SOIL VAPOR SURVEYS FOR COST CUTTING SITE CHARACTERIZATION

Stephen E. Camp
Water Resources Associates, Inc.
2702 North 44th Street, Suite 101-B
Phoenix, AZ 85008

Abstract

New technical approaches and cost cutting alternatives are being utilized in the environmental engineering field. These unique methods are used in the mapping, delineation and remediation of contaminated sites. One development which has seen a sudden increase in the recent past is the utilization of soil vapor surveys to map contamination plumes in the vadose zone. Using the soil vapor method, industrial sites and sites containing potential buried drums or underground storage tanks can be quickly evaluated for the presence of volatile contaminants. This information can be especially important in property transactions where buyers desire to protect themselves from potential costly clean-ups.

The soil vapor survey consists of sampling volatile vapors in the vadose zone and analysis of the vapors on analytical instruments. The survey targets those contaminants which have volatilized from residues in soils or shallow ground water. One method of sampling soil vapors is penetrating five to ten feet into the sub-surface with a sampling probe. Upon collection of the vapors, concentrations may be measured. The analytical instruments can range from simple Drager Tubes to a laboratory gas chromatograph.

The methodology for selecting sampling locations depends on the site. An underground storage tank facility may be approached by completing sampling locations at the tank pit and near the product lines. A grid sampling location map may be used to sample a property with an unknown organic content. Soil vapor surveys have limitations in regards to soil types, sampling depths and constituents being analyzed. However, given the proper conditions, soil vapor surveys can provide qualitative data at lower costs than alternative methods.

Introduction

During the course of environmental investigations, large sites are often encountered with potential vadose zone or ground-water contaminants. These possible contaminants may be caused by spills or leaks from underground or above ground storage tanks. Another source might be unknown buried objects or landfill operations. The contaminants can range from heavy metals to oils to volatile organics. Evidence of spills or existing contamination can be a considerable concern to a potential land buyer.

Due to increasingly stringent environmental standards, the liabilities for purchasing a potentially contaminated site are severe. The future land owner must do everything possible to prevent purchasing a site that may require a costly clean up. Although a site may appear to be clean on the surface, the underlying vadose zone or ground water may potentially be contaminated.

Rational for Soil Vapor Surveys

A common procedure for analyzing the vadose zone or underlying ground water is drilling into the soil and collecting soil or water samples for laboratory analysis. Although this method is effective for quantifying the contaminants, the costs can sometimes be prohibitive. A large site may require days or sometimes weeks to collect a sufficient number of soil samples to properly characterize the site. The collected soil samples must then be properly contained, logged and shipped to an analytical laboratory. Once the samples reach the laboratory, communication of analytical results may take an additional five to ten days. If the results are required in an earlier time frame, the laboratory fee generally increases 50 to 200%. Therefore, the conventional method of drilling and collecting soil samples to initially characterize a site not only costs money, but time as well.

However, there is an alternative to this costly process of characterizing a site. Instead of collecting soil samples, the vapors volatilizing from the soil may be collected and analyzed. A soil vapor survey is the method of collecting a sample of vapors from volatile organic compounds from potentially contaminated soils in the vadose zone or from relatively shallow contaminated ground water. The soil vapor sample is generally collected at a depth of approximately five to 10 feet below ground surface. The vapor samples are then analyzed on an analytical instrument and data are quickly established. The time required for each data point is typically 15 to 30 minutes. Therefore, a large number of data points can be collected in a short period of time. In addition, the results of the analytical testing can be almost immediate if the process includes an on-board analytical instrument. Instead of requiring many days or weeks, a large site can be characterized in one or a few days.

Methodology

The instrumentation and equipment required for a soil vapor survey can be easily contained in a van or light truck. Equipment required includes a sampling probe, a device to drive the probe into the sub-surface, an extraction pump and an analytical instrument. The analytical instrument may be deleted if the vapor sample can be stored and analyzed at a later time, although this is typically not preferable.

A soil vapor probe is driven into the sub-surface by electric, pneumatic hydraulic or manual methods. The probe itself is generally made of a hardened material such as steel. A slotted section or removable point on the end of the probe allows for transportation of the vapors to the analytical instrument or collection device.

The volume of the vapors evacuated via a vacuum pump, is generally five to ten probe volumes. Collection of the vapors can be made into a syringe or tedlar bag, or the sample may be directly injected into the analytical instrument through an injection valve.

The relative accuracy of the data depends upon the particular analytical instrument used in detecting the contaminants. Probably the most inexpensive method of analyzing the vapors is utilizing a simple Dragger Tube. This instrument is comprised of a simple hand operated suction device which moves the vapors through a sorbent media. The media changes color depending on the concentration of contaminant in the vapors. A step above the Dragger Tube is the hand held field instrument. This instrument employs a detector, usually a flame ionization (FID) or photoionization detector (PID) to provide a metered reading of total volatile organic compounds detected. The Dragger Tube and field instruments provide only a single constituent of the contaminant group or a total combined reading. Individual constituents or the make-up of the contaminants may not be characterized using these instruments. The Dragger Tube or hand held PID/FID are typically used for surface soil monitoring, unlike the soil gas analysis which requires insertion of probes into the sub-surface.

For a full characterization of the contaminants within the collected vapor, a gas chromatograph is required. A gas chromatograph can be designed for field or laboratory use and is well suited for use in a mobile van. A laboratory gas chromatograph can be used in the field if the necessary criteria are met. A gas chromatograph consists of a column and a detector. The column separates the contaminants, generally based on volatility and polarity. With the use of three different detectors (PID, FID or electron capture detector), a full range of chlorinated, aromatic and other volatile constituents may be identified.

The soil vapor survey is a relatively simple method. However, strict operating and QA/QC methods must be maintained for accurate and reliable data. When the proper number of soil vapor samples are collected and analyzed for the contaminants of interest, an isoconcentration contour map may be generated. The isoconcentration contour map may then be utilized to locate potential "hot spots" and migration patterns. With this data, the lateral extent can be estimated with a high degree of accuracy.

A drill rig can then be brought to the site to confirm the soil vapor data with laboratory analysis. The drill rig can also be utilized to collect soil samples at the defined "hot spots" at depth to generate data on the vertical extent of contamination. Therefore, the soil vapor survey has not only shortened the on-site time of the drill rig, but has made the best possible use of the time. In less time than it may have taken for a drill rig alone to be used to collect samples for laboratory analysis and determine the possible lateral extent of contamination, the full lateral and vertical extents of contamination may be determined using soil vapor analysis.

Limitations

As quick and cost-effective that a soil vapor survey may be, it is not without its limitations. The only contaminants which may be detected are volatile components such as gasoline and solvents. Heavier fuels, such as diesel may be detected, but only at very high concentrations.

Soil vapor surveys are best suited for sites with a vadose zone characterized as a dry, porous soil with a minimum amount of organic carbon. Sites containing soils with a very fine grain or clay material are not well suited for a soil vapor survey. Soil vapor analysis in clay soils may be compared to sucking air through a straw in ice cream.

Abnormalities in the vadose zone can cause interferences in the soil vapor survey. A layer of perched water, a clay lens or buried foundation may mask a potential contaminant located below. Sewer lines, conduits or other buried lines may also act as conduits for the soil vapor. However, such conduits may also be located using the soil vapor survey.

A soil vapor survey may be used to map or track a contaminated ground water problem. The underlying ground water should be no deeper than 50 to 100 feet and the contaminants in the ground water must partition easily out of the water phase into the vapor phase. Volatile components such as alcohols, ethers and keytones are highly soluble in water and do not typically allow tracking in the vapor phase.

The soil vapor survey can also be a quick method to confirm that a site does not have a contaminated aquifer or vadose zone. Used in conjunction with a Phase I Environmental Site Assessment, a potential land purchaser has a very accurate characterization of the site's environmental condition. This protects the land owner from a costly clean-up and provides a responsive due-diligent approach.

Summary

With the ever increasing costs for environmental investigation and remediation, the soil vapor survey is one method that provides an accurate and cost-effective alternative to drilling an endless number of borings. Given the proper conditions, a soil vapor survey should not be overlooked in developing a site characterization. The soil vapor survey should not be used as a substitute for determining actual ground-water quality or soil contaminant concentrations. However, when used in conjunction with a historical records review and possibly a follow-up with a drill rig, substantial savings can be observed with the soil vapor method.