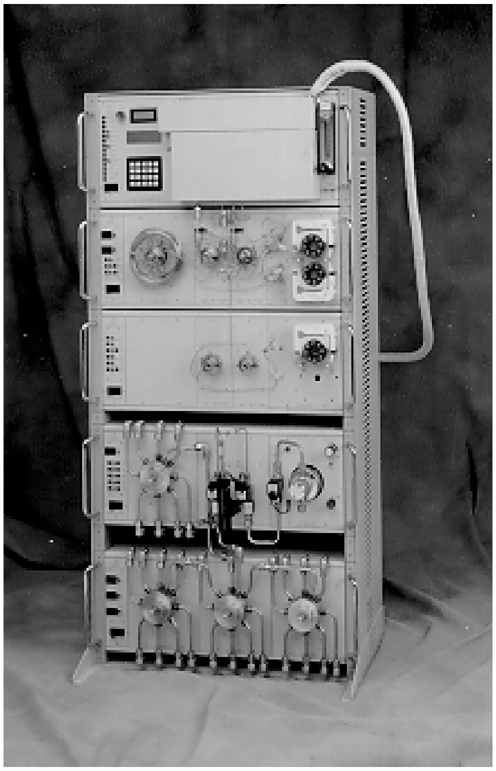
ANALYTICAL AND REMEDIAL TECHNOLOGY, INC.

(Automated Sampling and Analytical Platform)

TECHNOLOGY DESCRIPTION:

Analytical and Remedial Technology, Inc. (A^+RT), produces components that can be assembled in various configurations to allow automated sampling and analysis of water streams. The A^+RT components are mounted in a custom case to produce an automated sampling and analytical platform (ASAP). A complete ASAP system consists of the following basic components:

- An ASAP sampling manifold module with internal pump
- An optional module to allow the ASAP to control up to 48 Grundfos 2-inch submersible pumps
- One or more ASAP sample preparation modules
- One or more third-party gas or liquid chromatographs with appropriate detectors
- One or more third-party integrators for processing raw data and producing hard copies of chromatograms
- A Windows 3.X-compatible microcomputer running A^+RT software to control the system, store results in a database, and provide telecommunication capabilities.



Sampling and Analytical Platform

The photograph below illustrates an ASAP configured for automated sampling of 29 points using 0.25-inch stainless steel tubing.

The A^+RT purge-and-trap concentrator draws a precise volume of water (selectable from 0.2 to 10 milliliters) from the selected sample stream and prepares it for volatile organic compound (VOC) analysis using a gas chromatograph. The A^+RT concentrator differs from the customary batch purging approach in that it uses a flow-through, countercurrent stripping cell.

The A^+RT high performance liquid chromatograph (HPLC) sample preparation module collects a sample in a fixed volume loop and delivers it to the HPLC. With additional components, the module can support a second channel for HPLC analysis along with either automated or manual sample selection. The module can also be configured to process the samples using solid-phase extraction. This process concentrates analytes, which are then backflushed with solvent and extracted for subsequent HPLC analysis.

An optional Grundfos pump interface module (GPIM) allows the ASAP, for a given sample, to select and operate one of up to 48 Grundfos RediFlo-2™ 2-inch submersible pumps connected to the ASAP. Thus, this module allows automatic sampling of groundwater for groundwater depths greater than 15 to 20 feet below surface. Control of up to 48 pumps requires only one Grundfos MP1 controller interfaced with the GPIM.

The A^+RT components and software are designed to allow continuous (24-hour) monitoring for long periods of time (months to years) with automated continuing calibration checks and recalibration when necessary. The ASAP is designed to be installed with the other system components permanently or semipermanently in a secure, temperature-controlled space on site.

WASTE APPLICABILITY:

The ASAP is designed for automated sampling and analysis of aqueous samples, such as those obtained from a treatment or process stream or from wells emplaced in a groundwater contaminant plume. The ASAP can be configured for a wide variety of contaminants, including VOCs, polynuclear aromatic hydrocarbons, ionizable organic chemicals, and a range of inorganic substances.

STATUS:

Several commercial ASAP systems have been purchased by universities for use in groundwater remediation research at U.S. Department of Defense facilities. The ASAP has considerably broader capabilities than the prototype system (the Automated Volatile Organics Analytical System, or AVOAS) evaluated under the SITE Program. The AVOAS was demonstrated in May 1991 at the Wells G and H Superfund site in EPA Region 1. The results of the demonstration have been published by EPA ("Automated On-Site Measurement of Volatile Organics in Water, EPA/600/R-93/109, June 1993").

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AQUATIC RESEARCH INSTRUMENTS

(Sediment Core Sampler)

TECHNOLOGY DESCRIPTION:

The Russian Peat Borer is a manually driven, chambered-type, side-filling core sampler designed to collect discrete, relatively uncompressed sediment samples. Sampler components include a stainless-steel core tube, aluminum extension rods, a stainless-steel turning handle, and a Delrin core head and bottom point that support a stainless-steel cover plate. The cover plate and bottom point are sharpened to minimize sediment disturbance during sampler deployment. The core tube is hinged to the cover plate by two pivot pins at the top and bottom of the plate. Support equipment for the sampler may include a slide-hammer mechanism to aid sampler deployment and retrieval in consolidated sediment. To collect a sediment sample, the Russian Peat Borer is manually inserted into sediment, and the core tube is turned 180 degrees clockwise. This procedure allows the core tube to rotate and its sharp edge to longitudinally cut through the sediment, collecting a semi cylindrical sediment core. While the core tube is manually turned, the stainless-steel cover plate provides support so that the collected material is retained in the core tube.

WASTE APPLICABILITY:

The Russian Peat Borer is a manually driven core sampler designed to consistently collect uncompressed samples of bog and marsh sediment. The sampler is designed to operate in shallow water (a depth of up to 15 feet) and to achieve complete sediment profile collection to a maximum depth of 65 feet bss (below sediment surface), depending on the sediment thickness.

STATUS:

In April and May 1999, the EPA conducted a field demonstration of the Russian Peat Borer along with one other sediment sampler. It was demonstrated at sites in EPA Regions 1 and 5. At the Region 1 site, the sampler was demonstrated in a lake and wetland. At the Region 5 site, the sampler was demonstrated in a river mouth and freshwater bay. A complete description of the demonstration and a summary of its results are available in the Innovative Technology Verification Report (EPA/600/R-01/010).

DEMONSTRATION RESULTS:

Mean sample recoveries ranged from 71 to 84 percent for the shallow depth interval, and 75 to 101 percent for the moderate depth interval. Samples were collected at all depth intervals and demonstration areas, which contained various sediment types. Samples were collected with consistent physical characteristics from two homogenous layers of sediment. Samples were collected from a clean sediment layer below a contaminated sediment layer at least as well as comparable technologies. The sampler was able to be adequately decontaminated. Samples were collected in a short sampling time.

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ART'S MANUFACTURING AND SUPPLY

(AMS™ Dual-Tube Liner Soil Sampler)

TECHNOLOGY DESCRIPTION:

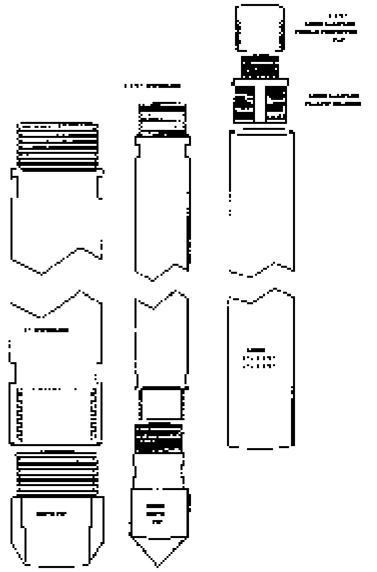
The Art's Manufacturing and Supply (AMS™) dual tube soil sampler, shown in the figure below, is designed to work with direct-push sampling rigs. The sampler consists of two steel tubes of differing diameters designed so that the two tubes fit within one another. The outer tube is equipped with a metal drive tip at the lower end and threaded at the upper end to allow additional metal extensions with increasing sampling depth and the addition of a drive head adaptor. The lower end of the inner tube is threaded with a plastic grabber to allow attachment of a polybutyrate liner during sampling or a solid-point metal inner drive tip during sampler advancement. The inner drive tip fits snugly within the outer drive tip, and both extensions and drive tips are held firmly in place by the drive head. Dual tube sampler extensions are available in 1-, 2-, 3-, and 4-foot lengths with wall thicknesses of 0.25 or 0.375 inch. The outer extension serves as a temporary casing so that continuous or discrete soil samples can be collected using the inner extension liner and drive tip assembly. The inner extension by itself can also be used for sampling.

The direct-push drill rig used to mount the dual tube liner sampler must be a 0.75-ton or heavier pickup truck supplied by the buyer or a custom-made truck assembled by AMS.

The dual tube liner sampler decreases the likelihood of cross-contamination, preserves sample integrity, collects samples chemically representative of the target sampling interval, can collect either discrete or continuous soil samples of unconsolidated materials, and does not generate drill cuttings.

WASTE APPLICABILITY:

The AMS™ dual tube liner sampler can be used to collect unconsolidated, subsurface soil samples at depths that depend on the capability of the direct-push advancement platform. The sampler has been used to collect samples of sandy and clayey soil contaminated with high concentrations of volatile organic compounds (VOC). It can also be used to collect samples for semivolatile organic compound, metals, general minerals, and pesticides analyses.



Dual-Tube Liner Soil Sampler

STATUS:

The AMS™ dual tube soil sampler was demonstrated under the Superfund Innovative Technology Evaluation (SITE) program in May and June 1997 at two sites: the Small Business Administration (SBA) site in Albert City, Iowa, and the Chemical Sales Company (CSC) site in Denver, Colorado. Samples collected during the demonstrations were analyzed for VOCs to evaluate the performance of the samplers.

Demonstration results indicate that the dual tube liner sampler had higher sample recoveries in the clayey soil present at the SBA site than the standard methods. Conversely, the sampler had lower recoveries than the standard methods in the sandy soil present at the CSC site. VOC concentrations in samples collected with the dual tube liner sampler did not significantly differ statistically from concentrations in samples collected using the standard methods. Sample integrity using the dual tube liner sampler was preserved in highly contaminated soil. The sampler's reliability and throughput were generally as good as those of the standard methods. Costs for the dual tube liner sampler were lower than costs related to the standard sampling methods. According to the developer, all sampler decontamination was done using the on-board wash station on the AMS direct push platform (the AMS Powerprobe 9600). This significantly reduced the overall time to sample and decontaminate its equipment.

Demonstration results are documented in the "Environmental Technology Verification" report for the sampler dated August 1998 (EPA/600/R-98/093).

Organics were the primary groundwater contaminant at the site, and trichloroethene (TCE) was selected as the contaminant of concern for the demonstration. The Demonstration Bulletin (EPA/540/MR-95/511) and Demonstration Capsule (EPA/540/R-95/511a) are available from EPA.

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ART'S MANUFACTURING AND SUPPLY

(Sediment Core Sampler)

TECHNOLOGY DESCRIPTION:

The Split Core Sampler is an end-filling sampler designed to collect undisturbed core samples of sediment up to a maximum depth of 4 feet below sediment surface (bss). The sampler collects samples from the sediment surface downward, not at discrete depth intervals. Sampler components include one or more split core tubes, couplings for attachment to additional split core tubes, a ball check valve-vented top cap, a coring tip, one or more extension rods, and a cross handle. All of these components are made of stainless steel, carbon-steel extension rods are also available from the developer. The sampler may be used with a core tube liner to facilitate removal of an intact sample from the split core tube. To collect a sediment sample, the sampler can either be manually pushed into the sediment using the cross handle or hammered into the sediment using a slide hammer or an electric hammer. The check valve in the sampler's top cap allows water to exit the sampler during deployment and creates a vacuum to help retain a sediment core during sampler retrieval. The sampler can be retrieved by hand, by reverse hammering using the slide hammer, or by using a tripod-mounted winch.

WASTE APPLICABILITY:

The Split Core Sampler is designed to take virtually undisturbed samples of soils either at the surface or from the bottom of predrilled holes. These samples may be used for geotechnical testing, chemical or physical analysis.

STATUS:

In April and May 1999, the EPA conducted a field demonstration of the Split Core Sampler along with one other sediment sampler. The performance and cost of the Split Core Sampler were compared to those of two conventional samplers (the Hand Corer and Vibrocorer), which were used as reference samplers. A complete description of the demonstration and a summary of its results are available in the "Innovative Technology Verification Report: Sediment Sampling Technology-Art's Manufacturing and Supply Inc., Split Core Sampler for Submerged Sediments" (EPA/600/R-01/009).

DEMONSTRATION RESULTS:

The Sediment Core Sampler collects partially compressed samples of both consolidated and unconsolidated sediments from the sediment surface downward; sample representiveness may be questionable because of core shortening and core compression. Mean sample recoveries ranged from 89 to 100 percent in the shallow depth interval (0 to 4 inches bss), and 37 to 100 percent for the moderate depth interval (4 to 32 inches bss). No samples were able to be collected in the deep depth interval (4 to 11 ft bss). The Split Core Sampler's actual core lengths resembled the target core lengths in 96 percent of the sampling attempts in the shallow depth interval, and in 39 percent of the sampling attempts in the moderate depth interval. The sampler preserves sediment stratification in both consolidated and unconsolidated sediment samples.

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BIONEBRASKA, INC.

(BiMelyze® Mercury Immunoassay)

TECHNOLOGY DESCRIPTION:

The BioNebraska, Inc., BiMelyze® Mercury Immunoassay technology measures mercury concentrations in solid matrix samples. The field-portable immunoassay technology provides semiquantitative results based on the activity of mercury-specific monoclonal antibodies. The technology consists of two kits: an extraction kit and an assay tube kit. The kits together can process 16 samples.

The solid matrix samples are first extracted using a 2:1:1 mixture of hydrochloric acid, nitric acid, and deionized water. A buffer solution provided in the extraction kit is then added to the sample pH to 6 to 8, and the samples are filtered.

The extracted and filtered samples are then transferred to mercury assay tubes supplied in the assay tube kit. These tubes are coated with sulfhydryl-rich proteins that trap the mercury ions. After the addition of kit-supplied antibodies, conjugate, and substrate, the presence of mercury can be semiquantitatively determined by comparing the color of the sample tubes to the color of tubes of the mercury standards supplied in the kit. The standards are determined, within limits, by the customer. The limit of detection is 0.5 parts per million (ppm) and the analytical range is 0.5 to 40 ppm. The absorbance of the sample tubes can be measured using a spectrophotometer.

WASTE APPLICABILITY:

The BiMelyze® Mercury Immunoassay technology has been used to analyze soil and sediment samples containing mercury. The technology works best on fine-grained material because of the larger surface- to-volume ratio. The effect of moisture content on the technology's applicability is unknown. The technology can provide semiquantitative or sample screening information and has been found to have a good potential as a Level I analytical method.

STATUS:

The BiMelyze® Mercury Immunoassay technology was accepted into the Superfund Innovative Technology Evaluation (SITE) program in 1994 and was demonstrated in August 1995 at two sites: the Carson River Mercury (CRM) site in Reno, Nevada, and the Sulfur Bank Mercury Mine (SBMM) site in Clear Lake, California. Samples collected during the demonstrations were split for analysis in the field using the BiMelyze[7] Mercury Immunoassay technology and for later confirmatory analysis using standard inductively coupled plasma (ICP) mass spectrometry (MS). A total of 110 soil and sediment samples were collected from the CRM and SBMM sites (55 samples from each site) and split. The demonstration results indicate that the BiMelyze® Mercury Immunoassay technology agreed with ICP MS results for 66 percent of the samples analyzed. Demonstration results are documented in the "Innovative Technology Evaluation Report" from July 1998.

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BRUKER ANALYTICAL SYSTEMS, INC.

(Mobile Environmental Monitor)

TECHNOLOGY DESCRIPTION:

The Bruker Analytical Systems, Inc. (Bruker), mobile environmental monitor (see photograph below) is a field-transportable, gas chromatography/mass spectrometer (GC/MS) designed to identify and measure organic pollutants in various environmental media. The MS uses a quadruple mass analyzer similar to most conventional instruments. Like conventional MSs, this instrument can identify and quantify organic compounds on the basis of their retention time, molecular weight, and characteristic fragment pattern. The integrated GC allows introduction of complex extracts for separation into individual components and subsequent analysis in the MS.

The Bruker instrument's design and electronics are specially designed for field use. The instrument is designed to operate with battery power and can be used in various environmental situations with minimum support requirements.

The mobile environmental monitor was originally designed for the military to detect and monitor chemical warfare agents. Environmental samples may be introduced to the MS through the direct air sampler or the GC. Results are collected and stored in a computer, where data is reduced and analyzed. The computer provides reports within minutes of final data acquisition.

WASTE APPLICABILITY:

The Bruker mobile environmental monitor is designed to detect the full range of volatile and semivolatile organic compounds directly in air and in water, soil, sediment, sludge, and hazardous waste extracts. It provides in-field, real-time support during the characterization and remediation phases of cleanup at a hazardous waste site.

Bruker Mobile Environmental Laboratory

STATUS:

This technology was demonstrated at the Re-Solve, Inc., and Westborough Superfund sites in EPA Region 1. The technology was used to analyze polychlorinated biphenyls and polynuclear aromatics in soil and the full range of Superfund-targeted volatile organic compounds in water. Splits of all samples analyzed in the field were shipped to a laboratory for confirmatory analysis using standard EPA analytical methods.

The SITE demonstration was completed in September 1990, and the final report (EPA/600/X-91/079) is available from EPA. The results of this study were presented at the American Society for Mass Spectrometry Conference in May 1991 and at the Superfund Hazardous Waste Conference in July 1991. A recent survey of regional laboratories identified additional testing of this technology as a priority need.

Bruker has developed an additional system that addresses recommendations made in the project report. This system, designated the EM640, has increased mass range, decreased power consumption, faster sample analysis, and automated report generation. The EM640 was evaluated in July and September 1995 through the U.S. EPA Environmental Technology Verification Program (ETV). The evaluation showed that the EM640 provides "useful, cost-effective data for environmental problem-solving and decision-making." The Environmental Monitoring Systems Laboratory-Las Vegas purchased a Bruker mobile environmental monitor in fiscal year 1992 to pursue other applications and to expand the scope of this project.

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CHEMetrics, Inc.

Total Petroleum Hydrocarbon Field Soil Test Kit
(RemediAid™)

TECHNOLOGY DESCRIPTION:

The RemediAid™ Total Petroleum Hydrocarbon Test Kit is a rapid, simple field test for measuring petroleum hydrocarbon contamination in soil. The patented test is based upon the Friedel-Crafts Reaction. The kit responds to all hydrocarbon products as long as they contain aromatic hydrocarbons; thus, gasoline, diesel and other petroleum products heavier than diesel (such as lubricating oil), can be detected. RemediAid™ is unique because the colored reaction product is measured directly in the solvent by a portable absorbance photometer.

The test kit is administered as follows: A premeasured sample of soil is added to a reaction tube that contains anhydrous sodium sulfate, a drying agent. The soil is extracted with 20 mL of dichloromethane. Florisil™, is added to the soil extract to remove any natural organic material from the extract and minimize associated interference. A vacuum-sealed ampoule containing aluminum chloride is snapped in the soil extract. The hydrocarbons in the solvent react with the aluminum chloride to produce a soluble colored product directly proportional to the petroleum hydrocarbon concentration in the sample. The absorbance of the sample is measured in a portable, battery powered, LED-based colorimeter at 430 nm and converted to mg/kg (ppm) hydrocarbon in the soil by use of a formula. The soil extract can be diluted to bring absorbance readings in range in cases where the contamination levels are high.

Both the dichloromethane and the aluminum chloride are packaged in vacuum-sealed ampoules, which help minimize user contact with reagents. The starter kit includes the portable photometer, balance, and enough supplies to complete eight soil analyses. These come packaged in a portable carrying case. A replenishment kit includes enough supplies to perform 16 soil analyses. The device is designed to be used by those with basic wet chemistry skills.

WASTE APPLICABILITY:

RemediAid™ Total Petroleum Hydrocarbon Kit can detect petroleum fuels containing aromatic hydrocarbons in soils.

STATUS:

In June 2000, the RemediAid™ kit performance was evaluated for a wide range of performance attributes in a SITE field demonstration at Port Hueneme, California. Results were compared to an off-site laboratory that utilized reference methods from "Test Methods for Evaluating Solid Waste" (SW-846) Method 8015B (modified). Results from the demonstration have been published in an Innovative Technology Verification Report (ITVR) (EPA/600/R-01/082).

DEMONSTRATION RESULTS:

The demonstration involved the analysis of 74 soil environmental samples, 89 soil performance evaluation (PE) samples and 36 liquid PE samples. Collectively, these samples represented a wide range of matrix types and contamination. The ITVR report concluded that RemediAid™ exhibited the following desirable characteristics of a field TPH measurement device: (1) good accuracy, (2) good precision, (3) lack of sensitivity to interferents that are not petroleum hydrocarbons (PCE and 1,2,4-trichlorobenzene), (4) high sample throughput, (5) low measurement costs, and (6) ease of use. Despite some of the limitations observed during the demonstration, the demonstration findings collectively indicated that the RemediAid™ kit is a reliable field measurement device for TPH in soil.

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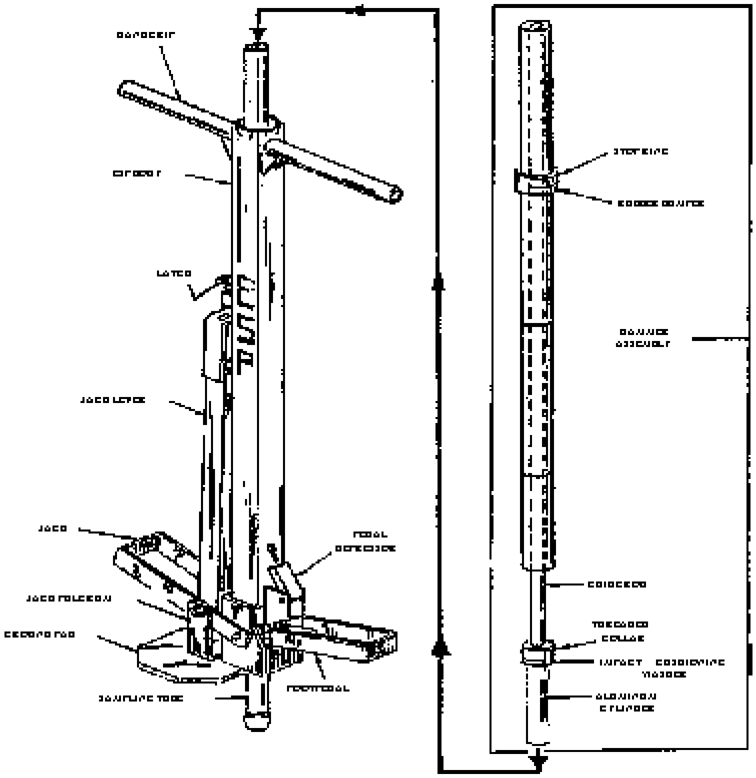
CLEMENTS, INC.

(JMC Environmentalist's Subsoil Probe)

TECHNOLOGY DESCRIPTION:

JMC Environmentalist's Subsoil Probe (ESP) developed by Clements Associates, Inc., consists of a sampling tube assembly, the ESP body, and a jack used to assist in sample retrieval (see figure below). The sampler can be advanced using manual or direct-push methods. The primary component of the ESP body is a heat-treated, 4130 alloy steel, nickel-plated sampling tube. The tube has a uniform 1.125-inch outer diameter and is 36 inches long. The ESP tube comes with three interchangeable stainless-steel tips (a solid drive point, a standard cutting tip, and a wet cutting tip) and inner sample liners that can also be used for sample storage.

The ESP body serves as a base and guide for the sampling tube as it is driven into or retrieved from a borehole. The jack used to retrieve the sample also allows operators to smoothly lower the sampler and tool string into the borehole at a controlled rate, thereby minimizing borehole disturbance.



Clements' ESP

According to the developer, the ESP sampler is simple to operate and requires no special training to use, is unaffected by variable field conditions, can collect either discrete or continuous soil samples of unconsolidated materials, can be used to characterize subsurface soil contamination, is easily transportable, and does not generate drill cuttings.

WASTE APPLICABILITY:

The ESP sampler can be used to collect unconsolidated, subsurface soil samples at depths of 4 feet below ground surface (bgs); however, through the use of extensions, samples from depths of up to 25 feet bgs can be collected. Physical limitations of ESP sampler operation depend on the method of sampler advancement and the nature of the subsurface matrix. The technology is primarily restricted to unconsolidated soil free of large cobbles or boulders. The sampler can also be used in sediment containing gravel-sized material supported by a finer-grained matrix. Originally, the sampler was designed for sampling agricultural residues containing radioactive trace elements. The sampler has been used to collect samples of sandy and clayey soil contaminated with high concentrations of volatile organic compounds (VOC). The sampler can also collect samples for polychlorinated biphenyl, polynuclear aromatic hydrocarbon, pesticides, and metals analyses. The ESP sampler was accepted into the Superfund Innovative Technology Evaluation (SITE) program in May 1997 and was demonstrated in May and June 1997 at two sites: the Small Business Administration (SBA) site in Albert City, Iowa, and the Chemical Sales Company (CSC) site in Denver, Colorado. Samples collected during the demonstrations were analyzed for VOCs to evaluate the performance of the samplers.

STATUS:

Demonstration results indicate that the ESP sampler had higher sample recoveries in both the clayey soil present at the SBA site and in the sandy soil present at the CSC site than the standard methods. VOC concentrations in samples collected with the ESP sampler from the SBA site significantly differed statistically from concentrations in samples collected using the standard methods; however, this difference was not observed for samples collected from the CSC site. Sample integrity using the ESP sampler was preserved in highly contaminated soil. The sampler's reliability and throughput were generally better than those of the standard methods. Costs for the ESP sampler were much lower than costs related to the standard sampling methods.

Demonstration results are documented in the "Environmental Technology Verification" report for the sampler dated August 1998 (EPA/600/R-98/097).

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DEXSIL CORPORATION

(Environmental Test Kits)

TECHNOLOGY DESCRIPTION:

The Dexsil Corporation (Dexsil) produces two test kits that detect polychlorinated biphenyls (PCB) in soil: the Dexsil Clor-N-Soil PCB Screening Kit, and the Dexsil L2000 PCB/Chloride Analyzer. The Dexsil Clor-N-Soil PCB Screening Kit, (see photograph below) extracts PCBs from soil and dissociates the PCBs with a sodium reagent, freeing chloride ions. These ions then react with mercuric ions to form mercuric chloride. The extract is then treated with diphenylcarbazone, which reacts with free mercuric ions to form a purple color. The less purple the color, the greater the concentration of PCBs in the sample.

The Dexsil L2000 PCB/Chloride Analyzer (see photograph on next page) also extracts PCBs from soil and dissociates the PCBs with a sodium reagent, freeing chloride ions. The extract is then analyzed with a calibrated, chloride-specific electrode. The L2000 instrument then translates the output from the electrode into parts per million (ppm) PCB.

These kits produce analytical results at different data quality levels. The Dexsil Clor-N-Soil PCB Screening Kit identifies samples above or below a single concentration, which is generally tied to regulatory action levels. The Dexsil L2000 PCB/Chloride Analyzer quantifies specific concentrations of PCBs, from 2 to 2,000 ppm, in a sample. The applicability of these methods depends on the data quality needs of a specific project. Both technologies can be used on site for site characterization or a removal action.

Dexsil Clor-N-Soil PCB Screening Kit

WASTE APPLICABILITY:

The Dexsil Clor-N-Soil PCB Screening Kit and the Dexsil L2000 PCB/Chloride Analyzer can detect PCBs in soil, sediment, transformer oils, and water.

These test kits were demonstrated at a PCB-contaminated facility in EPA Region 7. About 200 soil samples were collected and analyzed on site using the Dexsil test kits. Soil samples were not dried prior to analysis. Split samples were submitted to an off-site laboratory for confirmatory analysis by SW-846 Method 8080. Demonstration data were used to evaluate the accuracy and precision of the test kits relative to internal quality control samples and to formal laboratory data. These data were also used to determine operating costs.

The sampling and field analyses for this technology demonstration were completed in August 1992. The Innovative Technology Evaluation Report (EPA/540/R-95/518) is available from EPA. The Office of Solid Waste has designated the L2000 Method for PCB screening of soil as Method 9078, to be included in the third update to the third edition of SW-846.

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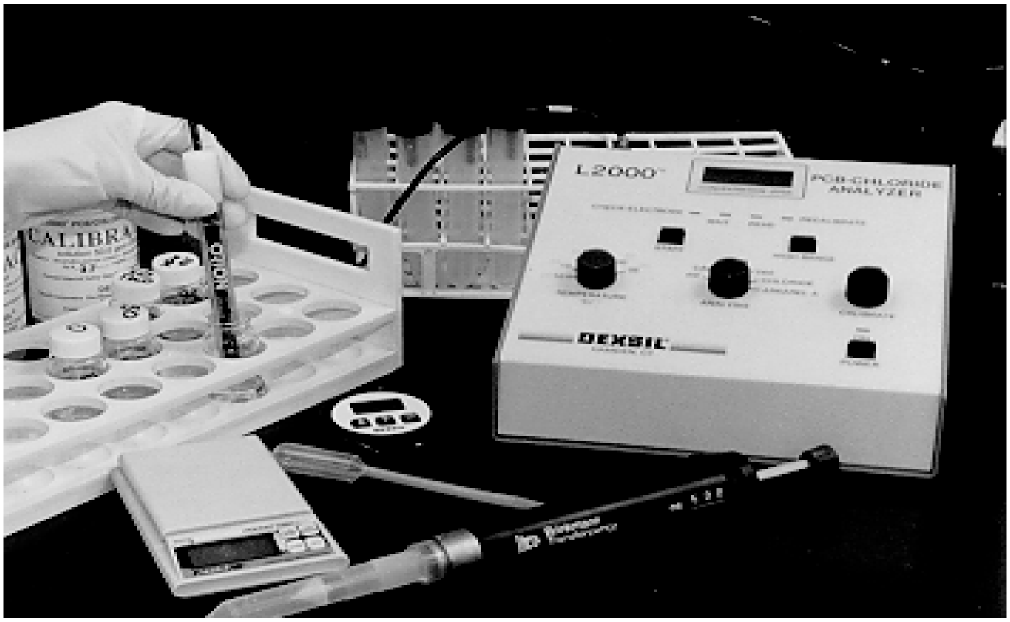

Dexsil L2000 PCB/Chloride Analyzer

DEXSIL CORPORATION

(Emulsion Turbidimetry)

TECHNOLOGY DESCRIPTION:

The PetroFLAG^{TM} System manufactured by Dexsil is based on emulsion turbidimetry, which involves measurement of the light scattered by an emulsion. With the PetroFLAG^{TM} System, a proprietary, nonpolar, organic solvent mixture composed of alcohols, primarily methanol, is used to extract petroleum hydrocarbons from soil samples. A proprietary developer solution that is polar in nature that acts as an emulsifier is added to a sample extract in order to precipitate the aromatic and aliphatic hydrocarbons and form uniformly sized micelles. Light at a wavelength of 585 nanometers is passed through the emulsion, and the amount of light scattered by the emulsion at a 90-degree angle is measured using a turbidimeter. The total petroleum hydrocarbon (TPH) concentration in the emulsion is then determined by comparing the turbidity reading for the emulsion to a reference standard or to a standard calibration curve. The TPH concentration thus measured is a function of the mean molecular weight of the hydrocarbons present in the sample.

WASTE APPLICABILITY:

The PetroFLAG System is a field portable method capable of determining total petroleum hydrocarbons in soil.

STATUS:

In June 2000, the EPA conducted a field demonstration of the PetroFLAG^{TM} System and six other field measurement devices for TPH in soil. The performance and cost of the PetroFLAG^{TM} System were compared to those of an off-site laboratory reference method. A complete description of the demonstration and summary of its results are available in the "Innovative Technology Verification Report: Field Measurement Devices for Total Petroleum Hydrocarbons in Soil-Dexsil® Corporation PetroFLAG^{TM} System " (EPA/600/R-01/092).

DEMONSTRATION RESULTS:

The method detection limits for the PetroFLAG^{TM} System were determined to be 20 millograms per kilogram. Seventy-three percent of results agreed with those of the reference method. Of 91 results used to measure measurement bias, 9 were biased low, and 82 were biased high. For soil environmental samples, the results were statistically the same as the reference method for one out of four sampling areas. The PetroFLAG^{TM} System exhibited similar overall precision to the reference method (RSD ranges were 6 to 19 percent and 5.5 to 16 percent for the PetroFLAG^{TM} System and the reference method respectively). The PetroFLAG^{TM} System showed a mean response of less than 5 percent for interferents such as MTBE, PCE, and soil spiked with humic acid. There were varying responses for other interferents, such as Stoddard solvent (42.5 percent), turpentine (103 percent), and 1, 2, 4-trichlorobenzene (16 percent). The PetroFLAG^{TM} System showed a statistically significant decrease (17 percent) in TPH results when the soil moisture content was increased from 9 to 16 percent in weathered gasoline samples. This effect was not observed in diesel soil samples.

Both the measurement time and cost compared well with those of the reference method.

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EDAX PORTABLE PRODUCTS DIVISION

(formerly C-Thru Technologies Corporation)
(Metal Analysis Probe [MAP®] Spectrum Assayer)

TECHNOLOGY DESCRIPTION:

The C-Thru Technologies Corporation (C-Thru) Metal Analysis Probe Spectrum Assayer (see photograph below) is a field portable X-ray fluorescence (FPXRF) analyzer. This FPXRF analyzer can simultaneously analyze for select metals. It is compact, lightweight, and does not require liquid nitrogen. A rechargeable battery allows the FPXRF analyzer to be used at remote sites where electricity is unavailable.

The instrument is composed of a control console connected to an ambient scanner with a cable. The basic MAP® system also includes a carry pack, rechargeable batteries, operator's manual, target metal standard, and a shipping case. The control console contains a 256-multichannel analyzer with a storage capacity of 325 spectra and analyses. The control console with batteries weighs 11 pounds and the ambient scanner weighs about 2.5 pounds.

The MAP® Spectrum Assayer uses a silicon X-ray detector to provide elemental resolution. The unit demonstrated under the SITE Program used a Cadmium-109 radioisotope as the excitation source. Cobalt-57 and Americium-241 sources are also available.

The MAP® Spectrum Assayer is capable of analyzing 9 to 12 samples per hour based on a 240-second analysis time. The instrument is empirically calibrated by the developer. C-Thru requires a 1-day operator training and radiation safety course prior to obtaining a specific license to operate the instrument. The standard MAP® 3 Portable Assayer package used in the demonstration sold for $32,000.

The MAP® Spectrum Assayer provides high sample throughput and is reportedly easy to operate. Analytical results obtained by this instrument may be comparable to the results obtained by EPA-approved methods.

MAP® Assayer

WASTE APPLICABILITY:

The MAP® Spectrum Assayer can detect select metals in soil and sediment samples and in filter and wipe samples. It can also detect lead in paint. The MAP® Portable Assayer reportedly can quantitate metals at concentrations ranging from parts per million to percentage levels.

STATUS:

The MAP® Spectrum Assayer has been used at a number of Superfund sites across the country. It was evaluated in April 1995 as part of a SITE demonstration of FPXRF instruments. The results are summarized in Technical Report No. EPA/600/R-97/147, dated March 1998. The instrument was used to identify and quantify concentrations of metals in soils. Evaluation of the results yielded field-based method detection limits, accuracy, and precision data from the analysis of standard reference materials and performance evaluation samples.

Comparability of the FPXRF results to an EPA-approved reference analytical method was also assessed during the demonstration. The Draft Fourth Update to SW-846 includes Method 6200, dated January 1998, which is based on this work.

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ENVIRONMENTAL SYSTEMS CORPORATION

(Ultraviolet Fluorescence Spectroscopy)

TECHNOLOGY DESCRIPTION:

The Synchronous Scanning Luminoscope (SSL) uses a xenon lamp to produce a multiwavelength ultraviolet light beam that passes through an exitation monochromator before irradiating a sample extract held in a quartz cuvette. When the sample extract is irradiated, aromatic hydrocarbons in the extract emit light at a longer wavelength than does the light source. The light emitted from the sample extract passes through another monochromator, the emission monochromator, and is detected using a photomultiplier tube. The photomultiplier tube detects and amplifies the emitted light energy and converts it into an electrical signal. This signal is used to determine the intensity of the light emitted and generate a spectrum for the sample.

The components of the SSL are structured to maintain a constant wavelength interval between the excitation and emission monochromators. This modification of classical fluorescence technology is called synchronous fluorescence and takes advantage of the overlap between the excitation and emission spectra for a sample to produce more sharply defined spectral peaks.

WASTE APPLICABILITY:

The SSL gives a quantitative measurement of total petroleum hydrocarbons (TPH) concentrations in soil samples using ultraviolet fluorescence spectroscopy.

STATUS:

In June 2000, the EPA conducted a field demonstration of the SSL and six other field measurement devices for TPH in soil. The performance and cost of the SSL were compared to those of an off-site laboratory reference method. A complete description of the demonstration and summary of its results are available in the "Innovative Technology Verification Report: Field Measurement Devices for Total Petroleum Hydrocarbons in Soil-Environmental Systems Corporation Synchronous Scanning Luminoscope" (EPA/600/R-01/083).

DEMONSTRATION RESULTS:

The method detection limit for the SSL was determined to be 36 mg/kg. Seventy-five of 108 results used to draw conclusions regarding whether the TPH concentration in a given sampling area or sample type exceeded a specific action level agreed with those of reference method. There were 10 false positives, and 23 false negatives. Of 102 results used to measure measurement bias, 64 were biased low, 37 were biased high, and 1 showed no bias. For soil environmental samples, the results were statistically the same as the reference method for all five sampling areas. The SSL exhibited greater overall precision than the reference method (RSD ranges were 8 to 12 percent and 5.5 to 18 percent for the SSL and the reference method, respectively). The SSL showed a mean response of less than 5 percent for interferents such as MTBE, PCE, Stoddard solvent, turpentine, 1, 2, 4-trichlorobenzene, and soil spiked with humic acid. The SSL TPH results were unaffected when the moisture content was increased. Both the measurement time and cost compared well with those of the reference method.

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ENVIRONMENTAL TECHNOLOGIES GROUP, INC.

(AirSentry Fourier Transform Infrared Spectrometer)

TECHNOLOGY DESCRIPTION:

This air monitoring system (see photograph below) is a field-deployable, open-path Fourier transform infrared (FTIR) spectrometer that measures infrared absorption by infrared-active molecules. The spectrometer system transmits an infrared beam along an open air path to a retroflector target that returns it to the spectrometer. The total air path can be up to 1 kilometer long. Analysis is performed using a quantitative reference spectrum of known concentration, together with classical least squares data fitting software routines. The system does not require acquisition of an air sample; this factor assures that sample integrity is not compromised by interaction between the sample and the collection and storage system.

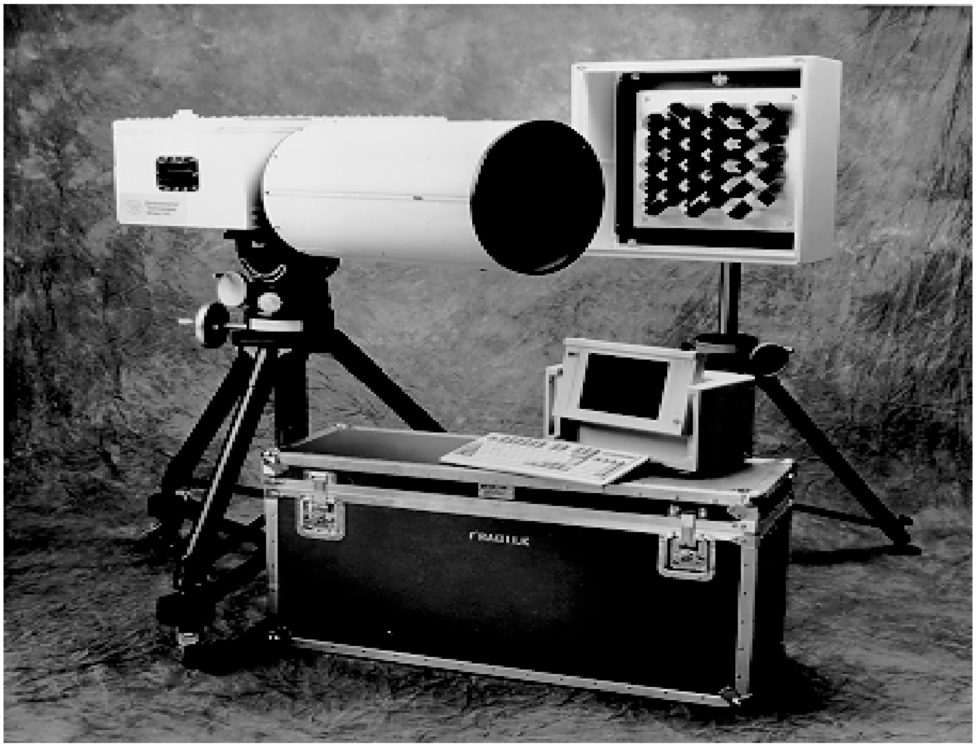
A measurement over several hundred meters requires only a few minutes, which allows determination of temporal profiles for pollutant gas concentrations. The spectrometer requires performance verification procedures, but does not require calibration.

WASTE APPLICABILITY:

The AirSentry FTIR spectrometer can collect information on spectral absorption from a number of airborne vapors at one time, including both organic and inorganic compounds. This information is processed to obtain the average concentration over the entire pathlength. The system has been used to monitor fugitive emissions from industrial plants and from hazardous waste sites. By combining these measurements with measurements of wind speed, emission rates can be estimated. It can be used to monitor emissions from hazardous waste sites during remediation and removal.

STATUS:

The AirSentry FTIR spectrometer was demonstrated during a 1990 SITE study at Shaver's Farm, a Superfund site in northwest Georgia. The purpose of this demonstration was to test performance during remedial activities and to develop and test on-site quality assurance procedures. Results of this study



AirSentry Fourier Transform Infrared Spectrometer were published in a paper titled "Use of a Fourier Transform Spectrometer As a Remote Sensor at Superfund Sites: Proceedings of the International Society for Optical Engineering" --SPIE Vol. 1433, p. 302, Measurement of Atmospheric Gases, Los Angeles, CA, 21-23 January 1991, presented at a 1991 conference.

The AirSentry FTIR spectrometer has been evaluated in several other field studies and has been proven capable of detecting various airborne atmospheric vapors. The AirSentry FTIR gas analysis software, which automatically identifies and quantifies compounds in the presence of background interferences, was evaluated in a 1991 field study sponsored by EPA Region 7. Results of this field evaluation are published in an EPA report entitled "A Field-Based Intercomparison of the Qualitative and Quantitative Performance of Multiple Open-Path FTIR Systems for Measurement of Selected Toxic Air Pollutants."

Another field evaluation of the AirSentry FTIR spectrometer was conducted at a Superfund site in January 1992. During the field evaluation, the FTIR spectrometer was compared with gas chromatography/mass spectrometry techniques using air samples collected in canisters. Results from this field evaluation are published in an EPA report titled "Superfund Innovative Technology Evaluation, The Delaware SITE Study, 1992" (EPA/600/A3-91/071).

A guidance document detailing the steps required for successful field operation of the FTIR-based open path monitoring systems is available from EPA and is referred to as Method TO-16 in the "EPA Compendium of Methods for Determination of Toxic Organic Compounds in the Ambient Air". For a copy of the draft document, contact the EPA Project Manager listed below.

This technology remains available from the Environmental Technologies Group, Inc. as well as other commercial companies. For further information about the technology, contact the EPA Project Manager.

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FUGRO GEOSCIENCES, INC.

(formerly LORAL CORPORATION)
(Rapid Optical Screening Tool)

TECHNOLOGY DESCRIPTION:

The Fugro Rapid Optical Screening Tool (ROST^{TM}), shown in the figure below, is an in situ screening sensor used in conjunction with Cone Penetration Testing (CPT) systems that provides rapid delineation of petroleum hydrocarbons (PHC). ROST^{TM} characterizes the PHCs from the fluorescence response induced in the polycyclic aromatic hydrocarbon (PAH) compounds contained within the contaminant material. ROST^{TM} continuously detects separate phase PHCs in the bulk soil matrix in the vadose, capillary fringe, and saturated zones and provides a screening of the relative concentration present. ROST^{TM} also presents the spectral signature of the detected PHC, which often allows identification of the contaminant type (such as gas, diesel, coal tar,creosote, etc.). CPT testing is conducted simultaneously with ROST^{TM} testing and provides real-time, in situ lithologic data. Fugro can also deploy ROST^{TM} from percussion-type Direct Push Technology equipment.

The measurements are performed in situ and physical sampling during the delineation phase is not required. However, since ROST^{TM} is a screening tool, a limited amount of confirmation soil sampling is recommended. The list of petroleum products for which this method is appropriate includes, but is not limited to: gasoline, diesel fuel, crude oil, jet fuel, heating oil, coal tar, kerosene, lubricating oils, and creosote.

The ROST^{TM} methodology utilizes laser-induced fluorescence spectroscopy for PHC screening. Pulsed laser light is used to excite PAHs and is delivered via a fiber optic cable to a sub-unit mounted directly behind the CPT penetrometer probe (cone). The light is directed through a sapphire window on the side of the sub-unit and onto the surface of the soil. PAHs present within the soil absorb the excitation light and emit the absorbed energy as fluorescence. A portion of this fluorescence is returned by a collection fiber to the surface and is analyzed by the ROST^{TM} unit. ROST^{TM} measures and reports the following three fluorescence parameters in real time:

Rapid Optical Screening Tool

- Intensity of the fluorescence emitted by the PHC.
- Spectrum of wavelengths of light emitted by the PHC.
- Lifetime of duration of the fluorescence emitted by the PHC.

The fluorescence intensity is generally proportional to concentration and identifies the relative PHC concentration present. The fluorescence intensity is plotted continuously with depth on a computer monitor in the CPT rig as testing proceeds and allows immediate identification of affected soils. The spectral and temporal data are also presented on the computer monitor in real-time and comprise the spectral signature of the contaminant which often allows identification of product type. A log of the fluorescence intensity with depth and contaminant signatures is plotted on a printer in the CPT rig immediately following each test.

WASTE APPLICABILITY:

The Fugro ROST ™ system is designed to qualitatively detect contaminant materials containing PAH constituents, including, but not limited to gasoline, diesel fuel, crude oil, jet fuel, heating oil, coal tar, kerosene, lubricating oils, and creosote.

STATUS:

ROST ™ has been commercially available since September 1994 and was evaluated under the U.S. EPA's Environmental Technology Verification (ETV) program. The final report (EPA/600/R-97/020), dated February 1997 is available from EPA or may be downloaded from the EPA's web site (http://clu-in.com/csct/verstate.htm).

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