EPA-542-R-97-011
November 1997

Field Analytical and Site Characterization Technologies
Summary of Applications

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office
Washington, D.C. 20460

NOTICE

This material has been funded wholly by the United States Environmental Protection Agency under Contract Number 68-W5-0055. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Copies of this report are available free of charge from the National Center for Environmental Protection and Information (NCEPI), PO Box 42419, Cincinnati, Ohio 45242-2419; telephone (800) 490-9198 or (513) 489-8190 (voice) or (513) 489-8695 (facsimile). Refer to document EPA-542-R-97-011, *Field Analytical and Site Characterization Technologies, Summary of Applications*. This document also can be obtained through EPA's Clean Up Information (CLU-IN) System on the World Wide Web at *http://www.clu-in.com*.

Comments or questions about this report may be directed to the United States Environmental Protection Agency, Technology Innovation Office (5102G), 401 M Street, SW, Washington, DC 20460; telephone (703) 603-9910.

ACKNOWLEDGMENTS

This document was prepared for the United States Environmental Protection Agency's (EPA) Technology Innovation Office. The study was designed in coordination with EPA's National Environmental Research Laboratory at Las Vegas. Information in this document was compiled with the assistance of EPA's regional contacts for field analytical and site characterization technologies.

Special acknowledgment also is given to the federal and state staff and other remediation professionals listed as contacts for individual sites and projects. Those individuals provided the detailed information presented in this document. Their willingness to share their expertise will help to further the application of field analytical and site characterization technologies at other sites.

ABSTRACT

This report provides information about experiences in the use of field analytical and site characterization technologies at contaminated sites drawn from 204 applications of the technologies listed below. For each technology, information is presented on the reported uses of the technology; including the types of pollutants and media for which the technology was used; reported advantages and limitations of the technology; and cost data for the technology, when available. Information was obtained from federal and state site managers and from the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS) database. This report is intended to provide information that will facilitate the broader use of various field analytical and site characterization technologies at hazardous waste sites by encouraging information exchange among federal, state, and private-sector site managers. However, it is not intended to provide a comprehensive review of all field analytical and site characterization technologies or of all potential uses of the technologies it does list. More detailed information about them may be obtained from other sources, including those listed in Section 1.2.

This report documents uses of the following field analytical and site characterization technologies at contaminated sites:

Chemical Technologies

- Biosensor
- Colorimetric test strip
- Cone penetrometer mounted sensor
- Fiber-optic chemical sensor
- Fourier-transformed infrared (FTIR) spectrometry
- Gas chromatography
- Immunoassay
- Mercury vapor analyzer
- X-ray fluorescence

Geophysical Technologies

- Bore-hole geophysical
- Direct-push electrical conductivity
- Electromagnetic induction
- Ground penetrating radar
- Magnetometry
- Seismic profiling

Radionuclide Technologies

- Gamma radiation detector
- Passive alpha detector

Sampling and Sampler Emplacement Technologies

- Closed-piston soil sampling
- Direct-push prepacked well screen
- Low-flow ground-water pumping
- Soil gas sampling
- Vertical ground-water profiling
- Vibrating well installation

CONTENTS

Tables

Table | **Page**

1.0 INTRODUCTION

Newer field analytical and site characterization technologies offer potential savings in time and cost compared with traditional technologies. The United States Environmental Protection Agency (EPA) is interested in increasing awareness of these technologies by encouraging information exchange among federal, state, and private-sector site managers, remediation professionals, and other interested parties. Various field analytical and site characterization technologies have been used at Superfund and Resource Conservation and Recovery Act (RCRA) sites and at sites with leaking underground storage tanks. In addition, as a result of EPA's Brownfields Initiative to encourage the productive reuse of abandoned properties that are or are perceived to be contaminated, there is increasing interest in the use of these technologies at such sites.

EPA believes that providing information about actual applications of new technologies can be very useful in increasing awareness and promoting information exchange. EPA has collected information about the uses of field analytical and site characterization technologies at 204 sites and has summarized the experiences of those involved in applying the technologies at contaminated sites.

This report has two sections. Section 1.0 discusses the purpose and background of the report. Section 2.0 provides a summary of the information obtained about the uses of field analytical and site characterization technologies, including a detailed tabular presentation of the data collected about sites at which field analytical and site characterization technologies have been used. Limitations of the data, including factors that affect the applicability and cost of field analytical and site characterization technologies is also provided. Appendix A provides a list of relevant acronyms, and Appendix B describes the methodology used in collecting the data. Appendix C provides information about the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS) database.

1.1 PURPOSE

This report is a summary of information about uses of 23 field analytical and site characterization technologies, as reported by federal and state site managers. The purpose of this report is to: (1) provide information that will facilitate the broader use of various field analytical and site characterization technologies at hazardous waste sites by encouraging information exchange among federal, state, and private-sector site managers and (2) provide a selected inventory of sites at which various types of field analytical and site characterization technologies have been used. It is important to note that this report presents a summary of the information obtained from federal and state site managers and is not intended to be a comprehensive review of field analytical and site characterization technologies or of all potential uses.

Table 1-1 presents a summary, by number of sites, of the field analytical and site characterization technologies included in this report. As Table 1-1 shows, information was collected from 204 sites. Appendix B presents a description of the methods used to collect the information for this report.

It is important to note that many factors can affect the technical feasibility and cost of field analytical and site characterization technologies. Such factors include physical constraints, site layout, data quality requirements, time constraints, matrix interferences, expected levels of contamination, and other considerations particular to a given site. Such factors should be considered in determining whether specific field analytical and site characterization technologies are appropriate for a particular site.

Table 1-1
Number of Sites by Technology

Technology	Number of Sites Included in this Report
Chemical Technologies	
Immunoassay	43
X-ray fluorescence	39
Cone penetrometer mounted sensor	34
Gas chromatography	24
Fourier-transformed infrared spectrometry	3
Colorimetric test strip	3
Fiber-optic chemical sensor	3
Mercury vapor analyzer	2
Biosensor	1
Geophysical Technologies	
Seismic profiling	8
Ground penetrating radar	4
Bore-hole geophysical	4
Electromagnetic induction	3
Magnetometry	2
Direct-push electrical conductivity	1
Radionuclide Technologies	
Gamma radiation detector	3
Passive alpha detector	1
Sample and Sampler Emplacement Technologies	
Low-flow ground-water pumping	9
Vibrating well installation	6
Soil gas sampling	5
Vertical ground-water profiling	4
Closed-piston soil sampling	1
Direct-push prepacked well screen	1
Total	**204**

With respect to cost information for applications of these technologies at specific sites, provided in Section 2.0 of this report, it is important to note that the costs are presented exactly as reported by site contacts and that the ways in which site contacts reported costs varied. For example, site contacts reported cost information as cost per sample, foot, time, or item. This report did not attempt to recalculate the costs on a consistent basis (normalize the costs) by technology, medium, or other parameter. Cost information provided by site contacts usually was based on their comparison of the cost of using the technology with the cost of off-site laboratory analysis. **Therefore, cost information should be considered qualitatively.**

1.2 BACKGROUND

To better understand the factors that affect field analytical and site characterization technologies and for more detailed information about those technologies, the reader should consult:

- *Expedited Site Assessment Tools for Underground Storage Tank Sites: A Guide for Regulators*, EPA-510-B-97-001, 1997

- *Field Sampling and Analysis Matrix and Reference Guide* (under preparation by the EPA and U.S. Navy, with publication expected in November 1997)

- *Site Characterization and Monitoring Bibliography of EPA Information Resources*, EPA-542-B-96-001, February 1996

- *Superfund Innovative Technology Evaluation Program, Technology Profiles*, EPA-540-R-97-502, December 1996

In addition, EPA's Environmental Technology Verification Site Characterization Pilot Project (also known as the Consortium for Site Characterization Technology) verifies field analytical and site characterization technologies. The program has completed verification reports for the site characterization and analysis penetrometer system and laser-induced fluorescence (SCAPS-LIF) technology and the rapid optical survey tool (ROST™) , also a LIF-based technology. The EPA document numbers for those reports are EPA 600-R97-019 and EPA 600-R97-020, respectively. Verification reports are pending for seven field-portable x-ray fluorescence technologies and two field-portable gas chromatography/mass spectroscopy (GC/MS) technologies. Currently, there are 20 field analytical and site characterization technologies in EPA's verification program. Information about the program is available on the World Wide Web at *http://www.epa.gov/etv/.* In addition, EPA is developing an encyclopedia of field analytical and site characterization technologies. This encyclopedia will be available in 1998 through EPA's Clean-Up Information (CLU-IN) World Wide Web site at *http://www.clu-in.com/char1.htm*.

This page intentionally left blank.

2.0 SURVEY OF APPLICATIONS OF FIELD ANALYTICAL AND SITE CHARACTERIZATION TECHNOLOGIES

2.1 SUMMARY OF RESULTS

This section provides a summary of the information obtained from 204 sites about uses of selected field analytical and site characterization technologies. Tables 2-1, 2-2, and 2-3, respectively, summarize the general uses of the technology (such as site screening, site characterization, compliance monitoring, and cleanup monitoring), the medium monitored, target analytes, and detailed reported data. Table 2-1 presents information about the general uses of data generated through the use of the field analytical and site characterization technologies summarized in this report. Table 2-2 presents information about the technologies by type of medium and analyte. Seven categories of analytes were reported: volatile organic compounds (VOC), semivolatile organic compounds (SVOC), fuels, inorganic compounds, pesticides, explosives, and radionuclides. An additional category, geophysical, was included among the analytes to allow reporting of applications in which the technologies were used to analyze the physical environment. Sections 2.1.1 through 2.1.4 provide a brief description of the technologies and a discussion of the reported advantages and limitations of each technology, when compared with traditional sampling and analysis techniques. The sections are organized by technology type.

Federal and state site managers identified several common concerns related to the use of field analytical and site characterization technologies. Many users reported that the innovative technologies required experienced operators. Users also noted that several technologies yielded false negative results because of insufficient lower detection limits and other causes. Several users reported difficulty in extracting the contaminants from the soil sample and other matrix interferences. Several comments were associated with EPA's role in the use of the technologies. One user reported that his EPA region had no established sample collection procedures for a particular innovative technology. Users reported that little information was available about official verification procedures for the use of the technologies. In addition, one user noted that quality assurance and quality control (QA/QC) procedures for a certain field analytical technology were not well developed.

Table 2-1
Reported Uses of Data Generated by Field Analytical and Site Characterization Technologies

Technology	Site Screening	Site Characterization	Cleanup Monitoring	Compliance Monitoring	Confirmation Sampling	Enforcement	Health and Safety Monitoring	Waste Characterization	Risk Assessment
Chemical Technologies									
Biosensor	✔		✔	✔					
Colorimetric test strip	✔	✔	✔	✔					
Cone penetrometer mounted sensor	✔	✔							
Fiber-optic chemical sensor	✔	✔							
Fourier-transformed infrared spectrometry		✔	✔	✔			✔		
Gas chromatography	✔	✔	✔		✔				
Immunoassay	✔	✔	✔	✔	✔			✔	
Mercury vapor analyzer		✔					✔		
X-ray fluorescence	✔	✔	✔	✔	✔	✔			✔
Geophysical Technologies									
Bore-hole geophysical		✔							
Direct-push electrical conductivity	✔								
Electromagnetic induction		✔							
Ground penetrating radar	✔	✔							
Magnetometry		✔							
Seismic profiling	✔	✔							
Radionuclide Technologies									
Gamma radiation detector	✔	✔							
Passive alpha detector	✔	✔					✔		

Table 2-1
Reported Uses of Data Generated by Field Analytical and Site Characterization Technologies
(continued)

Technology	Site Screening	Site Characterization	Cleanup Monitoring	Compliance Monitoring	Confirmation Sampling	Enforcement	Health and Safety Monitoring	Waste Characterization	Risk Assessment
Sampling and Sampler Emplacement Technologies									
Closed-piston soil sampling		✔							
Direct-push prepacked well screen		✔		✔					
Low-flow ground-water pumping	✔	✔		✔					
Soil gas sampling		✔							✔
Vertical ground-water profiling		✔		✔					
Vibrating well installation	✔	✔							

TABLE 2.2 TO BE INSERTED HERE

TABLE 2.2 TO BE INSERTED HERE

2.1.1 Chemical Technologies

Biosensor (Number of Sites: 1)

Biosensors are analytical tools in which the sensing element is an enzyme, antibody, deoxyribonucleic acid, or microorganism and the transducer is an electrochemical, acoustic, or optical device. The technology was used to detect explosives (trinitrotoluene [TNT]; cyclo-1,3,5-trimethylene-2,4,6-trinitramine [RDX]; and cyclotetramethylenetetranitramine [HMX]) in soil, ground water, and composite residues.

Reported Advantages:
- Potentially cost-effective
- Real-time data

Reported Limitations:
- None identified

Colorimetric Test Strip (Number of Sites: 3)

Colorimetric test strips are a single measurement, portable technology that uses a wet chemistry non-immunoassay test to detect analytes in soil or water. The intensity of the color formation can be determined visually or with a spectrophotometer. Colorimetric test strips were used to detect nitrates, TNT, RDX, and HMX in soil and ground water.

Reported Advantages:
- Potentially cost-effective
- Easy to use
- Real-time data

Reported Limitations:
- Possible interference caused by nitrite
- Creation of soil slurry necessary to use test strips

Cone Penetrometer Mounted Sensor (Number of Sites: 34)

Cone penetrometer mounted sensors are real-time, in situ, field screening methods for petroleum hydrocarbons and other contaminants, as well as lithologic parameters. Table 2-3 includes several uses of the Site Characterization and Analysis Penetrometer System Laser-Induced Fluorescence (SCAPS-LIF) cone penetrometer mounted sensor technology. The SCAPS-LIF technology was developed through a collaborative effort of the Army, Navy, and Air Force, under the auspices of the Tri-Service SCAPS Program. The method uses a fiber optic-based laser-induced fluorescence sensor system, deployed with a standard 20-ton cone penetrometer. Cone penetrometer mounted sensors were used to perform field screening and site characterization for PAHs and total petroleum hydrocarbons (TPH) such as diesel and jet fuel, gasoline, waste oil, heating fuel, and kerosene, in soil and ground water, as well as the lithologic parameters (pH, redox potential, conductivity, soil type, and other factors).

Reported Advantages:

- Potentially cost-effective
- Continuous, real-time data
- Accurate measurements
- Three-dimensional mapping possible
- Contaminant fingerprinting capability
- Enhanced delineation of contaminant (2-inch vertical resolution)
- No soil cuttings
- Quick decontamination
- Data allowed selection of optimal confirmation soil boring locations

Reported Limitations:

- Expensive for a limited number of sample locations
- Naturally occurring fluorescent material can lead to false positives
- Limited by rough terrain
- Difficult to maneuver in tight spaces
- Subsurface cobbles cause probe refusal

Fiber-Optic Chemical Sensor (Number of Sites: 3)

Fiber-optic chemical sensors are coating-based sensors on fiber optics that detect contaminants by monitoring the change in the refractive index on the coating of the fiber optics that alters the amount of light transmitted to a detector. The technology was used to measure concentrations of TPH; benzene, toluene, ethylbenzene, and xylene (BTEX); and halogenated VOCs, such as trichlorethylene (TCE), in ground water and soil gas.

Reported Advantages:

- Potentially cost-effective
- Can be used in situ
- Easy to use
- Portable
- Quick turnaround time

Reported Limitations:

- Possible interference from other chlorinated VOCs
- Results affected by bailing method and amount of water bailed
- Concentration of contaminants affects response time

Fourier-Transformed Infrared Spectrometry (FTIR) (Number of Sites: 3)

This method is an air monitoring technique that identifies compounds by fingerprinting spectra. A sample's molecular constituents are revealed through their characteristic frequency-dependent absorption bands. The technology was used to measure the concentration of VOCs in air for health and safety, compliance, and cleanup monitoring.

Reported Advantages

- Adequate detection levels
- Portable
- Real-time data

Reported Limitations

- Interference caused by water vapor
- QA/QC methods not fully developed
- Not appropriate when a high degree of spatial resolution is required

Gas Chromatography (Number of Sites: 24)

Gas chromatography (GC) is an analytical technique used to separate and analyze environmental matrices for contaminants. Gas chromatography has been accepted widely as a primary analytical tool for site characterization because of its capability to separate, detect, identify, and quantify target analytes in a complex mixture. The technique is suitable for the analysis of thermally stable organic compounds only. Gas chromatography, with the use of various detectors (photoionization, flame ionization, electron capture, electrolytic conductivity, nitrogen-phosphorus, mass spectrometer, and others), and with various sample extraction and introduction methods (headspace, purge and trap, solvent extraction, solid phase extraction, thermal desorption, and others), was used to measure concentrations of halogenated and nonhalogenated VOCs, SVOCs (including polychlorinated biphenyls [PCB], polynuclear aromatic hydrocarbons [PAH], and pentachlorophenol [PCP]), TPH, pesticides, and dioxins in soil, soil gas, sediment, ground water, and air.

Reported Advantages:

- Potentially cost-effective
- Low detection limits (able to measure maximum contaminant level [MCL] concentrations)
- Quick turnaround time
- High-quality data generated
- Portable
- High sample throughput
- Good correlation with EPA's Contract Laboratory Program (CLP) laboratory data
- Ability to perform simultaneous analysis for BTEX and other hydrocarbon compounds

Reported Limitations:

- Experienced operator required
- Learning curve associated with use of equipment
- Library of components limited for mass spectrometer
- Petroleum carrier solvent caused interference with analysis for PCP
- Modification of extraction time required to improve consistency of results
- Poor extraction of diesel fuels from soils with high organic matter
- Co-elution of three types of contaminants hindered ability to meet detection limits

Immunoassay (Number of Sites: 43)

Immunoassay is a technique for detecting and measuring a target compound through the use of an antibody that binds only to that substance. Quantitation is performed by monitoring color change, either visually or with a spectrophotometer. The technology was used to detect or to measure the concentrations of halogenated VOCs, PAHs, TPH, BTEX, PCBs, organic pesticides, mercury, and bacteria in soil, sludge, sediment, surface water, ground water, and composite residues.

Reported Advantages:

- Potentially cost-effective
- Near real-time data
- Reproducible results
- Reasonable correlation with laboratory results
- Low rate of false negative results, except when fuel compounds were highly degraded
- Portability
- Detection limits capable of meeting action levels
- Capable of defining boundaries of contamination

***Reported Limitations*:**

- High rate of false positives found in results from PCB and organic pesticide kits
- Incapable of identifying individual PAHs
- Poor extraction efficiency in peat or bog samples

Mercury Vapor Analyzer (Number of Sites: 2)

This technology monitors mercury vapors emitted from soil. These analyzers were used for health and safety monitoring and to determine soil sampling locations.

Reported Advantages

- Allowed for real-time understanding of exposure
- Quick turnaround time for data

Reported Limitation:

- Learning curve associated with equipment

X-ray Fluorescence (Number of Sites: 39)

X-ray fluorescence (XRF) analyzers operate on the principle of energy dispersive XRF spectrometry. Energy dispersive XRF spectrometry is a nondestructive analytical technique used to determine the metals composition of environmental samples. Field-portable and transportable XRF units were used to detect or measure concentrations of heavy metals (mercury, chromium, lead, cadmium, copper, nickel, and arsenic) in both in situ and ex situ soils, sludge, sediment, and ground water.

Reported Advantages:
- Potentially cost-effective
- No investigation-derived waste (IDW)
- Good correlation with analytical laboratory results
- Real-time data
- Quick turnaround time
- Capability to determine multiple analytes simultaneously
- Nondestructive method
- Little sample preparation
- Consistent quality of data

Reported Limitations:
- Limit on penetration depth
- Some field-portable units require liquid nitrogen
- One field-portable unit weighs 50 pounds
- Preparation of quality control sample required
- Difficulty in obtaining sufficiently low detection limits because of matrix interference
- Detection limits sometimes not low enough to respond to ecological concerns

2.1.2 Geophysical Technologies

Bore-hole Geophysical (Number of Sites: 4)

Bore-hole geophysical technologies include ground penetrating radar (GPR), electromagnetic induction, and acoustic methods. These technologies were used to map fractures in bedrock, and to determine ground-water flow and depth of the water table. The technologies were used to generate data for use both in site characterization and in placement of monitoring wells.

Reported Advantages:
- Accurate results
- Sensitivity
- Facilitation of better understanding of ground-water flow

Reported Limitations:
- Well diameter must be greater than two inches
- Well casing must be nonmetallic

Direct-push Electrical Conductivity (Number of Sites: 1)

The direct-push sensing of electrical conductivity is a geophysical technique based on the physical principles of inducing and detecting the flow of electrical current within geologic strata. Measurements of soil conductivity and logs of soil conductivity combine to supply information about the lithologic features of a site. This technology was used for site characterization and mapping to support placement of monitoring wells, and to define subsurface geologic and hydrogeologic conditions.

Reported Advantages:

- Potentially cost-effective
- Easy to use
- Portable
- Quick turnaround time
- Capability to identify thin stratigraphic layers that conventional methods miss
- No soil cuttings

Reported Limitations:

- Large metal objects can cause interference
- Susceptible to operator error
- Experienced operator needed to calibrate and interpret logs

Electromagnetic Induction (Number of Sites: 3)

Electromagnetic induction units use a transmitter coil to establish an alternating magnetic field which induces electrical current flow in the earth. The induced currents generate a secondary magnetic field which is sensed by a receiver coil. This technology was used during site characterization to locate disposal trenches at a landfill.

Reported Advantages:

- Easy to use
- Portable
- Quick results

Reported Limitations:

- Large metal objects such as fences can cause interference

Ground Penetrating Radar (Number of Sites: 4)

Ground penetrating radar (GPR) provides a rapid, real-time display of information about the subsurface, ranging from geological features to hydrologic features. The GPR method uses a transmitter that emits pulses of high-frequency electromagnetic waves into the subsurface. The electromagnetic energy that is scattered back to the receiving antenna on the surface is recorded as a function of time. This technology was used during site characterization to identify abandoned waste pits and other subsurface disturbances, bedrock stratigraphy, and the depth to water table. The technology was also used to develop profiles of a river bottom.

Reported Advantages:

- Data useful in identifying subsurface disturbances without soil borings
- Data allowed the selection of optimal soil boring locations
- Focused mapping of sample location
- Information compared favorably with that obtained through other methods

Reported Limitations:

- Surface vegetation can inhibit transmission of signals
- Soils with high electrical conductivity can inhibit transmission of signals
- Interpretation of data is complex; experienced data analyst required

Magnetometry (Number of Sites: 2)

Magnetometers detect the presence of ferrous objects in the subsurface by measuring the earth's magnetic field or how the field changes spatially. Hand-held and vehicle-towed magnetometry units were used during characterization and mapping to identify buried ferrous metals.

Reported Advantages:

- Ability to detect large ferrous metal objects 12 to 20 feet below ground surface
- Ability to discriminate among subsurface anomalies

Reported Limitations:

- Vehicle-based magnetometers limited by terrain and field conditions
- Vehicle-based magnetometers tend to underestimate the number of targets, compared with hand-held devices
- Signals from extraneous metals must be filtered out

Seismic Profiling (Number of Sites: 8)

Seismic profiling technology is based upon the principle that, if an acoustic signal is introduced into the ground, a wave will echo to the surface whenever a change in the medium is encountered. Sensors at the surface receive the signal, which is recorded by a seismograph and processed by software developed by the oil industry. Two- and three-dimensional seismic profiling technologies were used during site screening and characterization to determine bedrock stratigraphy, soil type, and depth to water table.

Reported Advantages:
- Potentially cost-effective
- Very detailed image of soil stratigraphy
- Bedrock fractures defined to within one foot
- Easy to use
- Drilling costs minimized

Reported Limitations:
- Large surface objects cause interference
- Data return is very specific
- Trained technician required to interpret data
- Vegetation must be removed
- Equipment requires direct contact with the ground, presenting a problem for use in buildings

2.1.3 Radionuclide Technologies

Gamma Radiation Detector (Number of Sites: 3)

Gamma radiation detectors are portable instruments that often use sodium iodide or cesium iodide scintillation counter detectors to detect gamma emissions. The technology was used to detect radionuclides in soil, sediment, and liquid waste.

Reported Advantages:
- Easy to use
- Portable
- Lower cost than conventional methods
- Data compared favorably with laboratory data
- Real-time data

Reported Limitations:
- Sensitive to power fluctuations
- Liquid nitrogen required
- Protection from weather required

Passive Alpha Detector (Number of Sites: 1)

Two types of commercially available passive radon detectors, electric ionization chambers and alpha track detectors, have been modified for use in screening of soil in situ for alpha contamination. The detectors were used to measure alpha contamination in soil.

Reported Advantages:
- Potentially cost-effective
- Easy to use
- Fast

Reported Limitations:
- None identified

2.1.4 Sampling and Sampler Emplacement Technologies

Closed-piston Soil Sampling (Number of Sites: 1)

This technology is a discrete-depth sampling technology that uses a locking piston. The locking piston enables the user to collect samples from a previously sampled boring without allowing unwanted material from the overlying borehole to be included in the sample. This sampling technology was used in conjunction with direct-push technology during site characterization to obtain continuous soil cores from below the water table.

Reported Advantages:
- No soil cuttings
- Less expensive than conventional drill rigs
- Faster than conventional methods

Reported Limitations:
- Sampler is designed for use only in soils and unconsolidated sediments
- Generally used at depths of less than 50 feet
- If used for sampling discrete subsurface intervals, the hole must be preprobed

Direct-push Prepacked Well Screen (Number of Sites: 1)

This technology uses a direct-push method to install prepacked stainless steel screens. The technology was used during site characterization and compliance monitoring to install small-diameter monitoring wells.

Reported Advantages:
- Less expensive and faster than installing a conventional well
- No soil cuttings

Reported Limitations:
- Cannot be used in bedrock
- Limit on depth
- Small diameter of well may limit sampling options

Low-flow Ground-water Pumping (Number of Sites: 9)

Low-flow ground-water sampling involves the use of any number of ground-water sampling pumps that purge a monitoring well slowly so as not to cause turbulent flow into the well. The method decreases the turbidity of the water sample and allows collection of a more representative ground-water sample than is possible with conventional technologies. The technology was used to obtain ground-water samples for analysis of VOCs and heavy metals.

Reported Advantages:
- Production of low-turbidity samples possible
- Less purge water generated
- More effective in low recharge wells

Reported Limitations:
- None identified

Soil Gas Sampling (Number of Sites: 5)

A number of passive and active sampling devices can be used to obtain soil gas samples. Passive soil gas absorption devices, in-well monitoring equipment, and canister devices were used to obtain soil gas samples for on- and off-site analysis of VOCs.

***Reported Advantages*:**

- Potentially cost-effective
- Quick turnaround time
- Easy to use
- Large amounts of data generated
- Passive soil gas sampling technology can absorb low-volatility compounds
- Good correlation with monitoring well data

Reported Limitations:

- Active soil gas sampling is not effective in impermeable soils
- Passive soil gas sampling results may not correlate well with results of active soil gas sampling

Vertical Ground-water Profiling (Number of Sites: 4)

Vertical ground-water profiling technology collects point samples rather than samples over a screened interval, as is the case with conventional monitoring wells. The technology uses a probe that is advanced by a pneumatic piercing tool (air hammer) driven by a gasoline-powered air compressor. Ground water is extracted from the profiler by means of a peristaltic pump. This technology was used to vertically delineate contaminants in ground-water.

Reported Advantages:

- Potentially cost-effective
- Enables vertical profiling
- Enables tracking the boundaries of the contaminant plume

Reported Limitations:

- Problem with data comparability
- Difficulty in modeling the migration of TCE

Vibrating Well Installation (Number of Sites: 6)

This technology uses a specially designed all-terrain vehicle that uses a vibrating push mechanism to install small-diameter wells. This vibrating well installation technology was used to install ground-water wells and monitoring wells to depths up to 200 feet.

Reported Advantages:

- No soil cuttings
- Can be installed to 100 feet without pilot hole
- Equipment fits into tight spaces

Reported Limitations:

- Well screens clog easily
- Equipment overheats frequently
- Casing requires welding

2.2 SUMMARY OF DATA ON SPECIFIC TECHNOLOGIES

The information collected using the data collection form in Appendix B has been organized and presented in tabular format to more clearly display data from individual sites. Table 2-3 is organized by technology, with site information listed sequentially by EPA region for each of the technology types.

Table 2-3
Summary of Field Analytical and Site Characterization Technologies
Reported Data on Specific Technologies

Contents

APPENDIX A

LIST OF ACRONYMS

LIST OF ACRONYMS

AFB	Air Force Base
BTEX	Benzene, toluene, ethylbenzene, and xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	EPA Contract Laboratory Program
CLU-IN	Clean-Up Information (Internet home page containing clean-up information)
CPT	Cone penetrometer testing
CSCT	Consortium for Site Characterization Technologies
DDT	Dichlorodiphenyltrichloroethane
DNAPL	Dense nonaqueous phase liquids
EPA	U.S. Environmental Protection Agency
FTIR	Fourier-transformed infrared
GC	Gas chromatography
GC/MS	Gas chromatography/mass spectroscopy
GPR	Ground penetrating radar
HMX	Cyclotetramethylenetetranitramine
IDW	Investigation-derived waste
LIF	Laser-induced fluorescence
LNAPL	Light nonaqueous phase liquids
MCL	Maximum contaminant level
mg/kg	Milligrams per kilogram
NERL-LV	EPA National Environmental Research Laboratory-Las Vegas
NPL	National Priorities List (CERCLA)
NRaD	Navy Research and Development
OB/OD	Open burn/open detonation
OSC	On-scene coordinator
OSW	EPA Office of Solid Waste
PAH	Polycyclic aromatic hydrocarbon
PCE	Pentachloroethane
PCP	Pentachlorophenol
PCB	Polychlorinated biphenyl
ppb	Parts per billion
ppm	Parts per million
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclo-1,3,5-trimethylene-2,4,6-trinitramine
RPM	EPA Remedial Project Manager
SCAPS	Site Characterization and Analysis Penetrometer System
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
TCE	Trichlorethylene
TIO	EPA Technology Innovation Office
TNT	Trinitrotoluene
TPH	Total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
UST	Underground storage tank
Vendor FACTS	Vendor Field Analytical and Characterization Technologies System
VOC	Volatile organic compound
XRF	X-ray fluorescence

APPENDIX B

DATA COLLECTION METHODOLOGY

DATA COLLECTION METHODOLOGY

Two methods were used to compile information for this report:

- A network of regional contacts for field analytical and site characterization technologies was used to obtain information from the Environmental Protection Agency remedial project managers (RPM), on-scene coordinators (OSC), site managers, and other project managers who are closely involved in the use of site characterization technologies.

- Available files, reports, and other sources, such as the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS) database, that contain information about field analytical and site characterization technology applications at EPA-lead and non-EPA-lead hazardous waste sites were reviewed.

To expedite that process, EPA developed a form for gathering relevant information about the use of field analytical and characterization technologies at Superfund, Resource Conservation and Recovery Act, and federal facilities sites. The form, included in this appendix, was distributed to all EPA regions.

The data collection form had three parts; generally, 10 to 20 minutes were required for its completion. Part 1 of the collection form requested general information about the individual who completed the form, to provide a reference or contact familiar with the application of the technology at a particular site. Part 2 of the form requested general information about the site. Part 3 of the form requested data about the technology and the application of the technology at the site. Requested specifically in Part 3 were: (1) the type of technology used, (2) the type of data produced and how the data were used at the site, (3) the medium characterized and monitoring targets, and (4) information about costs. In addition, Part 3 of the form inquired about the performance of the technology at the site (advantages and limitations) and the presence of independent verification of performance (such as a comparison of data produced in the field with those obtained by analysis of samples at an off-site laboratory).

Status Report on Field Analytical Technologies Utilization

EPA's Office of Solid Waste and Emergency Response is compiling an inventory of sites where field portable, analytical and site characterization technologies have been used. The purpose of this project is to support a broader use of new monitoring techniques that are capable of streamlining the site assessment and remediation processes. This effort will result in a product which will improve the capability for networking between project managers tasked with site assessment and remediation. The report will be similar to EPA's *Innovative Treatment Technologies: Annual Status Report* that describes applications of new technologies at hazardous waste sites.

In order to compile information for this new report on field analytical and characterization technologies, EPA's Technology Innovation Office (TIO) is interviewing site managers who are closely involved in the use of site characterization technologies at contaminated sites. To expedite this process, TIO has developed a data collection form that is included in this package of information. Regional Project Managers (RPMs) and On-Scene Coordinators (OSCs) should use the form to provide relevant information about the demonstration of field analytical technologies at Superfund projects. In addition, TIO will use the form to collect information from other project managers on technologies used at Resource Conservation and Recovery Act (RCRA), underground storage tanks (UST) and federal facility sites and projects.

The blank data collection form contains three parts and generally requires 10 to 20 minutes to complete. *Part 1* of the collection form requests general information about the individual who is completing the form. Its purpose is to provide a reference or contact concerning the application of the technology at a particular site. *Part 2* of the form requests some general data about the site at which the application of the technology occurred. *Part 3* of the form requests data about the technology and application of the technology at the site. Specifically, *Part 3* of the form identifies: the type of technology used; its vendor; the type of data produced and how it was used at the site; the media characterized and monitoring targets; and cost information. In addition, *Part 3* of the form inquires about the performance of the technology at the site, any interferences noted, and references, such as a removal assessment or remedial investigation report, that may describe an independent verification of the technology's performance (such as the comparison of data produced in the field to that obtained by analysis of samples at an off-site laboratory).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

FIELD ANALYTICAL AND CHARACTERIZATION TECHNOLOGIES
ANNUAL STATUS REPORT

DATA COLLECTION FORM

JUNE 1996

FIELD ANALYTICAL & CHARACTERIZATION TECHNOLOGIES
DATA COLLECTION FORM

PART 1: GENERAL INFORMATION

1. Name ______________________

2. Organization ______________________

3. Phone ( ) ____-______ Ext. ______

4. Fax Number ( ) ____-______

5. E-mail Address ______________________

6. **Additional Contact(s).** Please list any other individuals who may be familiar with the application of the field analytical or characterization technology at this site.

   Name ______________________ Phone ( ) ____-______

   Name ______________________ Phone ( ) ____-______

PART 2: SITE INFORMATION

1. Site Name ______________________

2. Region ____ State ________ City ______________

3. **Site Type or Waste Source.** Describe the historic activity and/or source (such as a landfill or surface impoundment) that caused contamination at the site.

____

____

____

4. **Regulatory Status/Statute/Organization of Site.** Please describe the regulatory status of the site. For example, is the site a RCRA treatment, storage, or disposal facility (TSDF) subject to corrective action? *Please check all that may apply.*

- ❒ CERCLA
- ❒ RCRA Corrective Action (RCRA Subtitle C)
- ❒ UST Corrective Action (RCRA Subtitle I)
- ❒ TSCA
- ❒ Safe Drinking Water Act
- ❒ State (specify) ______________
- ❒ DoD
- ❒ DOE
- ❒ Other (specify) ______________
- ❒ Not Applicable

PART 3: TECHNOLOGY DESCRIPTION

Site Name/Technology ______________________

1. Technology or Trade Name. ______________________

____

2. **Technology Type.** *Please check all that apply.*

Analytical

- ❑ Air Measurement (Weather Measurement Technologies Excluded)
- ❑ Analytical Detectors (Stand Alone Only)
- ❑ Biosensors
- ❑ Chemical Reaction-Based Indicators (Colormetric)
- ❑ In situ Chemical Sensors
- ❑ Fiber Optic Chemical Sensors and Analyzers
- ❑ Gas Chromatography (GC)
- ❒ Other Chromatography
- ❑ Mass Spectrometry (MS) (May include GC/MS)
- ❒ Ion Mobility Spectroscopy
- ❒ Other Spectroscopy Techniques
- ❑ Immunoassays
- ❑ Soil Gas Analyzers
- ❑ X-Ray Fluorescence Analyzers
- ❒ Electrochemical-based Detectors
- ❒ Thermal Desorption Devices
- ❒ Other: ______________________

Geophysical

- ❑ In situ Physical Sensors
- ❒ Ground Penetrating Radar
- ❒ Shallow Seismic Reflection/Refraction
- ❒ Subsurface Resistivity Geophysical Instruments (including cone penetrometer)
- ❒ Subsurface Conductivity Geophysical Instruments
- ❒ Subsurface Magnetrometry Geophysical Instruments

Extraction

- ❒ Extraction Technologies (Analytical Traps)
- ❒ Supercritical Fluid Extraction

Other Sampling Technology

- ❒ Air Sampling Technologies
- ❒ Water Sampling Technologies
- ❒ Soil Sampling Technologies

Other: ______________________

3. **Vendor Name.** Please provide the name of the manufacturer of the technology or equipment used at the site.

____

(**Note:** Questions 4 through 9 may be answered by including a vendor or manufacturer's fact sheet or sales brochure with the completed form)

☛ (For PRC only) Check to see if vendor is listed on Vendor FACTS: ❒ Yes ❒ No

4. Vendor Address ____________________

____

City ____________ State ____________ Zip Code ____________

5. Vendor Phone Number (   ) ___-______

6. **Technology Description.** Provide a brief description of the monitoring/measurement device or technology, including scientific principles on which the technology is based; key steps; unique or innovative features; whether the full-scale system is continuous, on demand, or single measurement; and whether the technology is transportable, portable, or in situ.

____

____

____

7. **Data Type.** What type of data does the technology produce? *Please check all that apply.*

❐ Qualitative (yes/no, absence or presence)

❐ Quantitative (specific number)

❐ Semi-quantitative (measurement within range)

8. **Use of Data Produced By the Technology.** At this site, identify how the data produced by the technology was used?

❐ Screening

❐ Cleanup monitoring or verification sample analysis

❐ Compliance monitoring

❐ Risk assessment

❐ Enforcement

❐ Site characterization

❐ Other: ____________________

9. **Sample Throughput/Measurement Frequency.** Please indicate the sample throughput (that is, how long it takes to generate a useable data point). Throughput is measured by the total time required to obtain the data divided by the total number of data points.

Units

___ per hour ___ per ft^2 ___ per linear ft ___ per acre ___ continuous readout

❐ Other specify ____________________

10. Time Period Technology Used. Identify how long the technology or equipment was used at the site.

Number of months/days ______________ or From: ________ To: ________

11. Media Monitored or Characterized. Identify all media in which the technology for monitoring or measurement was used.

- ❐ Soil (in situ)
- ❐ Soil (ex situ)
- ❐ Sludge
- ❐ Solid (for example, slag, rock)
- ❐ Sediment (in situ)
- ❐ Sediment (ex situ)
- ❐ Light Non-aqueous Phase Liquids (NAPLs)
- ❐ Dense Non-aqueous Phase Liquids (DNAPLs)
- ❐ Groundwater
- ❐ Soil gas
- ❐ Surface water
- ❐ Leachate
- ❐ Air particulates
- ❐ Other (specify) ______________

12. Monitoring Targets. *Please check all that apply.* Identify all the contaminants that have been monitored or measured by the technology at the site.

Chemical	**Monitoring Target**
❐	Halogenated volatiles
❐	Halogenated semivolatiles
❐	Nonhalogenated volatiles
❐	Nonhalogenated semivolatiles
❐	Organic pesticides/herbicides
❐	Dioxins/furans
❐	PCBs
❐	Polynuclear aromatics (PNA)
❐	Solvents
❐	Benzene-toluene-ethyl benzene-xylene (BTEX)
❐	Acetonitrile (organic cyanide)
❐	Organic acids
❐	Heavy metals
❐	Nonmetallic toxic elements
❐	Radioactive metals
❐	Radionuclides
❐	Asbestos
❐	Inorganic cyanides
❐	Inorganic corrosives

Physical	**Monitoring Target**
❐	Water Table
❐	Soil Types
❐	Bedrock Stratigraphy
❐	Resistivity
❐	Conductivity
❐	Buried Ferrous Materials
❐	Buried Non Ferrous Materials
❐	Soil Moisture
❐	Temperature
❐	Other (specify) ______________
	Miscellaneous
❐	Explosives/propellants
❐	Organometallic pesticides/herbicides
❐	Radon
❐	Other (specify) ______________

13. Discussion of the Technology. Describe the benefits, accomplishments, or advantages obtained by using this technology at the site. (For example, cost effectiveness, quick turn-around time in obtaining data, portability, or ease-of-use).

____

____

____

____

14. Cost of Using The Technology.

a. Who operated the equipment/technology?

❐ Vendor ❐ Respondent Other (explain) ____________________

b. Are there any cost data available? (For example, can you explain the cost of using the technology in terms of the purchase of equipment, rental costs, or cost per sample).

c. At this site or project, were there any specific factors affecting the cost of using the equipment or technology (such as, labor rates, calibration time, other equipment needed, depth to contamination, interferences, or access to power)?

15. **Independent Verification of Technology Performance.** During this project, was there independent verification of the results produced by this technology?

❐ Yes ❐ No ❐ Unknown

a. If the answer to question 13 is yes, is there a report(s) that documents the verification of the results and how may the report be obtained?

16. General Comments. Please provide any other general comments concerning the use or performance of the technology (such as, discussion of any technical limitations, site conditions, contaminants, or other interferences encountered when using the technology at this site, or lessons learned from applying the technology at this site). Please also indicate if you were satisfied or dissatisfied with the performance of the technology and technical support of the vendor.

____

____

____

____

____

____

17. Additional Information. The following information will not be included the Annual Status Report summarizing information on field analytical and characterization technologies, but may provide important additional information concerning future efforts to evaluate or assess the use of field analytical and characterization technologies.

Benefit of a More Detailed Case Study. Indicate whether the technology would benefit from additional study or evaluation to verify its performance (such as that which may be provided by a detailed case study).

❒ Yes ❒ No Comments: ______________________________

____

Participation in Further Analysis of The Technology. Please indicate if you would be interested in participating or contributing to further evaluation of the technology.

❒ Yes ❒ No

Additional Data on Field Analytical and Characterization Technologies. Identify any additional field analytical and characterization technologies on which you are interested in obtaining useful data.

____

____

____

____

APPENDIX C

VENDOR FIELD ANALYTICAL AND CHARACTERIZATION TECHNOLOGIES SYSTEM DATABASE

VENDOR FACTS

The Vendor Field Analytical and Characterization Technologies System (Vendor FACTS) is a Windows[TM]-based database of innovative measuring and monitoring technologies for site characterization. It is a searchable database that allows users to: (1) obtain information about innovative measurement and monitoring technologies for use in the field; (2) search the database to identify technologies that measure or monitor specific types of contaminants or specific media; (3) identify technologies that are used for analytical measurement, physical characterization, site mapping, or health and safety monitoring; (4) identify vendors by technology or trade name; (5) view cost and performance data for a technology, reported by project; (6) scroll through a vendor's information record page by page, using menu selections; and (7) print or download to a file the results of custom searches and system reports.

To access Vendor FACTS, the user first must select one of the following search categories:

General Vendor Information	**Project Data**
Vendor Name	Site Name
Technology Type	Site Location
Trade Name	Regulation/Statute
Media	Project Type
Monitoring Targets	Equipment Scale
Waste Source	Contaminant Type
Technology Maturity	
Intended Use	
Data Quality Use	

A menu of vendor information will appear. The user then can select one of the following information options:

- Company Profile
- Technology Profile
- Technical References
- Technology Description
- Operation and Maintenance
- Cost and Licensing
- Monitoring Targets
- Conditions Affecting Performance
- Data Collected
- Representative Projects

To become a registered user, mail or fax your name, organization, address, and telephone number to the address below. Please indicate whether you wish to order the Vendor FACTS software or to register as a Vendor FACTS user.

U.S. EPA/NCEPI
PO Box 42419
Cincinnati, OH 45242-0419
Facsimile: (513) 489-8695