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Standard Guide for Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases¹

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1. Scope

1.1 This guide covers a process to rapidly and accurately characterize a confirmed or suspected petroleum release site. This guide is intended to provide a framework for responsible parties, contractors, consultants, and regulators to streamline and accelerate the site characterization process or supplement incomplete characterization data. The accelerated site characterization (ASC) approach may be incorporated in state and local regulations as a cost-effective method of making informed corrective action decisions sooner.

1.2 This guide describes a process for collecting site characterization information in one mobilization, using rapid sampling techniques; field analytical methods; and on-site interpretation and iteration of field data to refine the conceptual model for understanding site conditions as the characterization proceeds. This information can be used to determine the need for interim remedial actions; site classification or prioritization, or both; further corrective actions; and active remediation. The process outlined in this guide can be incorporated into existing corrective action programs, and is organized to be used in conjunction with Guides E1599 and E1739.

1.3 For guidance concerning contractor health and safety issues, appropriate federal, state, and local regulations (for example, Occupational Safety and Health Administration) and industry standards should be consulted. For sampling quality assurance/quality control (QA/QC) practices, see references in Section 2. Considerations for field analytical method quality assurance/quality control are discussed in Section 5.

1.4 This guide is organized as follows:

- 1.4.1 Section 1 describes the scope,
- 1.4.2 Section 2 lists Referenced Documents,
- 1.4.3 Section 3 defines Terminology,
- 1.4.4 Section 4 identifies the Significance and Use,
- 1.4.5 Section 5 describes the Accelerated Site Characterization Process,

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1.4.6 Appendix X1 identifies Additional Referenced Documents,

1.4.7 Appendix X2 provides an Example of a Data Quality Classification System,

1.4.8 Appendix X3 contains a list of physical and chemical properties and hydrogeologic characteristics applicable to site characterizations, and a list of input parameters and methodologies for ASTM RBCA Tier 1 and Tier 2 evaluations, and

1.4.9 Appendix X4 contains a case study example of the ASC process, including a RBCA Tier 1 and Tier 2 evaluation.

1.5 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Ground Water

E1599 Guide for Corrective Action for Petroleum Releases (Withdrawn 2002)³

E1689 Guide for Developing Conceptual Site Models for Contaminated Sites

E1739 Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites

2.2 EPA Documents:

USEPA SW 846, Recommended Analytical Procedures, Test Methods for Evaluating Solid Waste-Physical/Chemical Methods⁴

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

USEPA, Draft Field Methods Compendium, OER 9285.2-11⁴

USEPA, Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide-Vols I and II, EPA 625/R-93/003a and b⁴

USEPA, Description and Sampling of Contaminated Soils: A Field Pocket Guide, EPA 625/12-91/002⁴

USEPA, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996, USEPA Region⁴

USEPA, Expedited Site Assessment Tools for UST Sites: A Guide for Regulators, EPA 510-B-97-001⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *accelerated site characterization (ASC)*— a process for collecting and evaluating information pertaining to site geology/hydrogeology, nature and distribution of the chemical(s) of concern, source areas, potential exposure pathways and points of exposure in one mobilization. The ASC employs rapid sampling techniques, on-site chemical analysis and hydrogeological evaluation, and field decision making to provide a comprehensive “snap-shot” of subsurface conditions.

3.1.2 *active remediation*—actions taken to reduce the concentrations of chemical(s) of concern. Active remediation could be implemented when the no further action and passive remediation courses of action are not appropriate.

3.1.3 *chemical(s) of concern*—specific constituents that are identified for evaluation in the site characterization process.

3.1.4 *conceptual model*—a summary of information that is known about a site. Available site information is compiled onto one or more simple graphics to develop an understanding of the site conditions. The conceptual model is not an analytical or numerical computer model, but may utilize these tools in developing a conceptual understanding of site conditions.

3.1.5 *corrective action*—activities performed in response to a suspected or confirmed release, which include one or more of the following: site characterization, interim remedial action, remedial action, operation and maintenance of equipment, monitoring of progress, monitoring of natural attenuation, and termination of remedial action.

3.1.6 *exposure pathway*—the course a chemical(s) of concern takes from the source area(s) to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to a chemical(s) of concern originating from a site. Each exposure pathway includes a source or release from a source, a point of exposure, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (for example, air) or media also is included.

3.1.7 *facility*—the property containing the source of the chemical(s) of concern where a release has occurred.

3.1.8 *field analytical methods*—methods or techniques that measure physical properties or chemical presence in soil, soil vapor, and ground water immediately or within a relatively short period of time to be used during a site characterization. Measurement capabilities range from qualitative (positive/

negative) response to below parts per billion (sub-ppb) quantitation. Accuracy and precision of data from these methods depends on the method detection limits and QA/QC procedures.

3.1.9 *field-generated analytical data*—information generated on site soon after sample acquisition that is used to direct the site characterization process. These data include: concentrations of chemical(s) of concern in air; soil; soil vapor or ground water, or both; and hydrogeologic conditions.

3.1.10 *indicator compounds*—compounds in ground water, soil, or air, specific to the petroleum product released, used to confirm the existence of the petroleum product, define the distribution of the chemical(s) of concern, define the target levels, monitor progress of the remedial action, and identify the termination point of the remedial action.

3.1.11 *interim remedial action*—the course of action to mitigate fire and safety hazards and to prevent further migration of hydrocarbons in their vapor, dissolved, or liquid phase.

3.1.12 *mobilization*—the movement of equipment and personnel to the site, to prepare for, collect, and evaluate site characterization data. These activities, when conducted as one continuous event (from one day to several weeks), are referred to as a single mobilization. Activities that are not conducted continuously are referred to as multiple-site mobilizations.

3.1.13 *on-site manager*—an individual who is on site and is responsible for directing field activities and decision-making during the site characterization. The on-site manager should be familiar with the purpose of the site characterization, pertinent existing data, and the data collection and analysis program. When conducting an ASC, it is necessary for the on-site manager to also be the principal investigator, developing and refining the conceptual model of site conditions. This individual must have the necessary experience and background to perform the required site characterization activities and to accurately interpret the results and direct the investigation. For the purposes of this guide, sufficient qualification criteria for the on-site manager includes knowledge and experience in the following areas:

3.1.13.1 Soil and ground water sampling and analytical methods to be used at the site;

3.1.13.2 Fate and transport of petroleum hydrocarbons in the subsurface;

3.1.13.3 Local geology/hydrogeology;

3.1.13.4 Local regulations and ordinances, including knowledge of state-specific certification requirements;

3.1.13.5 Personal health and safety requirements; and

3.1.13.6 Evaluation and interpretation of site characterization results.

3.1.14 *petroleum*—including crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure (60°F (16°C) at 14.7 psia). The term includes petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet oils, lubricants, petroleum solvents, and used oils.

3.1.15 *point(s) of exposure*—the point(s) at which an individual or population may come in contact with a chemical(s) of concern originating from a site.

3.1.16 *quality assurance/quality control (QA/QC)*—the use of standards and procedures to ensure that samples collected and data generated are reliable, reproducible, and verifiable.

3.1.17 *rapid sampling tools*—equipment and techniques that allow personnel to collect samples from different media, in a relatively short period of time, for on-site chemical analysis and hydrogeologic evaluation within the same mobilization.

3.1.18 *receptors*—persons, structures, utilities, surface waters, and water supply wells that are or may be adversely affected by a release.

3.1.19 *regulatory agency*—any state or local program responsible for overseeing underground storage tank (or other petroleum/hazardous material source) site characterization and corrective action.

3.1.20 *release*—any spilling, leaking, emitting, discharging, escaping, leaching, or disposing of petroleum products into ground water, surface water, soils, or air.

3.1.21 *remediation/remedial action*—activities conducted to protect human health, safety, and the environment. These activities include evaluating risk, making no-further-action determinations, monitoring, institutional controls, engineering controls, and designing and operating cleanup systems.

3.1.22 *site characterization*—an evaluation of subsurface geology/hydrogeology, and surface characteristics to determine if a release has occurred, the levels of the chemical(s) of concern, and the distribution of the chemical(s) of concern. The data collected on soil, soil vapor and ground water, potential exposure pathways and location of receptors and point(s) of exposure is used to generate information to support remedial action decisions.

3.1.23 *source area(s)*—the location(s) of liquid hydrocarbons or the zone(s) of highest soil or ground water concentrations, or both, of the chemical(s) of concern.

3.1.24 *user*—an individual or group involved in the ASC process including owners, operators, regulators, petroleum fund managers, attorneys, consultants, legislators, and so forth.

4. Significance and Use

4.1 An ASC is a process for collecting and evaluating information on site geology/hydrogeology, nature and distribution of chemicals of concern, source areas, potential exposure pathways, and points of exposure. The unique goal of an ASC is to complete a site characterization in one mobilization. This can be accomplished by developing and refining a conceptual site model, utilizing rapid sampling tools and techniques, obtaining field-generated analytical data, and on-site interpretation of results. Evaluation of data concurrent with the investigation allows the on-site manager to select subsequent sampling points based on actual subsurface conditions, resulting in a more comprehensive and cost-effective “snapshot” of subsurface conditions.

4.2 The ASC process has the following advantages:

4.2.1 Immediate identification of potential risks to human or environmental receptors or potential liabilities, or both;

4.2.2 Rapid determination of the need for interim remedial actions, site classification, and prioritization;

4.2.3 Rapid sample collection and analysis, near contemporaneous analytical results, and maximum data comparability;

4.2.4 Optimization of sample point locations and analytical methods;

4.2.5 Greater number of data points for resources expended;

4.2.6 Near immediate data availability for accelerating corrective action decisions; and

4.2.7 Collection of vertical and horizontal data, allowing for three-dimensional delineation of chemical(s) of concern in soil, soil vapor, or ground water.

4.3 The ASC process described in this guide is intended for use in situations where the potential exists that petroleum has been released. The same principles may be applicable to other indicator compounds or chemical(s) of concern, and sources (for example, chlorinated solvent releases). If the ASC process is used for chemical(s) of concern, other than petroleum, the user must consider the physical and chemical characteristics of the chemical(s) of concern and the media in which they are present to ensure that the sampling tools and analytical methods are capable of measuring and detecting the chemical(s) of concern.

4.4 A conventional site characterization approach most often involves several mobilizations. Each mobilization typically includes a predefined sampling and analysis plan, where analysis and interpretation of results are performed off-site after demobilization. A conventional site characterization can provide high-quality data; however, multiple mobilizations often prolong the process required to adequately characterize subsurface conditions.

4.5 The ASC process requires an on-site manager to make decisions to guide the characterization. Without an individual on site who is able to interpret data as it is generated, and is authorized to adjust sample locations or scope of the investigation, or both, an ASC has little chance of meeting its stated objective of full characterization in one mobilization. Levels of communication and authority between the on-site manager and the user should be established prior to beginning the characterization.

5. Accelerated Site Characterization Process

5.1 The unique feature of the ASC process is the collection, analysis, and evaluation of hydrogeologic and chemical data while on-site. A flowchart of the ASC process is presented in Fig. 1, and a discussion of each activity begins in 5.2. While many of the steps in an ASC are similar to those in a conventional characterization, the following activities, as illustrated in the area labeled “Field Activities” in Fig. 1, are performed on-site during an ASC:

5.1.1 Interpretation and evaluation of field-generated data as it is collected;

5.1.2 Continuous refinement of the conceptual model, and the understanding of site conditions;

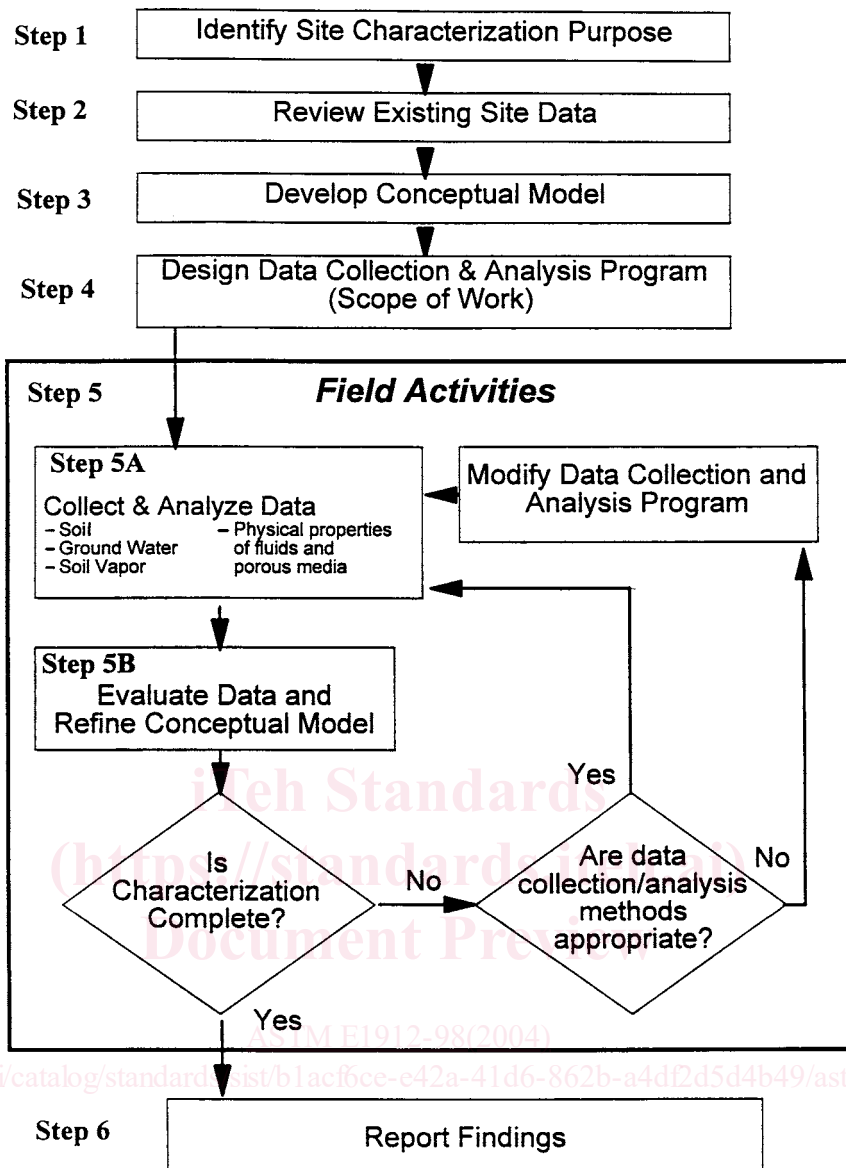


FIG. 1 ASC Process Flowchart

5.1.3 Modification of the sampling and analysis program to address any necessary adjustments in the scope of work; and

5.1.4 Collection of additional data necessary to complete the characterization.

5.2 Step 1—Identify Site Characterization Purpose:

5.2.1 Purpose—The objectives of any environmental site characterization, as noted previously, are to understand the site geology/hydrogeology, the nature and distribution of the chemicals of concern, the migration pathways and location of potential receptors and point(s) of exposure. The scope of work, however, will vary depending upon the purpose of the specific characterization. Typical purposes include one or more of the following: hazard determination, initial response action, release confirmation, risk determination, remedial action evaluation, regulatory compliance, or real estate transaction. For example, an ASC for an initial response action might focus on defining imminent hazards, potential migration of chemical(s) of concern and the location of receptors and point(s) of

exposure, while a characterization for a real estate transaction focuses on identifying the presence of chemicals of concern. A corrective action evaluation will require a higher priority be placed on understanding subsurface hydrogeologic conditions, whereas a risk determination will focus first on receptors, exposure pathways and points of exposure, in addition to levels of chemical(s) of concern.

5.2.2 The scope of the ASC is determined prior to mobilization, but will often be revised based on interpretation of the field-generated data.

5.3 Step 2—Review Existing Site Information:

5.3.1 A variety of regional and site-specific information should be obtained prior to mobilization. A review of existing information, and a site visit, are important in the design of a data collection and analysis program, and in the development of the conceptual model. Information obtained through the site visit, interviews, and records search include the following:

5.3.1.1 Local and regional hydrogeologic maps to identify general soil types/regional depth to bedrock, rock type, depth to ground water, aquifer properties, and so forth;

5.3.1.2 Past and current land use history of the site and adjacent properties (including future land use if known);

5.3.1.3 Location of potential sources (for example, current and former storage tank systems);

5.3.1.4 Releases, spills, and overflow incidents on the site and adjacent properties;

5.3.1.5 Previous or on-going corrective action activities, or both, on-site and on nearby properties (that is, existing monitoring wells);

5.3.1.6 Potential receptors and point(s) of exposure including private and public water supply wells, surface waters, utility conduits, basements, sensitive ecosystems, and other sensitive land uses within a given proximity of the site;

5.3.1.7 Potential migration pathways and transport mechanisms to the points of exposure (ground water flow, vapor migration through soils and utilities, and so forth);

5.3.1.8 Other potential off-site sources of chemical(s) of concern; and

5.3.1.9 Site conditions that may affect the health and safety plan.

5.3.2 If the review of existing data does not provide adequate information regarding UST or subsurface structure locations, the use of surface geophysical survey techniques may be appropriate.

5.4 Step 3—Develop Conceptual Model:

5.4.1 The initial conceptual model is the starting point of the characterization, and is used as a basis for planning field activities. The model is developed by compiling and interpreting all information obtained from the existing site information review, and may include the following:

5.4.1.1 Anticipated locations and depths of subsurface geologic units;

5.4.1.2 Anticipated ground water depth and flow direction(s) and possible interaction with surface water bodies;

5.4.1.3 Layout of the site, including areas and depths of artificial fill (tank and trench backfill), subsurface utility lines, and subsurfacing piping;

5.4.1.4 Existing soil and ground water analytical data and information regarding the location and volume of the release;

5.4.1.5 Potential releases in the vicinity of the site (especially upgradient from the site);

5.4.1.6 Location of potential receptors, point(s) of exposure, and migration pathways; and

5.4.1.7 Topographic conditions.

5.4.2 The on-site manager should summarize this information onto simple graphics such as a large-scale base map, structure contour maps, ground water elevation contour maps, isoconcentration contour maps, and geologic/hydrogeologic cross sections. These graphics can easily be hand drawn or can be generated using computerized graphics programs before actual field work begins. These documents should be used on-site and updated as the characterization progresses.

5.4.3 The initial conceptual model, developed before beginning any field work, focuses on specific features that are relevant to the characterization objectives. For example, the

features of a conceptual model of a leaking underground storage tank site may include preliminary estimates of: source areas; three dimensional distribution of chemical(s) of concern; chemical(s) of concern impact to and distribution in the ground water; geologic units or structures that influence migration of chemical(s) of concern; and ground water depth, flow direction and velocity. The components of the initial conceptual model that are emphasized depends on the purpose of the characterization, and assists the investigator in focusing on the most salient site features. For more information regarding developing conceptual models, see Guide E1689.

5.5 Step 4—Design Data Collection and Analysis Program:

5.5.1 The data collection and analysis program is developed based on the initial conceptual model, prior to mobilization. This program does not need to be a formalized document, but should be agreed upon between the on-site manager and the responsible party prior to initiation of field activities (in some cases, the regulatory agency is involved as well). The exact number and location of data collection points are left somewhat flexible, and are determined in the field based on the actual site conditions. Levels of communication and authority between the on-site manager and the responsible party will keep all parties informed as the ASC progresses.

5.5.2 Proper implementation of the data collection program requires that the on-site manager be familiar with the capabilities and limitations of the sampling tools and field analytical methods, and that he or she interpret the field-generated data as it becomes available.

5.5.3 The design of the data collection and analysis program should consider the following:

5.5.3.1 Purpose of the ASC;

5.5.3.2 Initial conceptual model, including site historical information, hydrogeologic characteristics of the site, and physical properties of fluids and porous media;

5.5.3.3 Methods to collect and analyze data;

5.5.3.4 General location and number of initial samples and the decision process for locating additional samples;

5.5.3.5 Media to be analyzed;

5.5.3.6 Sample collection and analysis criteria (depth, interval, sampling protocol, chemical(s) of concern, data quality levels, analytical methods, and data validation);

5.5.3.7 Specific qualifications of the on-site manager(s);

5.5.3.8 Site constraints (for example, USTs, structures, canopy, limited space, utilities, property boundaries, depth to bedrock, and access constraints);

5.5.3.9 Data for fate and transport modeling, risk evaluations, or corrective action design (for example, soil properties, air permeability, natural attenuation indicators);

5.5.3.10 Level of communication between the on-site manager and the responsible party (for example, agreement on changes to the scope of work or the data collection and analysis program);

5.5.3.11 Contingencies based on reasonably anticipated deviations from expected site conditions, such as shallow bedrock, depth to ground water, disposal of investigatory wastes, change in equipment requirements, and the appearance or detection of unanticipated chemical(s) of concern; and

5.5.3.12 Determination of the possible need for off-site access.

5.5.4 *Data Collection Methods*—The selection of sampling tools should be based on the following:

- 5.5.4.1 Purpose and anticipated scope of the ASC;
- 5.5.4.2 Capabilities, limitations, and cost of each tool;
- 5.5.4.3 Speed by which samples can be obtained;
- 5.5.4.4 Advantages of using a combination of tools;
- 5.5.4.5 Site features and layout;
- 5.5.4.6 Anticipated geologic site conditions;
- 5.5.4.7 Anticipated chemical(s) of concern and concentrations;
- 5.5.4.8 Disturbance to site operations and neighboring properties; and
- 5.5.4.9 Anticipated next steps.

5.5.4.10 **Table 1** presents several common tools and devices that can be used to obtain samples. This guide recognizes that additional tools and techniques exist and continue to be developed, and sample collection during an ASC is not limited to those tools listed in **Table 1**. The sample collection tools are an integral, though not an exclusive part of an accelerated site characterization in defining subsurface structures, potential migration pathways, or barriers at a site, and in selecting areas for further investigation. The case study example in **Appendix**

X4 identifies information and data collection methods which may be necessary to complete an ASC and perform an ASTM Tier 1 or Tier 2 evaluation.

5.5.4.11 In addition to the tools listed in **Table 1** to obtain samples, surface and downhole geophysical techniques (for example, ground penetrating radar, electromagnetic induction, electrical resistivity) may assist in obtaining information regarding subsurface features such as undocumented USTs, utility lines or other unknown features. This information can assist the on-site manager in determining locations of intrusive sampling points.

5.5.5 *Sample Analysis:*

5.5.5.1 *Hydrogeologic Conditions and Physical Properties*—Information on the geology/hydrogeology and physical characteristics of the subsurface is essential to refine the conceptual model, evaluate potential migration pathways and transport mechanisms, and to develop an appropriate corrective action plan. A list of characterization properties and parameters, including physical properties, chemical properties, hydrogeologic characteristics and input parameters/methodologies for an ASTM RBCA Tier 1 and Tier 2 evaluations are located in **Appendix X3**.

5.5.5.2 *Chemical Analysis*—Field analytical methods are used in an ASC to analyze soil, soil vapor, ground water or air,

TABLE 1 Example Sample Collection Tools^A

Method	Access ^C	Suitable Media			Sample Depth (m) ^B	Comments
		Soil	Soil Vapor	Ground Water		
Grab samplers (trowels, scoops, shovel, post-hole digger)	M, B	X			< 1	Low cost. Loss of volatiles. Ease of use.
Hand augers	M	X			< 3	Slow. Labor intensive. Shallow depth. Can be used near located utility/product lines.
Slam Bar & Tubing						
Split spoon	DP, DR	X			< 100	Minimal sample disturbance. Difficult to use below water table w/o auger.
Sample sleeve	DP	X			< 100	Difficult in cobbles or hardpan. Visual obs of sample. Can be used below water table. Minimal sample dist.
Other core samplers ^D	M	X			< 2	Equipment-specific capabilities and limitations.
	DP	X			< 100	
	DR	X			< 100	
Active gas samplers (vacuum pumps & tubing)	OH, DP, DR		X		< 100	Larger sample volume. Loss of volatiles. Low \$
Passive gas samplers	M		X		< 1	Time intensive.
Pneumatic depth-specific samplers	OH		X	X	< 100	
Check valve and tubing	OH			X	< 100	Limited sample volume. Low cost.
Exposed-screen sampler	DP			X	< 100	
Bailer	OH			X	< 100	Labor-intensive.
Sheathed Wellpoint	DP, DR			X	< 100	
Peristaltic pump	OH			X	< 10	
Gas-drive/displacement pump	OH			X	< 100	
Gas-drive/piston pump	OH			X	< 100	
Bladder pump	OH			X	< 100	
Helical rotor pump	OH			X	< 100	

^A Some commonly-used tools for shallow and intermediate depth investigations (generally < 50 meters) are listed. Many other tools are available. Refer to "Subsurface Characterization Monitoring Techniques: A Desk Reference Guide, Vols. I and II," (EPA/625/R-93/003a&b), USEPA, May 1993, for additional information about these and other methods.

^B Sample depth refers to practical depth limitation range, depending upon the sampling device used and the lithologic conditions.

^C Access to the sample for collection or installation of sample tool via the listed approaches.

M = manual (hand-operated equipment).

B = backhoe (mechanical excavating equipment).

OH = open hole (unobstructed access to the sample medium via a pit or cavity, a cased well, or narrow-diameter sampling point).

DR = drill rig (mechanical boring equipment, such as hollow-stem auger, mud/air rotary).

DP = direct-push (mechanical, hydraulic, pneumatic or vibratory devices which push or drive narrow diameter sampling points into the subsurface).

^D Numerous types and sizes available for different soil conditions. Drill rig is the only sample access equipment listed in this table which can be used readily to sample consolidated material.

or a combination thereof. On-site analysis for indicator compounds/chemicals of concern allows the on-site manager to determine the location of, or need for additional samples. Field analytical methods can typically provide more data at lower cost with minimal sample disturbance than sending samples to an off-site laboratory. Key considerations in selecting field analytical methods are as follows:

5.5.5.3 Analyte—The analytical method(s) selected will depend on the chemical(s) of concern or indicator compound(s) of interest. For example, when gasoline is the suspected release, the indicator compound may be total volatile organics. Therefore, a method that measures total organic vapors may be used. In many cases, specific chemicals of concern, such as benzene, may need to be measured. Depending on the chemical(s) of concern, it may be necessary to use either field analytical method capable of providing chemical-specific results, or a combination of methods capable of analyzing a broader suite of compounds. **Table 2** is a summary of commonly used field screening and analytical techniques. For a discussion of the level of data quality produced by each method, see the data quality level discussion below.

5.5.5.4 Media—Consideration must be given to the targeted sample media (soil, soil vapor, ground water, air) and the method's capability of measuring concentrations in that medium. The performance of field analytical methods will vary depending on the sample preparation required for the media being analyzed (especially for soil analyses).

5.5.5.5 Data Quality Level—The reliability of results is related to the data quality level of the method used. An example of a data quality classification system for commonly used analytical methods is presented in **Appendix X2**. As

shown in the example, several of the field analytical methods are capable of measuring chemical(s) of concern and/or indicator compounds at differing data quality levels. Selection of field analytical methods should be based in part on the chemical of concern or indicator compounds of interest, the intended use of the data, and the capability of the method. For example, lower quality methods (often called field screening methods) may be used for source identification, while higher data quality methods should be used to delineate chemicals of concern at lower detection limits. Both quantitative and qualitative field analytical methods should be used to acquire data necessary to perform a risk evaluation, or to develop future action plans. When determining what level of data quality is most appropriate, the following is considered:

5.5.5.6 The quality level selected should be consistent with the purpose and scope of the ASC and the intended use of the data.

5.5.5.7 Many points containing lower quality level data can provide a better understanding of site conditions than fewer data points at a higher data quality level.

5.5.5.8 Regulatory requirements should be considered with respect to the detection limit of the selected field analytical method.

5.5.5.9 Limitations—All analytical methods and instruments have limitations that may affect results. These include affects of temperature or humidity, cross-sensitivity issues, and masking of certain constituents. In addition, the operational expertise of the person performing the analysis may also effect results. These limitations should be considered when selecting analytical methods or instruments.

TABLE 2 Example Sample Field Screening and Analytical Techniques^A

Method	Analyte	Media			Detection Range			Limitations	Result Time
		Soil Vapor	Soil	Ground Water	Soil Vapor	Soil	Ground Water		
PID- or FID- headspace	TOV ^B	X	X	X	ppmv	ppmv	ppmv	Temperature. Humidity. Instrument flowrate. Cross Sensitivity Issues.	Immediate.
Indicator tube	Specified compound	X	X		ppmv	ppmv			
O ₂	Oxygen	X			%				
CO ₂	Carbon dioxide	X			ppmv				
pH meter	pH			X			1-14	None.	
DO meter	Dissolved oxygen			X			mg/l	Temperature. Active fouling	
REDOX meter	REDOX potential			X				by materials that react, coat, or clog.	
Conductivity meter	Electrical conductivity			X					
Ion-specific meter	Indicator compounds			X			mg/l		
Infrared (IR) spectrometer	Indicator compounds		X	X		mg/kg	mg/l	Low bias for aromatics.	Minutes.
Turbidimetric test kit	Indicator compounds		X			mg/kg		Organic rich soils may cause bias.	
Colorimetric methods	Indicator compounds		X	X		mg/kg	mg/l		
Immunoassay kits	Indicator and specific compounds		X	X		mg/kg	ug/l	Cross-reactivity.	
Portable GC	Specific compounds	X	X	X	ppbv	ug/kg	ug/l	Moderate peak resolution.	
Laboratory grade GC (on-site)	Specific compounds	X	X	X	ppbv	ug/kg	ug/l	Negligible.	Minutes to hours.
Laboratory grade mass spectrometer (on-site)	Specific compounds	X	X	X	ppbv	ug/kg	ug/l	Negligible.	
Laboratory grade GC (off-site)	Specific compounds	X	X	X	ppbv	ug/kg	ug/l	Negligible.	Days to weeks.
Laboratory grade mass spectrometer (off-site)	Specific compounds	X	X	X	ppbv	ug/kg	ug/l	Negligible.	

^A Some commonly-used techniques for analyzing environmental media are listed. Many other techniques are available. This list was generated using "Field Analysis Manual," New Jersey Department of Environmental Protection and Energy, May 1994, and "Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide, Vols. I and II," (EPA/625/R-93/003a&b), USEPA, May 1993.

^B TOV refers to Total Organic Vapors.

5.5.5.10 *Regulatory Acceptance*—Field analytical methods are changing rapidly and the appropriate regulatory authority should be consulted in advance of collecting and analyzing data for accepted methods and procedures when an ASC is performed for regulatory purposes.

5.5.5.11 *Method Protocol and QA/QC Considerations*—Each analytical method has a standard protocol established either by the United States Environmental Protection Agency (USEPA), a state regulatory agency, an industry consensus group or manufacturer, or has a protocol specifically developed for use on-site. Prior to performing the analysis, method protocol and quality control procedures should be developed and documented in a quality control plan. A method quality control plan should specify the following: instrument calibration procedures; generation of calibration curves; preparation and analysis of field standards; analysis of matrix spikes, matrix spike duplicates, blanks and control samples; frequency for instrument calibration and quality control sample analysis; and acceptable criteria for results of instrument calibration and quality control samples.

5.5.5.12 The on-site manager must be familiar with the quality control plan and must ensure that the methods are being performed and the samples are being analyzed in accordance with the plan. The results of the quality control sample analysis should be recorded and reviewed as the data is being generated as well as during data evaluation and refining of the conceptual model. Quality control procedures and analytical results should be included in the final site characterization report.

5.5.5.13 **Table 2** presents several analytical methods that can be used to analyze soil vapor, soil and ground water samples. The methods are listed in the order of increasing capabilities and time required for analysis. Both field analytical and off-site laboratory methods are listed. This guide recognizes that additional methods continue to be developed and sample analysis during an ASC is not limited to those methods listed in **Table 2**. The case study in **Appendix X4** demonstrates the use of on-site analytical methods which may be used in completing an ASC and in performing an ASTM RBCA Tier 1 and Tier 2 evaluation.

5.6 Step 5—Field Activities:

5.6.1 *Step 5A—Collect and Analyze Data*—The established data collection and analysis program is implemented to perform an intensive, short-term field investigation. As samples are acquired, it is important to observe physical appearance and conditions such as lithology, structure, soil staining, color and moisture content (see **Appendix X3**). Flexibility is a key component for a successful ASC, therefore, the data collection and analysis program should be used to guide the site characterization to completion. As data is collected and analyzed, it may be necessary to adjust the data collection and analysis program to refine the conceptual model and satisfy the purpose of the site characterization.

5.7 Step 5B—Evaluate Data and Refine Conceptual Model:

5.7.1 Hydrogeologic, and analytical data collected during the field investigation are periodically interpreted on-site by the field manager. As shown in the flowchart in **Fig. 1**, the conceptual model is refined in an iterative process of data collection and evaluation. Compilation of the data onto simple

graphics is essential for on-site data interpretation. This is best done by updating the maps and cross sections prepared to develop the initial conceptual model. As the investigation proceeds, the maps and cross sections are continually revised (geologic contacts are erased and moved, borehole lithologic data are plotted on cross sections, new isoconcentration contour lines are drawn, and so forth), by incorporating the new data. Using the field-generated graphics, the on-site manager directs the investigation to fill in data gaps or resolve differences between anticipated and actual results, or both. As new data are collected and the investigation proceeds, variances between the initial conceptual model and the data obtained during the characterization are used to adjust the sampling and analysis program in an iterative, scientific manner, until the site geology/hydrogeology, and nature and distribution of the chemical(s) of concern in soil and ground water are accurately defined.

5.7.2 The degree of detail and accuracy of the graphical representation of site conditions varies according to the purpose of the characterization, complexity of the site geology/hydrogeology, and the type and volume of the chemical(s) of concern. As multiple measurements are made and the amount of information that describes more complex subsurface conditions increases, the site data can be compiled on graphical software that is commercially available for laptop computers.

5.7.3 *Data Validation*—To ensure that it is useful, field-generated data must be validated. Considerations for data validation include the following:

5.7.3.1 Quality assurance/quality control (QA/QC) results (for example, duplicates, multi-point calibration curves, calibration checks, blanks, and so forth);

5.7.3.2 Comparison of higher quality level data to check lower quality level data;

5.7.3.3 Consistency of results among analytical methods and sampling techniques;

5.7.3.4 Comparison with results from other media;

5.7.3.5 Comparison with other chemical(s) of concern or indicator compounds;

5.7.3.6 Comparison against previous data, if available; and

5.7.3.7 The data should make sense in the context of the site conditions and previously generated data.

5.7.4 Once the validity of the data has been assessed, it can be used to determine whether data quality requirements have been satisfied.

5.8 Termination of Data Collection:

5.8.1 The data collection and evaluation should continue until the on-site manager has determined that the purpose of the site characterization has been met or that constraints prevent complete characterization. Typically, the ASC is complete and no further data collection is required when the following have been satisfied:

5.8.1.1 The conceptual model of the site geology/hydrogeology, the nature and distribution of chemicals of concern, and indicator compounds fit the regional hydrogeologic setting; and

5.8.1.2 The conceptual model of the site generally incorporates/fits all of the site data; and

5.8.1.3 The conceptual model can be used to make accurate predictions of subsurface conditions, and

5.8.1.4 Sufficient detail and delineation of the chemicals of concern have been achieved to fulfill the requirements of the user; or

5.8.1.5 Constraints prevent collection of any additional data.

5.9 Step 6—Report Findings:

5.9.1 Upon completion of the field work, a report of findings is provided to the user. The report should contain at a minimum: the purpose of the characterization, a statement of objectives, the background data, a description of the data collection and analysis program, a presentation or summary of the data, and quality assurance/quality control measures. The report may be used to identify the appropriate course of action, which may include the following:

5.9.1.1 No further action;

5.9.1.2 Compliance monitoring;

5.9.1.3 Further risk evaluation under the RBCA process Tier 2 or Tier 3 analysis (data collection during the ASC should be sufficient to meet the requirements of a Tier 1 and Tier 2 analysis); or

5.9.1.4 Evaluation of remedial action alternatives, and subsequent selection of technologies, or combination thereof.

5.9.2 For further information on these courses of action, please refer to Guides [E1599](#) and [E1739](#).

5.9.3 The steps of an ASC process presented in [5.1](#) to [5.8](#) are illustrated in the example in [Appendix X4](#). In addition, the example uses the results of the ASC to perform a RBCA Tier 1 and Tier 2 evaluation.

6. Keywords

6.1 accelerated; analytical methods; borings; characterization; chemicals of concern; corrective action; data quality; exposure pathways; field methods; ground water; LUST; mobilization; parameters; petroleum ; risk based approach; sampling tools

APPENDIXES

(Nonmandatory Information)

X1. OTHER REFERENCES

- X1.1 *ASTM Standards* : <https://standards.iteh.ai/catalog/standards/sist/b1ac16ce-e42a-442a-9801-142715314188/e1912-98>
- D1452 Practice for Soil Investigation and Sampling by Auger Borings²
 - D1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils²
 - D1587 Practice for Thin-Walled Tube Geotechnical Sampling of Soils²
 - D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)²
 - D3550 Practice for Ring-Lined Barrel Sampling of Soils²
 - D4447 Guide for Disposal of Laboratory Chemicals and Samples²
 - D4448 Guide for Sampling Ground Water Monitoring Wells²
 - D4700 Guide for Soil Sampling from the Vadose Zone²
 - D4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)²
 - D4823 Guide for Core-Sampling Submerged, Unconsolidated Sediments²
 - D5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers²
 - D5299 Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes and Other Devices for Environmental Activities²
 - D5314 Guide for Soil Gas Monitoring in the Vadose Zone²

X2. AN EXAMPLE OF A DATA QUALITY CLASSIFICATION SYSTEM

X2.1 Introduction :

X2.1.1 This appendix describes an example of a four tiered data quality hierarchy modified from *New Jersey Department of Environmental Protection Field Analysis Manual*.⁵ Two significant modifications to the New Jersey Department of Environmental Protection and Energy (NJDEPE) Manual⁶

have been incorporated into the example data quality level hierarchy. First, the applications are for petroleum products only. The second modification designates Level 1 as screening levels, either qualitative or semiquantitative, that may require confirmatory analyses with higher data quality methods. Levels 2, 3, and 4 are considered to be essentially quantitative, with Level 2 being less quantitative than Levels 3 or 4. These levels can produce data of sufficient quality that does not necessarily need laboratory confirmation on a routine basis. An overview of these data quality levels are presented in this appendix.

⁵ New Jersey Department of Environmental Protection and Energy, *Field Analysis Manual*, July 1994.

⁶ New Jersey Department of Environmental Protection and Energy, *Alternative Groundwater Sampling Techniques Guide*.

X2.1.2 The USEPA utilizes a two-tiered approach to data quality. The first category “Screening Data With Definitive Confirmation” would include data quality Levels 1 and 2. The second category “Definitive Data” would include data quality Levels 3 and 4.

X2.1.3 State regulatory programs may develop their own definitions for data quality for the methods listed in this appendix, and may have specific reporting requirements when using these methods. Details on data quality levels, use of field analytical methods, and specific reporting requirements can be obtained by contacting the appropriate state environmental regulatory agency, fire marshal, or other local jurisdictions.

X2.2 *Data Quality Level 1:*

X2.2.1 Level 1A methods are intended to be used for health and safety evaluations, initial screening of soil and ground water for chemical(s) of concern. The measurements made with these methods (1A) are qualitative and only provide an indication of the presence of contamination above a specified value (for example, pass or fail, positive or negative). Because measurements made with these methods may not always be consistent, the data shall only be used as an initial screening for sample locations for analysis using higher level methods. Clean samples cannot be determined from these methods at this level.

X2.2.1.1 Instruments used for data quality Level 1 include: photoionization detector (PID) survey instruments, flameionization detector (FID) survey instruments, colorimetric analysis, and headspace analysis.

X2.2.1.2 Quality control procedures are limited primarily to instrument calibration, consistency in method procedure, and background level checks. Since relatively few quality control procedures are employed compared to higher-level field methods, data quality is very much a function of sample handling techniques and analyst skill.

X2.2.2 Level 1B methods can be used for qualitative and semiquantitative screening and defining the location of known types of contamination (that is, orders of magnitude or ranges). Level 1B data can be generated when PIDs and FIDs are used with controlled sample preparation and analysis procedures that include additional QA/QC such as that used with polyethylene bag headspace.

X2.2.2.1 Quality Assurance (QA) procedures include multipoint calibration curves using matrix-spiked field standards, a calibration check using matrix spike duplicates, and a field blank/background sample.

X2.2.2.2 Depending on regulatory requirements, laboratory confirmation may be needed for establishing laboratory-field correlation over the concentration ranges measured for confirming the achievable lower detection limit.

X2.3 *Data Quality Level 2:*

X2.3.1 Level 2 methods are intended to be used for delin-
eation of chemical(s) of concern. These methods can achieve a high degree of reproducibility when required QA/QC procedures are employed.

X2.3.2 Level 2 methods are typically laboratory methods that have been adapted for field use (that is, field gas chromatograph (GC), portable infrared (IR)) or are EPA-derived methods (for example, immunoassay). These methods may not be as rigorous because field extraction’s are not directly comparable to laboratory extraction methods.

X2.3.3 Quality assurance (QA) requirements include initial multi-point calibration curves, continuing calibration checks, matrix spike duplicates, background/blank samples, laboratory confirmation of clean samples, and possibly contaminated samples depending on the objective. A matrix spike recovery should be performed on a site-specific basis.

X2.3.4 Level 2 methods that provide a direct numerical value for the indicator measured but do not definitively identify the chemical(s) of concern present (for example, immunoassay, portable IR) are considered semiquantitative. Level 2 methods that measure specific constituents (for example, transportable GC’s) are considered quantitative.

X2.3.5 Depending on regulatory requirements, laboratory confirmation of a portion of the samples may be needed for establishing laboratory-field correlation over the concentration ranges measured for confirming the achievable lower detection limit.

X2.3.6 Level 2 methods also include EPA field screening and laboratory methods. The laboratory methods considered to be Level 2 have limited QA information documented. The quality of the data generated using Level 2 laboratory methods depends on the sample handling, storage, and preservation procedures, and analytical procedure and QC used.

X2.4 *Data Quality Level 3*—Level 3 methods are approved laboratory methods with complete QA/QC (for example, EPA Laboratory Methods [see USEPA SW846], third or more recent edition). Level 3 analyses can be performed at off-site laboratories or at on-site mobile laboratories that perform EPA methods. Certain regulatory agencies may require these laboratories to be certified.

X2.5 *Data Quality Level 4:*

X2.5.1 Level 4 methods are generally “state of the art” methods developed specifically for a particular site or chemical(s) of concern. Level 4 methods are used when standard laboratory methods are either unavailable or impractical.

X2.5.2 Generation of Level 4 data may necessitate the use of a laboratory that specializes in methods development.