Chapter 7
Field Data Instruments

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7.1 Introduction

The New Jersey Department of Environmental Protection (NJDEP) is committed to streamlining the collection of data in the field.

The applicable activities should follow the appropriate program specific rules and guidance, which places emphasis on the use of laboratory analytical methods to provide accurate and representative data. However, field analytical instruments may be employed if sufficient documentation can be provided to the NJDEP to support the proper application of the instrument.

The NJDEP maintains a library of guidance manuals on its website at https://www.nj.gov/dep/srp/guidance/. It is recommended the reader access the website and review the guidance manuals pertinent to the respective task. Additional guidance may also be found at websites of the EPA and the American Society for Testing and Materials (ASTM). Examples of some of the relevant guidance manuals and websites pertaining to this chapter are:

Soil Investigation Technical Guidance https://www.nj.gov/dep/srp/guidance/#si_ri_ra_soils;

Ground Water Technical Guidance: https://www.nj.gov/dep/srp/guidance/#pa_si_ri_gw;

Ecological Evaluation Technical Guidance: https://www.nj.gov/dep/srp/guidance/#eco_eval;

Quality Assurance Project Plan Technical Guidance https://www.nj.gov/dep/srp/guidance/#analytic_methods;

US EPA Field Analytical Methods PA Region 3: https://www.epa.gov/quality/epa-region-3-field-analytical-methods;

ITRC Implementing Site Characterization Tools: https://asct-1.itrcweb.org/;

Vapor Intrusion Technical Guidance: https://www.nj.gov/dep/srp/guidance/#vi; and

OSHA: https://www.osha.gov.

7.2 Role of Field Instruments According to the NJDEP Technical Requirements for Site Remediation, N.J.A.C. 7:26E

The role of field instruments in acquisition of field data for expedited site characterization (ESC) should operate within the framework of existing regulatory programs of NJDEP. Therefore, screening quality data (e.g., enzyme kits) should be verified by a more quantitative analytical method.

The instrument can be used in screening mode and or analytical mode in acquisition of field data. A site characterization and/or investigation shall follow the Technical Requirements for Site Remediation, N.J.A.C. 7:26E 3.3 and applicable NJDEP Guidance. The role of field screening methods defined by N.J.A.C. 7:26E, section 2.1(b) is as follows:

- For delineation when the contaminant identity is known or if there is reasonable certainty that a specific contaminant may be present (e.g., benzene, toluene, ethylbenzene, xylenes in the case of sampling for a gasoline release); or
- To bias sample location to the area of greatest suspected contamination.

In accordance with N.J.A.C. 7:26E-2.1(b)2, field screening methods shall not be used to determine contaminant identity or clean zones. However, where 10 or more samples are required for initial characterization sampling at an area of concern, field screening methods may be used to document that up to 50 percent of sampling points within the area of concern are not contaminated.

7.3 Application of Field Instruments to Acquire Data

Advanced site characterization tools (ASCTs) are capable of quickly generating data that can be used to provide a more precise and accurate conceptual site model (CSM) per the Interstate Technology and Regulatory Council (ITRC) guidance on site characterization. ASCTs deliver semi-quantitative or qualitative data that can aid the investigator in determining the best locations and depths where quantitative data could be collected for continued refinement or completion of a CSM or to allow decisions to be made. Specifically, ASCTs can provide images of site conditions in three dimensions showing spatial context of variations in geology and contaminant distribution that can then be used to target investigations and remedial actions. These more targeted investigations potentially reduce costs while improving results. Data can be collected by field portable handheld instruments or using in-situ devices that will be described below.

Field-portable instrumentation provides useful information for making critical decisions in the field. Typical application of field instruments includes the following:

- Emergency Response, Health, Safety and Industrial Hygiene, and Fence Line Monitoring – to determine possible exposure of the community and of personnel. For example, field test kits can provide rapid detection of polychlorinated biphenyls (PCBs) or explosives during site characterization.
- Source/Process Monitoring – Determines regulatory compliance-related monitoring of stack emissions or effluent discharge.
- Odor Investigation – A portable gas chromatograph/mass spectrometer (GC/MS) will permit analysis for unknown compounds and leak detection (source detection), a portable gas chromatograph (GC) will permit analysis of suspected contaminants.
- Site Characterization/Remediation/Brownfields – Field portable instrumentation/method is well suited to implement dynamic sampling plans in which the goal is to perform a rapid characterization. For example, headspace GC can be a useful option for rapid evaluation of volatile organic compounds (VOCs) in soil and water samples.

Field-portable instrumentation can be hand-held, rugged, and offer rapid results in the field. Field portable instruments include GCs, micro-GCs, GC/MS, extractive Fourier transform infrared (FTIR) spectrometers, filter-based and other infrared (IR) spectrometers, X-ray fluorescence (XRF) spectrometers, flame ionization detectors (FIDs), and photoionization detectors (PIDs).

7.4 Choosing Appropriate Field Analytical Instruments for Contaminant Investigation

There are many useful tools and resources for selection of field analytical instruments appropriate for project specific needs. This section is not intended to provide a complete summary of those. Instead, this section details the types of considerations which should be made when evaluating field analytical instruments. For additional information about ASCTs, ITRC has prepared a tool selection guide that can be found at: https://asct-1.itrcweb.org/.

7.4.1 Considerations When Selecting Field Analytical Instruments

Field analytical instruments can provide accurate results instantaneously or within a short period of time;

however, the field analytical instrument chosen must be appropriate for the analytes of concern and site conditions. When choosing a field analytical instrument, the first consideration should be to determine what analytes of concern are present on the site (i.e., Semivolatile Organic Compounds (SVOCs), PCBs, metals, etc.) and what level of detection (i.e., ppb, ppm, etc.) must be achieved to reach the goals established in the Quality Assurance Project Plan (QAPP).

7.4.1.1 Matrix Effects

The matrix or matrices (i.e., soil type, sediment, water, etc.) may cause one field analytical instrument to be preferable to another or may cause interference in an analytical instrument. An example of matrix effects is the presence of extremely fine clays, which may cause an immunoassay test to be biased low. Another example of matrix effects is the presence of large pebbles, which may render it difficult to use an XRF efficiently, as a flat, relatively uniform, surface is required for analysis. This problem may be solved by sieving the soil prior to analysis. Some field analytical instruments require sample extraction or other sample preparation methods, and therefore are not amenable to be used with certain matrices. Knowledge of the unique characteristics of the site matrices will permit identification of potential interferences due to matrix effects. Variation in elemental composition between different types of soil or matrices might cause interferences (e.g., between arsenic and lead). Some groundwater samples may effervesce, which can complicate use of a Field GC for groundwater samples. In this situation the laboratory should be contacted to change sample preparation. Site-specific equipment calibration can compensate for some of these effects.

7.4.1.2 Analyte(s) of Concern

The field analytical instrument chosen must be capable of detecting the analyte or analytes of concern at the site. Unlike most laboratory methods which detect suites of analytes, and provide quantitation for each of the individual analytes, many field analytical instruments tentatively identify only individual analytes or groups of analytes, without providing quantitation for each of the individual analytes. Several field analytical instruments (i.e., XRF, Field GC, etc.) can analyze a suite of analytes and provide quantitation for each individual analyte; however, these instruments require calibration for each analyte of concern. Several field analytical instruments can be used in conjunction to determine an array of analytes or cross-reference a common analyte. The data quality objectives in the QAPP will determine which field analytical instruments will be employed at the site. If several similar analytes are present at a site, it may be difficult to quantify certain analytes accurately because interference may create false positive results. Results obtained by some field analytical instruments (i.e., indicator tubes) are qualitative to semi-quantitative at best. The minimum detection levels for some field analytical instruments are influenced by factors such as water vapor (i.e., humidity) and interference from other chemicals.

7.4.1.3 Interfering Constituents

Prior to selecting a field analytical instrument, the presence of other site constituents should be considered. Other constituents, even those not regulated or below regulatory limits, may cause interference with the chosen field analytical instrument. An example of this type of interference is XRF use on soils with high iron levels. While the level of iron may be below regulatory levels, its abundance may raise the detection limit for other metals with low regulatory limits. Familiarity with other site constituents prior to selecting a field analytical instrument will permit quick identification of possible interference issues. Some field analytical instruments (e.g., field GC) may experience coelution of analytes which may cause biased high results of the analyte of interest, false positives, or make identification and quantification difficult or impossible.

7.4.1.4 Limitations

All analytical methods (fixed laboratory methods, field analytical methods, etc.) have limitations.

Understanding these limitations will help to apply the technology properly to generate data that meets the needs of the project. These limitations should be listed in the QAPP along with an explanation of how they relate to the objectives for the project. Some methods may not perform well for certain groups of analytes (e.g., petroleum hydrocarbon [immunoassay] methods may not perform well for motor oil or grease, or for highly degraded petroleum fuels) and therefore, these methods may have a potential for false negative results. Some reagents may require refrigeration, mandating a cooler or refrigerator be on site. While analysis with some field analytical instruments can be accomplished quickly, others can be time consuming to perform. Certain instrumentation operation (e.g., field GC) requires a higher degree of expertise than most other field analytical methods. Some field analytical instruments may require judgement made by the operator (e.g., color comparison to a chart) which can lead to inaccurate results. Some field analytical instruments may require that the specific analyte to be tested must be known so that the instrument can be calibrated correctly. Some field analytical instruments may have limited field-portability, such that they may require a field trailer or an electrical power source. Some field analytical instruments may be cost prohibitive on small-scale projects, or a specific license may be required to operate certain instruments (e.g., XRF).

7.4.1.5 Physical Conditions

Physical conditions (e.g., heat, cold, excessive sunlight, humidity, etc.) on site may cause logistical problems (e.g., space limitations, flat surfaces, dry surfaces, etc.) with certain field analytical instruments, or cause interferences during equipment operation. Examples of a logistical problem would be providing enough room with a relatively flat surface in an up-wind location for the setup of a field GC. Extreme temperatures will negatively affect most field analytical instruments and excessive sunlight may cause some reagents to break down, or LCD screens to blackout. Humidity may affect the accuracy of field analytical instruments and should be considered when planning field work. Familiarity with the site conditions will permit a determination of whether a given field analytical method is viable at a particular site.

7.4.2 Listing Limitations and Interferences for Selected Field Analytical Instruments

All field analytical testing equipment has limitations and interferences; however, these limitations and interferences do not preclude field instruments from providing useful information. A thorough understanding of the field analytical instrument’s limitations and interferences, as related to site conditions, can define the usefulness of the instrument and the data produced by that instrument. The limitations and interferences should be detailed in the QAPP. The QAPP should list the limitations and interferences of the planned field equipment and the ways of compensating for these limitations and interferences, or provide reasons why they will not interfere with the objectives of the QAPP for a given phase of site investigation.

7.4.2.1 Analytes of Concern

Some field analytical instruments analyze for general classes of analytes, while others analyze for target analytes of concern. Several field analytical instruments can be used to test for more than one analyte. Some field analytical instruments are designed for classes of analytes (e.g., polyaromatic hydrocarbons [PAHs], carcinogenic PAHs, benzene/toluene/ethylbenzene/xylenes [BTEX], etc.), and will provide a concentration of the total class of analytes but will not indicate the concentrations of individual analytes. Some field analytical instruments may analyze/target one specific analyte, but will respond in various degrees to other related analytes (e.g., immunoassay for pentachlorophenol [PCP] will respond to other chlorophenols). Several field analytical instruments can be used together when testing for multiple analytes.

Some field analytical instruments may provide quantitative results, semi-quantitative results, or qualitative results. Depending on the objectives specified in the QAPP, any of these types of results may be acceptable for certain phases of the project. Target analytes, target groups of analytes, and related detection limits should be listed in the QAPP with an explanation of how these results will satisfy the data quality objectives in the QAPP for each phase of the investigation.

7.4.2.2 Interfering Constituents

When interfering constituents are present on the site, generally the method cannot be altered to compensate for the interference. When the interfering constituent still allows analysis of the analyte of concern to be performed, but with a higher detection limit, then the field analytical method may still be valid for the site, but in a limited capacity. Although the field analytical method may not be appropriate for site closure purposes or final delineation purposes, the field analytical method may still be a valuable tool in early sampling rounds delineating gross contamination. The way in which the field analytical method will be employed at the site will determine whether interfering constituents preclude the method's use at a given site. A list of interfering constituents, their effect on the analyte(s) of concern, and how this relates to the objectives of the QAPP should be addressed.

7.5 Field Screening Instruments/Characterization Tools

Field screening instruments/characterization tools can measure compounds of concern through direct contact, or discrete sampling. Some can determine soil lithology and soil permeability, while others can detect the presence of VOCs or NAPLS. The various tools can be combined to identify both lithology and contaminants to provide a subsurface picture of the extent of the plume.

The field screening instruments discussed herein are not inclusive but are generally the most common ones used in the field. Reference https://asct-1.itrcweb.org/1-introduction/ for further information on field screening instruments and other methods of site characterization.

Please note that some direct sensing tools rely on direct-push technology, so appropriate utility mark-outs and subsurface clearance procedures may need to be performed. As noted above, tool selection is based on the contaminant type and matrix type you are investigating.

7.5.1 Field Detection of Volatile Organic Compounds (VOCs)

7.5.1.1 Portable Gas Chromatograph

Portable GCs are available for field screening of select volatile organic compounds. Small portable units (such as Frog-5000 ^{TM}) can deliver quantitative results in a relatively short timeframe (approximately 5 to 10 minutes or less) and can be used to sample multiple types of media. Common applications include site characterization, ground water monitoring, surface water monitoring, soil vapor monitoring, and indoor air quality. The portable gas chromatograph can provide the concentrations and identification of the targeted volatile organic compounds. Depending upon the portable gas chromatograph used, identification of the volatile organic compounds may be detected at parts per billion levels. Compound specific detections and concentrations can only be generated for compounds for which the gas chromatograph has been calibrated, so it is important to know what compounds you are looking for. To verify the accuracy of the data collected a percentage of the samples should be sent to the laboratory for confirmation analysis. See Chapter 2 for additional quality assurance considerations.

Advantages:

- Light Weight
- Deliver results quickly
- Sensitivity for detection of VOCs ranging from sub-part-per-billion levels to high part-per-million levels depending on the configuration

Limitations:

- Rental cost
- Field Analysis to laboratory analytical results are not always comparable
- Battery Life
- Weather durability
- Semi Quantitative and Qualitative Results
- Equipment may require multiple cleanings
- Manufacturer calibration
- Low concentrations may not be detected

7.5.1.2 Organic Vapor Analyzers (OVAs)

A common field screening direct reading instrument (DRI) used during contaminated site field investigations is the organic vapor analyzer (OVA). The majority of OVAs can be subdivided into two types, photoionization detectors (PIDs) and flame ionization detectors (FIDs). Portable/field designed OVAs can measure volatile organic compounds (VOCs) over a wide concentration range. The units continuously draw in air through an internal air vacuum pump where the air stream is directed to a detector. Compounds in the air stream are then ionized by the energy source of the detector. The resulting positively charged ions and electrons are attracted to nearby electrodes producing a measured electrical current which is converted to a reading. The response readings (i.e., output) of the units represent the concentration of VOCs in the air sample, relative to the calibration gas. The DRI readings do not identify specific compounds or their concentrations, unless the component of the sample gas is known. The readings from a DRI represent the total concentration of compounds ionized in the air stream. Reported concentrations are relative to the calibration gas used for the unit. As such, unit readings likely vary from the actual compound concentrations in the air stream.

The OVA readings represent the concentration of VOCs in the air that is at the detector inside the unit. When testing a location, the air intake hose should remain at the testing location for a sufficient amount of time for the air to be pulled up through the sample line and ionized in the unit. Response times for standard units are generally in the 3-5 second range. If hose extensions are used, the unit response time will be proportionally longer. Response times are typically provided in the manufacturer's operation manuals for the instruments. Response times can also be tested during a bump test (e.g., testing the response of the unit to a gas of known concentration).

While the purpose of these two types of OVAs is the same (the detection and quantification of organic vapors), they have different sensitivities and are calibrated with different gases, so they may generate different results from the same sample. In broad terms, PID response varies by functional group (A functional group is a set of atoms or bonds within a molecule that function together to react in predictable or similar ways. Functional groups are responsible for the physical and chemical properties of the molecule (e.g., alcohol group, alkene group, etc.)), whereas FID response varies by carbon chain length. In general, FIDs are usually used when evaluating easily combustible hydrocarbons such as methane, gasoline, and diesel. PIDs are more commonly used when evaluating non-combustible compounds such as chlorinated solvents. In addition, PID units can usually detect lower concentrations than FIDs.

Calibration

At a minimum, OVA units should be calibrated daily before use in accordance with the manufacturer's recommendations and instructions. Thereafter, the unit should be "bump" tested at least one time during the day's activities. The bump test is a qualitive test to verify sensor performance. The results of the bump test should be within a predetermined percentage of the calibration gas standard concentration which may vary depending upon the use of the data being produced by the DRI. This percentage should be presented in the site-specific quality assurance project plan (QAPP). If the results fall outside the established range, the unit should be re-calibrated.

7.5.1.2.1 Photoionization Detectors (PIDs)

PIDs are a field screening instrument that uses a high energy ultraviolet (UV) light source to ionize compounds in the air stream pulled into the unit by an air vacuum pump. PIDs only detect those compounds that can be ionized by the UV lamp in the respective unit. UV lamps of different electron voltages (eV) can be installed in the unit. Common PID lamp electron voltages are 9.8, 10.6, and 11.7. The PID will only ionize compounds that have an electron voltage (voltage/energy needed to ionize the compound) below that of the unit lamp. Therefore, the compounds the unit can detect are directly linked to the eV of the UV lamp installed in the unit. Equipment manufacturers have generated lists that provide the eV needed to ionize certain compounds. Comparing these lists to the eV of the PID lamps will allow one to determine what eV lamp is appropriate for the intended work.

PIDs do not require hydrogen or other fuel sources to operate. PID units are commonly calibrated with isobutylene, but may be calibrated to a site specific compound.

PIDs are better (i.e., higher sensitivity) than FIDs at detecting chlorinated hydrocarbons, formaldehyde, amines, methanol, and aromatic compounds.

PID sensitivity reportedly decreases in the order: aromatics & iodine compounds > olefins, ketones, ethers, amines & sulfur compounds > esters, aldehydes, alcohols & aliphatics > chlorinated aliphatics & ethane.

PIDs can detect some substances for which FIDs are not effective, such as ammonia and hydrogen sulfide. Additionally, PID models have different sensitivity ranges and can provide field readings in parts per million (ppm) or parts per billion (ppb). The user should be aware of the targeted range anticipated for field use (i.e., soil screening vs indoor air walkthrough screening) and may want to select the appropriate PID for the best field application.

PIDs cannot detect methane. As such, PID units are good for detecting non-methane organic compounds in anaerobic locations, such as landfills, where methane generation is common. Caution should be exercised in these situations. While PIDs cannot detect methane, methane will quench the PID signal. For example, at methane concentrations of 1.0% (20% of the lower explosive limit), the PID signal will be reduced by 10%. When using a PID in the presence of high methane concentrations or high VOC readings, a dilutor may be employed. This device dilutes the sample stream with ambient air to bring concentrations within operational range of the detector. To obtain accurate readings using a dilutor, a dilution factor will need to be determined with calibration gas.

Readings from PIDs can be affected by moisture and relative humidity. This is a common problem with PIDs and its negative effects on the data quality cannot be overstated. PIDs have reduced responses as humidity increases. This means as the humidity increases, the response of the unit to a fixed compound concentration will decrease, producing a bias low reading. Water vapor scatters and absorbs photons, reducing the PID output. The reduction in PID response due to humidity is called “quenching”. At high humidity PIDs can error in the opposite direction, developing false positive readings that appear as a rising upward drift. This is caused by current leakage along the sensor walls, resulting in higher than actual readings. These issues are likely due to moisture condensing on the sensor or the UV lamp (i.e., fogging) inside the unit. For the PID unit to produce accurate readings, the internal sensor and UV lamp need to be maintained in a clean and dry condition. Examples of situations where the PID response may be affected include:

- screening monitor well head space;
- monitoring a borehole during or just after is has been drilled;

- screening soils or water on a humid day; and
- moving the unit from a cooler environment (e.g., air-conditioned building or vehicle) to a warmer environment.

To address the aforementioned problems: 1) maintain a clean dry sensor and UV lamp; 2) reduce the potential for condensation to develop inside the unit by acclimating the unit to site conditions before being operated. Sometimes turning on the unit and warming it up prior to entering the humid environment may prevent internal condensation from occurring.

Drying the sample air using desiccant filter tubes attached to the air intake tube can address responses for non-polar compounds like gasoline and tetrachloroethene (TCE). However, high molecular weight and polar compounds tend to adsorb to the desiccant material, resulting in a slower response, particularly at low temperatures and concentrations. Some compounds, such as amines adsorb completely to the desiccant and cannot be measured using desiccant tubes. Desiccant filter tubes may only be usable for 15 minutes to an hour due to water saturating the media, and exceeding its moisture trapping capacity.

Preventing dirt and dust from entering the PID sensor is the best measure to reduce the potential for moisture issues. It is recommended to use a moisture filter when operating a PID in high humidity conditions.

Where the chemicals of concern for an area under investigation have not been determined, NJDEP recommends that the PID unit used at the site contain a higher eV lamp. It should be noted that higher eV lamps (e.g., 11.7 eV) increase the number of detectable VOCs at the cost of a shorter lamp life and a shorter operational battery cycle.

When using a PID at a site where the chemicals of concern have been identified, the PID unit used should possess a UV lamp that is of sufficient energy to ionize the compounds of concern. This can be accomplished by reviewing tables of compound ionization potentials/eVs prior to conducting the field work.

Due to common field issues with PIDs, NJDEP recommends that a backup PID unit be available during field work where a PID unit is needed.

Operators of PID units should be aware that the units may detect naturally occurring compounds that can be volatilized during drilling and excavation activities. An example would be aromatic oils released from the tree roots of sassafras trees.

Advantages:

- The unit does not require hydrogen or other fuel sources
- Detection levels for some units may be in low ppb range
- The unit can detect a wide range of volatile compounds
- Can detect some inorganic substances

Limitations:

- The range of compounds detected by the unit is dependent on the energy (eV) of the unit lamp/ultraviolet light
- High levels of methane can quench/reduce the PID signal, resulting in bias low readings
- Can produce inaccurate readings when exposed to situations of elevated moisture or humidity

7.5.1.2.2 Flame Ionization Detectors (FIDs)

FIDs are a field screening instruments that pull air into the unit via an air vacuum pump and pass it through a flame (usually fueled by a hydrogen tank). Organic compounds in the air stream are burned forming positively charged ionized compounds. The positively charged ionized compounds come in contact with an ionization detector and result in the production of electrical current. The magnitude of electrical current represents the output reading of the unit.

Unlike PIDs, FIDs are generally free from humidity effects except if water condenses in the sensor. This may cause the unit to flame out or not ignite.

FIDs are usually calibrated to methane but may be calibrated to a site-specific compound.

Modern units detect concentrations ranging from 1 to 50,000 ppm. The units are non-compound specific. Responses represent total ionizable compounds. Detection linearity is good throughout the concentration range.

FIDs principally measure compounds containing carbon. The FID's sensitivity is highly dependent on the chemical structure and bonding characteristics of the compound being burned. The combustion efficiency of a compound determines its sensitivity. Simple saturated hydrocarbons (methane, ethane, etc.) possess high combustion efficiencies and are among the compounds that produce the highest FID response. Organic fuels (acetylene, refined petroleum products, etc.) also burn easy and produce good responses.

Generally the FID can detect aromatics (e.g., benzene, toluene, total xylenes), ketones and aldehydes (e.g., acetone, methyl ethyl ketone, acetaldehyde), amines and amides (e.g., compounds containing carbon and nitrogen such as diethylamine), saturated hydrocarbons (e.g., methane, ethane, butane), unsaturated hydrocarbons (e.g., butadiene, isobutylene), alcohols (e.g., methanol, ethanol, isopropanol), and combustible sulfur compounds (e.g., mercaptans).

FIDs can detect but do not respond well (i.e., poor sensitivity) to organic compounds that contain nitrogen, oxygen, sulfur, or halogen (e.g., fluorine, chlorine, bromine, iodine, etc.) atoms, and they cannot detect inorganic compounds that do not contain a carbon atom. As such, FIDs exhibit poor sensitivity to highly halogenated organic compounds such as PCE, TCE, carbon tetrachloride, and freons. The release of halogen atoms during the combustion process can damage the FID detector/sensor.

Since the operation of the unit is based on the combustion of vapors in the air stream, FID units are not sensitive to non-combustible gases such as hydrogen sulfide, ammonia, and water vapor.

FID sensitivity reportedly decreases in the order: aromatics and long chain compounds > short chain compounds > chlorine, bromine and iodine compounds.

Advantages:

- Can detect methane
- Less prone to moisture and humidity effects

Limitations:

- Process involves the burning of the compound, so a fuel source for the unit is required
- Detection levels are generally in the PPM range
- For compounds to be detected they must be combustible
- Unit sensitivity is related to combustion efficiency of compound
- Poor sensitivity to compounds containing nitrogen, oxygen and halogens
- Generally will not detect inorganic compounds that do not contain carbon
- Considered to be portable, but units can be considerably larger than PIDs

7.5.1.3 Membrane Interface Probe

A Membrane Interface Probe (MIP) is a soil and ground water field screening tool that can detect volatile organic compounds such as chlorinated solvents and petroleum hydrocarbons in the subsurface. MIP logging detects the presence of volatile chemicals by simultaneously using multiple types of sensors, such as a FID, a PID, a halogen specific detector (XSD), or an electron capture detector (ECD). Contamination can be detected in ground water and soil; including the vapor phase, absorbed phase, and dissolved phase. Selection of XSD versus ECD should be evaluated when looking at specific chlorinated VOCs. An ECD detector is primarily used for identification of chlorinated solvents; however, an ECD can reach saturation limits and does have difficulty identifying daughter products. As such, XSD has been a common replacement for ECD in mixed chlorinated VOC plume investigation. ECD does tend to work well and provide a good response in a single chlorinated VOC plume investigation with lower concentrations.

The MIP is pushed into the ground surface via direct-push technologies. As the MIP is pushed into the soil, VOCs in the subsurface encounter the probe's semi-permeable membrane. This membrane is comprised of a thin film polymer, which is impregnated onto a stainless-steel screen for support. During the advancement of the MIP, the membrane is heated to approximately 120 degrees Celsius. This increases the volatility of the VOCs in the subsurface, facilitating the transition of some of the VOCs into the vapor phase. The vapor phase of the VOCs diffuses across the membrane into an inert gas loop that carries the vapors to the surface. At the surface the detectors measure the VOC concentrations from compounds like chlorinated solvents and petroleum hydrocarbons in real time.

MIP equipment can generate continuous vertical logs of MIP results. The MIP logs can be used to develop vertical profiles, transects, and 3D pictures of VOC distribution.

MIP tools can also be used simultaneously with cone penetrometer technology (CPT) to provide lithological information as the direct-push drill is advanced into the soil. Additionally, MIP tools can be advanced with a hydraulic profiling tool (HPT) to further evaluate properties of the subsurface. HPT provides hydraulic conductivity, pressure, flow and provides data for flow pathways and confining layers. HPT also allows for the collection of discrete ground water samples in very small increments (<6 inches). The results of the MIP investigation, coupled with the results of the CPT and HPT work, can produce data suggesting plume geometry, soil properties, and soil permeability.

MIP results can be used to generate vertical profiles, transects, and 3D pictures and maps based on the generation of logs or profiles of continuous data.

Advantages:

- Provides real-time data/readings which allows for decision to be made in the field
- MIP can detect contamination in soil and ground water including vapor phase
- MIP can provide distinction between non-chlorinated VOCs and chlorinated VOCs by comparing the results of the various detectors
- Plume delineation can be estimated without soil borings or monitoring wells
- Expedited investigations can be conducted and rapid data from MIP can be used to strategically place permanent monitoring wells, collect soil samples or vapor/soil gas samples efficiently
- Can significantly reduce the data gaps for a site conceptual model when evaluating extent of contamination at a site
- Results can be provided in a 3D image, providing robust visual understanding of the extent of a plume
- MIP, CPT, and HPT can be combined on the same direct-push tooling to provide a comprehensive direct read results for plume evaluation simultaneously

Limitations:

- MIP equipment and sensors are limited to certain chemicals/compound groups.
- MIP equipment has detection level limitations due to how it works. Lower detection levels may be obtained by implementing the "Low Level MIP" (LL MIP) technique. The MIP technique will not detect low concentrations of contaminants, and high concentrations may saturate ECD detectors.
- Drilling via direct-push technology has limitations with lithology (e.g., glacial till) and depth based on formation/lithology.
- When targeting specific zones in the subsurface, MIP equipment requires more vertical clearance than typical direct-push drilling set up as the MIP probe tooling sensors are stacked on the probe tool. As such, there are limitations for detecting compounds immediately above the bedrock surface or a confining layer. There should be discussions with the MIP contractor to confirm each sensor has reached the targeted depth interval.
- Data collected is for evaluation purposes and typically does not replace laboratory analytical data as point of compliance for regulatory purposes.
- Data output from the detectors is in a graphical form which can be presented in varying scales/sensitivity ranges. Attention to the graphical scales and sensitivity ranges should be discussed with the trained professionals on interpretation of results. Care should be taken when comparing the logs from different MIP locations as the concentration scales may be different.
- Equipment can be sensitive to geologic, weather, and calibration issues. The electronics in the MIP tool are prone to failure when driven into compacted fine sands and silts, or hitting rocks or bedrock.
- MIP tools may not be cost effective for small sampling programs or investigations.
- Equipment may experience clogging or fouling on lenses. Backpressure on the HPT affect the response output of the HPT tool.
- Requires professionals trained in the operation and understanding of the equipment, also requires a specialty drilling company with the MIP tooling.

7.5.2 Field Detection of Semi-Volatile Organic Compounds (SVOCs)

7.5.2.1 Petroleum Hydrocarbon Analyzer (PHA)

The analysis of total petroleum hydrocarbons can be grouped into two different methods, analyzers and field kits. The analyzers incorporate various electronic detectors such as infrared spectrometers, FIDs, or gas chromatography. The field kits typically involve adding a reagent to the sample and measuring the reaction.

Total petroleum hydrocarbon (TPH) analyzers are a field screening instruments that are available for the non-compound-specific screening of TPH and various petroleum hydrocarbons (e.g., fuels, oils, etc.). The TPH analyzers can be used to evaluate relative concentrations in soil, water, or air depending upon the detector type and model. Typical soil detectors may not distinguish between aromatic and aliphatic hydrocarbons but will provide a total petroleum hydrocarbon concentration within the equipment's specific unit range. As with any field screening tool, considerations (e.g., media type) should be taken to use the appropriate equipment to achieve the best results.

Examples of PHA field test kits include immunoassay petroleum fuels in soil test kit, turbidimetric based hydrocarbon test kit for soil, colorimetric kit, and a total organic carbon (TOC) analysis instrument using persulfate oxidation. For additional information on the application of the technology see https://doi.org/10.1016/S0304-3894(00)00328-9.

Advantages:

- Provides real-time field results in parts per million
- Reduces the amount of laboratory analytical samples to meet remediation goals
- Allows for field decisions to expedite site investigations and remediation
- Portable and handheld
- Sample only requires a small soil sample (~10grams)
- Easy to use
- Kits are relatively inexpensive
- Works with all soil types

Limitations:

- Results can be impacted by soil moisture
- Results can be effected/biased high when soil is collected near naturally occurring sources of terpenes (pine, cedar, or fir trees) and creosotes
- Requires purchasing test kits which are expendable and may expire
- Cannot differentiate between aliphatic and aromatic hydrocarbons
- Cannot differentiate between contaminants of concern and compounds present due to anthropogenic sources such as asphalt roadways
- Data collected is for evaluation purposes and typically does not replace laboratory analytical data as point of compliance for regulatory purposes
- Weather durability
- Large temperature changes may require recalibration
- Requires calibration of equipment
- Meter has limited lower and upper detection limits and can be extended using the High Range Extraction option

7.5.3 Field Detection of Polychlorinated biphenyls (PCBs) and Polycyclic aromatic hydrocarbons (PAHs)

Several field screening/testing options are available for analysis of PCBs in oil, soil, water, sediment, and wipe samples. Testing options can be performed via assay or detector-type field kits. The assay testing option uses an enzyme-linked immunosorbent assay testing process for qualitative and sensitive screening results. The detector sampling option uses a field analyzer to measure total organic chlorine and compares it to targeted or expected analyte concentrations. Below are two examples with advantages and limitations for each. It should be noted that these field screening/testing methods are primarily used to make in the field decisions. The field screening methods should not be substituted for final endpoint/compliance samples that are sent to a NJ-certified laboratory.

7.5.3.1 Assays

PCB assay kits are available for field screening of PCBs. The kits apply the principle of enzyme linked immunosorbent assay to determine PCB concentrations. The kits can be used for rapid field testing of soil, water, and wipe sampling to provide quantitative, semi-quantitative or qualitative results. The field kits are used in conjunction with a series of reagents and a field filter photometer to provide results within a relatively short period of time instead of sending a sample to an offsite laboratory.

Advantages:

- Provides field results in parts per million (solid sample), parts per billion (liquid sample), or micrograms per wipe (wipe samples)
- Reduces the amount of laboratory analytical samples to evaluate remediation goals
- Soil extraction time is approximately 2 minutes with assay run time of approximately 60 minutes
- Allows for field decisions to expedite site investigations and remediation and waste disposal
- Relatively easy to use with training
- Kits are relatively inexpensive per tube kit vs laboratory analysis

Limitations:

- Assay requires extraction and is not an instantaneous reading/measurement
- Requires purchasing test kits which are expendable and have a shelf life (typically one year from date of manufacturer) per manufacturers specification
- Kits have a maximum sample number per each batch which should be considered in the sampling plan for per sample cost efficiency
- Kits are temperature sensitive and should be stored at 4-8 degrees Celsius when not in use and 18-27 deg C for the day of use
- Kits have some reagents that are photosensitive, and some solutions should not be exposed to direct sunlight
- Data collected is for screening purposes and typically does not replace laboratory analytical data as point of compliance for regulatory purposes
- Assay kits require analyzer to provide testing results in the field
- Training is strongly recommended
- Kits have a minimum detection limit that may not meet project goals

7.5.3.2 PCB Analyzers

Field testing analyzers for PCBs are available for field screening. These small portable units can deliver quantitative results in a relatively short timeframe (~5 to 10 minutes or less) and can be used to sample multiple types of media including transformer oil, soil, water, and surface wipe samples. The PCB field analyzer measures total organic chlorine which are compared to target or expected analyte concentrations. The PCB analyzer system can be used to expedite remediation, allowing for field decisions to confirm the extent of contamination or to identify the location of confirmation sample collection for regulatory compliance. This approach can reduce the expense of laboratory analysis and sample collection for shipment offsite.

Advantages:

- Provides relatively quick results in the field, sample time takes approximately 5-10 minutes
- Reduces analytical lab costs and resampling
- Supports targeted/focused remediation
- Reduces remediation timeframes
- Field portable, weighs approximately 6 pounds and can be run on rechargeable batteries for up to 8 hours
- Requires minimal training
- Samples can be prepared concurrently and analyzed at a later time

- No refrigeration is needed

Limitations:

- Requires calibration of equipment; up to 20 samples can be analyzed before recalibration is needed
- Reagent kits have a shelf life and must be used within their operating window per manufacturer's instructions
- Reagent kits are made to order and require preplanning
- Temperature sensitive; if ambient temperature changes by more than 5 deg C, equipment requires a recalibration. Allowable working temperature of the meter is 13-38 deg C
- Reagents/titration slightly involved and requires a good, clean workspace (preferably protected from the elements) to perform the lab set up and run samples
- Analyzer requires power source
- Results confined to upper and lower detection limits (3-2000 ppm)
- Data collected is for evaluation purposes and typically does not replace laboratory analytical data as point of compliance for regulatory purposes
- Weather dependent, should not be operated above 85% humidity

7.5.4 Field Detection of Metals

7.5.4.1 X-Ray Fluorescence (XRF)

XRF detectors are field screening tools used for the field analysis of various metals. They can be used for the evaluation of both solid and aqueous matrices, but are generally more effective with solid sample matrices such as soil, sediment, and surfaces. XRF's can be used to quantify and/or qualify various elements but not all. The XRF analyzer can detect various elements by focusing an x-ray beam onto the target sample. The X-ray beam interacts with the atoms in the sample, energizing electrons from the inner orbital shells of the atom to higher more energetic orbitals. Outer orbital electrons decay back inward to fill the electron vacancy in the inner orbit and emit a characteristic wavelength of light (photons) corresponding to that metal. During this process energy is released as the higher energy outer orbit electron moves inward to fill a lower energy inner orbit location. The energy released during this process is element specific. The XRF unit detects the energy released from the atom/element during the movement of the electron from an outer to an inner orbit.

The benefits of utilizing XRF detectors include the ability to quickly screen multiple samples while in the field, the ability to screen for multiple elements at the same time, the ability to generate real time data, portability of the instrument, and identification of hot spots which may not be feasible based solely on traditional field screening techniques. However, there are considerations which must be made before using XRF detectors. Some of the XRF issues include detection limits which may be above remedial actions thresholds, matrix interference, special licensing requirements, and safety considerations due to the use of x-ray radiation.

Advantages:

- Provides real-time readings of metal content in tested materials
- Can provide expedited evaluation of extent of metals contamination for remediation investigation
- XRF handheld units are very portable and can be used by a single person in various locations inside or outside
- Sampling is non-destructive
- Equipment requires limited training

Limitations:

- Equipment contains a radioactive source and special considerations regarding training, operation, and safety procedures during use of XRF equipment is recommended
- Field conditions such as soil moisture can affect consistency of results
- Equipment requires periodic calibration and/or check with standard reference material to confirm accurate readings
- May experience variability in data depending on alignment of unit on to surface of test material
- Data collected is for evaluation purposes and typically does not replace laboratory analytical data as a point of compliance for regulatory purposes
- XRF cannot test for all metal analytes

7.5.5 Field Detection of Hydrocarbons

7.5.5.1 Laser Induced Fluorescence (LIF)

LIF is a field screening instrument that uses laser light to excite fluorescent molecules that exist in some types of non-aqueous phase liquids (NAPLs), such as petroleum fuels/oils, coal tars, and creosotes (i.e., liquids containing compounds that are constructed of one or more benzene rings).

Advantages:

- LIF detects the PAH fluorescence in NAPL, allowing the detector to log NAPL presence with depth
- LIF is a mature technology, with hundreds of miles of LIF logging at hundreds of sites in the last 20 years
- LIF is logged continuously with depth (2 cm/second) - no data gaps or partial recovery
- Can differentiate the type of NAPL detected
- LIF detects NAPL in both the vadose and saturated zones
- LIF detection limit ranges between 10 and 1000 mg/kg (TPH), depending on fuel type and soil matrix

Limitations:

- Limited to lithologies where direct –push drilling can be used.
- Limited to substances containing compounds containing one or more benzene rings.
- LIF typically does not respond to dissolved **phase VOCs or SVOCs due to the lower concentrations.**
- BTEX compounds may not be detectable as their fluorescence absorption and emission may be below the range of some detectors.
- Depending on the detector used, larger PAH compounds may not fluoresce.
- Soil matrix affects fluorescence – sands and gravels may have as much as 10 times higher response than clays and silts.
- LIF's potential false positives include shell hash (due to calcareous matrix), meadow mat, peat, wood, and calcareous sands. The waveform shape and low fluorescence intensity nearly always identify these materials as suspect.
- LIF will not detect clean chlorinated solvent NAPL (DNAPL) because it does not contain fluorescent molecules. If the chlorinated solvents are contaminated with oils, fuels or dyes they may fluoresce.

7.5.5.2 Dye-enhanced laser induced fluorescence system (DyeLIF) ™

LIF technology is a field screening instrument that is capable of detecting chlorinated solvent DNAPLs. DyeLIF™ is a tool capable of detecting residual chlorinated solvent DNAPL in the subsurface. DyeLIF™ is based on combining time-resolved LIF technology with the injection of a fluorescent dye ahead of the window to bond with non-fluorescent NAPLs and create an in-situ fluorescent tag.

Advantages

- DyeLIF™ is capable of detecting chlorinated solvent DNAPLs

Limitations

- DyeLIF™ is limited by lithologies that can be pushed and cannot differentiate between DNAPL product types.
- Limited to lithologies where direct –push drilling can be used

7.5.5.3 Optical Image Profiler (OIP)

Similar to various LIF technologies, OIP is a field screening instrument and a high-resolution site characterization (HRSC) tool that efficiently delineates NAPL.

OIP-UV Probe - The OIP-UV probe uses an UV LED and visible light camera and is suitable for delineation of lighter fuels such as gasoline, diesel.

OIP-G Probe - The OIP-G probe uses a green laser diode and an infrared camera, ideal for delineating coal tars, creosote and heavy fuels or oils.

Advantages:

- Real-time data
- Visible images of in-situ soils provide an additional line of evidence for soil characterization. Qualitative assessments of grain size and soil color can be made to improve the site conceptual model
- No waste products

Limitations:

- Limited to lithologies where direct –push drilling can be used
- Not effective in detecting dissolved phase
- Cannot differentiate product type

7.5.5.4 Tar-specific Green Optical Screening Tool (TarGost)®

TarGost® is a registered OIP and is a field screening instrument. It was developed to detect and characterize the heavier PAH NAPLS, coal tars, creosotes, and heavy crude oils.

Advantages:

- Real-time data
- No production of investigation derived wastes

Limitations:

- Limited to lithologies where direct –push drilling can be used
- Not effective on light PAH NAPL or chlorinated DNAPL
- Not effective in detecting dissolved phase contamination

7.5.5.5 Ultra-Violet Optical Screening Tool (UVOST)®

UVOST® is used as an in-situ tool for field screening of hydrocarbon-derived contamination in soil and ground water. Best used to delineate petroleum, oil, and lubricant contaminants in the subsurface including, gasoline, diesel fuel, jet fuel, and hydraulic fluids.

Advantages:

- Typical detection limit of 10-500 ppm (detection limit varies with NAPL type and soil type)
- Effective above and below the saturated zone
- One-inch data density coupled with nearly instantaneous response provides continuous detailed log of product distribution and heterogeneity
- Waveforms offer product identification/verification and rejection of non-contaminant fluorescence such as mineral, peat, and other minor interferents

Limitations:

- Limited to lithologies where direct-push tooling can be used
- Does not work well to detect high-PAH content NAPLs such as tars, bunkers

7.6 Data Quality Levels for Implementation of Field Analytical Methods

This section defines the NJDEP Contaminated Site Remediation and Redevelopment Program (CSRRP)'s Data Quality Levels for contaminant investigation. The type of data required depends on the decision to be made. There are four types of data that can be used to support different types of decisions.

- <u>Preliminary or Field Screening Data</u> – (Data Quality Objective Level 1): These data are described as screening data. The analyses use field portable instruments. Results often are not compound specific (determinative) and not quantitative, but results are available in real time. The key feature is that additional confirmatory analysis of the same samples is usually required with respect to the remedial decision to be made.
- <u>Effective Data or Field Analytical Data</u> – (Data Quality Objective Level 2): The data is "effective" when a portion (10 percent or more) of the results is substantiated or verified by off-site analysis using EPA-approved methods. The effective data are adequate or effective for the intended use (usually because associated quality control is sufficient to inspire confidence).

  These data are generated by more sophisticated portable analytical instruments and the instruments can generate effective data. The term effective or acceptable data quality is meaningful only when the intended uses for the data are established. Therefore, the goal is to generate the quality data required to accomplish the DQO of the project. Depending on the objective, that may or may not mean laboratory quality data. The quality of the data depends on the use of suitable calibration standards, reference material, and sample preparation equipment and the training of the operator. Results are available in real time or within several hours.

  For example, a site has been characterized well enough that the identities of the contaminants are known, and "yes or no" decisions about categorizing waste piles must be made. The analytical tool selected may be known to cross-react with a range of analytes, but, because it is known (from previous confirmatory investigation) that those interferences are not present, the tool is acceptable for support of the "yes or no" decision without confirmatory analysis by another method.

  The field analytical instruments should provide data of sufficient quality to meet the data quality objectives. Supporting Quality Assurance (QA) and Quality Control (QC) procedures should be provided to document data quality (please refer to the QA and QC procedures in section 7.7).

As previously stated, according to N.J.A.C. 7:26E-2.1(b), field screening methods are generally not to be used to determine contaminant identity or clean zones. However, where ten or more samples are required for initial characterization for an area of concern and a variance is utilized, field analytical methods (as opposed to field screening methods) may be used to document that up to fifty percent of the sampling points are not contaminated.

- Meticulous or Definitive Data – (Data Quality Objective Level 3): These data are generated by a method that determines the identity and the concentration of the analyte with "reasonable" certainty. These data can stand on their own with respect to the vast majority of possible decisions.

  The meticulous or definitive data are generated from an approved laboratory method and contain QA/QC deliverables as required in N.J.A.C. 7:26E, Appendix A. These data can be used for clean zone confirmation and for delineation during the remedial investigation.

- "State-of-the-Art" Data – Special "state-of-the-art" methods may be developed specifically for a particular site.

Table 7.1 Overview of Data Quality Classifications

Data Quality Level	Purpose of Sample	Example Methods or Instruments
Data Quality Level 1: Screening Data	Health & Safety, Field use when excavating, Contaminant Screening & Delineation	PID, FID, Colorimetric Analysis, XRF, Headspace Analysis, Hydrophobic Dye Test
Data Quality Level 2: Field Analytical Data	Field use when excavating, Contaminant Delineation, Clean Sample Confirmation during SI	Portable GC, XRF, Immunoassay, USEPA SW-846 Field Screening Methods Laboratory Analyzed Samples with Limited QA/QC requirements, {i.e., USEPA SW- 846 Laboratory Methods (most recent edition)}
Data Quality Level 3: Definitive Data	Delineation, Clean Zone Confirmation	Laboratory Analyzed Samples, with full QA/QC documentation, {i.e., USEPA SW-846 Laboratory Methods (most recent edition)}
State-of-the-art Data	Non-standard method analysis	Laboratory Special Services, Mobile Laboratory

7.7 Quality Assurance Requirements

7.7.1 Preliminary or Field Screening Data (Data Quality Level 1)

Field screening data are intended to be used for Health & Safety, initial contaminant screening and/or contaminant delineation (i.e., approximation of contaminated zone).

Instruments used for field screening data include PID survey instruments, FID survey instruments and XRF. Methods used for field screening data include hydrophobic dye test, colorimetric analysis, and headspace analysis.

The data produced by field screening should only be considered an indicator of contamination. Quality control procedures and deliverable requirements are limited to a brief method review, instrument calibration, maintenance logs, field logs, reported data values and background levels.

Field screening data are real-time, but are semi-qualitative and semi-quantitative, and measurements may be erratic. Therefore, data should only be used for health and safety and to guide sample placement for analysis by higher level methods.

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.

7.7.2 Effective Data or Field Analysis Data (Data Quality Level 2)

Effective Data or Field Analysis Data are intended to be effective for the end use and to provide reliable, rapid, contaminant delineation.

Effective Data or Field Analysis Data can achieve a high degree of reproducibility when required QA/QC procedures are employed.

Field analysis methods are typically laboratory methods, which have been adapted for field use (i.e., field GC, portable XRF).

In addition to screening data requirements, QA deliverables should include:

- Initial calibration curves
- Continuing calibration curves (1 per 10 samples)
- Field Duplicates (1 per 20 samples)
- Background/Blank data
- Analyses Run Log
- Raw data submission (e.g., chromatograms, recorded instrument readouts, etc.)
- Chain of Custody Documentation (or field sample tracking sheets)
- Non-conformance summary listing all deviations from the approved Standard Operating Procedure (SOP) and QA/QC parameters outside control limits. The non-conformance summary should include an analyst certification statement.
- If laboratory confirmation data is collected along with the field analytical data to support investigation findings it shall be submitted in accordance with N.J.A.C. 7:26E-1.6
- The laboratory performing the confirmation analyses using a standard method (e.g., a USEPA SW- 846 method or a CLP method) must be certified to perform the analyses.
- Results of analyst competency tests (e.g., performance evaluation tests and proof of training) are required
- Matrix Spike Recovery (case-by-case)
- Surrogate Analyte Analysis (case-by-case)
- Method Blank Analysis (case-by-case)
- Quality Control Check Sample Analysis (case-by-case)

Field analysis data may be semi-quantitative (i.e., providing an estimated value) and semi-qualitative or class specific (definitive contaminant identification is not provided).

Environmental samples frequently contain contaminants of unknown identity and concentration. Laboratory data represents the best estimate of the true concentration of a contaminant in an environmental sample. Therefore, a comparison of field and laboratory data can help to provide some guidance on the validity of the field data.

A laboratory-field correlation of field analysis data has two components and can be calculated by the following regression analysis equation:

$L = xF + y$

where:

L = the reported laboratory concentration of a contaminant

F = the reported field concentration of the same contaminant

x = the slope of the correlation of field and laboratory data

y = the intercept of the field and laboratory data (constant)

R squared = fit of equation

The two components of the laboratory-field correlation are: 1) the fit (R squared) and 2) the intercept (y). Given the lack of homogeneity of environmental samples, variation in sample handling and variations inherent in both field and laboratory data, the fit of the equation is not expected to be perfect (i.e., in most cases, R squared $\neq$ 100%); however, R squared, and a plot of the scatter graph should be developed by the data reviewer and submitted to the NJDEP. An examination of the R squared, and scatter graph should be made to determine the usefulness of the field data. Professional judgement should be used when determining whether field data should be used for delineation and/or clean samples (with an approved variance).

The intercept (y) is important due to differences in concentrations determined in field verses laboratory data. During the remedial investigation (RI), field-based contaminant zone delineation levels may be adjusted per the following equation:

$C_f = C + y$

where:

C_f = contamination zone delineation criteria for field generated data

C = cleanup criteria for laboratory data

y = the intercept of the field and laboratory data correlation equation

Field Analytical methods also include published laboratory methods such as USEPA SW- 846 laboratory methods, which are highly reproducible; however, field analytical data are generally documented using only limited quality assurance deliverables.

The quality or effectiveness of Field Analytical data generated using published (laboratory) methods with limited deliverables is a function of sample handling, storage and preservation procedures, and analytical instrument maintenance. These data should be reliable if proper sampling, analytical, and QC procedures are followed.

7.7.3 Meticulous or Definitive Data (Data Quality Level 3)

Final remediation should be based on the site-specific cleanup criteria using Meticulous or Definitive Data because this type of data is intended to generate the most reliable data practicable.

Meticulous or Definitive Data are highly reproducible and can provide the end user with complete QA/QC documentation in accordance with N.J.A.C. 7:26E, Appendix A.

Methods that generate Meticulous or Definitive Data are generally the same published laboratory methods as Field Analytical Data but are supported with full laboratory data deliverables or reduced laboratory data deliverables in accordance with subchapter 2 and Appendix A of N.J.A.C. 7:26E.

Meticulous or Definitive Data can only be generated by a certified or otherwise approved laboratory pursuant to N.J.A.C. 7:26E section 2.1.

7.7.4 "State-of-the-Art" Data:

Generally, "State-of-the-Art" methods are developed specifically for a particular site or contaminant.

"State-of-the-Art" methods are used when standard laboratory methods are either unavailable or impractical.

Data generated using a "State-of-the-Art" method may have variable deliverable requirements. These requirements will be proposed by the laboratory or person performing the analysis and evaluated by the NJDEP for each method proposed. If the method and the deliverables requirements are approved, the data produced by methods conforming to these requirements will be acceptable for their intended use.

"State-of-the-Art" methods may be accepted to delineate a contaminant, define a "clean zone", or confirm field data.

Generation of "State-of-the-Art" data may necessitate use of a laboratory, which specializes in methods development.

7.8 Field Data Deliverables Format

The following requirements can be incorporated into a dynamic workplan and to establish standard operating procedures (SOPs) and the QAPP. SOPs for sample collection and analysis should be developed with other SOPs required to answer site-specific questions (e.g., geophysical and hydrogeological surveys, etc.). In addition, please refer to the sections on the QAPP, CSRR QAPP Technical Guidance, and CSRR Quality Assurance Requirements of this chapter, and N.J.A.C 7:26E.

7.8.1 Field-Screening Data – QA/QC Requirements

The following represents the minimum data deliverables required for field screening data. The "Data Deliverables" section of each method will provide specific requirements:

- A brief method review should be provided.
- A single point calibration should be conducted prior to any field activities using site-specific standards.
- Calibration checks should be performed at a minimum of twice daily bracketing the sample analyses. If a calibration check falls outside the manufacturer's suggested range, then a complete multi-point calibration is required.
- A baseline or blank scan (i.e., "clean air," "clean water" or "clean soil" as appropriate) should be run each day prior to analyzing any site samples.
- An instrument log should be maintained and submitted (where appropriate). This log should include instrument maintenance blank, and calibration information, including date, time, analyst's name, calibration standard compounds, the concentrations, and readings of the calibration standards.
- Field logs should document sample ID#, date, time, location, depth, matrix (i.e., soil type, water, air), soil moisture (qualitative estimate where appropriate), and the reading and concentration/result of the analysis.
- A non-conformance summary should state all data inconsistencies and all divergences from the approved sampling/analysis program. The implication of all non-conformances should be clearly explained and quantified (when possible).

7.8.2 Effective Data or Field Analysis Data – QA/QC Requirements

In addition to the requirements listed for the field screening data, the following represents the minimum data deliverables required for field analysis data. The "Data Deliverables" section of each method will provide specific requirements:

- Each project team that uses a field analysis method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of capability and an ongoing analysis of calibration standards.
- To establish the ability to generate acceptable accuracy and precision, the analyst should perform the following operations for the media being investigated:
    - A soil QC check sample. The soil QC check sample should be prepared by the laboratory using stock standards prepared independently from those used for calibration.
    - An aqueous QC sample, prepared in the same fashion as the soil QC sample, is also required.
    - Analyze four aliquots of each of the well-mixed QC check samples according to standard procedures.
    - Calculate the percent recovery mean (X%) and the standard deviation of the recovery for each parameter of interest in each matrix using the four results.
        - For each compound, X% should be between 60% and 140% of the true value. Additionally, the standard deviation of recovery should be within ± 40% of X.
    - Method blanks (i.e., syringe blanks, equipment blanks, and instrument blanks) should be run at the beginning and during each workday or after a sample when carry-over is anticipated. A higher frequency of blank analyses may be required depending upon equipment use and results.

The instrument should be calibrated with a 3-point or 3-level (minimum) laboratory certified standards and should also be calibrated daily with 1-mid point or 1-mid level laboratory certified standards. Recalibration is required when the check standard exceeds a threshold of 2 or 3 sigma, as specified in the data quality objectives for recalibration. The standard analytes and concentrations should be chosen based on known site contamination and encompass the range of expected concentrations. Surrogate compounds should also be included. Matrix-specific minimum detection limits should be determined and reported for all site-specific compounds.

If standard curves remain linear over the entire analysis range, only one midpoint standard should be analyzed at a frequency of 1 per 10 samples. If standard curves are not linear over the entire analysis range, a minimum of two (2) calibration standards, one low level and one high level standard should be analyzed at a frequency of 1 per every 10 samples.

Matrix spike and matrix spike duplicate (MS/MSD) samples may be required at a rate of one per every 20 samples. The project team should determine if MS/MSD samples are required on a case-by-case basis.

Chain of custody or sample tracking documentation should be generated for all samples collected and analyzed. This documentation should include a statement certifying that all data were generated following proper procedures.

Proof of training for the technician performing the analyses is required.

For additional information on electronic deliverables and submittals see https://www.nj.gov/dep/srp/hazsite/ and N.J.A.C. 7:26e1.6.

7.9 Data Management Plan

The ability to manage and easily use all the data produced in the field is critical to the success of the field analysis technologies. Protocols for sample logging, analysis, data reduction, and site mapping should be established. The data management plan should be established during the planning phase and included in the workplan or QAPP for the data collection, processing, and analysis of the field generated data.

References

Technical Requirements for Site Remediation, N.J.A.C. 7:26E

ITRC - https://asct-1.itrcweb.org/3-2-membrane-interface-probe/

ITRC - https://asct-1.itrcweb.org/3-5-cone-penetrometer-testing/

ITRC - https://asct-1.itrcweb.org/3-6-hydraulic-and-groundwater-profiling-tools/

EPA - https://clu-in.org/characterization/technologies/xrf.cfm

EPA - https://www.epa.gov/quality/field-x-ray-fluorescence-measurement

EPA - https://archive.epa.gov/nrmrl/archive-etv/web/pdf/01_vr_dexsil_l2000dx.pdf