sample: these are unacceptable. Stainless steel scoops are preferred; however, scoops made from alternative materials may be applicable in certain instances (e.g., polyethylene for trace element sampling in sediments).

Samples can be put directly into sample containers or be processed through sieves to acquire the desired grain size. Stainless steel trowels and scoops can be purchased from scientific or environmental equipment supply houses.

Procedures for Use:

- At specified intervals, take small, equal portions of sample from the surface and immediately below the surface.
- Transfer samples into laboratory cleaned sample bottles and follow procedures for preservation and transport.

Advantages:

- Easy to use and clean.

Disadvantages:

- Not the preferred method for volatile organic sample collection.

2. Bucket Auger

The bucket auger (Figure 2) consists of a stainless steel cylindrical body with sharpened spiral blades on the bottom and a framework above allowing for extension rod and T-handle attachments. When the tool is rotated clockwise by its T-handle, it advances downward as it cuts into the soil and moves loosened soil upward where it's captured in the cylindrical body. Cutting diameters vary. The overall length of an auger is about 12 inches and extensions can extend the sample depth to several feet. There are three general types of augers available: sand, clay/mud, and augers for more typical mixed soils.

Figure 2. Bucket Augers. Photographs publish with permission by Art's Manufacturing and Supply

Depending on soil characteristics, chose the auger best suited for your needs. These tools can be purchased from scientific or forestry equipment supply houses. The auger is particularly useful in collecting soil samples at depths greater than 8 cm (3 in.). However, this sampler destroys the cohesive structure of soil and clear distinction between soil collected near the surface or toward the bottom may not be readily apparent as a result of the mixing effect. The bucket auger is not preferred when an undisturbed soil sample for volatile organic compounds is desired. It should be noted that this exception does not include analysis of other organics e.g., base-neutrals/acid extractables, pesticides, PCBs, total petroleum hydrocarbons, and total organic carbon. Bucket augers are also acceptable for inorganic analysis.

Procedures for Use:

- Remove unnecessary rocks, twigs, and other non-soil materials from selected sampling point.
- Attach the bucket and handle to an extension rod.
- Begin turning the auger with a clockwise motion and continue until the desired sampling depth is obtained.
- Transfer the sample into laboratory cleaned sample containers using a decontaminated stainless steel spoon or trowel.
- When collecting samples at depths greater than 12 inches, it's advisable to discard one-half inch of material in the top portion of the auger due to cave-in.
- Follow procedures for transport.

Advantages:

- Relatively speedy operation for subsurface samples.

Disadvantages:

- Soil horizons may not be evident.
- Not the preferred method for volatile organic sample collection.

3. Soil Coring Device

The soil-coring device (Figure 3) consists of a stainless steel, machined split-cylinder with threaded ends, cutting shoe and end cap with a slide hammer used for advancement into the soil. The cutting shoe and end caps of the corer are also constructed of stainless steel. Use of a plastic collection tube and soil-retaining basket is optional.

Once the desired depth is reached, the slide hammer can be used to assist in pulling back the device. Caution should be used when back-hammering so as not to loosen soil captured within the barrel if a liner/retaining basket is not used. This device may be used in conjunction with a soil auger if core analysis of depth profiles need to be performed.

Once opened and screened with a PID or FID, a soil sub-sample can be collected for volatile organic analysis soil using a soil core device or other appropriate sampler.

Figure 3. Soil Coring Device (Photograph by J. Schoenleber)

Procedures for Use:

- Assemble the split barrel and screw on cutting shoe and end caps. Liner and basket retainers are optional.
- Place the sampler in position with the bit touching the ground.
- Drive with slide hammer until unit is completely advanced. Avoid sample compression.
- After reaching the required depth, use the slide hammer to back out device using caution so as not to lose sample.
- Remove both ends and tap barrel to break open split sections.

- Use a utility hook knife to open plastic liner.
- Record visual observations and field screening data in boring log.
- For volatile organic analysis use a soil core device or other appropriate sampler to collect the sample prior to preservation.
- Follow procedures for transport.

Advantages:

- Can be used in various substances.
- Core sample remains relatively intact.
- Bit is replaceable.

Disadvantages:

- Depth restrictions.
- Not useful in rocky or tightly packed soils.
- Only soil coring devices of stainless steel construction are recommended for collection of soils for chemical analysis.

4. Split Spoon Sampler

A split spoon sampler (Figure 4) is used to collect representative soil samples at depth. The sampler itself is carbon or stainless steel tubing split longitudinally and equipped with a drive shoe and a drive head. These are available in a variety of lengths and diameters and are typically advanced by blows of a hammer dropped from a drill rig mast. The weight and throw of the hammer varies by drill rig.

Figure 4. Split Spoon Sampler (Photograph by D. Dibblee)

Procedures for Use:

- Assemble the sampler by aligning both sides of the barrel and then screwing the drive shoe with retainer on the bottom and the heavier headpiece on top.
- Drive the tube utilizing a sledgehammer or well drilling rig if available. Do not drive past the bottom of the headpiece as this will result in compression of the sample.

- Record the length of the tube that penetrated the material being sampled, the weight of the hammer and distance dropped and the number of blows required to obtain this depth.
- Once soil core is acquired, conduct field screening readings with PID/FID of the exposed soil core. Field screening must be conducted in accordance with Section 1A of this document. If collecting samples for analyses of volatile compounds, collect and preserve samples in accordance with Section C2.
- Collect additional samples for non-volatile analyses as necessary

When split tube sampling is perform*ed to gain geologic* information, all work should be performed in accordance with ASTM D1586.

Advantages:

- Easily available.
- Strong.
- Ideal for split sample collection.

Disadvantages:

- Requires drilling or tripod for deeper samples.

5. Shelby Tube Sampler

A Shelby tube is used mainly for obtaining geological information but may be used in obtaining samples for chemical analysis. The Shelby tube consists of a thin walled tube with a tapered cutting head. This allows the sampler to penetrate the soil and aids in retaining the sample in the tube after the tube is advanced (without excessive force) to the desired depth.

Procedures for Use:

- Place the sampler in a perpendicular position on the material to be sampled.
- Push the tube into the soil by a continuous and rapid motion, without impact or twisting. In no instance should the tube be pushed further than the length provided for the soil sample.
- Let sit for a few minutes to allow soils to expand in the tube.
- Before pulling out the tube, rotate the tube at least two revolutions to shear off the sample at the bottom. If the sample is to be shipped for further geologic analysis, the tube must be appropriately prepared for shipment. Generally, this is accomplished by sealing the ends of the tube with wax in order to preserve the moisture content. In such instances, the procedures and preparation for shipment shall be in accordance with ASTM D1586.

Advantages:

- Inexpensive.
- Tube may be used to ship the sample without disturbing the sample.
- Provides core sample.
- Easily cleaned.

Disadvantages:

- Sometimes difficult to extract sample.
- Not durable when rocky soils are encountered.

6. Soil Core Samplers (VOCs):

While soil core samplers are the preferred method for collecting VOC samples other sampling tools may also be acceptable, with ADEC approval.

There are a number of soil core sampling devices available for VOC sample collection which are approved for EPA method 5035A. The En Core® sampler, or equivalent brand of soil core sampler, is acceptable to collect soil samples for VOC analysis as described in ASTM D6418-09. These devices are used to collect a specific soil sample mass for volatile organic analysis in a manner that minimizes loss of contaminants due to volatilization, biodegradation, or both. In performing the ASTM collection practice, the integrity of the soil sample structure is maintained during sample collection, preservation, storage, and transfer in the laboratory for analysis. The sample is expelled directly from the coring body/storage chamber into the appropriate container for preservation without disrupting the integrity of the sample and as a result has limited exposure to the atmosphere during the collection, storage, and transfer process. Methanol field preservation is required for all volatiles soil analysis. Alternate low level volatile collection and analysis techniques per EPA SW846 Method 5035A must be approved by the ADEC on a site-specific basis.

Below are examples of coring devices for collecting soil to be tested for volatile contaminants. Soil is extruded from sampler after collection and placed in a container and preserved with methanol.

Figure 5. Example Soil Coring Devices:

Core N' One™ tool

SoilMoisture Equipment Corp.0200 Soil Core Sampler

Procedures for Use (En Core® provided as an example only):

- Open foil package containing 5-gram En Core® Sampler.
- Insert 5-gram Teflon® sampler into En Core® T-handle.
- DO NOT pull plunger back prior to use.
- Set device aside on a clean surface.
- In controlled setting, open coring device and expose core for field screening with direct reading instrument.
- Once the sample increment is identified, carefully prepare soil core surface for sub-core sampling by scraping away a small portion of soil with a stainless steel spatula.
- Position En Core® with T-handle squarely over the prepared surface and press into soil to a depth of approximately 5/8" to achieve 5-gram sample.
- Extrude core into sample jar with methanol preservative and **repeat as necessary to obtain the required sample mass.**

Advantages:

- Engineered to maintain integrity of soil sample without loss of volatile organics.

Disadvantages:

- Plunger is designed to open as it is pressed into the soil core. Depending on the cohesive nature of the material being sampled, obtaining a full sample in one movement may be difficult.
- Cores consisting of small rocks, shale, cobble, tight clays, peat/tundra or similar material cannot be effectively sampled. If soil matrix is not amenable, other sampling methods may be proposed in the work plan for review and approval.
- Depending on the size of the core sampling device and the required sample mass, multiple cores may be required, resulting in additional sample handling and possible VOC loss.

7. Power Auger

The power auger is not a tool for sample collection, in and of itself. Instead, a power auger is used in lieu of a bucket auger to reach the depth of a desired sample interval. The power auger is composed of a length of auger flight, usually three feet; attached to a power source which turns the auger either hydraulically or mechanically. Various sizes and types of power sources are available, from one man to equipment mounted units. Additional auger flights can be used to increase the depth obtainable by the unit. The power auger is used to bore just above the desired sampling depth. A bucket auger or coring device, smaller in diameter than the auger flight, is then used to obtain the sample.

Advantages:

- Reduces sampling time.
- Inexpensive.

Disadvantages:

- Use of gasoline powered engine increases possibility of contamination of sample.
- Not useful in rocky soils.
- Extensive decontamination procedure (high pressure, hot water cleaning of auger flights).

8. Direct Push Technology

Use of Direct Push Technology to obtain soil samples has gained wide acceptance. The relative ease to collect minimally disturbed soil cores at the surface or at depth plus the ability to provide a wide array of geotechnical options has made this an attractive system. While various manufacturers make and distribute their own equipment and accessories, the same general principles still apply when collecting soil samples.

For more information related to direct push technology go to the following EPA web site: http://www.epa.gov/superfund/programs/dfa/dirtech.htm#vendor

Procedures for Use:

- Hammer sampling barrel to desired sampling interval and remove.
- Open the sampling barrel, remove the plastic sleeve containing the core and cut open the sleeve.
- Conduct field screening readings with PID/FID of the exposed soil core. Field screening must be conducted in accordance with Section 1A of this document. If collecting samples for analyses of volatile compounds, collect and preserve samples in accordance with Section C2.
- Collect additional samples for non-volatile analyses as necessary.

Advantages:

- Allows for continuous sampling.
- Profiling and collection of soils over large areas can be accomplished in less time.

- Efficient access to remote locations due to equipment size and mobility.

Disadvantages:

- Direct push sampling is limited to soils and unconsolidated materials that can be penetrated with available equipment.
- Decontamination of reusable equipment is required between boreholes.

IV. Groundwater Sampling

The importance of proper ground water sampling cannot be overemphasized. Care must be taken to ensure that the sample is not altered or contaminated by the sampling equipment, sampling process, or the sample handling procedure. Sampling must be targeted at the interval(s) within the water column based on the physical characteristics of the contaminant.

A. General Guidelines

For monitoring well design, construction, development, maintenance, and decommissioning information refer to ADEC's *Monitoring Well Guidance* at http://www.dec.state.ak.us/spar/csp/guidance/mw_guidance.pdf.

During monitoring well installation it is recommended that the grout be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed. It is also recommended that the surface pad be allowed to cure for a minimum of 24 hours before the monitoring well is developed. ADEC recognizes that remote site work may make these recommended installation times impractical. Contact your ADEC project manager for site specific approval if development is to be conducted prior to these 24-hour waiting periods.

Except when compressed air is being used for well development, monitoring well sampling can be initiated as soon as the groundwater has re-equilibrated, is free of visible sediment, water quality parameters have stabilized (see below) or 24 hours have passed following development. In the case of using compressed air to develop a monitoring well, wait at least 7 days before sampling. If sampling is conducted prior to the prescribed waiting period, the data for that sampling event may be considered screening level only and subsequent sampling event(s) may be required.

If purging monitoring wells prior to sampling:

- remove at least three casing volumes, **or**
- monitor water quality parameters until a minimum of three (minimum of four, if using temperature as an indicator) of the parameters listed below stabilize, **or**
- for low yield wells, until the well casing is evacuated.

If using in-line water quality monitoring equipment (flow through cell), water quality parameters should be continuously monitored during purging. For low-flow sampling the goal is minimum drawdown (<0.1 m) during purging. Temperature and pH, while commonly used as purging indicators, are insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured and recorded (EPA 540/S-95/504, April 1996).

Water quality parameters are considered stable when three successive readings, collected 3-5 minutes apart, are within:

- ± 3% for temperature (minimum of ± 0.2 ^{o}C),
- ± 0.1 for pH,
- ± 3% for conductivity,
- ± 10 mv for redox potential,
- ± 10% for dissolved oxygen (DO), and
- ± 10% for turbidity.

A minimum of three (minimum of four if using temperature as an indicator) of these parameters should be monitored and recorded. Low flow purging and sampling are particularly useful for wells that purge dry or take one hour or longer to recover. If a well is low yield and purged dry, do not collect a sample until it has recharged to approximately 80% of its pre-purge volume, when practical.

Groundwater samples must be collected as close as possible to the soil/groundwater interface (i.e. water table), and caution should be exercised to insure that the water table is within the screened interval of the well. However, site conditions may dictate that representative groundwater samples be collected from other depth intervals, e.g. diving plumes, confined aquifers, etc. If further vertical delineation of contaminant concentration(s) is necessary, the interval(s) within the water column where samples are collected should be based on the physical characteristics of the contaminant. This should be a consideration especially for chlorinated solvents or other dense non-aqueous phase liquids (DNAPLS).

The groundwater sampling methodology must be stated in the work plan, support the intended data use and site decision, and be approved by ADEC. Collect groundwater samples for all appropriate contaminants of concern using the method specifications listed in Appendix E.

Groundwater sampling devices must compliment the intended data use and site decisions. Select groundwater purging and sampling equipment to minimize increases in sample temperature, water column agitation, and sample agitation. Materials comprising sampling devices and tubing must not adsorb, desorb, or leach contaminants of concern and must be resistant to chemical and biological degradation.

Peristaltic pumps (section D2 of Groundwater Sample Equipment) and bailers (section D1) are not the preferred method for the collection of volatiles or other air sensitive parameters. Rather the use of bladder pumps (section D3), positive pressure submersible pumps (section D4), gear pumps (section D5), passive diffusion bag samplers (section D6), or samplers like HydraSleeve (section D8) or Snap Samplers (section D9) are preferred to reduce the loss of volatiles during sampling. For more information on

HydraSleeve and Snap Samplers see the ITRC's March 2006 Technology Overview of Passive Sampler Technologies (http://www.itrcweb.org/Documents/DSP_4.pdf).

If any sheen, free product, or RCRA hazardous waste is generated during well development, purging, or sampling it must be disposed of in an approved manner.

If contamination is not visible (i.e. free product, heavy sheen), the monitoring well purge water may be filtered using a type of water filter system appropriate for the contaminants in the purge water. This filtered purge water may be reapplied to the ground surface within site boundaries and a minimum of 100 feet away from any drinking water wells and/or surface waters with site-specific ADEC approval.

If there is no evidence of contamination based on historical data and contamination is not visible, monitoring well purge water may be re-applied directly to the ground surface within site boundaries and a minimum of 100 feet away from any drinking water wells and/or surface waters with site-specific ADEC approval.

The creation of a preferential pathway during site work may impact groundwater. As necessary, implement precautionary measures to assure the groundwater will be protected (i.e. grouting boreholes and compacting soil). If groundwater is encountered, grout soil borings, and decommission well points/monitoring wells in accordance with ADEC's *Monitoring Well Guidance*, see section IV, subsection A, of this document.

B. Drinking Water

Reference the Drinking Water Program's web page at http://www.dec.state.ak.us/eh/dw/publications/sample.html for additional information on how to collect drinking water samples.

C. Groundwater Laboratory Analytical Sample Collection

1. General Guidelines

Teflon® sampling equipment (e.g. tubing, bailers) is preferred. The use of HDPE equipment should be minimized to the extent practical. Studies have indicated that Teflon® shows the least absorption and leaching biases and should be the material of choice for detailed organic sampling purposes.

Sample holding times must conform to the specifications in the required laboratory method (see Appendix E).

Prior to sampling, determine depth to groundwater to within 0.01 feet. Check the monitoring well for the presence of non-aqueous phase liquids (NAPL) that might be floating on top of the water or in a separate layer at the bottom of the casing. Laboratory samples are typically not collected from wells that contain NAPL.

Identify NAPL by one of the following methods, unless otherwise approved by the ADEC.

- Carefully lower a bailer into the well before purging in a manner that will create minimum disturbance and observe the liquids removed from the top and/or the bottom of the water column.
- Use an electronic device designed to detect non-aqueous liquids and to measure the thickness of the non-aqueous layer.

Sample the wells least likely to be contaminated first. Collect samples parameters in the following order:

- In-field water quality measurements,
- Volatile Organic Compounds (VOCs, AK101 GRO, BTEX),
- Semi-volatiles organic compounds (SVOCs); including pesticides, herbicides, DRO/RRO, PCBs,
- Total Organic Carbon (TOC), and
- Total metals; and Dissolved metals (filtered), refer to 18 AAC 75.380(c)(2).

2. No Purge Techniques

No purge groundwater sampling is a method for obtaining representative groundwater samples under natural flow conditions without purging the well beforehand. This procedure is directed primarily at monitoring wells that have a screen, or open interval of 10 feet or less.

The method for no purge sampling is quick, inexpensive, and may eliminate variability introduced by other purging methods. No purge sampling can employ various sampling methods and is suitable for routine sampling. However, it is not recommended for use in making critical site decisions; such as initial sampling, for making the conceptual site model, risk characterization, no further action, or site closure. Additional information on no purge sampling can be found at the websites:
http://www.api.org/ehs/groundwater/bulletins/index.cfm or
http://www.api.org/ehs/groundwater/upload/12_Bull.pdf

3. Passive Groundwater Sampling for VOCs

Passive groundwater sampling allows a sample to be collected from a discrete location without active media transport induced by pumping or purge techniques. Passive technologies rely on the sampling device being exposed to media in ambient equilibrium during the sampler deployment period. For example, well water is expected to be in natural exchange with the formation water.

The Interstate Technology and Regulatory Council's website describes various tools and techniques for passive groundwater sampling. Refer to the ITRC website at http://www.itrcweb.org/guidancedocument.asp?TID=12 for current guidance.

D. Groundwater Sampling Equipment

1. Bottom Fill Bailer

Bailer design is simple and versatile, consisting of a cylindrical length of HDPE, Teflon® or stainless steel with a check valve at the bottom. Bailers (Figures 6 and 7) are available in numerous dimensions to accommodate a wide variety of well diameters. Their low relative cost allow them to be utilized for a one-time use per well per sampling episode.

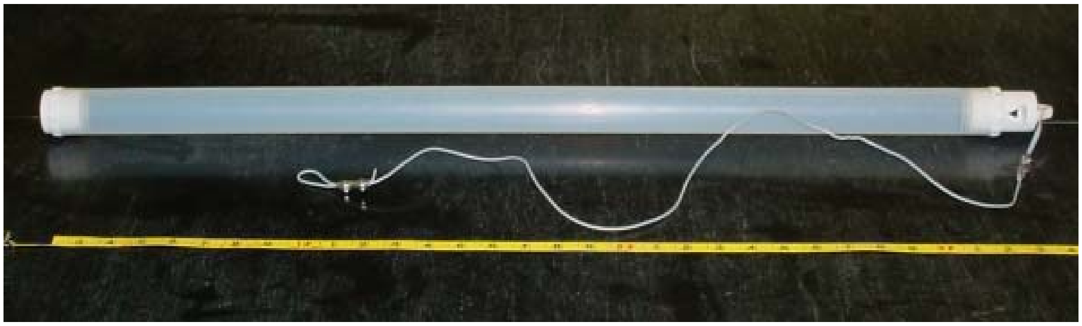

Figure 6. Bottom fill bailer with Teflon® coated stainless leader (Photograph by J. Schoenleber)

The bailer, line, and any other equipment entering the well, must be new or laboratory cleaned and handled with new surgical gloves to prevent cross contamination. Surgical gloves must be changed between each sample location. Clean sampling equipment and any other objects entering the well should not be allowed to contact the ground or any other potentially contaminated surfaces (e.g. gasoline-fueled generators). If this should occur, that item should not be placed in the well or utilized for sampling. It is always good practice to have extra laboratory cleaned bailers available at the site. Additionally, bailers and sample bottles must be physically separate from pumps or generators during transport and storage.

Figure 7. Teflon® constructed bailer with Teflon® ball check valve (Photograph by J. Schoenleber)

Disposable bailers are recommended and available in Teflon® and polyethylene construction. Teflon® disposable bailers are preferred, see section C1. Disposable bailers are typically decontaminated by the manufacturer and must be provided in a sealed polyethylene bag. The manufacturer must be prepared to provide certification that the bailers are clean and state in writing the methods used to achieve decontamination. These bailers may then be acceptable for use depending on site-specific objectives and conditions.

Bailers, even when carefully handled, result in some disturbance of the sample. Samples collected with bailers must be recovered with a minimal amount of aeration. This can be accomplished if care is taken to gradually lower the bailer *until* it contacts the water surface and is then allowed to fill as it slowly sinks in a controlled manner. However, despite the care taken to control aeration during the fill process, filling and emptying the bailer *will* alter dissolved oxygen concentrations. Due to these reasons (operator induced turbulence and air exposure) this device cannot be relied upon to deliver accurate and reproducible measurements of any air sensitive parameter including, but not limited to, dissolved oxygen, pH, carbon dioxide, iron and its associated forms (ferric and ferrous). In addition, volatile organic analytical results may be biased low (due to aeration) and metals analytical results may be biased high (due to turbidity). If bailers are used to collect samples for VOCs analyses, an appropriate device (e.g. VOC tip) attached to the bottom of the bailer should be used to fill sample containers.

Procedures for Use:

- Allow sufficient time after purging for the well to equilibrate and fines to settle. If full recovery exceeds one hour , collect samples soon as soon as the well has recharged to 80% its pre-purged volume, when practical.
- Fit reusable bailers with a new bailer line for each well sampled; the bailer and line may be handled only by personnel wearing clean disposable gloves.
- Lower the bailer slowly to minimize disturbance of the well and water column.
- The leader or bailer line that comes in contact with the water should be new or decontaminated.
- Prevent the bailing line from contacting the outside of the well, equipment, and clothing.
- Obtain samples as close as possible to the water level/air interface, unless analysis indicates that contamination is at a different depth.
- Lift the bailer slowly and transfer the contents to a sample container with a minimum of disturbance and agitation to prevent loss of volatile compounds.

Advantages:

- No external power source required.
- Economical enough that a separate laboratory cleaned bailer may be used for each well, therefore eliminating cross contamination.
- Available in Teflon® , HDPE, or stainless steel construction.
- Disposable bailers acceptable when material of construction is appropriate for contaminant.

- Simple to use, lightweight, portable.

Disadvantages:

- Limited volume of sample collected.
- Unable to collect discrete samples from a depth below the water surface (vertical delineation).
- Field cleaning not acceptable.
- Reusable polyethylene bailers are not acceptable sampling devices for chemical analysis.
- Ball check valve function susceptible to wear, dimension distortion and silt buildup resulting in leakage in reusable bailers. This leakage may aerate succeeding sample and may gather unwanted material by rinsing unwanted material from well casing.
- Cannot provide reliable or reproducible data for air sensitive parameters, e.g., dissolved oxygen, pH, carbon dioxide or iron and its associated forms.
- Volatile organic analytical results may be biased low (due to aeration) and metals results may be biased high (due to turbidity).
- Dedicating a bailer and leaving it in a well for long term monitoring is not recommended due to the potential risk of accumulated contamination.

2. Peristaltic Pump

Figure 8. Geopump™ Peristaltic Pump. Photograph reproduced with permission from Geotech Environmental Equipment, Inc.

A peristaltic pump (Figure 8) is a self-priming suction lift (negative air pressure) pump utilized at the ground surface, consisting of a rotor with ball bearing rollers. One end of dedicated tubing is inserted into the well and the other end is attached to a short length of flexible tubing, which has been threaded around the rotor, out of the pump, and connected to a discharge tube. The liquid moves totally within the tubing, thus no part of the pump contacts the liquid. Tubing used for well evacuation may also be used for sample collection. Teflon® or Teflon® -lined polyethylene tubing is recommended for sampling. Silicone tubing is recommended for tubing in contact with the rotors. The grade of silicone tubing should be appropriate for its intended application. Based upon the required analysis and sampling objectives other materials are acceptable, but must first be approved on a case by case basis.

Procedures for Use:

- Check tubing at rotor for cracks or leaks, replace if necessary.
- Thread flexible length of tubing through rotor/pump.

- Insert dedicated length of tubing in well and attach to flexible tubing at rotor.
- Tubing depth introduced into the water column should not exceed 12 inches.
- If necessary, add a small stainless steel weight to tubing to aid introduction of tubing into well casing (especially helpful in 2-inch diameter wells).
- Attach evacuation line to outlet of flexible pump tubing such that the discharge is directed away from pump and well.
- Engage pump and commence evacuation. Pump speed should be maintained at a rate that will not cause significant drawdown (>0.3 ft.). After well has been properly purged, begin sampling.
- Collect sample into laboratory cleaned sample bottles.

Advantages:

- May be used in small diameter wells.
- Sample does not contact the pump or other sampling equipment other than tubing prior to collection.
- Ease of operation.
- Speed of operation is variably controlled.
- No decontamination of pump necessary (however, all tubing must be changed between wells).
- Can be used for sampling inorganic contaminants.
- Purge and sample with same pump and tubing.

Disadvantages:

- Depth limitation of ~25 feet.
- Potential for loss of volatile fraction due to negative pressure gradient.
- Unless using an in-line flow through cell for field readings, may not provide reliable or reproducible data for air sensitive parameters e.g. dissolved oxygen, pH, carbon dioxide or iron and its associated forms.

3. Bladder Pump

An example of positive-displacement, the bladder pump (Figure 9) consists of a Teflon® or stainless steel housing that encloses a flexible Teflon® or HDPE membrane. Below the bladder, a screen may be attached to filter any material that may clog check valves located above and below the bladder. The pumping action begins with water entering the membrane through the lower check valve and, once filled, compressed gas is injected into the cavity between the housing and bladder. Utilizing positive-displacement, water is forced (squeezed) through the upper check valve and into the sample discharge line. The upper-check valve prevents back flow into the bladder. All movement of gas and sample is managed through a series of regulators housed in a control mechanism at the surface. The source of gas for the bladder is either bottled (typically nitrogen, carbon dioxide, or ultra zero air) or via an on-site oil-less air compressor. Flow rates can be reduced to levels much like the variable speed centrifugal submersible pump without fear of motor stall.

Figure 9. Example of a Teflon® constructed bladder pump, complete (top) and exploded version illustrating internal Teflon® bladder (Photograph by J. Schoenleber)

Field cleaning of bladder pumps is acceptable if the bladder pump housing is constructed of stainless steel or Teflon® with an internal disposable bladder.

Procedures for Use:

- Check all fittings for tightness.
- Lower decontaminated pump and dedicated tubing into the well below the water table.
- Connect compressor to power source ensuring the power source is downwind to prevent fumes from entering sampling area. If compressor is not used, connect to external air source.
- Engage air source (compressor or external) via control box. Full water flow will begin after five to fifteen pumping cycles. After stabilization of well water has been observed and recorded, sampling may begin.
- Adjust the refill and discharge cycles in accordance with manufacturer's instructions to optimize pumping efficiency. Reduce the flow rate, by adjusting the throttle control, to 100-150 ml/min or less while sampling volatile and semi-volatile organics.
- Collect sample directly from discharge line into laboratory cleaned sample bottles after well has stabilized and follow procedures for transport.

Advantages:

- Positive-displacement.
- Acceptable for well evacuation and sample collection for all parameters.
- Operational variables are easily controlled.
- Minimal disturbance of sample.
- In-line filtration possible.
- Available in a variety of diameters.
- No variances from the Technical Requirements for Site Remediation necessary.
- Sample depth up to 1,000 feet

Disadvantages:

- Large gas volumes may be needed, especially for deep installations.

- Only pumps with disposable bladders may be field cleaned for portable use when approved decontamination methods are employed.
- Sample flow rate of a typical bladder pump is not sufficient for purging some larger diameter wells.
- The check ball design of bladder pumps may make it an unacceptable method for sampling wells that contain excessive amounts of sediment (check balls may not seal properly if dirty).
- At high pumping rates, use of the bladder pump may cause disturbance of the water column.

4. Variable Speed Submersible Centrifugal Pump

Improvements in the design of submersible centrifugal pumps over the last decade have resulted in pumps significantly reduced in overall size with variable speed discharge control. These two key features, coupled with stainless steel and Teflon® construction have enhanced the desirability of this pump for application of low-flow purging and sample collection. Some examples include:

- Proactive Environmental Products®
- QED®
- Grundfos®

The variable speed feature is one of the key design items, which allows for application of low-flow purging and sample collection.

When using variable speed submersible pumps to collect the equipment blank, one must follow the same general rules for all ground water sampling equipment. This includes the requirement that all sampling equipment that comes in contact with the sample must also come into contact with the equipment blank water.

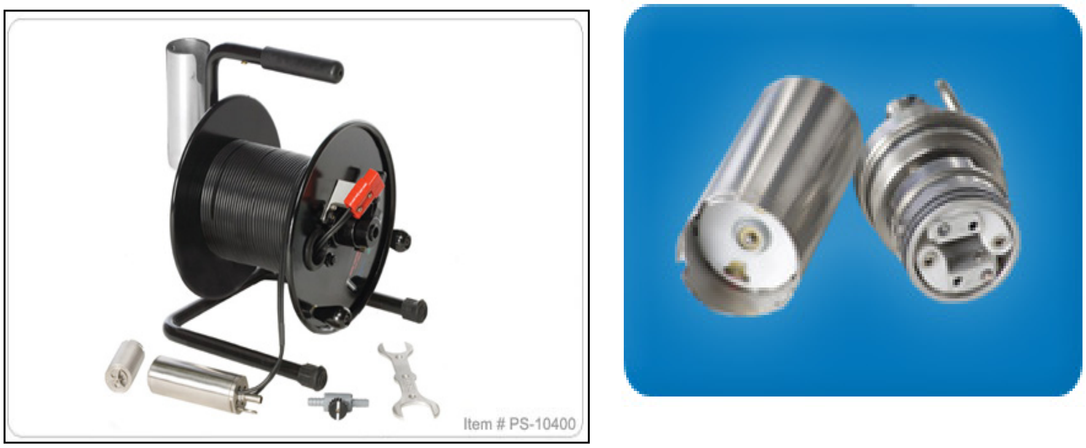

Figure 10. Proactive SS Monsoon® Pump. Example with disassembled pump (right)

Figure 11. Dissassembled Grundfos® Pump being prepared for decontamination (Photograph by J. Schoenleber)

Procedures for Use: (depending on pump manufacturer and/or model)

- Decontaminate pump, electrical leader and all associated fittings.
- For low-flow purging and sampling, attach precut tubing whose length has been predetermined based upon well-specific pump intake depth.
- For volume-average sampling, set the pump either within three feet of the top of water column, or, immediately above the well screen depending on chosen method.
- Install pump slowly through water column wiping down tubing with DI saturated paper towel.
- If a portable gasoline generator is used, it should be placed downwind. Initiate purge based on procedure selected.
- After purging, collect sample as specified in approved sampling plan.

Advantages:

- Positive-pressure.
- Variable speed control at surface allows for fine tuning of flow rate.
- Stainless steel and Teflon® construction.
- Complete disassembly allows for access to all parts for thorough decontamination.
- Acceptable for low-flow purging and sampling.

Disadvantages: (depending on pump manufacturer and/or model)

- During low-flow purging and sampling temperature increases may be observed.
- At extremely low-flow rates, motor stall is possible. To re-establish flow, high pumping rate may be needed to restart.
- Should manufacturer's disassembly instructions for decontamination not be followed, cross contamination of well is possible.
- Low yielding wells can also test the limits of variable speed design.
- Decontamination issues.

5. Gear Pump

Positive-displacement pumps, e.g. Fultz Pumps, Inc, also have the capacity for variable speed control (Figure 12). The applications of this pump are similar to the variable speed submersible centrifugal pump. Choose a pump with stainless steel housing and fluorocarbon polymer rotors or gears (Figure 13). Internal parts (gears) may not be readily accessible on-site, therefore careful attention must be made when cleaning. This must be considered when choosing to use this pump for a portable application. Pumps may be designed with the power supply molded into the sample tubing. This makes custom length of tubing based on individual well requirements impractical during a portable application. Single molded power supply and sample tubing is also difficult to decontaminate when using this pump on a portable basis. Instead, pumps whose power supply and pump discharge lines are separate are also available. This pump may be best applied when used in a dedicated system.

Figure 12. Fultz Pump. Illustration published with permission of Fultz Pumps, Inc.

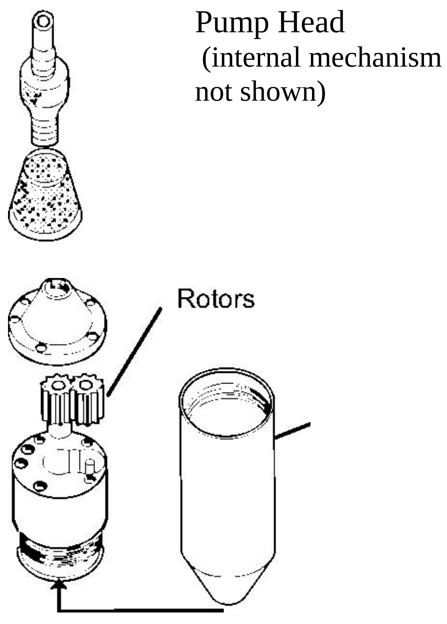

Figure 13. Gear Pump. Illustration published with permission of Fultz Pumps, Inc.

Procedures for Use:

- Decontaminate pump, electrical leader and all associated fittings.
- For low-flow purging and sampling, attach precut tubing whose length has been predetermined based upon well-specific targeted zone of influence information.

- For volume average sampling, set the pump either within three feet of the top of water column, or, immediately above the well screen depending on chosen method.
- Install pump slowly through water column wiping down tubing with DI saturated paper towel.
- Initiate purge based on procedure selected.
- At end of purge, collect sample as specified in approved sampling plan.

Advantages:

- Positive-displacement.
- Light weight.
- Good variable speed control, especially at low rates.
- Acceptable for low-flow purging and sampling.

Disadvantages:

- For portable sampling, many are designed with power supply molded into tubing, which is difficult to decontaminate.
- Turbid purge water wears on fluorocarbon gears and may clog the pump.
- New rotors require wear-in time before the pump can be put back into service.
- Submersible motor lead connection exists with portable pump applications that may be susceptible to degradation and loss of power connection to pump.

6. Passive Diffusion Bag Samplers (PDBs)

When confronted with sampling a monitoring well that displays little or virtually no recharge capability during well evacuation (where historic data indicate drawdown exceeds 3 tenths of a foot while purging at flow rates that are equal to or below 100 ml per minute), the option to use this no-purge sampling technique may be justified. More appropriately, there may be instances where long term monitoring during the operation and maintenance phase of remediation justifies their use.

PDB samplers cannot be used for all contaminants. PDB samplers are applicable to a select list of volatile organic compounds (VOCs). For a list of applicable VOC compounds refer to the following websites http://www.clu-in.org/characterization/technologies/passdiff.cfm or http://www.itrcweb.org/guidancedocument.asp?TID=12.

Metals and other organics will not diffuse through the membrane. Additionally, PDBs should not be used for semi-volatile contaminants and petroleum hydrocarbons (GRO, DRO, RRO). Due to the limited number of contaminants PDB samplers are capable of detecting, these devices are not recommended for initial investigations where a more complete understanding of the contaminants of concern remains to be determined. PDBs may be applicable to sites where adequate characterization has determined that applicable VOCs are the only groundwater contaminants of concern.

In addition, samplers should be cautious when using PDB samplers in wells where the vertical distribution of contaminants has not been determined. Multiple PDB samplers are recommended in wells when the well screen or saturated portion of the borehole is greater than 5 feet, following the general recommendation that a single PDB should not represent more than 5 feet of water column. In an uncontaminated sentinel well, contaminants might enter the well in a stratified manner that could elude a single PDB. Therefore, the conservative approach for a sentinel well would be to deploy multiple bags as appropriate (ITRC 2004).

PDB samplers are made of low-density polyethylene plastic tubing (typically 4 mil), filled with laboratory grade (ASTM Type II) deionized water and sealed at both ends (Figure 14). The samplers are typically about 18 to 24 inches in length and can hold from 220 ml to 350 ml of water. Vendors can usually modify the length and diameter of a sampler to meet specific sampling requirements.

Teflon® coated stainless-steel wire is preferable for deploying the samplers in the well. Teflon® coated stainless-steel wire can also be reused after proper decontamination. As an alternative to Teflon® coated stainless steel wire, synthetic rope may be used as the deployment line for single-use applications if it’s low stretch, non-buoyant, and sufficiently strong to support the weight of the sampler(s). An example of acceptable rope would be uncolored (white) 90-pound, 3/16-inch-braided polyester. Extreme care must be exercised when using rope as a deployment line in deep wells due to the potential for the deployment line to stretch, which may result in the improper location of the PDB sampler within the well screen or open hole of the well. Deployment lines consisting of material other than Teflon® coated stainless steel wire may not be used in another well and must be properly disposed of after a one-time use.

The sampler is positioned at the desired depth interval in the well by attachment to a weighted deployment line and left to equilibrate with the water in the well. Many VOCs equilibrate within 48 to 72 hours; however, the minimum recommended equilibration period for PDBs is 2 weeks. This allows the formation water and well water to re-stabilize after deployment of the samplers, and to allow diffusion between the stabilized well water and the PDB sampler to occur. In low-yielding formations additional time may be required for the well to re-stabilize.

If quarterly sampling is being conducted, it is acceptable to leave PDB samplers in the well for up to three months so that samplers can be retrieved and deployed for the next monitoring round during the same mobilization. Unfortunately, data are currently unavailable to support longer deployment periods (i.e., semi-annual or annual). Leaving samplers in a well for longer than 3 months is not recommended. Additionally, PDBs are susceptible to damage by freezing and therefore, are not recommended if freezing conditions are anticipated to be present in the well. If future data become available which demonstrate longer deployment timeframes are appropriate, this condition will be modified.

Figure 14. Eon PDB Sampler with accessories (Photograph by J. Schoenleber)

Advantages:

- Purge water associated with conventional sampling reduced or eliminated.
- The devices are relatively inexpensive.
- Simple deployment and recovery reduces the cost and the potential for operator error.
- Monitoring well stability parameters are not required which reduces associated cost.
- PDB samplers are disposable.
- The stainless steel weights and Teflon® coated wire are the only pieces of equipment needing decontamination.
- Quick deployment and recovery is a benefit when sampling in high traffic areas.
- Multiple PDB samplers can be deployed along the screened interval or open borehole to detect the presence of VOC contaminant stratification.
- Has been shown to deliver accurate dissolved oxygen measurement.
- Alkalinity conditions in the well are not transferred across the membrane.
- Effervescence associated with HCl preservation is avoided.

Disadvantages:

- PDB samplers provide a time-weighted VOC concentration that is based on the equilibration time of the particular compounds; usually that period is 2 to 3 days. This is a limitation if sampling objectives are to identify contaminant concentrations at an exact moment the sample is collected. The time-weighted nature of the PDBS may be a factor in comparison with low-flow sampling if concentrations have been shown to be highly variable over time.
- PDB samplers are limited to VOC contaminants.
- PDB samplers work best when there is unrestricted horizontal movement of ground water through the well-screen or open hole. If filter packs or screens are less permeable than the surrounding formation, ground water flow lines may not

enter the well and PDB samples may not be able to provide a representative sample.

- As with low-flow samples, PDB samplers represent a specific depth interval within the water column.
- Contamination migrating above or below the targeted depth interval will not be detected.
- Difficult to measure water quality parameters.
- In some cases, heavy iron or biofouling of the bag may inhibit sampler performance.
- PDBs may burst in freezing conditions.

7. Direct Push Technology

Use of direct push technology to obtain ground water samples via temporary well points has gained wide acceptance. While various manufacturers make and distribute their own ground water equipment and accessories, the same general principles still apply when collecting ground water samples. Direct push wells installed without proper filter packs and annular seals are not recommended for long-term monitoring (e.g. more than one sampling event), but may be appropriate for collecting grab samples during site characterization, as long as the well is properly developed prior to sampling. It is important to note that the resulting data may be restricted in use. Direct push wells installed with proper filter packs and annular seals may be approved by ADEC for long-term monitoring. As with any monitoring well, all direct push monitoring wells and well points will need to be decommissioned in accordance with the ADEC Monitoring Well Guidance.

Advantages:

- Relative ease of collecting minimally disturbed ground water samples at depth.
- Ability to collect hydrogeological data while installing monitoring well.

Disadvantages:

- Decontamination of reusable equipment is required between boreholes.
- For decommissioning, grouting starting from the bottom of the boring and completed at the surface is recommended.
- Depending on casing diameter, some groundwater sampling equipment may not be applicable.

General guidance on the construction of temporary wells installed via direct push technology can be referenced through ASTM D6001-96, *Direct Push Water Sampling for Geoenvironmental Investigations*, and via the following Internet links:

http://www.epa.gov/superfund/programs/dfa/dirtech.htm

http://epa.gov/swerust1/pubs/esa-ch5.pdf,

http://geoprobe.com,

http://www.ams-samplers.com/

8. HydraSleeve^{TM}

The HydraSleeve^{TM} groundwater sampler consists of three basic components: the sampling sleeve, a stainless steel weight, and a self-sealing valve. The sleeve comes in various volumes and sizes to account for different well diameters and sampling needs. The HydraSleeve^{TM} is typically used for no-purge sampling, but can be used for purged wells also.

Procedures for use:
- Attach the weight to the bottom of the flattened sleeve and attach a cord to the top.
- Lower the sleeve to the desired sampling interval.
- Pull sharply on the cord to initiate sample collection.
- Retrieve sampler, insert discharge straw and fill sample containers as needed.

Advantages:
- Disposable, simple to use and inexpensive.
- Effective in sampling low yield wells.
- Can sample discrete intervals.
- Sleeves can be deployed in-line to create a vertical contaminant profile.

Disadvantages:
- Larger sample volumes are difficult to retrieve.

Figure 15. 1.5-inch HydraSleeve^{TM} and stainless steel weight (1-liter capacity)

9. Snap Sampler^{TM}

The Snap Sampler^{TM} is designed to collect representative groundwater samples in-situ without purging. The sampler utilizes a double ended cap to close the bottle while it is submerged in the well, eliminating the need to transfer the sample to another container. Samplers are typically leased from the manufacturer or purchased and dedicated to a particular well.

Procedures for use:

- Snap Sampler ™ container is placed within the Snap Sampler ™ and the Snap Caps ™ are attached in the open position.
- Sampler is lowered into a well to the desired interval using the trigger tubing which contains the trigger line and is attached to a docking station at the wellhead.
- Pull trigger line to close sampler and retrieve.
- If necessary, preservative is added to a specialized cavity in one of the Snap Caps ™.

Advantages:

- Capable of sampling discrete intervals.
- Minimal disturbance if allowed to equilibrate prior to sample collection.
- Can be deployed in-line to create a vertical contaminant profile.

Disadvantages:

- Limited sample volume depending on type and well diameter.
- Can only be used in wells that are 2 inches in diameter or greater.
- Fixed trigger length generally means each trigger line is dedicated to a specific well.
- Not all analytical laboratories are equipped to analyze Snap Sampler bottles.

Figure 16.
Snap Sampler ™ VOA vial

V. Air Sampling

A. Vapor Intrusion

Vapor intrusion is the migration of volatile chemicals from a subsurface vapor source into overlying buildings. See ADEC's *Draft Vapor Intrusion Guidance* at http://dec.alaska.gov/spar/csp/guidance/draft-vi-guidance.pdf for more specific guidance for evaluating and responding to a vapor intrusion exposure pathway at contaminated sites.

B. Outdoor Air

This section is under development.

C. Remediation Systems

This section is under development.

VI. Surface Water Sampling

This section is under development.

VII. Sediment Sampling

This section is under development.

VIII. Quality Control (QC) Measures

It is expected that all sampling and field screening activities discussed in this document are performed using standard industry methods and practices. In addition, all sampling and field screening methods are performed using tools and instruments that are either single use (disposable) or are free of contamination and will not contribute to false readings in the field or in the laboratory.

A. Field Documentation

Document all field readings, sample locations, and field observations in a field record or log book. Refer to ADEC's *Site Characterization Work Plan and Reporting Guidance for Investigation of Contaminated Sites* at http://www.dec.state.ak.us/spar/csp/guidance/site-characterization-wp&r.pdf for a list of specific field documentation requirements.

Correct erroneous field record or log book entries with a single line through the error. Do not erase incorrect information. Date and initial revised entries. Include complete copies of all field notes and log sheets in reports submitted to the ADEC.

B. Instrument Calibration

All field instruments must be calibrated prior to each project according to manufacturer's specifications and instrument calibration must be checked and documented onsite on a daily basis. Certain field screening parameters may require more frequent calibrations depending on site conditions, such as temperature, barometric pressure, etc. Retain a reference copy of manufacturer's operating instructions in the field. All instrument users must be trained in routine maintenance and operation. Calibration standard(s), dates, times and all calibration results must be recorded in the field record or log book.

C. Sample Containers and General Sample Collection QC

Obtain containers from the lab with the appropriate preservative. Sample containers must conform to the specifications in the required laboratory procedure.

Sample container and preservative shipments must comply with Department of Transportation (DOT) and/or International Air Transport Association (IATA) regulations.

Inspect sample containers before transit to the site to ensure that they are undamaged and are tightly sealed. Sample containers should be packaged so that they are secured to prevent damage or tampering in transit to the site. Re-inspect sample containers and lids at the job site. Sample containers that have lost lids or that have been damaged may not be used for sample containment.

Use indelible, waterproof ink to label containers. Document information entered onto the label or container in the field record or log book.

Ensure that sample container threads and rims are clean before tightening lids. Do not tape lids to jars when collecting samples. Change disposable gloves after each sampling location.

Include the following information on the containers or labels:

- Project name,
- Unique identifying alphanumeric assigned to the sample for laboratory analysis,
- Date and time of collection,
- Sampler's name or initials,
- Requested laboratory analysis, and
- Preservative, as applicable.

D. Quality Control Field Sample Collection

A sampling approach that is properly designed and implemented will allow the sampling objectives to be met, avoid confusion in the field, and contribute to the generation of high quality data necessary to support defensible decision-making. Measures of quality include the appropriateness and accuracy of the sample collection; adherence to sample handling protocols; the quality and appropriateness of the laboratory analysis; and the representativeness of the data with respect to the study objectives.

Collect Quality Control samples per the requirements in Table 3.

Table 3 - Minimum Quality Control Requirements

Minimum Field QC Samples	**Applicability**	**Allowable Tolerance**
Field Duplicate (Minimum of one per every 10 field samples for each matrix sampled, for each target analyte, minimum of one)	All soil and water samples	Relative percent differences (RPD) less than: 30% water, 50% soil
Decontamination or Equipment Blank (One per set of 20 similar samples, minimum of one)	Per project specifications	Less than the practical quantitation limit
Trip Blank - Water One trip blank per analysis and cooler	All water samples being analyzed for GRO, BTEX, or VOCs.	Less than the practical quantitation limit
Methanol Trip Blank - Soil One trip blank per set of 20; a minimum of one per analysis and cooler	All soil samples being analyzed for GRO, BTEX or VOCs using AK101or 5035A/8260B field methanol preservation	Less than the practical quantitation limit
Field Blank (One per set of 20, minimum of one)	Per project specifications. Used for highly contaminated sites with volatile organic contaminants	Less than the practical quantitation limit

1. Field Duplicate Requirements

A minimum of one (1) field duplicate must be collected for every 10 field samples for each matrix sampled and for each target analyte unless otherwise approved by ADEC. Field duplicates should be collected from locations of known or suspected contamination, and duplicate soil and water samples must be collected in the same manner and at the same time and location as the primary sample.

Field duplicates must be:

- submitted as blind samples to the approved laboratory for analysis,
- given unique sample numbers (or names) and sample collection time, and
- adequately documented in the field record or log book.

Field duplicate results must be used to calculate and report a precision value for field sampling quality control according to the following equation:

RPD (%) = Absolute value of: $\frac{(R1-R2)}{((R1+R2)/2)}$ x 100

Where: R_1 = Sample Concentration
R_2 = Field Duplicate Concentration

E. Equipment Decontamination

Depending on the contaminant, wash water and rinsate solutions may need to be collected in appropriate containers and disposed of properly in accordance with federal, state, and local regulations.

Decontaminate all reusable equipment such as steel tapes, well sounders, transducers, and water quality probes after each sampling point using a stiff brush and a solution of water and laboratory-grade detergent. An appropriate solvent may be used to remove heavy contaminant residues from the sampling tools. Rinse tools twice in clean water and again with distilled or deionized water.

Properly collect, store, and dispose of solvent waste and wash water in accordance with hazardous waste regulations, if applicable.

Clean drill auger sections, split spoons, and drive hammers that come in contact with bore holes before use and between borings. Scrub tools with a stiff brush in a solution of water and laboratory-grade detergent. High pressure water or steam may also be used.

Visibly contaminated decontamination water for sites with petroleum hydrocarbons may be containerized for off-site shipment or with ADEC approval filtered on-site and re-applied directly to the ground surface within site boundaries a minimum of 100 feet away from any drinking water wells and/or surface water bodies. If not visibly contaminated, decontamination water may be re-applied directly to the ground surface within site boundaries a minimum of 100 feet away from any drinking water wells and/or surface water bodies.

Refer to ASTM D5088 - Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites.

F. Chain-of-Custody and Sample Handling and Shipment

The purpose of the chain-of-custody is to demonstrate accountability and document sample integrity from the time of sample collection until sample analysis. .

ADEC requires the following elements of chain-of-custody for sample collection:

- Sample labeling,
- Laboratory receipt forms,
- Field custody form (chain-of-custody form), and
- Inter-laboratory transfer documentation, if applicable.

Maintain samples according to the holding times and temperatures in Appendix C and Appendix D.

The chain-of-custody form must include information on analyses specifying the method to be performed.

Do not place samples into the shipping container unless they are recorded on the chain-of-custody form.

Obtain a copy of the shipping manifest if using a lab courier or commercial carrier for sample shipment.

Sample shipments must comply with DOT and/or IATA regulations.

Refer to ASTM D4840 - Guide for Sample Chain-of-Custody Procedures for additional information.

Refer to ASTM D6911 - Standard Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis for additional information.

Appendix A - References

ADEC, 2002, Underground Storage Tank Manual

ADEC, 2005, Conceptual Site Model Policy Guidance

ADEC, 2006, Biogenic Interference and Silica Gel Cleanup Technical Memorandum

ADEC, 2008, Cumulative Risk Guidance

ADEC, 2008, Guidelines for Total Organic Carbon (TOC) Sample Collection and Data Reduction for Method Three and Method Four

ADEC, 2009, Monitoring Well Guidance

ADEC, 2009, Draft Guidance on Multi Increment Soil Sampling

ADEC, 2009, Draft Vapor Intrusion Guidance

ADEC, 2009, Arsenic in Soil

ADEC, 2009, Draft Guidance on Multi Increment Soil Sampling

ADEC, 2009, Ecoscoping Guidance

ADEC, 2009, Risk Assessment Procedures Manual

ADEC, 2009, Site Characterization Work Plan and Reporting Guidance for Investigation of Contaminated Sites (2009)

ADEC Amended April 2009, Drinking Water Regulations, 18 AAC 80.

Alaska State Regulation 18 AAC 75

Alaska State Regulation 18 ACC 78

ASTM D1586-08, ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D4840-99 Standard Guide for Sample Chain-of-Custody Procedures

ASTM D5088-02(2008) Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites.

ASTM D6001-96, Direct Push Water Sampling for Geoenvironmental Investigations

ASTM D6418 – 09 Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis

ASTM D6911-03 Standard Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis

Alabama Department of Environmental Management, Land Division
http://www.adem.state.al.us/LandDivision/guidance.htm

General Guidance for Selecting Petroleum Hydrocarbon Field Screening Methods, IT Corporation and U.S. Army Cold Regions Research and Engineering Laboratory, June 1999.

Indiana Department of Environmental Management, Risk Integrated System of Closure, User's Guide, Technical Guide
http://www.in.gov/idem/4153.htm

New Jersey Department of Environmental Protection, Site Remediation Program, Field Sampling Procedures Manual, August 2005.
http://www.state.nj.us/dep/srp/guidance/fspm/

Nielson Environmental Field School Inc. The Environmental Sampling Field Course Training Manual (Developed for the AK Dept. of Environmental Conservation, October 2008).
Wisconsin Department of Natural Resources, Bureau of Drinking Water and Groundwater, September 1996
http://dnr.wi.gov/org/water/dwg/

USEPA, 1996, Low Stress (low flow) Purging and Sampling Procedures for the Collection of Ground Water Samples from Monitoring Wells

USEPA, 2002, Guidance on Choosing a Sampling Design for Environmental Data Collection

USEPA, 2002, Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites

USEPA, 1994, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)

Appendix B - Initial Comparison For Selecting The Appropriate Field Screening Method

Field Screening Method Categories	Principle Used To Detect & Measure Petroleum Hydrocarbons	Detectable Target Analytes	Effects Caused by Weathered Petroleum Hydrocarbons	Data Quality Objectives	Applicable Concentration Ranges
Colorimetric Wet Chemistry	Colorimetric reagents mix with petroleum hydrocarbons providing a visual response	Petroleum hydrocarbons	Bias is minimal	Qualitative	Yes (petroleum hydrocarbon present) No (petroleum hydrocarbon not present) at a concentration >300 ppm
Headspace Organic Vapor Monitoring	Vapor phase volatile hydrocarbons are ionized or passed through colorimetric reagents for detection	Volatile organic compounds	Low bias due to loss of volatile organic compounds	Semi-quantitative	1.0 to >10,000 ppm
Immunoassay	Some kits are selective for BTEX and aromatic compounds, while other kits are selective for aliphatic compounds	Gasoline, Diesel Fuel, and Heavier Fuels OR Oils	Low bias using test Methods that quantify using BTEX and other aromatic compounds	Quantitative or Semi-quantitative	100 to >25,000 ppm Semi-quantitative methods Provide a greater than/less Than to two calibration point concentrations
Infrared Spectrophotometry	Method measures infrared adsorption of C-H bonds present in all organic compounds	Gasoline, Diesel Fuel, and Heavier Fuels or Oils	No bias	Quantitative	100 to >25,000 ppm
Qualitative Physical Screening Methods	Physical properties are use do determine if petroleum hydrocarbons are present	Petroleum hydrocarbons	Bias is minimal	Qualitative	Yes (petroleum hydrocarbon present) No (petroleum hydrocarbon not present)

Appendix C - Technical And Logistical Screening Method Comparison

Field Screening Method Categories	Factors Affecting Accuracy	Factors Affecting Precision	Training and Required Expertise	Interferences		Waste Byproducts	Logistic Considerations	Comments
				Cause	Effect			
Colorimetric Wet Chemistry	Weathered petroleum mixtures	Soil heterogeneity	Qualified personnel necessary	Moisture	Low bias from dilution	Petroleum Hydrocarbons Colorimetric reagent mixture	No significant considerations	Test kit literature should be reviewed during the selection process
Headspace Organic Vapor Monitoring	Moisture, weathered petroleum mixtures, operator error	Soil heterogeneity and operator error	Qualified personnel necessary	Moisture and non-target analytes that respond to ionization detector instruments	Erroneous readings	Empty gas cylinders used to store calibration gases	Shipping of USDOT hazardous substances (isobutylene, hydrogen, and methane)	Most ionization detectors are limited by altitudes greater than 4,000 feet and temperatures less than 40 F
Immunoassay	Moisture, weathered petroleum mixtures, multiple petroleum mixtures, operator error	Soil heterogeneity and operator error	Training of qualified personnel is recommended by test kit manufacturers	Moisture and biological organic matter	Low bias High bias	Methanol and Enzymatic reagent wastes	Shipping of USDOT hazardous substances (methanol). Some methods require low temperature preservation	Manufacturer literature should be consulted during the field screening method selection process
Infrared Spectrophotometry	Operator error	Soil heterogeneity and operator error	Trained chemist support necessary	Moisture Biological organic matter	No bias Limited bias with high concentrations	Methanol; hexane; possibly chlorinated solvent wastes	Shipping of USDOT hazardous substances (methanol, hexane, or other chlorinated solvents)	Biological organics and moisture removed during sample extraction process. Excessive quantities of the biological organics may overwhelm the silica gel.
Qualitative Physical Screening Methods	Soil adsorption and weathering of petroleum product	Soil heterogeneity	Qualified personnel necessary	Natural organic materials	Limits visibility	Petroleum; soil and water mixture	No significant considerations	Warm water sheen test and direct visual observation

Appendix D – Sample Collection Reference Guide – Soil, Sediment, Sludge, Fill Material

Parameter	Analytical Method1	Container Description (Minimum) [Clear glass may be substituted for amber if samples are protected from exposure to light]	Preservation/ Holding Time
Gasoline range organics**	AK101*	4 oz. amber glass, TLS	Methanol preservative, $4^{o} \pm 2^{o}$C / 28 days
Diesel range organics	AK102*	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Residual range organics	AK103*	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)**	8021B or 8260C	4 oz. amber glass, TLS	Methanol preservative, $4^{o} \pm 2^{o}$C / 14 days
Volatile Organic Compounds (VOCs)[4]	8260C or 8021B	4 oz. amber glass, TLS	Methanol preservative, $4^{o} \pm 2^{o}$C / 14 days
Semi Volatile Organic Compounds (SVOC)	8270D	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Polynuclear Aromatic Hydrocarbons (PAH)[2]	8270D or 8310	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Pesticides	8081B	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Herbicides	8151A	4 oz. amber glass, TLC	$4^{o} \pm 2^{o}$C / 14 days to extraction, 40 days to analysis of extract
Polychlorinated biphenyls (PCBs)	8082A[5]	4 oz amber glass, TLC	$4^{o} \pm 2^{o}$C /None, 40 days to analysis of extract (recommended)
Metals [†] except mercury	6010C, 6020A,	100mL Wide mouth HDPE or amber glass jar[3], TLC	None / 6 months
Mercury	7471B	100mL Wide mouth HDPE or amber glass jar[3], TLC	$4^{o} \pm 2^{o}$C / 28 days

Notes:

Several of the 7000 series methods have been deleted from SW846 but these methods may still be approved by ADEC project managers. Check the laboratory's approval status.

[1] Unless otherwise noted, all preparation and analytical methods refer to most current of EPA's Test Methods for the Evaluating Solid Waste, Physical/Chemical Methods, SW-846, adopted by reference in 18 AAC 78.090(i).

[2] Naphthalene can be analyzed by 8021B or 8260C, if naphthalene is the only PAH contaminant of concern; however methods 8270D or 8310 are preferred.

[3] HDPE, High Density Polyethylene or amber glass sample collection bottles, certified clean for trace metals analysis.

[4] May be analyzed out of AK101 methanol preserved sample, if not, then sample must be preserved with methanol in the field. Alternate volatile collection methods per SW-846 method 5035A <u>must</u> be approved on a site-specific basis by the CS program <u>prior to sample collection.</u>

[5] PCBs must be prepared using extraction method 3540C or 3550C

† Analytical method 6010C may used be for high contaminant level screening. These results can be used for closure only if laboratory reporting limits meet the site-specific cleanup levels. Analytical method 6020A is acceptable for closure.

* ADEC Analytical Methods AK101, AK102, and AK103 are included in Appendix D of the UST Procedures Manual.

** The AK101 method can be extended for specific determination of volatile aromatics (BTEX) as specified in EPA Method 8021B or 8260B for solids utilizing methanol preservation option only. All AK101 and volatile aromatic samples must be preserved with methanol.

Appendix E – Sample Collection Reference Guide – Groundwater, Surface Water, Marine Water, Drinking Water[7], Wastewater

Parameter	Analytical Method[1,7]	Container Description	Preservation/ Holding Time
Gasoline range organics	AK101*	Duplicate or Triplicate 40 mL VOA, TLS	HCL to pH less than 2, 4° ± 2°C /14 days
Diesel range organics	AK102*	min. 100 ml[2] - 1 L amber glass, TLC	HCL to pH less than 2, 4° ± 2°C /14 days to extraction, 40 days to analysis of extract
Residual range organics	AK103*	min. 100 ml[2] - 1 L amber glass, TLC	HCL to pH less than 2, 4° ± 2°C / 14 days to extraction, 40 days to analysis of extract
Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)	8021B or 8260C	Duplicate or Triplicate 40 mL VOA, TLS	HCL to pH less than 2, 4° ± 2°C /14 days
Volatile Organic Compounds (VOCs)	8021B or 8260C	Duplicate or Triplicate 40 mL VOA, TLS	HCL to pH less than 2, 4° ± 2°C / 14 days
Semi Volatile Compounds (SVOC)	8270D	1 L amber glass, TLC	4° ± 2°C / 7 days to extraction, 40 days to analysis of extract
Polynuclear Aromatic Hydrocarbons (PAH)[5]	8270D or 8310	1 L amber glass, TLS	4° ± 2°C, 7 days to extraction, 40 days to analysis of extract
Pesticides	8081B	1 L amber glass, TLC	4° ± 2°C / 7 days to extraction, 40 days to analysis of extract
Herbicides	8151A	1 L amber glass, TLC	4° ± 2°C / 7 days to extraction, 40 days to analysis of extract
Polychlorinated biphenyls (PCBs)[6]	8082A	1 L amber glass, TLC	4° ± 2°C / None, 40 days to analysis of extract (recommended)
Metals † except mercury	6010C, 6020A,	min. 100 mL HDPE[4]	HNO_3 to pH less than 2 / 6 months max. total holding time
Mercury	7470B	min. 100 mL HDPE[4]	HNO_3 to pH less than 2 / 28 days max. total holding time

Notes:

Several of the 7000 series methods have been deleted from SW846 but these methods can be approved by ADEC project managers. Check laboratories approval status.

[1] Unless otherwise noted, all preparation and analytical methods refer to the most current of EPA's Test Methods for the Evaluating Solid Waste, Physical/Chemical Methods, SW-846, adopted by reference in 18 AAC 78.090(i).

[2] Minimum (100 ml) is listed for the modified "small volume" method. This requires a separate lab approval and is designated AK102-SV or AK103-SV. Verify the laboratory approval status for this method.

[3] Sample collection and laboratory analyses for water collected from drinking water sources must be done in accordance with 18 AAC 80 and appropriate drinking water methods.

[4] HDPE, High Density Polyethylene sample collection bottles, certified clean for trace metals analysis.

[5] Naphthalene can be analyzed by 8021B or 8260C, if naphthalene is the only PAH contaminant of concern; however, methods 8270D or 8310 are preferred.

[6] PCBs should be prepared using method 3510C or 3520C

[7] Drinking water samples must be analyzed by the appropriate drinking water analytical methods as follows:
Volatile Organic Compounds (including BTEX, 1,2-DCA, MTBE); EPA 524.2
Ethylene Dibromide (EDB): EPA 504.1
Semi volatile Organic Compounds (including PAHs): EPA 525.2
Polychlorinated Biphenyls (PCBs), Pesticides: EPA 508.1
Metals: EPA 200.8

* ADEC Analytical Methods AK101, AK102, and AK103 are included in Appendix D of the UST Procedures Manual.

† Analytical method 6010C may used be for high contaminant level screening. These results can be used for closure only if laboratory reporting limits meet the site-specific cleanup levels. Analytical method 6020A is acceptable for closure.

Legend: Appendix D and E:

PAH = acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, ideno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene
VOA = Volatile Organic Analysis
TLC = Teflon® lined screw caps
TLS = Teflon® lined septa sonically bonded to screw caps

Appendix F – Determination of Sampling and Lab Analysis for Petroleum in Soil and Groundwater:

Product Type	**GRO[1]**	**DRO**	**RRO**	**BTEX[1,2]**	**PAHs[3,4,5]**	**Other VOCs[1,2,3]**	**EDB[7]** **1,2-DCA**	**MTBE**	**Metals[8]**	**PCBs**
Test Methods[9]	*AK101*	*AK102*	*AK103*	*EPA 8021B* *EPA 8260C*	*EPA 8260C[3]* *EPA 8270D* *EPA 8310*	*EPA 8021B* *EPA 8260C*	*EPA 8260C[1,6]* *EPA 8011[6]* *EPA 504.1[6]*	*EPA 8260C*	*EPA 6010C* *EPA 6020A, or 7000 series*	*EPA 8082A*
Site COPCs	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Leaded Gasoline	required			required	naphthalene only required	may be required by PM	required	may be required by PM	lead only	
Aviation Gasoline	required			required	naphthalene only required	may be required by PM	required	may be required by PM	lead only	
Unleaded Gasoline	required			required	naphthalene only required	may be required by PM		may be required by PM		
JP-4, Kerosene, Jet B	required	required		required	required	may be required by PM				
Diesel #1 or Arctic Diesel	required	required		required	required	may be required by PM				
#2 Diesel	required	required		required	required	may be required by PM				
JP-5, JP-8, or Jet A	required	required		required	required	may be required by PM				
#3-#6 Fuel Oils or Bunker C	may be required by PM	required	required	required	required	may be required by PM				
Crude Oil	required	required	required	required	required	may be required by PM			required	
Waste oil, used oil, or unknowns	required	required	required	required	required	required to test for solvents	required	may be required by PM	required	required

Notes:

[1] AK101 (GRO), BTEX, and VOC soil samples must be preserved in methanol.

[2] EPA 8260C may be required to evaluate non-BTEX volatile petroleum hydrocarbons, such as 1,2,4- and 1,3,5-trimethylbenzene, butylbenzene(s), etc. for vapor intrusion or other applicable pathways to protect human health and the environment.

[3] Naphthalene can be analyzed by 8021B or 8260C, if naphthalene is the only PAH contaminant of concern; however, methods 8270D or 8310 are preferred.

[4] PAHs must include acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, flourene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.

[5] For each source area, PAH analysis must be performed on a sufficient percentage of the samples with the highest GRO, DRO and/or RRO concentrations to determine if PAHs are contaminants of concern. In general, 10% is recommended for site characterization. If PAH concentrations are less than applicable cleanup levels, further PAH analysis is generally not required. PAHs should be sampled in groundwater if soil samples concentrations are above applicable cleanup levels and groundwater sampling is required.

[6] EPA 8260C is required for the analysis of 1,2-Dichloroethane (1,2-DCA). EPA 8011 or EPA 504.1 should be used when evaluating ethylene dibromide (EDB). EDB soil samples should be field preserved in hexane. EPA 8260 will quantify EDB in ground water; however, the detection limits do not meet the Table C cleanup level of 0.00005 mg/L.

[7] For each source area, EDB analysis must be performed on a sufficient percentage of the samples with the highest GRO concentrations to determine if EDB is a contaminant of concern. In general, 10% is recommended for site characterization. If EDB concentrations are less than applicable cleanup levels, further EDB analysis is generally not required.

[8] Metals must include arsenic, barium, cadmium, chromium, lead, nickel, and vanadium, unless otherwise noted.

[9] Drinking water samples must be analyzed by the appropriate drinking water analytical methods as follows:
Volatile Organic Compounds (including BTEX, 1,2-DCA, MTBE); EPA 524.2
Ethylene Dibromide (EDB): EPA 504.1
Semi volatile Organic Compounds (including PAHs): EPA 525.2
Polychlorinated Biphenyls (PCBs): EPA 508.1
Metals: EPA 200.8