

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 *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.

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 DEC.

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 Department of Environmental Conservation (DEC) 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- *Draft Guidance on Multi Increment Soil Sampling* (2009)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 technical regulatory guidance documents available for reference include:

- Interstate Technology and Regulatory Council (ITRC) web site is at <http://www.itrcweb.org/>.
- Environmental Protection Agency (EPA) has developed quality assurance reference documents for public use at http://www.epa.gov/quality/qa_docs.html#g-4.
- ASTM International standards, listed in Appendix A, are tools for the successful implementation of the sampling work plan and collection of valid samples. ASTM documents are available for purchase at <http://www.astm.org/>.

The initial release of the *Field Sampling Guidance* focuses on soil and groundwater. Sediment, surface water, and air sampling protocols are under development. More specialized material may be added in the future as input from staff and the regulated community is received.

DEC 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.

Suggestions on how DEC can improve the *Field Sampling Guidance* may be sent to Denise Elston at denise.elston@alaska.gov.

Any 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 DEC.

The 2002 EPA document *Guidance 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 pertinent to a particular site or support the data use objectives.¹ Different approaches may be applicable to sites with multiple source areas or to account for contaminant type, fate and transport considerations, or other factors. 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 approaches. A general guideline for a rigorous systematic random sampling design is to collect a minimum of 20 -30 samples from each decision unit in order to adequately perform statistical analysis.

¹ Chapter 10 of the EPA document addresses composite sampling. Standard composite sampling does not meet current regulatory requirements and is not allowed in Alaska except in the case of waste characterization analysis for proper disposal.

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.

The work plan should describe sampling procedures in detail so the project objectives can be met and the work plan adequately evaluated by DEC. DEC 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 DEC'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 DEC guidance documents to be referenced during the work plan design phase are *DEC'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>.

Reference DEC's *Draft Guidance on Multi-Increment Soil Sampling* at http://www.dec.state.ak.us/spar/csp/guidance/multi_increment.pdf to determine if the incremental soil sampling approach (developed after the 2002 EPA guidance was published) may be appropriate to your situation.

The environmental professional should notify the DEC 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 DEC 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 DEC 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 DEC 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 DEC.

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

Surface soil 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 a reasonable 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 DEC's *Monitoring Well Guidance*, available for reference at http://www.dec.state.ak.us/spar/csp/guidance/mw_guidance.pdf

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 DEC 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 health hazard through all exposure pathways is not suspected.

Consider applicable ASTM standard soil sampling practices. A list of these standards is provided in Appendix A and specific standards are referenced throughout this guidance. Note that all standards currently available through ASTM may not be listed.

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

DEC 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 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. These tables are provided as a general guide to some of the available field screening methods. 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. These differences may be important to you when selecting a field screening technology for your site.

Table 1 – Field Screening Methods Guide¹

Type	Use	Target
Warm water sheen test, shovel sheen test	Soil/sediment	Hydrocarbons
Field test kits Hach ^{®2}	Soil /Water	Metals, PCB, TPH, Organics
siteLAB [®]	Soil/Water/ Sediment	PAH, DRO, GRO, TPH, PCB
Hanby [®]	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
¹ The Department 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 Hach test kits have received an EPA approved equivalency.		

Use Table 2A to determine the minimum number of screening and laboratory analytical samples to collect from excavated soils at petroleum contaminated sites. For non-petroleum contaminants, DEC may require a different frequency of screening samples depending on data use, contaminant type, site management decisions, remediation goals, and other site-specific factors.

Excavated soils to be taken to a DEC 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.

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.

Conduct field screening at above ground 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

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 department determines necessary	3 samples, plus one (1) sample for each additional 200 cubic yards, or portion thereof or as the department determines necessary.

Use Table 2B to determine the minimum number of in-situ screening and laboratory surface samples to collect at petroleum-contaminated sites. For non-petroleum contaminants, DEC may require additional laboratory samples depending on data use, contaminant type, intended site management decisions, remediation goals, and other site-specific factors.

Table 2B – Surface/ Excavation 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 department determines necessary	2 samples, plus one sample for each additional 250 square feet, or portion thereof; or as the department 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 (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.

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

PID and FID

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

Headspace organic vapor monitoring involves the measurement of petroleum vapors emitted from soil samples in a sealed container. The headspace of 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 a re-sealable polyethylene bags, a blank sample should be tested prior to field screening to

account for potential interferences caused by the bags themselves. Results should be presented in the report.

The following 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 it 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) with instruments calibrated for the temperature used.
- 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 DEC, 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. 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. Record results in the field notebook.

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.

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 hexane or other suitable chlorinated solvents. 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.

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 of 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.

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 in soil. 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

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.

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.

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.

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 dilute sample extracts causing low bias or interference with the operation of direct reading instruments. This 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. One example is moist, dense, plastic, clay that is not easily broken apart. In this example, the generation of headspace hydrocarbon vapors for monitoring using a direct reading instrument is limited. Organic peat lithologies will introduce significant quantities of natural organics causing high bias in immunoassay screening results. Gravel and rock lithologies 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.

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).

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 recommended to reduce the loss of volatiles during sampling, however, should be of adequate size to obtain the minimum required soil mass. Multiple core samples may be required to obtain the necessary soil mass.

Small-diameter core samplers used for VOC sample collection must be constructed of non-reactive materials that will minimize loss of VOCs in the sample.

2. Volatile Soil Sampling Procedure

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 jars 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 within approximately 10 seconds of placing the soil in the sample jar.
- Do not place tape, including evidence tape, on the sample container directly.
- Cool and retain samples at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
- 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)
 - Metals.

3. Stockpiles

Segregate excavated petroleum contaminated soils into different stockpiles based on field screening results.

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 DEC.

4. Excavations

Obtain soil samples from freshly uncovered soil. Remove four to six inches of soil immediately before sample collection. If the excavation has been open for longer than one hour, remove at least 12 inches of soil immediately before collection. Do not collect samples from disturbed soil that has fallen into the bottom of the excavation pit.

Collect samples from the center of the excavator bucket if the depth of the excavation is such that sampling cannot be safely conducted in the excavation pit. Remove at least four to six inches of soil immediately before 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 DEC 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.

Use a sampling tool to quickly collect the sample from the undisturbed portion with minimum disturbance.

6. Multi-Increment Soil Sampling

A multi-increment sampling approach must adhere to DEC'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 DEC'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 DEC'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>.

DEC 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 DEC's technical memorandum, *Biogenic*

D. Soil Sampling Equipment

1. Scoop/Trowel/Stainless Steel Spoon

A trowel, scoop (Figure 1), 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.



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

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, choose 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 approved when an undisturbed soil sample for volatile organics (VOA) 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



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

The soil-coring device (Figure 3) [Art's Manufacturing and Supply] 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.

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.
- Field screen using a PID or FID.
- Record visual observations 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 a length of 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. Note: 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.
- Withdraw the sampler and open by unscrewing drive shoe and head and splitting barrel. If split samples are desired, a decontaminated stainless steel knife should be utilized to divide the tube contents in half longitudinally.
- Collect volatile organic sample first. Transfer sample into laboratory cleaned sample bottles, or, into bowl for homogenization for non-volatile analysis using a stainless steel scoop or trowel and follow procedures for transport
- When split tube sampling is performed *in order to gain geologic* information, all work should be performed in accordance with ASTM # D 1586-84 (re-approved 1974).

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 # D 1586-83.

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 encountering rocky soils

6. Soil Core Samplers (VOCs)

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 standard 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, or 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. During sample collection, storage, and transfer, there is very limited exposure of the sample to the atmosphere. The sample is expelled directly from the coring body/storage chamber into the appropriate container for preservation without disrupting the integrity of the sample. 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 department 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**



En Core Sampler® with T Handle.

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 substrate being sampled, obtaining a full 5-gram sample in one movement may be difficult
- Cores consisting of small rocks, shale, cobble or similar material cannot be effectively sampled

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 system attractive. While various manufacturers make and distribute their own equipment and accessories, the same general principles still apply when collecting soil samples.

After a soil core has been acquired, select an increment of soil for volatile organic laboratory analysis based on field screening (direct reading PID/FID) measurements of an exposed core using criteria relative to the instrument's initial background readings. If a boring is continuously cored to 20 feet below grade where ground water is first encountered, then 4 to 5 individual 48" - 60" soil core segments will have to be opened and screened before determination as to which increment is to be selected for sampling and analysis. Special attention must be paid to labeling and storage of individual core samples when continuous soil samples are collected from a single boring. In many instances soil cores can be produced faster than they can be opened, logged, screened and sampled by a technician. In those instances when a backlog of cores is being generated, care must be made to protect the cores from direct sunlight, excessive ambient temperatures and rain. These conditions may have an adverse effect on highly sensitive volatile organics within the core or the instruments used for screening. Always keep the cores labeled so that the up/down orientation is not lost. Proceeded carefully, but quickly when field screening. If necessary, log soils for lithology information *after* sample collection.

Another option is to select an increment from every individual core segment, collect a sample, and only submit the required samples to the laboratory. This option can be more costly as several En Core[®] samplers will have to be discarded at the end of the each boring. Sampling every individual core first, prior to determining which increments to prepare for laboratory analysis, will also require additional labor. This particular option, to collect a representative incremental sample from every individual segment of a continuous core with its associated cost, makes the first option to carefully protect and manage the cores to control the loss of volatile organics even more critical.

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

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 construction information refer to DEC's *Monitoring Well Guidance* at http://www.dec.state.ak.us/spar/csp/guidance/mw_guidance.pdf.

The groundwater sampling methodology must be stated in the work plan, support the intended data use and site decision, and be approved by DEC. 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, absorb, desorb, or leach contaminants of concern and must be resistant to chemical and biological degradation. Peristaltic pumps are not the preferred method for the collection of volatile, semi-volatile, or other air sensitive parameters.

Unless otherwise approved by DEC, wait at least forty eight hours after well development before sampling a newly constructed well.

Purge monitoring wells by removing three casing volumes of water prior to sampling, unless otherwise approved by DEC. A well is considered stable after the purging if three successive readings are within ± 0.1 for pH, $\pm 3\%$ for conductivity, ± 10 mv for redox potential, and $\pm 10\%$ for turbidity and dissolved oxygen (DO). A minimum of three 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 purged dry, do not collect a sample until it has recharged to approximately 80% of its pre-purge volume.

Groundwater samples must be collected as close as possible to the soil/groundwater interface (i.e. water table). If further vertical delineation of contaminant concentration(s) is necessary, groundwater samples should be collected at the interval(s) within the water column 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).

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

Monitoring well purge water should be filtered on-site or containerized if visibly contaminated. If 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 DEC 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).

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

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 department.

- 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 a paste type of detector with ingredients that will not lead to cross-contamination.
- Use an electronic device designed to detect non-aqueous liquids and to measure the thickness of the non-aqueous layer.

Sample the least likely contaminated wells 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);
- 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. Samples obtained utilizing this procedure are suitable for the analysis of

groundwater contaminants (volatile and semi volatile organics, pesticides, PCBs, metals and other inorganics) and naturally occurring compounds.

The EPA and ASTM International have developed or sponsored the employment of acceptable no-purge sampling techniques. Refer to the ASTM web site at <http://www.astm.org/> or EPA's Office of Underground Storage Tanks at <http://www.epa.gov/swrust1/> for documents pertinent to groundwater monitoring, including no purge and low flow techniques.

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 PTFE 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 allows them to be utilized for a one-time use per well per sampling episode.

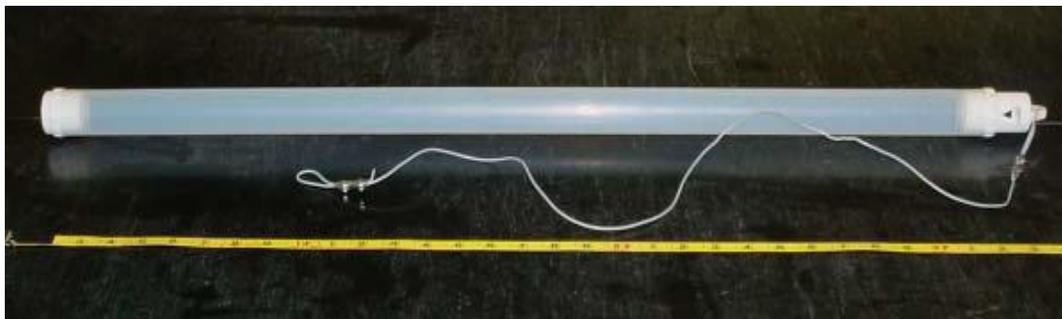


Figure 6. Bottom fill bailer with Teflon® coated stainless leader (Photograph by J. Schoenleber)

The leader or bailer line that comes in contact with the water should be constructed of PTFE coated stainless steel. Above the leader, dedicated polyethylene cord is acceptable, if it does not contact the water. The bailer, and any other equipment entering the well, must be 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's always a 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 available in Teflon® and polyethylene construction. Teflon® disposable bailers can be used for any analysis; however, polyethylene disposable bailers can only be used for metals analysis. 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).

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.
- Re-measure the water level after purging to document draw down.
- Collect an equipment blank unless using disposable field equipment.
- 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 constructed of PTFE coated stainless steel. Above the leader, dedicated polyethylene cord is acceptable if it does not contact the water.
- 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 utilized for each well, therefore eliminating cross contamination
- Available in PTFE 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
- Field cleaning not acceptable
- May not be used for well purging
- 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. 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

A peristaltic pump (Figure 8) is a self-priming suction lift (negative air pressure) pump utilized at the ground surface, which consists of a rotor with ball bearing rollers. One end of dedicated tubing is inserted into the well. 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[®]-lined polyethylene tubing is recommended for sampling. Medical grade silastic tubing is recommended for tubing in contact with the rotors. Based upon the required analysis and sampling objectives other materials are acceptable, but must first be approved on a case by case basis.



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

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 must 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 (2")
- 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
- Commercially available
- 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 when analysis is limited to inorganics

Disadvantages:

- Depth limitation of 25 feet
- Potential for loss of volatile fraction due to negative pressure gradient
- Cannot provide reliable or reproducible data for air sensitive parameters e.g. dissolved oxygen, pH, carbon dioxide or iron and its associated forms
- Not recommended for a pump in a low-flow purging and sampling scenario

3. Bladder Pump

An example of positive-displacement, the bladder pump (Figure 9) consists of a PTFE (e.g. Teflon®) or stainless steel housing that encloses a flexible Teflon® 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 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)

Bladder pumps must be laboratory cleaned and dedicated to each well. This means that bladder pumps are permanently installed for long-term monitoring as long as the bladder is made of material not affected by long-term exposure to contaminants.

Field cleaning of bladder pumps is acceptable if the bladder pump housing is constructed of stainless steel 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 to optimize pumping efficiency. This can be performed by the following process:
 - Adjust the refill and discharge cycles to 10-15 seconds each. Measure the water volume discharged in a single cycle.
 - Shorten the discharge cycle time until the end of the discharge cycle begins to coincide with the end of water flow from the pump outlet.
 - Shorten refill cycle period until the water volume from the discharge cycle decreases 10-25% from the maximum value measured in the first step.
 - 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
- Simple design and operation
- 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

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

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.

The Grundfos® Redi-Flo 2 (Figure 10) is one of the more common models of this style pump commercially available for sample collection. However, there are some limitations

to this model pump, which when properly identified and anticipated, will allow the user to overcome commonly encountered situations.

The variable speed feature is one of the key design items, which allows for application of low-flow purging and sample collection. In order to compensate for the reduction in impeller dimension without significant loss of pump capacity, the motor must turn at a high rate of speed. In the process of achieving high speed, low-end torque (power) has been sacrificed. The result is to start, or restart the pump, the speed control has to be increased considerably to overcome head pressure, especially if water must open a check valve. This sudden and increased change in flow rate may mobilize unwanted material from the surrounding formation. To address this potential “restart” issue, especially

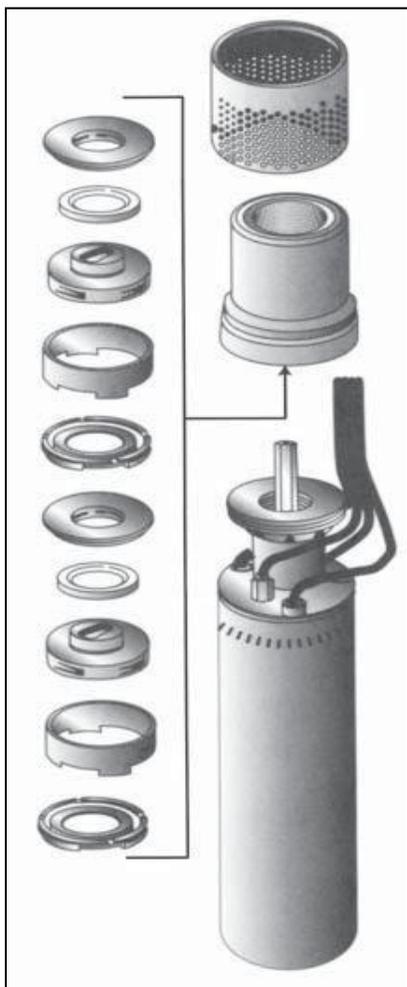


Figure 10. Grundfos® Pump.
Illustration published with permission
of Grundfos®Pumps Corporation

during the course of a low-flow purging and sampling episode, one must make sure that the generator supplying power to the pump is properly fueled to avoid power loss.

In addition, when selecting check valves, look for valves that open with the least amount of resistance and can be placed in-line at the surface. Accessibility to a check valve at the surface may eliminate the need to pull the pump from the well in order to remove the standing column of water within the tubing. Pulling the pump from the well to relieve head pressure will result in extending the time it takes to reach stabilization due to unwanted disturbance of the well.

Low yielding wells can also test the limits of variable speed design. When low yield wells are encountered and excessive drawdown restricts flow rates to 100 ml/min or less, pump speed control becomes sensitive. In these conditions, the pump may stall and the flow rate cease altogether creating another “restart” situation where pump speeds have to be increased significantly to overcome head pressure. This is not the desired scenario when attempting low flow purging and sampling. To avoid this circumstance, make sure that the control box is equipped with a “ten-turn-pot” frequency control knob. This accessory will allow for

much better control over flow rates and incidental pump stoppage when sampling low yield wells.

Reduced overall pump dimension and high turning motor speeds make temperature control critical to overall performance. The pump is designed to use water flowing along the surface of the pump housing to prevent an increase in motor temperature. Elevated water temperature generated by the motor must be considered especially when a low-flow purging and sampling technique is being

utilized. Well casing diameters play a factor in the control equation. For large-diameter cased wells (> 4 inch), where flow to the pump intake is more horizontal than vertical, Grundfos® manufactures a sheath attachment to redirect flow patterns and control heat buildup. In small-diameter wells, movement is more conducive to the design function until low yielding conditions are encountered. For those instances where temperature is being monitored and there is a steady and significant increase in temperature, do not alternately turn the pump on and off to control temperature buildup. This action will only serve to disrupt the well. Instead, make note of the condition in the field log and disregard any attempt to achieve temperature stabilization prior to 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, which comes in contact with the sample, must also come into contact with the equipment blank water. To overcome some of the difficulties that sampling through the inside of a pumping system creates, the following procedure is strongly recommended. Prepare equipment blank collection by filling a 1000 ml decontaminated graduated glass cylinder with method blank water supplied by the laboratory performing the analysis. Place a properly decontaminated pump into the graduated cylinder with sample tubing and plumbing fittings attached. Activate the pump and collect the required equipment blank samples. As the water is removed from the cylinder, replace with additional method blank water.

Finally, this particular pump (Grundfos® Redi Flo 2) is designed to utilize a coolant fluid (deionized water) that is stored internally to assist in heat movement. This fluid is separated from the sample intake by a Viton® seal through which the spinning motor shaft passes. Wear on this seal can allow for fluid exchange with the sample intake. For this reason, proper decontamination of this pump is critical and includes the complete disassembly of the motor shaft from the stator housing (Figure 11). For proper cleaning, use the decontamination procedures for ground water sampling equipment. Always refill the housing with fresh distilled/deionized water.

Note: always wiggle the motor shaft while filling to ensure any trapped air is displaced by water, otherwise damage to the motor through overheating is possible. Replace the Viton® seal periodically and remember that care must also be taken with this pump during periods of cold weather to avoid freezing of the coolant water. Proper decontamination and maintenance not only helps to ensure more reliable data; it also prolongs the life of any pump.



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

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 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. The generator should not be operating while a sample is being collected.
- Initiate purge based on procedure selected.
- After purging, collect sample as specified in approved sampling plan.

Advantages:

- Positive-displacement
- Versatile and light weight
- 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

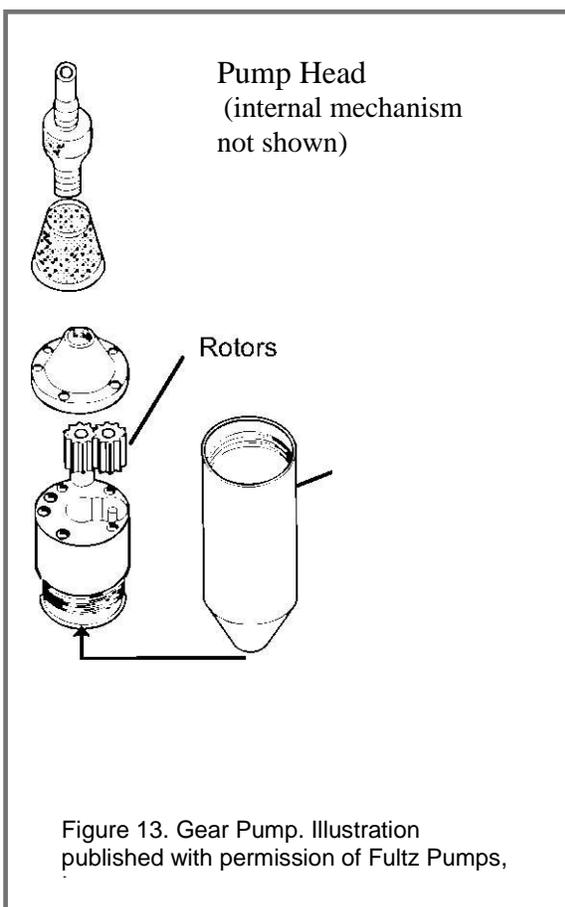
Disadvantages:

- During low-flow purging and sampling temperature increases may be observed
- At extremely low-flow rates, motor stall 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

5. Gear Pump

A positive-displacement pump, this small lightweight pump manufactured by Fultz Pumps, Inc, also has 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) are not readily accessible, therefore careful attention must be made when cleaning. This must be considered when choosing to use this pump for a portable application. Many are 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, choose pumps whose power supply and pump discharge lines are separate. This pump may be best applied when used in a dedicated system.



Procedures for Use:

- Decontaminate pump, electrical leader and all associated fittings.
- For low-flow purging and sampling, attach pre-cut 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 designed with power supply molded into tubing, which is difficult to decontaminate
- Turbid purge water wears on Fluorocarbon gears

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. 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. In addition, PDB samplers are not recommended for sampling sentinel wells.

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 20 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 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 is to allow 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. 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
- Since 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 have a limited detection capability
- 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 point sample
- Contamination migrating above or below the targeted depth interval will not be detected
- Membrane limitations restrict accurate pH, specific conductance or temperature data
- In some cases, heavy biofouling of the bag may inhibit sampler performance

7. Direct Push Technology

Use of direct push technology to obtain ground water samples via temporary well points has gained wide acceptance. The relative ease to collect minimally disturbed ground water samples depth plus the ability to provide other hydrogeological data has made this system attractive. While various manufacturers make and distribute their own ground water equipment and accessories, the same general principles still apply when collecting ground water samples.

One of the special applications of direct push technology relative to ground water sampling is the ability to obtain vertical profile information while working the same bore hole. This process only further stresses the need to eliminate all possible sources of extraneous or cross contamination, especially when contaminant levels are on the order of only 1 or 2 parts per billion. High pressure, hot water (100° C) cleaning is the only acceptable means to decontaminate sampling equipment and maintain confidence that data is not influenced by unwanted variables. In addition, equipment must be maintained in good working order to insure its performance. This means (but is not limited to) all

rods used for boring advancement must have unworn O-rings at each connection and undamaged threads to insure that each connection can be drawn tight, all down hole equipment must be decontaminated between each use and sample collection tubing must not be reused. Extreme caution must be taken to insure that communication between various water bearing zones within the same boring does not take place, therefore, all grouting must be tremied under pressure starting from the bottom of the boring and completed at the surface using grout of the required density.

General guidance on the construction of temporary wells installed via direct push technology can be referenced through this manual, 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>, and <http://www.ams-samplers.com/>

V. Air Sampling

A. Vapor Intrusion

Vapor intrusion is the migration of volatile chemicals from a subsurface vapor source into overlying buildings. See DEC's *Draft Vapor Intrusion Guidance* at <http://dec.alaska.gov/spar/csp/guidance/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 preformed 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 DEC'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 department.

B. Instrument Calibration

Calibrate all instruments on-site, on the day of use, and prior to field sample analysis per the manufacturer's specifications and requirements. 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 have undamaged lids 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 and unique identification number;
- 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

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	All 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 AK101 or 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, for each target analyte, unless otherwise approved by the DEC project manager.

Field duplicates should be collected from locations of known or suspected contamination.

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 times, in accordance with the identification convention of the standard field samples collected; 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:

$$\text{RPD (\%)} = \text{Absolute value of: } \frac{(R_1 - R_2)}{((R_1 + R_2)/2)} \times 100$$

Where: R₁ = Sample Concentration

R₂ = 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.

Visibly contaminated decontamination water for sites with petroleum hydrocarbons may be containerized for off-site shipment or with DEC 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.

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.

Properly discard and do not re-use disposable sampling equipment.

Refer to ASTM D 5088 - 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 disposal.

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

- Sample labeling;
- Shipping documentation such as a shipping manifest;
- Field custody form (chain-of-custody form); and
- Inter-laboratory transfer documentation.

Maintain samples according to the holding times and temperatures in Appendices C and 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 Standard D4840 - Guide for Sample Chain-of-Custody Procedures for additional information.

Refer to ASTM Standard D 6911 - Standard Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis for additional information.

Appendix A - References

ADEC, 2008, Monitoring Well Guidance.

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

ADEC, 2009, Draft Guidance on Multi Increment Soil Sampling.

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

ANSI/AWWA A100-97, Appendix H, Decommissioning of Test Holes, Partially Completed Wells, and abandoned Completed Wells.

ASTM D4448 - 01(2007) Standard Guide for Sampling Ground-Water Monitoring Wells.

ASTM D4547 - 06 Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds.

ASTM D4750 - 87(2001) Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well).

ASTM D4700-91 Standard Guide for Soil Sampling from the Vadose Zone.

ASTM D4841 - 88(2008) Standard Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents.

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 D5521 - 05 Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers.

ASTM D5903 - 96(2006) Standard Guide for Planning and Preparing for a Groundwater Sampling Event.

ASTM D6000 - 96(2002) Standard Guide for Presentation of Water-Level Information From Ground-Water Sites.

ASTM D6044 - 96(2003) Standard Guide for Representative Sampling for Management of Waste and Contaminated Media.

ASTM D6089 – 97 Standard Guide for Documenting a Ground-Water Sampling Event.

ASTM D6232 - 08 Standard Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities.

ASTM D6418 - 04 Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis.

ASTM D6452-99 Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations.

ASTM D6517-00 Standard Guide for Field Preservation of Ground-Water Samples.

ASTM D6564-00 Standard Guide for Field Filtration of Ground-Water Samples.

ASTM D6724 - 04 Standard Guide for Installation of Direct Push Ground Water Monitoring Wells.

ASTM D6771-02 Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations.

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

ASTM D7069 - 04 Standard Guide for Field Quality Assurance in a Ground-water Sampling Event.

*Note- The ASTM procedures are regularly updated. Be sure to check for the most current version.

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.

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
<i>Colorimetric Wet Chemistry</i>	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
<i>Headspace Organic Vapor Monitoring</i>	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
<i>Immunoassay</i>	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
<i>Infrared Spectrophotometry</i>	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
<i>Qualitative Physical Screening Methods</i>	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			
<i>Colorimetric Wet Chemistry</i>	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
<i>Headspace Organic Vapor Monitoring</i>	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
<i>Immunoassay</i>	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
<i>Infrared Spectrophotometry</i>	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.
<i>Qualitative Physical Screening Methods</i>	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 Method ¹	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° ± 2°C / 28 days
Diesel range organics	AK102*	4 oz. amber glass, TLC	4° ± 2°C / 14 days to extraction, 40 days to analysis of extract
Residual range organics	AK103*	4 oz. amber glass, TLC	4° ± 2°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° ± 2°C / 14 days
Volatile Organic Compounds (VOCs) ⁴	8260C or 8021B	4 oz. amber glass, TLS	Methanol preservative, 4° ± 2°C / 14 days
Semi Volatile Organic Compounds (SVOC)	8270D	4 oz. amber glass, TLC	4° ± 2°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° ± 2°C / 14 days to extraction, 40 days to analysis of extract
Pesticides	8081B	4 oz. amber glass, TLC	4° ± 2°C / 14 days to extraction, 40 days to analysis of extract
Herbicides	8151A	4 oz. amber glass, TLC	4° ± 2°C / 14 days to extraction, 40 days to analysis of extract
Polychlorinated biphenyls (PCBs)	8082A ⁵	4 oz amber glass, TLC	4° ± 2°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° ± 2°C / 28 days

Notes:

Several of the 7000 series methods have been deleted from SW846 but these methods may still be approved by DEC 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 must be approved on a site-specific basis by the CS program prior to sample collection.

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

- † Analytical method 6010C may be used 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 Water⁷, 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 DEC 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 be used 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 <i>Test Methods</i> ⁸	GRO ¹ <i>AK101</i>	DRO <i>AK102</i>	RRO <i>AK103</i>	BTEX ^{1,6} <i>EPA 8021B EPA 8260</i>	PAHs ^{2,3,7} <i>EPA 8260C³ EPA 8270D EPA 8310</i>	Other VOCs ^{1,3,6} <i>EPA 8021B EPA 8260C</i>	EDB 1,2-DCA <i>EPA 260C^{1,5} EPA 8011⁵ EPA 504.1⁵</i>	MTBE <i>EPA8260C</i>	Metals ⁴ <i>EPA 6010C EPA 6020A, or 7000 series</i>	PCBs <i>EPA 8082A</i>
Site COPCs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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 samples must be preserved in methanol.

- ² 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.
- 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 Metals must include arsenic, barium, cadmium, chromium, lead, nickel, and vanadium, unless otherwise noted.
- ⁵ EPA 8260 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.
- ⁶ EPA 8260 may be required to evaluate non-BTEX volatile petroleum hydrocarbons, such as 1,2,4- and 1,3,5-trimethylbenzene for vapor intrusion or other applicable pathways to protect human health and the environment.
- ⁷ 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.
- ⁸ 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