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Office of Solid Waste and Emergency Response
Technology Innovation Office

TECH TRENDS

The applied technologies journal for Superfund removals and remedial actions and RCRA corrective actions

Innovations in Monitoring & Measurement

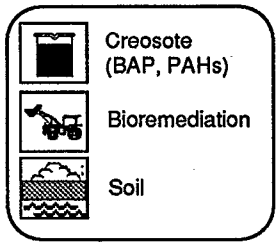
Special Supplement to ***TECH TRENDS***

You will notice that this edition of *Tech Trends* contains an insert, "Innovations in Monitoring and Measurement Technologies". Although the focus of *Tech Trends* is usually on innovative cleanup technologies ready for field application, we also want to bring you news of other emerging tools that can assist you in emergency response, remediation, and corrective actions. Therefore, from time to time, we will include a special supplement like this one. In it, EPA's Environmental Monitoring Systems Laboratory in Las Vegas showcases three portable monitoring systems. The EPA Environmental Research Laboratory in Athens, Georgia, highlights a multispectral identification technique for non-target analytes that improves upon the current low resolution system. The Athens lab also presents information on alternatives to the Eh Probe for measuring mobility of heavy metals. Ada introduces BIOPLUME II.

The monitoring supplement may whet your appetite for the upcoming February symposium on monitoring. See "Conference Alert" on page 4 for more information.

On-Site Bioremediation at Scott Lumber Under a Performance Contract

by Bruce Morrison, RPM, Region VII



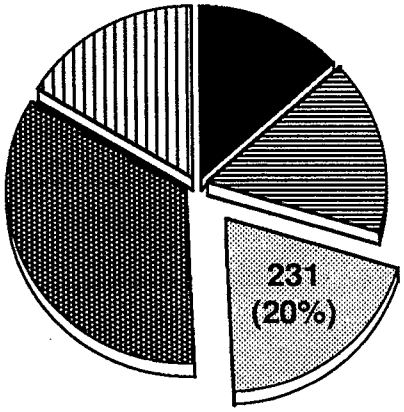
Scott Lumber in Missouri is one of the largest Superfund sites in the United States where bioremediation has been employed. EPA's Region VII Emergency Planning and Response Branch (EP&R) laid the groundwork well for their choice of bioremediation. EP&R suspected that indigenous microbes were present at the site that could possibly convert the creosote contaminated soil into harmless compounds on-site. But concentration levels of the creosote compounds were quite high. For example, creosote contamination revealed concentrations of benzo-a-pyrene (BAP) as high as 260 parts per million (ppm), with total concentration levels of polynuclear aromatic hydrocarbons (PAHs) as high as 64,000 ppm. Any cleanup at the site had to protect the aquifer that is the primary source of drinking water for Alton, Missouri.

EPA established cleanup levels for the site at concentrations less than 14 ppm for BAP and 500 ppm for total PAHs. EP&R then conducted a literature search and tasked their Technical Assistance Team (TAT) to perform a treatability study, independent of cleanup contractors, to determine the feasibility of bioremediation. Both the literature and the treatability study indicated a strong potential for significant biodegradation of creosote compounds and possible cost savings when compared to conventional off-site disposal.

EPA's Emergency Response Contractor for Region VII subcontracted the services of Remediation Technologies, Inc. (RETEC) to clean up the site using bioremediation. The contract agreement was written as a fixed-price, performance specification contract; that

(see Bioremediation, page 3)

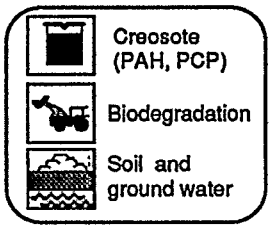
ATTIC: Thermal Treatment



The Alternative Treatment Technology Information Center Database contains 231 citations on Thermal Treatment.

See "Out of the ATTIC" on page 3 for one user's experience.

Bioremediation for Both Soil and Ground Water On-Site



With contaminants known to be biodegradable and indigenous microbes on-site to do the biodegrading, the signs pointed toward bioremediation to clean up both soil and ground water at the Champion International Superfund Site in Libby, Montana. Over the years, the major contaminants at the site—creosote and polycyclic aromatic compounds and pentachlorophenol from former wood preserving operations—had contaminated a number of soil areas and migrated into the upper aquifer. A waste pit was also a source of groundwater contamination. Champion International, Inc. and Woodward Clyde, Inc. of Denver conducted bench-scale laboratory studies and pilot-scale *in situ* bioremediation studies that indicated that biodegradation in the soil was occurring and could be further enhanced by bioremediation treatment techniques. They determined that the ground water could be treated through bioremediation as well. The full scale bioremediation remedial design and remedial action are in various stages of implementation. Most of the cleanup work to date has focused on the contaminated soil.

The remediation contractor did not have to construct a special stockpile area for the soils. Soils from the contaminated areas scattered throughout the site are excavated and brought to the pre-existing waste pit. The pit serves as a staging area to pretreat the soils. In the pit, biodegradation is enhanced as soil is sprinkled with water and nutrients to support the growth and activity of bacteria. Further, a tiller aerates and homogenizes the soil, so that the soil concentrations are relatively even when placed on the final land treatment area.

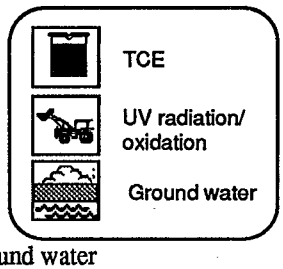
However, prior to being placed in

(see Soil and Ground Water, page 4)

SITE Subjects

On-Site Chemical Destruction of Organics with Ultraviolet Radiation and Oxidation

by Norma M. Lewis
Risk Reduction Engineering Laboratory



At a former drum recycling facility in San Jose, California, EPA demonstrated an innovative ultraviolet (UV) radiation/oxidation technology to treat ground water contaminated with volatile organic compounds (VOCs). Seven VOCs had been identified in the ground water, of which trichloroethylene (TCE), was the major contaminant. The ground water also contained dichloroethane (1,1-DCA) and 1,1,1-trichlorethane (1,1,1-TCA), which are relatively difficult to oxidize. The UV radiation/oxidation technology, developed by Ultrox International, chemically destroys organics in liquids (including those VOCs difficult to oxidize), with little or no harmful residuals from the process. During the testing at the San Jose site, no VOCs were detected in the exhaust from the treatment unit. The efficiency of destruction rendered the ground water in compliance with National Pollutant Discharge Elimination System (NPDES) standards at the 95% confidence level.

Essentially, the process uses a combination of UV radiation, ozone and hydrogen peroxide to oxidize organic compounds in water. The treatment system is comprised of four different treatment modules that are mounted on skids. The ozone generator module and hydrogen peroxide system feed into the UV radiation/oxidation reactor module. The liquid to be treated (ground water in the case of the San Jose site) is fed into the UV radiation/oxidation reactor. The reactor is divided into six chambers. Each chamber contains ultraviolet lamps and a diffuser that uniformly bubbles and distributes the ozone gas from the ozone generator through the liquid. The combination of the UV radiation, hydrogen peroxide and ozone chemically destroys the VOCs. Off-gassing ozone and any remaining VOCs in the reactor go to the catalytic ozone decomposer unit on top of the reactor where they are destroyed. The system allows you to enhance the oxidation of the organics according to the level of concentrations of the contaminants by adjusting parameters such as oxidant dose, UV radiation intensity and the pH level of the incoming ground water.

You have the option of pumping ground water directly from the aquifer into the reactor or of storing the liquid above ground for subsequent feeding into the reactor. At the San Jose site, the ground water was pumped into storage tanks because the flow from the wells was insufficient to support enough volume of water for flow through the reactor. The water was stored in inflatable heavy plastic bladder tanks. The construction of the inflatable tanks allows them to be filled to capacity, so that VOCs do not have space in the tank to off-gas into the air.

The Ultrox system achieved removal efficiencies as high as 90% for the total VOCs. The removal efficiency for TCE, the major contaminant at the site, was greater than 99 percent. The maximum removal efficiencies for 1,1-DCA and 1,1,1-TCA were about 65 and 85 percent respectively.

Use of the UV radiation/oxidation process at the San Jose site was part of the EPA Superfund Innovative Technology Evaluation (SITE) program. Overall, this treatment technology is intended to destroy dissolved organic contaminants, including chlorinated hydrocarbons and aromatic compounds, that are present in wastewater or ground water

(see UV Radiation/Oxidation, page 4)

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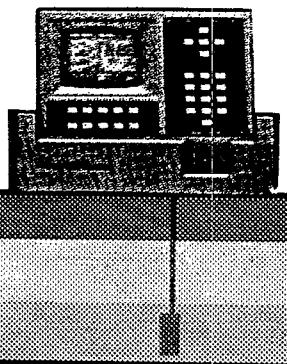

Innovations in Monitoring & Measurement Technologies

Innovative site investigation techniques are of increasing interest to those attempting to reduce the cost and increase the effectiveness of site remediation. This is one of a series of occasional supplements to *Tech Trends*, the applied technologies journal for Superfund removals and remedial actions and RCRA corrective actions.

EPA

U.S. Environmental Protection Agency

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Walter W. Kovalick, Jr., Ph.D.
Director

Chemical Warfare Defense Evolves Into Portable GC/MS for Hazardous Waste Sites

By Stephen Billets
Environmental Monitoring Systems Laboratory, Las Vegas

Gas chromatography/mass spectrometry (GC/MS) is the EPA-recommended method for the analysis of volatile organic compounds (VOCs) and semivolatile organic compounds. Until recently, it was not feasible to bring a GC/MS instrument to a hazardous waste site because its size and weight made it too cumbersome to handle. However, field-portable mass spectrometers were developed for military use in the mid-1980s to detect residual chemical warfare agents and have now been applied to the analysis of samples at hazardous waste sites. The Superfund Innovative Technology Evaluation (SITE) program recently demonstrated a mobile mass spectrometry system, developed by Bruker Instruments, Inc., at two Superfund sites in Region I: the Re-Solve, Inc., Site with PCB-laden soil and the Westborough Township Site with PAH-contaminated soil and VOCs in ground water. Test results harbinger field portable GC/MS as a major field technology for the 1990s.

The Bruker mobile environmental monitor (MEM) measures about 20" x 20" x 30" and weighs about 500 pounds. It can be mounted on a four-wheel drive

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BIOPLUME II Prediction of Natural Bioremediation in Ground Water Saves $3 Million at Traverse City Site

By Joseph Williams
Robert S. Kerr Environmental Research Laboratory, Ada

EPA's Robert S. Kerr Environmental Research Laboratory (RSKERL) has developed BIOPLUME II, a two-dimensional ground water model that can help you determine whether or not natural biodegradation can effectively remediate dissolved hydrocarbons in ground water. BIOPLUME II was used at the U.S. Coast Guard air station at Traverse City,

continued on page 4

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Field Portable X-Ray Fluorescence for Inorganic Analysis

By William H. Engelmann
Environmental Monitoring Systems Laboratory, Las Vegas

X-ray fluorescence has been a standard laboratory method for years and the recent availability of portable instruments now allows this method to be taken into the field for use at hazardous waste sites. Field-portable X-ray fluorescence (FPXRF) is a site screening procedure using a small, portable instrument that provides a rapid turnaround, low-cost method for *in situ* analysis of inorganic contaminants. The conventional methods of analyses in fixed location laboratories take from 20-45 days while FPXRF takes about three days and costs less than conventional laboratory analysis. The design of FPXRF provides flexibility for two levels of analysis: *in situ* analysis and hot spot screening.

FPXRF, while not strictly equivalent to conventional laboratory analyses, produces quantitative results because the FPXRF is calibrated based on limited conventional laboratory analyses of soil samples from the site. The *in situ* analysis is combined with a pre-survey aerial photographic evaluation of the site, documented quality control and geostatistical interpretation to produce isopleth maps denoting concentration levels for contaminants at various site locations. The complete procedure from pre-survey through the final report takes about six weeks and costs between $25,000 and $50,000. FPXRF has been used at a number of sites.

For "hot spot" screening, site-specific calibration samples are not used. Calibration is based on standards taken from similar sites. The results are useful for detecting surficial contaminant "hot spots" and merely indicate relative differences between measurements taken at the site. This "hot spot" screening is the most basic survey and generally takes less than a week at a cost of approximately $10,000 to $20,000. However, it is only a qualitative method and is not recommended as a substitute for the complete procedure. "Hot spot" screening is most appropriately used for some emergency response situations.

Six elements have been successfully analyzed by EMSL-LV using FPXRF: arsenic, chromium, copper, iron, lead and zinc. Other EPA Inorganic Target Analyte List elements may be quantifiable with FPXRF when appropriate standards and radioisotope sources are used. Also, costs are expected to significantly decrease with the advent of the automated locating and data logging system due in early 1991.

FPXRF has been used at varied sites, including battery plating, tannery and mining operations and a lead smelter. For example, FPXRF measured zinc at the Palmerton Zinc Site in Pennsylvania; mercury at the Orrington Mercury Site in Maine; chromium at the Vander Horst Site in New York State; lead in painting sludge waste at Caldwell Trucking in New Jersey and at a Tonolli Metals mining site in the Appalachian Mountains of Pennsylvania; lead and arsenic at Halby Chemical in Delaware; and cadmium, zinc, chromium and lead at New Hampshire Plating.

Remedial Project Managers and On Scene Coordinators can contact a Regional contractor with the necessary equipment and expertise to perform an FPXRF survey. If special assistance is needed, you can contact the Technical Support Center at EMSL-LV for expert advice. For more information, contact Ken Brown at EMSL-LV at FTS 545-2270 or 702-798-2270.

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Multispectral Identification Techniques Improve Identification of Non-Target Analytes

By William T. Donaldson, Environmental Research Laboratory, Athens and Mary Moorcones, Office of Solid Waste and Emergency Response

The EPA Athens Environmental Research Laboratory (AERL) can help you turn tentatively identified and unknown compounds at your sites into definitely identified compounds! A research team at AERL is applying multispectral identification techniques that can identify, with a high degree of confidence, most of the organic chemicals for which mass spectral information can be obtained. For the identification of non-target analytes, the technique offers a marked improvement over the current low resolution electron impact mass spectrum (Method 8270) used by Superfund contract laboratories in their gas chromatograph/mass spectrometry analyses. Although Method 8270 can provide reliable identifications of the 234 compounds targeted for detection at Superfund sites, it is only about 25% accurate for identification of unknown compounds. Whereas the universe of compounds that Method 8270 can identify accurately is constrained by the fact that the computer library is geared to the 234 target analytes, multispectral identification is driven by the ability to piece together highly definitive pieces of information for the full array of semivolatile compounds.

Here's how it works. In addition to the low resolution electron impact mass spectra that are produced by Method 8270, the AERL multispectral identification team develops additional spectroscopic information, which is pieced together to reveal the identities of the unknown compounds. High resolution chemical ionization mass spectra tell the analyst the number of atoms of each chemical element in the compound and high resolution electron impact mass spectra provide similar information for key fragments of the molecule. Infrared spectra indicate the presence of functional groups that are characteristic of compound types, such as aldehydes or ketones. During one recent study, the AERL team identified 63 of 70 non-target compounds in industrial wastewater samples.

AERL is eager to help Superfund site managers. For more information, contact John Mc Guire at AERL at FTS-250-3185 or 404-546-3185.

Rethinking Measurement Methods for Mobility of Heavy Metals

By David S. Brown, Environmental Research Laboratory, Athens and Kevin Novo-Gradac, AScI Corporation

The EPA Athens Environmental Research Laboratory (AERL) has several alternative ways to determine the mobility of metals at Superfund sites that overcome some of difficulties of the often-used platinum electrode probe method. The alternatives measure the oxidation/reduction (redox) potential, Eh, as a way of measuring mobility of metals. We will briefly discuss some of the problems posed with the platinum electrode method and then briefly describe several alternatives.

While the platinum electrode Eh measurements are effective in some idealized laboratory systems, the measurements in the field are often plagued by problems and should be held

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BIOPLUME II from page 1

Michigan where a spill of aviation gasoline had contaminated the shallow ground water. BIOPLUME II, in combination with other assessment techniques, indicated that natural processes would destroy the contaminated plume that had reached the residential area downgradient before the Coast Guard could let a contract and get a pump-and-treat remedy installed. The special assessments used in combination with BIOPLUME II included a geochemical characterization of the plume and microcosm studies establishing that microbial degradation of the contaminants was taking place.

Prior to these assessments, the State of Michigan was going to require, as a result of court action, that the Coast Guard install interdiction wells and a pump-and-treat system. Indeed, the Coast Guard had already installed a series of the interdiction wells downgradient of the source area to create a hydraulic barrier to contain the contaminants within the boundary of the Coast Guard base. However, the strength of the assessment evidence convinced the State of Michigan that further remediation beyond interdiction wells was of no value and thus saved the Coast Guard an estimated $3 million in remediation costs.

BIOPLUME II simulates the transport of dissolved hydrocarbons in ground water and the effect of oxygen-limited biodegradation on these contaminants. You can take the information from BIOPLUME II and use it with any graphics software to produce contaminant plume, oxygen distribution and head maps. This version of BIOPLUME II is available for DOS-compatible computers.

You can also use BIOPLUME II as a component of RSKERL's OASIS Parameter Estimation System, a decision support system developed on the Macintosh with HYPERCARD. A decision flowchart component of OASIS enables you to evaluate whether or not biorestoration is an appropriate remediation technique for your site. As part of OASIS, the BIOPLUME II component builds datasets through interactive "painting" of information on the computer screen. Another portion of the OASIS system, BIOGRAPH, allows the user to visualize the size, growth and degradation over time of the hydrocarbon plume. BIOGRAPH can also produce maps of the distribution of the head of the plume as well as aquifer oxygen concentration levels.

For more information on BIOPLUME II and on OASIS and its other components (hydrogeologic and chemical databases, bioremediation flowchart, the DRASTIC system for evaluating ground water pollution potential and reference library of information related to bioremediation), call Joe Williams at FTS-743-2246 or 405-332-8800 at RSKERL in Ada.

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suspect. Frequently, lack of redox equilibrium (often the case at Superfund sites) or contamination of the electrode surfaces by trace oxide coatings can yield erroneous readings. The presence of trace oxide coatings on the platinum surface causes the electrode system to respond like a new type of pH measurement device, rather than an indicator of Eh. (A linear relationship between measured pH and apparent Eh is a pretty good indication that the oxide coating problem is present.)

In spite of the difficulties associated with determining redox conditions at Superfund sites, the issue must not be neglected because of the critical importance of the redox state in influencing metals transport. The determination of Eh can make the all-or-nothing difference in mobility. Better options for evaluating Eh (described in more detail below) involve direct measurement of ion activity ratio, measurements of dissolved oxygen, detection of sulfides or a method involving iron solubility assumption.

Direct measurement of ion ratio activity provides an estimate of Eh—it determines the ratio of different forms of the species of the same metal as a way to

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Quick Measurement and On-site Data Analysis of Off-Gassing Air Emissions of Volatile Organics

By Donald F. Gurka
Environmental Monitoring Systems Laboratory, Las Vegas

If you want quick on-site data on air emissions of volatile organic compounds (VOC) that are off-gassing from soil and other sources at a site, you want to know about open path FT-IR (Fourier-transform infrared) spectrometry. With FT-IR you can reduce the number of points in the site where you need to collect samples in cannisters for laboratory analysis—and fewer cannister sampling points also translates into lower costs. FT-IR rapidly scans the site above ground over a path of up to several hundred meters to quickly narrow down those points in the site from which you will need to take specific soil or other samples for further analysis.

The open path FT-IR consists of two devices on tripods. The first device emits horizontal beams of infrared radiation across the path between the two devices. VOCs that are offgassing within the path absorb energy from the beam. This process enables the second device to record any VOCs in the path that have concentrations at the low parts per billion or higher level. The second device then records the average concentration of these VOCs in the path over a set period of time. Conversely, the cannister sampling method collects gases only at specific points. Another important advantage of FT-IR is that you can analyze the data on-site. Within a few hours, the field scientists can narrow down those points in the site where you need to collect samples for more extensive laboratory analysis. The current mobile instrument can be set up quickly at a site by trained personnel and can function with minimum operator intervention until the system is moved to a new location on the site.

EPA has two efforts focusing on testing, evaluation and application of FT-IR. Dr. Donald F. Gurka of EPA's Environmental Monitoring Systems Laboratory at Las Vegas (EMSL-LV), along with Region 7 personnel, formed a cooperative agreement with researchers at Kansas State University to investigate the application of a prototype open path FT-IR at Superfund sites. For example, open path FT-IR was successfully used at the Hastings NPL Superfund site in Region 7. Also, Dr. William McClenny of EPA's Atmospheric Research and Exposure Assessment Laboratory (AREAL) at Research Triangle Park, North Carolina, is working with a commercially available FT-IR system to demonstrate its application at Superfund sites, such as the Halby Chemical site in Delaware and the Shavers Farm site in Georgia. Several open path FT-IR systems will be demonstrated under the Monitoring and Measurement Technologies portion of the Superfund Innovative Technology Evaluation (SITE) Program in the spring of 1991.

Early assessments of the technology indicate that it is an important tool for VOC screening at hazardous waste sites. Preliminary data with about 25 common volatile solvents show that FT-IR can detect VOCs in the low parts per billion range. The technology promises to reduce the labor and time involved in traditional NPL site studies and in the monitoring of off-gassing during site remediations.

For further information on open path FT-IR, contact either: (1) EMSL-LV's Technical Support Center Manager, Ken Brown, at FTS-545-2270, or 702-798-2270 or (2) AREAL's Bill McClenny at FTS-629-3158 or 919-541-3158.

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Chemical Warfare from page 1

vehicle and taken directly to the site. This rugged instrument is equipped with built-in power supply, is resistant to shocks and is independent of cooling and heating needs. It can operate for six to eight hours on built-in battery power.

You can choose from several analysis modes and sample introduction methods, based on data quality objectives at your site. Two of these modes, "rapid screening" and "characterization," were tested in the SITE demonstration. The rapid screening mode allows a quick analysis for up to ten organic compounds simultaneously. The more accurate characterization mode follows a Contract Laboratory Procedure-type protocol. The mass spectrum generated by this instrument is compared against known compounds in the computer's library providing you with an instantaneous analysis of your sample.

The desirability of field-portable GC/MS instrumentation is obvious. The MEM provides the Agency with an instrument for field analysis with no compromise in methodology. The MEM affords the site manager access to the same quality of data as a conventional laboratory GC/MS. Unanticipated field problems can be quickly surmounted as the GC/MS measures for the full range of organic contaminants. Further, decisions can be made at the site, based on early results, to focus subsequent sampling in areas of greatest contamination. Thus, fewer samples need to be sent to the laboratory for analysis.

The MEM enhances risk communication and management by allowing field scientists and decisionmakers to compare field results to historical databases with rapid turnaround.

The MEM is commercially available. Additionally, as other mobile mass spectrometery instruments become available, EMSL-LV will perform comparisons and provide further information .

For more information, call Stephen Billets at EMSL-LV at FTS-545-2232 or 702-798-2232.

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determine Eh. The ratio of Fe(II) to Fe(III) is a good example since Fe is present in all soil and ground water.

The determination of dissolved oxygen (DO) is a relatively easy measurement that is amenable to field implementation. Care must be taken to assure that oxygen is not introduced during the sampling process or it will change the Eh.

If sulfides are detected, you can safely assume that most pollutant metals of interest will be in their reduced state, and hence have reduced mobility. Dissolved phase metal concentrations will also be very low.

The iron solubility assumption method for estimating Eh is a crude but simple estimate to use if analytical or budget constraints prohibit other approaches. This measurement can yield a rough redox estimate in systems of moderate to high pH.

A precise quantitative measure of Eh may not always be necessary to make a reasoned decision about the potential mobility of a particular metal at a particular site. Often, a rough estimate will suffice for making some determinations about metals transport from a particular site if used skillfully and appropriately. The options presented here allow you to make such determinations.

The focus of this article has been to introduce you to alternative ways to estimate redox conditions and ultimately the mobility of metals. It is not intended to give you an in-depth knowledge of the methods or the limitations of the methods. The EPA Athens Environmental Research Laboratory can help you with further information and in determining which method is appropriate for your site.

For further information, call Dave Brown at AERL at FTS-250-3310 or 404-546-3310.

ATTIC

Out of the ATTIC

First Time User Hooked on ATTIC While Researching Thermal Incineration

by Bill Sproat, Alternative Treatment Technology Information Center

Mike Scott with the Minnesota Pollution Control Agency was coordinating with the U.S. Army Corps of Engineers on a state lead site when he decided EPA's Alternative Treatment Technology Information Center (ATTIC) Database might be a good source of information on thermal technology. The State of Minnesota and the Corps knew that the soil and ground water were contaminated with semivolatile and volatile organic compounds. The Corps had already conducted treatability studies at the site and was leaning toward the use of thermal incineration to clean up the site. However, they needed additional information on thermal treatment technologies versus bioremediation. They also needed a list of incinerator vendors. Scott was able to respond to the Corps' needs by accessing ATTIC.

Scott had heard about ATTIC from a colleague. He contacted the ATTIC system operator and explained that he needed to have a thorough understanding of both bioremediation and thermal treatment, including performance levels and limitations. The subsequent search of the ATTIC Database yielded 14 abstracts, including three Records of Decision and two treatability studies related to thermal destruction and bioremediation. The abstracts proved helpful and led Scott to contact ATTIC again for specific additional information that enabled him to compile a report for the Corps that contained a list of incinerator vendors and compared the cost and efficiency of thermal destruction versus bioremediation.

Scott was also interested in determining what offices within EPA were involved in thermal treatment of hazardous wastes, including EPA's Combustion Research Facility. He was particularly interested in what the Superfund Innovative Technology Evaluation (SITE) Program had on innovative thermal technologies. Based on this request, an additional search of ATTIC specifically focused on SITE Program thermal technology demonstrations, including the demonstration test performed by American Combustion's Pyretron Thermal Destruction System at the Combustion Research Facility in Jefferson, Arkansas.

The Corps was not the only benefactor of Scott's new addiction to ATTIC. Scott was able to help a university researcher who is conducting research on lead treatment. When the researcher contacted Scott for information on alternative treatment for lead contaminated soil, Scott was ready with ATTIC abstracts to send to the grateful researcher.

Currently, almost 20% of the documents contained in the ATTIC Database include information on some form of thermal treatment technologies. Several types of thermal processes highlighted in the ATTIC Database include rotary kiln incineration, fluidized bed combustion, infrared incineration, pyrolysis and plasma heat systems.

For more information on how to use ATTIC, as well as information contained in ATTIC, do what Mike Scott did—call the ATTIC operator at 301-816-9153. Bill Sproat and his staff are ready to assist you.

Bioremediation

(from page 1)

is, RETEC cannot receive payment unless: (1) it completes the cleanup within 30 months; and (2) analytical data confirm that the contaminant concentrations are at or below the EPA established cleanup criteria for the site.

To prepare the soil for bioremediation, several steps were taken. First, all identified creosote-contaminated soil was excavated and stockpiled in an area that had a high-density polyethylene (HPDE) cover overlying a crushed limestone base. The excavated area was then prepared as a land farm treatment cell for the soil. The cell area was contoured and its perimeter bermed, *i.e.*, built up to avoid runoff. The base of the treatment cell was compacted and layered with two feet of densely compacted clay to prevent the contaminants from percolating into the ground water. Next, an underdrain system consisting of a ten-inch sand layer and a perforated pipe network was placed on the clay liner to collect irrigation and rain water within the treatment cell. A two-inch layer of top soil was then placed on top of the underdrain system to act as a buffer between the system and the top layer of contaminated soil.

The treatment cell was then ready for operation. A nine-inch layer of contaminated soil was placed on top of the treatment cell surface. Operation of the treatment cell, begun in June 1990, primarily consists of: (1) tilling and irrigating the soil to facilitate the biodegradation; and (2) removing the rocks. The rocks are pressure washed and will remain on-site. The water from the rock washing operation is incorporated into the irrigation system of the treatment cell. The underdrain system transports the water to an HPDE-lined holding basin, where it is either recirculated onto the treatment cell or pumped to the local publicly owned treatment works.

To date, approximately 60% of the excavated soil (9,200 tons) has been placed in the treatment cell. EPA has done some preliminary testing on 17 PAHs in a 6,000 square foot segment of the seven acre treatment cell. Results from this preliminary testing indicate that biodegradation is occurring at the desired rate of cleanup. As of September 20, 1990, the contaminant levels of soil have been reduced to 160 ppm for PAHs, with 13 ppm for BAP. Costs are running about $75 per ton for bioremediation as opposed to $100 per ton for off-site disposal. And, you will get to see it on video. EPA has approved the production of a videotape to document the project's progression.

For more information on the site, contact Bruce Morrison at FTS-757-3881 or 913-236-3881.

Soil and Ground Water
(from page 2)

the land treatment unit, the soil is routed through a derocking unit to remove the large stones and debris greater than one inch in diameter. The derocking operation substantially reduces the volume of soil materials that are transferred to the final land treatment unit.

Presently, a one-acre land treatment unit has been constructed in an uncontaminated area and lined with a high density polyethylene liner and compacted clay. To evaluate the performance of the unit, a leachate collection system and leachate sump were installed to monitor the chemical composition of the leachate. The soil is applied in six to eight inch increments. Each increment is treated to cleanup levels before additional soil is applied. The moisture, nutrient and pH levels of the soil are carefully maintained and the soil is tilled and aerated—all to enhance the biodegradation by the indigenous microbes. At present, plans are to expand the treatment unit to two-acres in the spring of 1991.

The rocks that are removed from the soil are also at the mercy of the microbes. The rocks are placed over an infiltration trench to be treated biologically. Water containing nutrients is percolated over the rocks to encourage microbial biodegradation of the contaminants. The water drains into the infiltration trench which, in turn, drains into the aquifer.

Full-scale *in situ* bioremediation of the ground water is close to implementation. To speed natural biodegradation in the ground water, oxygen and nutrients will be introduced by means of injection wells and infiltration trenches. In an effort to prevent contaminated ground water from migrating, extraction wells will be installed downgradient to extract ground water that will be treated above ground using a combination of the more innovative enhanced biodegradation together with the more traditional fixed film bioreactor treatment method. That is, the ground water will first pass through thermally enhanced fixed film bioreactors which treat the organic contaminants. The effluent from the bioreactors will then be injected with nutrients to promote biodegradation and reintroduced into the aquifer.

For more information, call Julie DalSoglio, the EPA Region VIII Remedial Project Manager for this site, at FTS-585-5415 or 406-449-5415. You can also call Scott Huling at FTS-743-2313 or 405-882-8800. Scott, along with Bert Bledsoe at EPA's Robert S. Kerr Laboratory, has been providing technical support for the site.

Conference Alert

The Second International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals will be held February 12-14, 1991, at the Sahara Hotel in Las Vegas, Nevada. The symposium brings an international view to the characterization and monitoring of hazardous wastes and toxic chemicals.

The symposium is sponsored by the U.S. Environmental Protection Agency; U.S. Army Toxic and Hazardous Materials Agency; U.S. Army Chemical Research, Development and Engineering Center; U.S. Department of Energy; Florida State University; National Environmental Technology Applications Corporation; and National Institute for Occupational Safety and Health.

For more information, contact Linda Hashlamoun at 216-464-3291.

UV Radiation/ Oxidation
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with low levels of suspended solids, oils and grease.

For more information, call Norma Lewis at FTS-684-7665 or 513-569-7665. A Technology Evaluation Report and an Application Analysis Report describing the complete demonstration are available. To get on the mailing list for the reports, call Dorothy Williams at FTS-684-7369 or 513-569-7369.

Tech Trends welcomes readers' comments, suggestions for future articles and contributions.
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