UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ETV✓

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM
VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**SOIL SAMPLER**
APPLICATION:	**SUBSURFACE SOIL SAMPLING**
TECHNOLOGY NAME:	**JMC ENVIRONMENTALIST'S SUBSOIL PROBE**
COMPANY: ADDRESS:	**CLEMENTS ASSOCIATES, INC. 1992 HUNTER AVENUE NEWTON, IOWA 50208**
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ETV PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency (EPA) created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative technologies through performance verification and information dissemination. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. The ETV Program is intended to assist and inform those involved in the design, distribution, permitting, and purchase of environmental technologies. This document summarizes results of a demonstration of the Clements Associates, Inc. JMC Environmentalist's Subsoil Probe (ESP).

PROGRAM OPERATION

Under the ETV Program and with the full participation of the technology developer, the EPA evaluates the performance of innovative technologies by developing demonstration plans, conducting field tests, collecting and analyzing demonstration data, and preparing reports. The technologies are evaluated under rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the demonstration results are defensible. The EPA's National Exposure Research Laboratory, which demonstrates field characterization and monitoring technologies, selected Tetra Tech EM Inc. as the verification organization to assist in field testing various soil and soil gas sampling technologies. This demonstration was conducted under the EPA's Superfund Innovative Technology Evaluation Program.

DEMONSTRATION DESCRIPTION

In May and June 1997, the EPA conducted a field test of the ESP along with three other soil and two soil gas sampling technologies. This verification statement focuses on the ESP; similar statements have been prepared for each of the other technologies. The performance of the ESP was compared to a reference subsurface soil sampling method (hollow-stem auger drilling and split-spoon sampling) in terms of the following parameters: (1) sample recovery, (2) volatile organic compound (VOC) concentrations in recovered samples, (3) sample integrity, (4) reliability and throughput, and (5) cost. Data quality indicators for precision, accuracy, representativeness, completeness, and comparability were also assessed against project-specific QA objectives to ensure the usefulness of the data.

The ESP was demonstrated at two sites: the Small Business Administration (SBA) site in Albert City, Iowa, and the Chemical Sales Company (CSC) site in Denver, Colorado. These sites were chosen because of the wide range of VOC concentrations detected at the sites and because each has a distinct soil type. The VOCs detected at the sites include cis-1,2-dichloroethene (cis-1,2-DCE); 1,1,1-trichloroethane (1,1,1-TCA); trichloroethene (TCE); and tetrachloroethene (PCE). The SBA site is composed primarily of clay soil, and the CSC site is composed primarily of medium- to fine-grained sandy soil. A complete description of the demonstration, including a data summary and discussion of results, is available in the report titled *Environmental Technology Verification Report: Soil Sampler, Clements Associates, Inc., JMC Environmentalist's Subsoil Probe*, EPA/600/R-98/091.

TECHNOLOGY DESCRIPTION

The ESP sampler is designed to collect subsurface soil samples and may be advanced by using manual or powered percussive techniques. The ESP can collect continuous or discrete samples. The ESP consists of a sampling tube, a body that guides the sampler as it is driven, and a foot-pedal-operated jack that retrieves the sampler. The sampler is a 36-inch long, solid barrel, open tube with an outside diameter of 1.125 inches. The sample tube is fitted with an inner sample liner and one of three interchangeable tips: a solid drive point, a standard cutting tip, or a wet cutting tip. The sampler is constructed of heat-treated 4130 alloy steel with nickel plating; the cutting tips and drive point are stainless steel. Liners facilitate retrieval of the sample and may be used for storage when applicable. The liner used for the demonstration was a 36-inch long by 0.90-inch inside diameter, thin-walled clear plastic tube that fits inside the sampler. It is capable of recovering a sample 36 inches long in the form of a soil core. Stainless steel liners are also available to meet the sample collection requirements and data quality objectives of a specific project.

VERIFICATION OF PERFORMANCE

The demonstration data indicate the following performance characteristics for the ESP:

Sample Recovery: For the purposes of this demonstration, sample recovery was defined as the ratio of the length of recovered sample to the length of sampler advancement. Sample recoveries from 28 samples collected at the SBA site ranged from 42 to 100 percent, with an average sample recovery of 96 percent. Sample recoveries from 42 samples collected at the CSC site ranged from 72 to 100 percent, with an average sample recovery of 95 percent. Using the reference method, sample recoveries from 42 samples collected at the SBA site ranged from 40 to 100 percent, with an average recovery of 88 percent. Sample recoveries from the 41 samples collected at the CSC site ranged from 53 to 100 percent, with an average recovery of 87 percent. A comparison of recovery data from the ESP sampler and the reference sampler indicates that the ESP achieved higher sample recoveries in both the clay soil at the SBA site and in the sandy soil at the CSC site relative to the sample recoveries achieved by the reference sampling method.

Volatile Organic Compound Concentrations: Soil samples collected using the ESP and the reference sampling method at five sampling depths in eight grids (four at the SBA site and four at the CSC site) were analyzed for VOCs. For 16 of the 18 ESP and reference sampling method pairs (seven at the SBA site and 11 at the CSC site), a statistical analysis using the Mann-Whitney test indicated no significant statistical difference at the 95 percent level between VOC concentrations in samples collected with the ESP and those collected with the reference sampling method. A statistically significant difference was identified for one sample pair collected at the SBA site and one sample pair at the CSC site. Analysis of the CSC site data, using the sign test, indicated no statistical difference between the data obtained by the ESP and the reference sampling method. However, at the SBA site, the sign test indicated that the data obtained by the ESP are statistically significantly different than the data obtained by the reference sampling method, suggesting that the reference method tends to yield higher concentrations in sampling fine-grained soils than does the ESP.

Sample Integrity: Seven integrity samples were collected with each sampling method at the SBA site, and five integrity samples were collected with each sampling method at the CSC site to determine if potting soil in a lined sampler became contaminated after it was advanced through a zone of high VOC concentrations. For the ESP, VOCs were detected in two of the 12 integrity samples: both at the SBA site. One of the integrity samples collected at the SBA site contained cis-1,2-DCE at 5,700 micrograms per kilogram (Fg/kg), TCE at 4,070 Fg/kg, and PCE at 212 Fg/kg; the other sample contained cis-1,2-DCE at 114 Fg/kg and TCE at 3.17 Fg/kg. These results indicate that the integrity of a lined chamber of the ESP may not be preserved when the sampler is advanced through highly contaminated soils. Results of sample integrity tests for the reference sampling method indicated no contamination in the potting soil after it was advanced through a zone of high VOC concentrations. Because potting soil has an organic carbon content many times greater than typical soils, the integrity tests represent a worst-case scenario for VOC absorbance and may not be representative of cross-contamination under normal field conditions.

Reliability and Throughput: At both the SBA and CSC sites, the ESP collected a sample from the desired depth on the initial attempt 100 percent of the time. Two target zones were not sampled at the SBA site due to the technology developer's absence on several days during the demonstration; however, no planned samples were omitted due to equipment failure. Collection of saturated soil samples using the ESP at 40 feet below ground surface (bgs) in Grid 5 at the CSC site was not attempted because the sample depth was beyond the ESP's performance range. For the reference sampling method, the initial sampling success rates at the SBA and CSC sites were 90 and 95 percent, respectively. Success rates for the reference sampling method were less than 100 percent due to (1) drilling beyond the target sampling depth, (2) insufficient sample recovery, or (3) auger refusal. The average sample retrieval time for a single operator to set up the ESP on a sampling point, collect the specified sample, backfill the hole with granular bentonite, decontaminate the sampler, and move to a new sampling location at the SBA site was 36.9 minutes per sample. The average sample retrieval time at the SBA site was 22.5 minutes per sample when two operators were used. Two operators were used for all grids sampled at the CSC site, resulting in an average sample retrieval time of 13.4 minutes per sample. For the reference sampling method, the average sample retrieval times at the SBA and CSC sites were 26 and 8.4 minutes per sample, respectively. A three-person sampling crew collected soil samples using the reference sampling method at both sites. One additional person was present at the CSC site to oversee and assist with sample collection using the reference method.

Cost: Based on the demonstration results and information provided by the vendor, the ESP can be purchased for $2,780 or rented for $250 per day. The optional electric hammer and generator can be rented for $150 to $300 per day. Operating costs for the ESP ranged from $2,480 to $4,210 at the clay soil site and $1,880 to $3,110 at the sandy soil site. For this demonstration, the reference sampling was procured at a lump sum rate of $13,700 for the clay soil site and $7,700 for the sandy soil site. Oversight costs for the reference method ranged from $4,230 to $6,510 at the clay soil site and $1,230 to $2,060 at the sandy soil site. A site-specific cost and performance analysis is recommended before selecting a soil sampling method.

A qualitative performance assessment of the ESP indicated that (1) the sampler is easy to use and requires no specialized training to operate; (2) logistical requirements are generally less than those of the reference sampling method; (3) sample handling is similar to the reference method; (4) the performance range is limited by the advancement platform, although the ESP successfully retrieved a sample on one of two sampling attempts at depths greater than 25 feet; and (5) no drill cuttings are generated when using the ESP.

The demonstration results indicate that the ESP can provide useful, cost-effective samples for environmental problem-solving. However, in some cases, VOC data collected using the ESP may be statistically different from VOC data collected using the reference sampling method. Also, the integrity of a lined sample chamber may not be preserved when the sampler is advanced through highly contaminated clay soils. As with any technology selection, the user must determine what is appropriate for the application and project data quality objectives.

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