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Cover: This year's Buyer's Guide adds product listings to our list of service providers.

Here's How It Works page 89

Here's How It Works page 91
Why do we have a new name? As Soils magazine begins its sixth successful year, we find we have outgrown our name. I wish you could have been at some of the meetings to find the new name that would reflect all that this magazine has grown to encompass. At one point, we were leaning very close to re-naming the magazine: "Contaminated-Soil-and-Groundwater-Prevention-Regulations-Assessment-Sampling-Analysis-Treatment-Monitoring-and-Kitchen-Sink." You may have guessed that the "Kitchen Sink" part was my contribution—I just wanted to make sure we didn’t leave anything out.

Here is what our new name means. First, you may not notice a great deal of change in the magazine, because, in many ways, the name change was needed to catch up with what the content has already become: focused as equally on groundwater contamination and cleanup as it is on soil. You can’t have one without the other... and we learned that a long time ago. The change you will probably begin to notice more is that the content will break out of its focus on hydrocarbon contamination to explore solutions for other contaminants—inorganics, chemicals, including PCBs, metals, pesticides, weapons ordnance, infectious waste, reactive wastes—any nasty that threatens us from the soles of our shoes down.

Needless to say, I am very excited about this expansion. Figures I have seen indicate that the petroleum and chemical industries account for perhaps up to 70 percent of the total quantity of waste generated. Metal-related waste constitutes some 22 percent. So, while the hydrocarbon focus was a great launching pad for the magazine back in 1990, it is time to stop discriminating against the other pollutants, and give them the attention they deserve.

I hope that my readers will understand the word "Cleanup" in our new name as all-encompassing—in the sense that any cleanup must include a study of the regulations, assessment, site characterization, sampling, analysis, treatment, monitoring and any other activities leading up to and following the actual treatment step. You don’t achieve "cleanup" without all these components. I also hope that the new name does not cause readers to think that this magazine does not cover preventative topics. Because as I discover new technologies to prevent soil and groundwater contamination, I will cover those as well. Heck, if I find a really great article about a kitchen sink, I just might stick that in too!!

Internet note: Our site has had some ups-and-downs, so please keep checking http://www.wavelinx.com
Electromagnetic images scan the subsurface
An environmental CAT scan of the subsurface
By Jess Maxwell

Electromagnetic Offset Log (EOL) survey technology is adapted from proven technology used by the natural resources industry. It is similar to running a "CAT scan" on the subsurface of a contaminated site. It uses a geophysical technique, coupled with computer processing, modeling and imaging to create a picture of the subsurface resistivity that can often be equated to hydrocarbon plumes present in the subsurface.
In 1988, James Pritchard, Ph.D., technical director of Gehm Environmental, Boonville, Mo., began adapting the EOL technology he had been using in the mining and oil and gas industries to the needs of the environmental industry. Pritchard recognized its value since hydrocarbons are highly resistive, and naturally occurring water is not.

The technology isn’t new, but its environmental application is a very good adaptation of this proven method. Resistivity is one of the most commonly used measurements to find oil and gas in the exploration industry. In mining, the opposite is true, and conductive materials are sought because most minerals and associated fluids are conductive.

The EOL technique uses a large, high-powered transmitter coil on the surface. A receiver coil placed in a receiver well measures the electromagnetic field as the tool is raised in the borehole. The transmitter coil is then moved to a new grid point, and the magnetic field is measured again. The surface grid typically has a 6 meter spacing. The well measurements are usually made at 0.1 foot 30 mm intervals.

The well used in the EOL survey must be drilled outside the contaminated area to a level below the targeted plume depth. The hydrocarbon plumes, like clouds, are easier to determine from the outside looking in. Often, the receiver wells are new wells that are converted to monitoring wells once the survey is finished.

Following acquisition, the data is analyzed at the Gehm Environmental Geophysics processing center in Dallas, Texas.

Data for each log is edited, processed and modeled into a simple model of apparent resistivity and first-order resistivity logs. From these logs, major fluid and geologic changes may be determined. The data is then modeled to second-order models, where features such as dissolved phase or residual hydrocarbons can be presented. The data log sets can then be modeled into three-dimensional resistivity images.

Based on the EOL resistivity survey presentations, soil or water

Continues on page 9 →

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Soil & Groundwater Cleanup June-July 1995 7
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Portable LTDD plants with vertical components have a small footprint. They have capability for higher afterburner temperatures needed for variety of contaminants.
Electromagnetic images, from page 7

samples are taken to define the level of contamination present. This is where the cost effective portion of the process is apparent. While the high-resistivity values can’t be translated point to point to a parts-per-million value, the resistivity values illustrate which zones are highly contaminated. Confirmation sampling remains an integral part of the overall process, but it’s done at a much reduced scale compared to defining the plume by drilling and sampling alone.

One of the big plusses of the EOL system is that it provides a resistivity picture of an entire site. The picture fills the gaps between test holes, or away from test holes, that are common when the conventional site characterization process alone is used. Once the resistive features have been evaluated by sampling, the site manager has a complete subsurface picture of the site, one that defines the vertical and horizontal extent of the contaminated plume.

The EOL technology has been tested by over 70 field applications, from depicting a plume for a simple

the hydrocarbon plumes supported by the FID readings from the post-EOL soil samples. This automotive repair center discovered a leak during the removal of a heating oil tank. Subsequent regulatory review determined that a site characterization was required. The resulting EOL resistivity picture indicates the plume is concentrated in two areas, the largest portion being under the building.

Using the EOL survey inside buildings is another positive feature. EOLs can be performed over re-enforced concrete floors, highways and runways. With proper flotation, it can also be performed over water. At the low frequency the Gehm EOL system operates, these materials do not affect the measurements.

Another example is an EOL survey of a pipeline area located in the southwestern section of the United States. Figure three

Continues on page 10 ➞
Figure three: Three dimensional image of above-average resistivities which represents gasoline migrating through fractures in the upper 3 feet of the limestone bedrock (3 meters grade) from station two’s UST to the apartment house at point A.

Electromagnetic images, from page 9

illustrates a high resistivity anomaly extending downward below the pipeline where the anomaly spreads laterally at water table depth.

A more complex example is illustrated in Figure four, where gasoline was discovered in the basement of an apartment house in a large metropolitan city. The apartment building was below a retaining wall behind two service stations. The state Department of Natural Resources required an EOL survey be made to determine which service station was responsible for the contamination. The survey tracked resistivity anomalies from the apartment house through fractures in the bedrock 3 meters below the surface to the underground storage tank belonging to Station two.

Pritchard said the technology has been used in a number of different areas. Resistivity anomalies have
Figure four: Three dimensional high resistivity anomalies that extends downward below the pipeline to where the anomaly spreads laterally at the water table.

been defined under runways, fuel terminals, bus terminals and oil refineries, where large hydrocarbon releases could be anticipated. Transmitter coils have even been floated on water to define a plume below the water in a Gulf coast state.

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Combustion is more than just hot air

Know the theory of combustion for efficient application

by Stephen M. Hirt and Greg Gatenby

To get maximum efficiency from a thermal oxidizer, flare, oven or any other type of heating unit, the operator should understand combustion theory and process.

Combustion — the process of burning — is a chemical reaction that appears to be fairly simple. Fuels, when burned, combine with oxygen from the air to form carbon dioxide (CO₂) and water (H₂O). An example equation of this process using a hydrocarbon fuel looks like this: CH₄ + 2O₂ → 2H₂O + CO₂.

Ideally, the desired result is to complete the reaction, obtaining all the heat possible from the fuel. In reality, there are many intermediate reactions that are not well understood.

Complete combustion involves three important parameters:
• **Turbulence**, the state of flow in which gases are highly agitated and have constant velocity changes, both in magnitude and direction. Because of this agitated state, fuel and air are mixed.
• **Temperature**, the point at which combustion reactions take place. Generally speaking, reaction speeds double with every 10°C rise in temperature.
• **Time**, the period when a fuel and air stream is contained in an area of elevated temperature where combustion reactions occur.

In heating equipment operations, proper flame temperature results from accurate metering and control of fuel and air. Solid fuels must reach a specific ignition temperature, while liquid fuels require vaporization. When dealing with gaseous fuels, superior mixing and proportioning of fuel and air reduce the importance of time. In the combustion of non-gaseous fuels, time is a more important factor. Gaseous fuels and oil produce about the same volume of combustion products. Therefore, a high percentage of installations requiring heat releases in the 10,000 to 200 million BTUH range can be converted from gaseous fuels to oil, or vice versa, through the use of properly designed burners.

Each cubic foot of air contains 21 percent oxygen by volume. It can release 1000 Btus gross heat from fuel. It is not necessary to know the exact kind of fuel to be burned to determine the air flow through a particular system. However, natural gas is commonly used.

One cubic foot of natural gas has a gross heating value of about 1,000 Btu. The amount of air present in the natural gas combustion process is critical since 10 cubic feet of air is required to burn each cubic foot of natural gas.

Natural gas contains methane (CH₄) mainly. Under controlled conditions, the first step in methane combustion results in the formation of carbon monoxide (CO) and hydrogen (H₂) gases. This step is endothermic, requiring an input of heat to cause the reaction, rather than generating its own heat output. Therefore, an ignition source is required to initiate the combustion process. When sufficient air is present, and conditions are compatible, complete combustion will occur.

Natural gas that is unburned because of a lack of air can make a significant difference in wasted fuel, resulting in hazardous conditions (incomplete productions) and high fuel costs. As little as 1 percent unburned combustibles in the stack represent at least a 10 percent waste of fuel. Carbon monoxide, present in the flue gases (fume stream) from incompletely burned fuel, is highly toxic in concentrations above 40 ppm (0.004 percent).

Theoretically, stoichiometric burning of natural gas produces a flame temperature of 1950°C. Excess air reduces the flame temperature proportionally. Excess air fed to a combustion process prevents unoxidized or incompletely oxidized fuel from being discharged from the stack but adds to the operating cost. It is theoretically possible to have no unoxidized combustibles with zero excess air. This can be accomplished by perfectly matching the air to the fuel.

Stephen Hirt is director of sales and Greg Gatenby is project engineer for E Products, Vadnais Heights, Minn.

Continues on page 15 ➔
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The size, capacity and maximum process rate of the thermal oxidizer is a function of the extraction stream flow rate and its maximum hydrocarbon concentration. The hydrocarbon concentration is

<table>
<thead>
<tr>
<th>MODEL</th>
<th>FLOW RATE</th>
<th>MAXIMUM HYDROCARBON</th>
<th>BURNER RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>200 SCFM*</td>
<td>15 lbs./hour</td>
<td>300,000 BTUH</td>
</tr>
<tr>
<td>500</td>
<td>500 SCFM</td>
<td>36 lbs./hour</td>
<td>750,000 BTUH</td>
</tr>
<tr>
<td>1000</td>
<td>1000 SCFM</td>
<td>73 lbs./hour</td>
<td>1,500,000 BTUH</td>
</tr>
<tr>
<td>1500</td>
<td>1500 SCFM</td>
<td>109 lbs./hour</td>
<td>2,250,000 BTUH</td>
</tr>
</tbody>
</table>

* SCFM: Standard Cubic Feet/Minute

If the vapor analysis is given in weight of hydrocarbons/unit volume, such as mg/M³ or mg/l of lbs/ft³, then convert these into lbs/ft³. For example, a vapor analysis indicates concentrations of four substances at the following levels:

Benzene: 670 mg/M³
Ethyl benzene: 200 mg/M³
Toluene: 740 mg/M³
Xylene: 910 mg/M³

The total is 2,520 mg/M³. To convert to lbs/ft³,

\[
2,520 \text{ mg} \times \frac{1 \text{ kg}}{10^3 \text{ mg}} \times \frac{2.205 \text{ lbs}}{1 \text{ kg}} \times \frac{0.0283 \text{ M}^3}{1 \text{ ft}^3} = 0.0001552 \text{ lb/ft}^3
\]

If the limit is 15 lbs/hour, then flow is limited to

\[
\frac{15 \text{ lbs}}{\text{ hour}} \times \frac{1 \text{ hour}}{60 \text{ minutes}} = 1,611 \text{ SCFM}
\]

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14 June-July 1995 Soil & Groundwater Cleanup
However, it is extremely difficult and impractical to attempt.

Although perfect burner design is virtually unachievable, there is a vast difference between the poorest and best burner designs. Poorly designed burners result in high fuel costs and unsafe operating conditions. A $1,000 burner on a $100,000 system makes no economic sense. Considering rapidly rising fuel costs, fuel waste will wipe out savings in burner equipment costs.

It is the function of burner equipment to meter the correct amount of fuel and match it with the corresponding quantity of air to affect complete combustion. All combustion reactions must occur before gases cool below the reaction temperature. Complete combustion is greatly facilitated by turbulent flow which causes intimate mixing of fuel and air. The necessary mixing can occur either before or after ignition, depending on the system’s burning characteristics. Inadequate mixing necessitates greater quantities of excess air to assure zero combustibles in the stack exhaust, which raises operating costs.

When combustion air is preheated, the rule of thumb for determining flame temperature states that 50 percent of the preheat temperature is added to the theoretical flame temperature. For example, if perfect combustion occurred with 537°C combustion air, a flame temperature of 2,230°C would result. \(1,952° + (0.5 \times 537°) = 2,489°\) The remaining 50 percent of the preheat does not increase flame temperature but is absorbed by the combustion products, causing some dissociation of carbon dioxide (CO\(_2\)) and water (H\(_2\)O). N\(_2\) (from combustion air) in the flue gas combines with the dissociated oxygen to form oxides of nitrogen, or NO\(_x\). The absorbed heat is recovered when the gases cool and are held at approximately 925°C. NO\(_x\) will be reduced to N\(_2\) much more rapidly in the presence of excess combustibles.

NO\(_x\) formation or nitrogen fixation is a time-temperature dependent reaction. Oxygen containing combustion products with high nitrogen content forms oxides of nitrogen at temperatures above 1,480°C. Inevitably, some oxides of nitrogen are formed through combustion because of nitrogen in the air. The key is to keep concentrations to a minimum by carefully monitoring burning temperature and time. The level of NO\(_x\) formation increases if temperatures go higher than 1,480°C or if the combustion products are maintained at 1,480°C for longer periods of time. Burner design is critical in controlling NO\(_x\) formation.

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More than hot air, from page 15

combustion. It should be noted that system efficiency is equal to the percentage of the fuel’s heating value realized as useful system Btu output. In equation form, that’s represented by: % Efficiency = [(Gross input - Total losses) / Gross input] x 100.

Let’s assume the system is a furnace operating continuously so there is no loss heating furnace walls. Also assume the walls are sufficiently insulated, resulting in negligible exterior heat loss. The efficiency of this system is then equal to the difference between the gross heat input from fuel and the heat exiting the system through the stack, divided by the gross heat input from the fuel. Suppose the process requires an operating temperature of 980°C. Because stack temperatures commonly exceed process temperatures by at least 204°C, the stack temperature for the system is at least 1,203°C. If a burner were operating at 100 percent excess air, the resulting system efficiency is near zero, and no heat is available to apply to items in the furnace. A perfect burner operating at zero percent excess air would have a system efficiency of 50 percent. Actual burners would have efficiency of near 40 percent, meaning 40 percent of the fuel heating value would be available to heat materials in the furnace. The cost associated with excess air rises as the process temperature rises. The source of excess air is irrelevant. Air in leakage through seams, cracks and ports requires the same heat input to reach stack temperature as does excess air introduced through the burner. Excess air and thermal inefficiency are synonymous.

The cost of fuel, excess air and burner equipment must be considered in every fuel application. Additional factors to consider are pollution control regulations which limit unburned hydrocarbons, particulate matter and oxides of nitrogen.

Write in 790 for more information
1995 Buyer’s Guide

This year, the Guide adds a Product section to the traditional Remediation Services section. The Products section begins on this page. The Remediation Services listings, organized by state, begin on page 34. In addition, we have added a cross-reference to the Services listings—organized by technology type. So, if you want to know everyone who does thermal treatment, for example, or bioremediation, or soil vapor extraction, and so on, turn to page 26.

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Denver, CO 80206
800-379-3786

Marley Pump
5600 Foxridge Dr.
Mission, KS 66202
800-262-7539

Modern Welding Corp.
See ad page 41

ModuTank Inc.
41-04 35th Ave.
Long Island City, NY 11101
800-245-6964

Process Heating Co.
Box 84582

Soil handling equipment

Alan Ross Mach.
See ad page 87

Aran America
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Denver, CO 80221
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  Cedar Rapids IA 52402
  319-363-3511
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  Columbia, SC 29224
  803-899-0413
  See inside back cover
- Clift Corp.
  Box 1985
  Oklahoma City, OK 73101
  405-491-2040
  See ad page 21
- Columbus Instr.
  Box 44049
  Columbus, OH 43204
  614-276-0861
  See ad page 59

**GenTec**
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  Louisville, KY 40243
  502-826-0223
  See ad page 19
- L&L Process Ind. Inc.
  303 Wyoming Ave.
  Wyoming, PA 18644
  717-693-1661
  See ad page 85
- Ryan-Murphy Inc.
  8810 Cherry Ave.
  Fontana, CA
  800-207-1995
- Soil Purification Inc.
  Division of Astec Industries
  Box 72515
  Chattanooga, TN 37407
  706-861-0069
  See ad page 38
- Tarmac Equipment Co.
  1850 N.E. 40 Hwy.
  Kansas City, MO 64105
  800-833-4383
  See ad page 3
- ThermoTech Systems Corp.
  5201 N. Orange Blossom Tr.
  Orlando, FL 32810
  407-290-6000
  See ad page 93

**Vapor extraction**
- Air Components Inc.
  1181 - 58th St. SW
  Grand Rapids, MI 49509
  800-383-2234
  See ad page 16
- Airex Corp.
  803 W. Angus Ave.
  Orange, CA 92666
  714-997-2349
- Arts Mfg. & Supply
  105 Harrison
  American Falls, ID 83211
  800-635-7330
  See ad page 59
- Atlantic Screen & Mfg. Inc.
  118 Broadkill Rd.
  Milton, DE 19968
  302-684-3197
  See ad page 38
- Bisco Environmental
  30 Stergis Way
  Dedham, MA 02026
  617-461-1560
- Blower Application Co.
  N114 W. 19125 Clinton
  Germantown, WI 53022
  414-255-5580
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  510-688-4474

• Env. Restoration Sys.
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  Middletown, PA
  800-944-5515

• Flite-Way Sales
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  Milwaukee, WI 53223
  800-236-3580
  See ad page 67

• Gast Mfg. Corp.
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  Benton Harbor, MI 49023
  800-952-4278
  See ad page 24

• Global Tech.
  4927 N. Lydell Ave.
  Milwaukee, WI 53217
  414-332-5987
  See ad page 23

• Key Industries Inc.
  604 N. Hill St.

• South Bend, IN 46617
  800-348-5257
  See ad page 63

• KVA Analytical Systems
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  Falmouth, MA 02541
  508-540-0561
  See ad page 62

• Lamson Corp.
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  Syracuse, NY 13221
  315-433-5500
  See ad page 46

• National Env. Sys.
  36 Maple Ave.
  Seekonk, MA 02771
  508-761-6611

• QED GrdWater Spec.
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  609-443-4545

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  Rancho Cordova, CA 95742
  916-638-5733
  See ad page 72

• Hydriplex
  120-4 Prospect
  Ridgefield, CT 06877
  203-431-1283
  See ad page 69

• Sunshine Makers
  15922 Pacific Coast Hwy.
  Huntington Harbor, CA 92549
  310-592-2844
  See ad back cover

• Texas Incinerator Co. Inc.
  2401 Neil Ave.
  Midland, TX 79701
  915-687-6700

• Water level measurement devices

• Ardan Enterprises
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  Mounds View, MN 55112
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  800-777-0977

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  801-753-1908

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  Los Banos, CA 93635
  209-826-3292

• Geopguard Inc.
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  P.O. Box 149
  Medina, NY 14103
  800-645-7654

• Geokon Inc.
  48 Spencer St.
  Lebanon, NH 03766
  603-448-1562

• Geotech Env. Equipt. Inc.
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Soil & Groundwater Cleanup June July 1995 23
Here’s what’s new in soil and groundwater remediation products from Gast.

Two free catalogs and disk describe new soil sparging/vapor extraction compressors and regenerative blowers from Gast.

Getting the right remediation product for your application just got easier.

That’s because Gast’s line now includes 14 models of rotary vane compressors for soil sparging, with pressures to 20 psi (140 bar), air flows to 112 ft³/m (190 m³/h), and three-phase or single-phase electric motors. Also included are seven models of high-pressure regenerative blowers with pressures to 10.25 psi (707 mbar) and air flows to 382 ft³/m (649 m³/h); and ten models of soil vapor extraction blowers that can be combined to provide flow rates to 840 ft³/m (1427 m³/h) and vacuum to 7" Hg (224 mbar).

To help you select the right blower, Gast also offers a free computer disk that provides product recommendations based on your application.

For free catalogs, disk, details of our “Regardless of Cause” guarantee, and the name of your local distributor, circle the number below or call 1-800-952-GAST (4278). ISO 9001 certified
if you're looking for reliable on-site testing, this will make your job a lot easier.
Whether you’re identifying hot spots, mapping sites, monitoring remediation, or screening field samples for laboratory analysis, D TECH environmental test kits make your job easier — and your results reliable.

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D TECH kits are validated against standard SW-846 analytical methods for correlation, cross-reactivity, false negative/false positive rates, and performance using actual environmental samples. As a result, the EPA now accepts D TECH test kits for screening soil and water samples.

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**THERE’S A D TECH KIT FOR YOUR JOB.**

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- PCB
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- TNT
- RDX

And with the help of customers like you, we’re continually learning new ways to improve our technology and expand our product line. As a result, you’re assured of a steady stream of innovative D TECH test products in the future.

You’re also assured of 100% satisfaction. In fact, it’s guaranteed — and backed by a nationwide network of D TECH service and support specialists.

**WITH D TECH KITS, THE ANSWERS COME EASY.**

If you’re looking for answers to your on-site testing questions, call EM Science at **1-800-222-0342**, and ask about our EPA-accepted test kits. We’ll show you how D TECH environmental test products make reliable on-site testing a whole lot easier.
Remediation Service Firms—Guide

This Guide lists various remediation service technologies, ranging from bioremediation to thermal treatment—and the companies that offer these services. Under each service category, the companies are listed alphabetically by state. The state abbreviations are given so that if you want to contact a particular company, note its home state, then turn to that state in the state-by-state listings, starting on page 34, to find the address, phone and fax number of the company.

**BIOREMEDICATION**
- EnecoTech Group, AR
- Exosorb Industries Inc., AR
- Klmke Environmental Co. Inc., AR
- Babcock Pacific Corp., CA
- Christian Engineering, CA
- CleanSols California Inc., CA
- EnecoTech Southwest Inc., CA
- Environmental Instruments Co., CA
- Enxero Supply & Services Inc., CA
- GDC Engineering Inc., CA
- Geoco Env. Consultants Inc., CA
- McLaren Hart/Chemtiks, CA
- National Technical Systems, CA
- PW Environmental, CA
- Quantum Envr. Tech. Inc., CA
- Smith Env. Technologies Corp., CA
- Sunshine Malabar South Green, CA
- Technichem Services Inc., CA
- Vapor Extraction Technology, CA
- Colorado Groundwater Res., CO
- EnecoTech Group, CO
- Montgomery Watson Const., CO
- Environmental Products & Servs., CT
- Land Tech Remedial Inc., CT
- The Spencer Turbine Company, CT
- Atlantic Sewage & Mgt, DE
- Hardy Environmental Svcs., DE
- WIK Biosystems Inc., DE
- Anderson Columbia Env., FL
- Custom Biologics Inc., FL
- Environmental Equip. & Constr., FL
- Equipment Plus Inc., FL
- Groundwater Control Inc., FL
- Horizontal Technologies Inc., FL
- Sensidyne Inc., FL
- CURA Inc., GA
- EnecoTech Group, IL
- Environmental Consulting Group, IL
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- PhiEnv. Servs. Corp., IL
- ATEC Associates Inc., IN
- Bio-Ren Inc., IN
- EnvironCorp Svcs. & Tech. Inc., IN
- R. Excavating/Land Renu Inc., IA
- EnecoTech Group, KS
- Environ-Lab, KS
- GDC Engineering Inc., LA
- Contaminated Soil Consultants, MD
- Continental Remediation Sys., MA
- Env. Products & Svcs. Inc., MA
- Clayton Env. Consultants Inc., MI
- EnecoTech Group, MI
- QED Environmental Systems Inc., MI
- Advanced Microbial Sys. Inc., MN
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- BioTol Inc., MN
- Braun Intertec Corp., MN
- E. Products, MN
- EnecoTech Group, MN
- Environmental-Rem, Technology, MN
- forestry suppliers Inc., MN
- Microbe Intotech Laboratories, MO
- Mid-America Environmental, MO
- Sunbelt Env. Svcs., MO
- Terracon Env. Inc., MO
- GBI-PRO Corp., MT
- KAI Technologies Inc., NH
- Universal Env. Tech. Inc., NH
- Accutech Remedial Sys. Inc., NJ
- Aerevac Systems Inc., NJ
- Bio-Cops Inc., NJ
- Camer Bros. Env. Excavating, NJ
- Castle Env. Contractors, NJ
- ENSR Remediation & Const., NJ
- Environmental Products & Svcs. Inc., NJ
- Lippincott, Jacobs & Gouda, NJ
- Quest Environmental Inc., NJ
- Sybron Chemical Inc., NJ
- TTI Environmental Inc., NJ
- United States Testing Co., NJ
- BDM Environmental, NM
- Rhino Env. Services Inc., NM
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- Environmental Products & Svcs., NY
- GIWA GeoEnvironmental Inc., NY
- Moducktan Inc., NY
- OBG Technical Svcs. Inc., NY
- Terra Tech Inc., NY
- Waste Stream Technology Inc., NY
- ENSC Environmental, NC
- Env. Svcs. Inc., NC
- Soil Solutions Inc., NC
- Patterson Exploration Svcs. Inc., NC
- Specialized Marine Services Inc., NJ
- American Waste Services Inc., OH
- Bio-Tech Solutions, OH
- Environmental Enterprises Inc., OH
- Environmental Resources Inc., OH
- Recycling Attachments, OH
- Sunpro, OH
- EnecoTech Group, OK
- Bioremediation Svcs. Inc., OR
- PEMCO, OR
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- Bioremediation Tech. Inc., PA
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- Emcon Inc., WA
- Flowmole Env. Services, WA
- Filteway Sales, WA
- Gabriel Environmental Services, WI
- Mid-State Associates, WI
- Fox Env. Co., WI
- Electro-Visions Inc., WI
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- EPSYS Corp., PA
- ETTG Environmental Inc., PA
- Finich Manufacturing Co., PA
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- Royer Industries Inc., PA
- Roy F. Weston Inc., PA
- RT Environmental Services Inc., PA
- R.W. & Co., PA
- Smith Env. Technol. Corp., PA
- Flor Daniel, SC
- Asteco/SN, TN
- BMW Environmental Inc., TX
- Brown & Root Env., TX
- CURA Inc., TX
- EnecoTech Group, TX
- FloTrend Systems Inc., TX
- Sweetwater Corp., TX
- Conosor Townsend Envirodyne, VA
- KEIMRON Env. Svcs., VA
- OmegFlex East Inc., VA
- Pabex Engineering Group, VA
- AccuChem Inc., VA
- AGI Technologies, WA
- Emcon Inc., WA
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- RCI Env. Inc., WA
- Filteway Sales, WI
- Global Technologies, WI
- Mid-State Associates, WI
- Angus Env. Ltd., ON

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- Geoco Env. Consultants Inc., CA
- McLaren Hart/Chemtiks, CA
- Paragon Env. Systems Inc., CA
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- Environmental Equip. & Constr., FL
- Metcalf & Eddy, FL
- Andersen 2000, Inc., GA
- CURA Inc., GA
- RCI Environmental Inc., HI
- August Mack Env., IL, IN, MD, OH
- Bio-Tech Inc., PA
- Peoria Disposal Co., IL
- Philip Env. Servs. Corp., IL
- ATEC Associates Inc., IN
- Bio-Ren Inc., IN
- EnvironCorp Svcs. & Tech. Inc., IN
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- EnecoTech Group, KS
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- Bennett Engineering Inc., MI
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- Env. Assessment & Remediation, NY
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- P.W. Gressor Env. & Hydrogeo., NY
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- Advanced GeoServices Corp., PA
- Baker Environmental Inc., PA
- Bethel Environmental Sys. Inc., PA
- CR Drilling Products, PA
- Environmental Restoration Sys., PA
- EPSYS Corp., PA
- ETTG Environmental Inc., PA
- Finich Manufacturing Co., PA
- R.E. Wright Environmental Inc., PA
- Royer Industries Inc., PA
- Roy F. Weston Inc., PA
- RT Environmental Services Inc., PA
- R.W. & Co., PA
- Smith Env. Technol. Corp., PA
- Flor Daniel, SC
- Asteco/SN, TN
- BMW Environmental Inc., TX
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- CURA Inc., TX
- EnecoTech Group, TX
- FloTrend Systems Inc., TX
- Sweetwater Corp., TX
- Conosor Townsend Envirodyne, VA
- KEIMRON Env. Svcs., VA
- OmegFlex East Inc., VA
- Pabex Engineering Group, VA
- AccuChem Inc., VA
- AGI Technologies, WA
- Emcon Inc., WA
- Flowmole Env. Services, WA
- RCI Env. Inc., WA
- Filteway Sales, WI
- Global Technologies, WI
- Mid-State Associates, WI
- Angus Env. Ltd., ON

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- Environmental Eng. & Tech., CA
- Environmental Translating Svcs., CA
- Granite Construction, CA
- McLaren Hart/Chemtiks, CA
- M.R.L. Inc., CA
- National Technical Systems, CA
- PW Environmental, CA
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Continues on page 26 →

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- Environmental Aqua Service, CA
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- GIS Solutions, CA
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- Anderson Columbia Env., FL
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- Equipment Plus Inc., FL
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- Horizontal Technologies Inc., FL
- Metcal & Eddy, FL
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- August Mack Env., IL, MD, OH
- Ejector Systems, IL
- EnecoTech Group, IL
- Feorosa Disposal Co., IL
- Philip Env. Svcs. Corp., IL
- ATEC Associates Inc., IN
- EnviroCorp Svcs. & Tech. Inc., IN
- Environmental Svcs. Inc., IA
- National Environmental Testing, IA
- EnecoTech Group, KS
- Enviro-Lab, KS
- Analysis Laboratories Inc., LA
- GDG Engineering Inc., LA
- Commercial Recycling Systems, ME
- Hoover Containment Sys., MD
- Continental Remediation Sys., MA
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- Braun Intertec Corp., MN
- Carbonair Env. Sys., MN
- CleanSoils Inc., MN
- EcoTechGroup, MN
- EPS Companies Inc., MN
- Forestry Suppliers Incs., MS
- Allstates Env. Svcs., MO
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- Alpha Environmental Inc., NE
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- Advanced Rem. Tech. Inc., NH
- ORS Environmental Systems, NH
- Universal Env. Tech. Inc., NH
- American Hi-Tech Inc., NJ
- Bio-Cops Inc., NJ
- Carner Bros. Env. Excavating, NJ
- Coastal Env. Contractors, NJ
- Ecology Alternatives Inc., NJ
- ENSR Remediation & Const., NJ
- Envi-Fix Laboratories Inc., NJ
- Environmental Products & Svcs., NJ
- Lippincott, Jacobs & Gouda, NJ
- Quest Environmental, NJ
- RYRan Environ Sciences Inc., NJ
- Sybron Chemical Inc., NJ
- TTI Environmental, NJ
- BDM Environmental, NM
- Baltac Associates Inc., NJ
- Earthwatch Waste Systems Inc., NJ
- Env. Assessment & Remediation, NJ
- Env. Products & Svcs., NJ
- QZA GeoEnvironmental Inc., NJ
- OBG Technical Svcs., NJ
- P.W. Grosser Eng. & Hydrogeo, NJ
- Terra Tech Inc., NY
- Cooper Environmental Inc., NC
- ENSC Environmental Inc.
- Enshey Env. Products Inc., NC
- Patterson Exploration Svcs., NC
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- American Waste Services Inc., OH
- Brookside Laboratories Inc., OH
- Environmental Enterprises Inc., OH
- Sunpro, OH
- EnecoTech Group, OK
- BioMediation Svcs., OK
- H2 Oil Recovery Equip., OK
- National Environmental Testing, PA
- PECMO, PA
- BioRemedial Tech. Inc., PA
- Bioscience Inc., PA
- Env. Products & Svcs., PA
- Environmental Waste Industries, PA
- EPSYS Corp., PA
- Geologic Services Corp., PA
- Highland Tank, PA
- Latimore Construction Corp., PA
- Remediation Inc., PA
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- Roy F. Weston Inc., PA
- RT Environmental Services Inc., PA
- Skelly & Coy Inc., PA
- Smith Env. Tech. Corp., PA
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- Brown & Root Env., TX
- CURA Inc., TX
- EnecoTech Group, TX
- Fluid Containment Inc., TX
- Solution Distributors, TX
- Swetterland Corp., TX
- ThermTech Inc., TX
- Associated Design and Mfg., VA
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- Environmental Directions Inc., VA
- Environmental Sys. & Tech., VA
- EMS Environmental, VA
- KEMRON Env. Sys., VA
- Omega Environmental Svcs., VA
- Plexus Engineering Group, VA
- Purgo Inc., VA
- Richard Simmons Drilling Inc., VA
- Simon & Associates Inc., VA
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- AGI Technologies, WA
- Encon Inc., WA
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- Exsorbet Industries Inc., AR
- Kimike Environmental Co., Inc., AR
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- Aran America Inc., CA
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- EnecoTech Group, CO
- Montgomery Watson Const., CO
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- Horizontal Technologies Inc., FL
- Andersen 2000 Inc., IA
- Soil Safe Inc., IA
- August Mack Env., IL, IN, MD, OH
- EnecoTech Group, IL
- Peoria Disposal Co., IL
- Philip Env. Svrs. Corp., IL
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- M.L. Charter Inc., MI
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- EnecoTech Group, MN
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- Terracon Env. Inc., MO
- Craner Bros. Env. Excavating, NJ
- Castle Env. Contractors, NJ

ENSRI Remediation & Const., NJ
- Environmental Products & Svc. Inc., NJ
- Raritan Enviro Sciences Inc., NJ
- Sybron Chemical Inc., NJ
- TTI Environmental Inc., NJ
- Allied Environmental Group, NJ
- Env. Products & Svc. Inc., NY
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- Patterson Exploration Svcs., NC
- Specialized Marine Inc., NC
- Stalite Environmental, NC
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- PEMCO, OR
- Earth Treatment Tech., Inc., PA
- Environmental Waste Industries, PA
- EPsys Corp., PA
- ETG Environmental Inc., PA
- Grosser-Steigman Inc., PA
- Rs Technologies Inc., PA
- D’Ambra Construction Co. Inc., RI
- Astec/SPI, TN
- Automation Products, TX
- Johnson & Assoc. Consulting, TX
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- Sweetwater Corp., TX
- Adveint Hill Int'l., Development, VT
- Encon Inc., WA
- Angus Env. Ltd., WI
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- National Technical Systems, CA
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- PW Environmental, CA
- Smith Env. Technologies Corp., CA
- Technicon Env. Services Inc., CA
- Unique Environmental, CA
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- Clayton Env. Consultants Inc., MI
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- QAST Mfg. Corp., MI
- QED Environmental Systems Inc., MI
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- Braun Intersect Corp., MN
- Carbonair Env. Sys., MN
- E. Products, MN
- EnecoTech Group, MN
- ERG Companies Inc., MN
- Forestry Suppliers Inc., MS
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- Sunbelt Env. Svcs., MO
- Terra Tech Inc., MO
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28 June July 1995 Soil & Groundwater Cleanup

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Flowmole Env. Services, WA
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RII Env. Inc., WA
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FilterWays Sales, WI
Global Technologies, WI
Kaw State Associates, WI
Fox Env., CO

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Terra Tech Inc., NY
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Stateline Environmental, NC
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Environmental Enterprises Inc., OH
Sunpro, OH
EnviroCorp., PA
Environmental Waste Industries, PA
EPV Env. Corp., PA
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RCI Env. Inc., WA
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Mid-State Associates, WI

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McLaren Hart/Chernmisk, CA
National Technical Systems, CA
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Sonos Earth Sciences, CA
Unique Environmental, CA
Vapor Extraction Technology, CA
Montgomery Watson Cons., CO
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Anderson Columbus Env., FL
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Equipment Plus Inc., FL
Site Remediation Systems Inc., FL
Andersen 2000, Inc., GA

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EnecoTech Group, IL
Philip Env. Svc. Corp., IL
Sen-Tech Env., IL
Asphalt Drum Mixers Inc., IN
ATEC Associates Inc., IN
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American Soil Processing Inc., IA
Cedar Rapids Inc., IA
EnecoTech Group, KS
GDC Engineering Inc., LA
Contaminated Soil Consultants, MD
Box Industries Inc., MA
EnecoTech Group, MI
Kalkaska Construction Svc., MI
Barr Engineering Co., MN
Braun Interpace Corp., MN
CleanSolis Inc., MN
E Products , MN
EnecoTech Group , MN
EPG Companies Inc., MN
Tarmac Industries Inc., MO
Alpha Environmental Inc., NE
Environmental Soil Mgmt. Inc., NH
KAI Technologies Inc., NY
Universal Env. Tech. Inc., NY
Castle Env. Contractors, NJ
Ecology Alternatives Inc., NJ
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Universal Process Equip. Inc., NJ
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Environmental Waste Industries, PA
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Association directory

Groups offer a variety of information and services to the industry

- AACE International-Cost Engineers
  Box 1557
  Morgantown, WV 26507
- Air & Waste Management Assn.
  Box 2861
  Pittsburgh, PA 15230
  412-232-3444
- American Association of Lab Accreditation
  656 Quince Orchard Rd., Ste. 304
  Gaithersburg, MD 20878
  301-670-1377
- American Consulting Engineers Council
  1015 15th St. NW, Ste. 802
  Washington DC 20005
  202-347-7474
- American Petroleum Institute
  1220 L St. NW
  Washington DC 20005
  202-682-8000
- American Society Testing & Materials
  1916 Race St.
  Philadelphia, PA 19103
  215-299-5400
- American Society of Mechanical Engineers
  1430 Broadway
  New York, NY 10018
  212-642-4900
- American Society of Safety Engineers
  1800 East Oakton St.
  Des Plaines, IL 60018
  708-692-4121
- Association for the Environmental Health of Soils
  150 Fearing St.
  Amherst, MA 01002
  413-549-5170
- Association of Engineering Firms Practicing in the Geosciences
  8811 Colesville Rd., Ste. G106
  Silver Spring, MD 20910
  301-565-2733
- Association of Engineering Geologists
  767 Lemonwood Ct.
  San Jose, CA 95120
  408-927-0710
- Environmental Assessment Association
  8383 E. Evans Rd.
  Scottsdale, AZ 85260
  602-483-8100
- Environmental Law Institute
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  Washington DC 20036
  202-328-5150
- Fiberglass Petroleum Tank & Pipe Institute
  1600 W. Sam Houston Pkwy. N.
  Houston, TX 77043
  713-465-3310
- Hazardous Waste Action Coalition
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  Washington DC 20005
  202-347-7474
- Institute for Professional Practice
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  Silver Spring, MD 20910
  301-567-6048
- International Association of Foundation Drilling
  Box 280379
  Dallas, TX 75238
  214-343-2091
- Industrial Biotechnology Association
  1625 K St. NW, Ste. 1100
  Washington DC 20006
  202-857-0244
- Industrial Environmental Association
  7777 Alvarado Rd., Ste. 708
  La Mesa, CA 91941
  619-460-4212
- Institute of Hazardous Materials Management
  11900 Parklawn Dr., Ste. 450
  Rockville, MD 20852
  301-984-8969
- Metropolitan Manufacturers Association
  Box 21734
  St. Louis, MO 63109
  314-772-4357
- National Association for Environmental Management
  1455 Pennsylvania Ave. NW
  Washington DC 20004
  202-737-3415
- National Association of Corrosion Engineers
  Box 218340
  Houston, TX 77218
  713-492-0535
- National Association of Environmental Professionals
  5165 MacArthur Blvd., N.W.
  Washington DC 20016
  202-966-5165
- National Association of Environmental Risk Auditors
  4211 E. Third St.
  Bloomington, IN 47401
  812-333-0077
- National Council of Structural Engineers
  8811 Colesville Rd., Ste. G106
  Silver Spring, MD 20910
  301-587-6284
- National Environmental Health Association
  720 South Colorado Blvd.
  South Tower, 970
  Denver, CO
  303-756-9090
- National Fire Protection Association
  Bettermarch Park
  Quincy, MA 02269
  800-344-3555
- National Leak Prevention Association
  4090 Rosehill Ave.
  Cincinnati, OH
  513-281-7693
- National Society of Professional Engineers
  1420 King St.
  Alexandria, VA 22314
  703-684-2800
- National Water Well Association
  6375 Riverside Dr.
  Dublin, OH 43017
  614-761-1711
- North American Thermal Soil Recycling Association
  Box 1468
  Lorton, VA 22199
  703-643-9619
- Petroleum Equipment Institute
  Box 2380
  Tulsa, OK 74101
  918-494-9696
- Soil & Water Conservation Society
  7515 NE Ankeny Rd.
  Ankeny, IA 50021
  515-289-2331
- Spill Control Association of America
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  Detroit, MI 48243
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Cleaned 125,000 gallons of gasoline contaminated water in 3 days!

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 15,127 PPB</td>
<td>B (2 PPB)</td>
</tr>
<tr>
<td>T 13,702 PPB</td>
<td>T (&lt; 2 PPB)</td>
</tr>
<tr>
<td>E 2,376 PPB</td>
<td>E (&lt; 2 PPB)</td>
</tr>
<tr>
<td>X 13,729 PPB</td>
<td>X (&lt; 4 PPB)</td>
</tr>
<tr>
<td><strong>Total BTEX:</strong> 44,934 PPB</td>
<td>(&lt; 10 PPB)</td>
</tr>
</tbody>
</table>

Batched treated 45,000 gallons per day

The Neola Project

THE PROBLEM:
350 yards diesel contaminated soil spilled from leaking tanker with average contamination 1,700 ppm.

THE SOLUTION:
Call R EXCAVATING

THE PRESCRIPTION:
Nov. 15- Excavate and build double pass windrows. Nov. 16- Apply nutrient amendments to achieve proper pH in soil. Nov. 19- Innoculate soil with bacteria. Nov. 22- Turn soil to oxygenate. Nov. 28- Collect seven grab samples from each windrow and ship to lab. Lab results: three of seven are CLEAN! Remaining four are within 100 ppm of cleanup objective.
Government Directory

EPA REGIONAL OFFICES
Region 1
One Congress St.
Boston, MA 02203
617-565-3420
Region 2
26 Federal Plaza
New York, NY 10278
212-264-2657
Region 3
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214-655-6444
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Seattle, WA 98101
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Department of Agriculture
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Greenbelt, MD 20770
301-344-0218
Department of Commerce
Office of Management Support
Environmental Safety and Compliance
Room 6020
14th & Constitution Ave., N.W.
Washington DC 20230
202-482-4115
Department of Interior
Bureau of Land Management
Public Affairs
Main Interior Bldg.
Rcom 5600
1849 C St., N.W.
Washington DC 20240
202-208-9435
Department of Justice
Public Affairs, Room 1216
10th & Constitution Ave., N.W.
Washington DC 20530
202-514-2007

STATE AGENCIES
Phone numbers given are contact points for underground storage tank regulations:
Alabama Department of Env. Mgt.
205-270-5613
Alaska Department of Env.
Conservation
907-465-5200
Arizona Department of Env. Quality

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New Jersey Department of Environmental Protection
609-984-3156
New Mexico Env. Department
505-827-0079
New York Department of Environmental Conservation
518-457-9412
North Carolina Department of Environmental Management
919-733-1320
North Dakota Department of Health
701-221-5166
Ohio Department of Commerce
614-752-7941
Oklahoma Corporation Commission,
405-521-3107
Oregon Department of Env. Quality
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Rhode Island Department of Environmental Management
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803-734-5331
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605-773-3296
Tennessee Department of Environment and Conservation
615-741-4081
Texas Natural Resource Commission
512-908-2247
Utah Department of Env. Quality
801-536-4100
Vermont Agency of Environmental Conservation
802-241-3888
Virginia Water Central Board
804-527-5188
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This section of the Buyer’s Guide is organized by U.S. state location, with Canadian listings at the end. Each listing shows a three letter code to indicate the particular remediation services the company offers. The key to the codes is in the black box, left. If you want to know all the firms that offer a particular service, use the guide on page 26 to find firm name and in which state it is listed. Then, find their detailed listing in this section.

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Representative Application Results

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Media</th>
<th>% Reduction</th>
<th>Elapsed Days</th>
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<tr>
<td>Bunker oil</td>
<td>Rock</td>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Soil</td>
<td>99.9 Non detect</td>
<td>7</td>
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<tr>
<td>Diesel</td>
<td>Soil</td>
<td>89</td>
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<td>Pond</td>
<td>93</td>
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<td>Beach</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>Crude oil</td>
<td>Pond</td>
<td>93</td>
<td>10</td>
</tr>
</tbody>
</table>

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Result of independent Tier II Test on AMS 521 crude oil

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Solution offers cleanup option

Wetting agent floats contaminants for recovery

The recently introduced HP-80 cleaning solution and Hydrocleaner 20-10 portable soil and sludge cleaning machine from Hydriplex Inc. offer remediation users another way to clean hydrocarbon contaminated soil and sludge. The Houston, Texas, based manufacturer says the products work together to create an environmentally safe and cost-effective method of removing hydrocarbon contaminants.

The solution is a new generation or modified tetrahedral polymer which is based on a non-toxic, organic and biodegradable silicon hydride compound. The modified polymer was developed as a cost-effective alternative to thermodesorption and bioremediation. It functions as a wetting agent, reducing surface tension by 50 percent.

HP-80 solution is a complex of silicon and hydrogen, a hydride in an aqueous solution with a polymeric structure. It is amphoteric in nature, capable of acting as an acid and as a base, combining with both acids and bases. It is not an inorganic monomer, like sodium silicate and many other materials originated from silicon.

It has a high pH, but has electrical and general behavioral properties that are typically on the acidic side of the pH scale.

When used with the cleaning machine, the solution can process up to 18 metric tons per hour of hydrocarbon contaminated soil and sludge on site. Operating on site can reduce hauling costs associated with other technologies. The system also saves the cost of incineration.

The soil cleaning system works like this: Excavated contaminated soil is fed into the machine's primary treatment unit. In the case of soils, the unit is fed by conveyor; in the case of sludge or contamination that is liquid or near-liquid, a vacuum system is used. The contaminated soil may enter an optional screening pulverizing plant for removal of oversized material.

Soil is moved on a variable speed conveyor belt through a hammermill, where it is pulverized into a size suitable for treatment. An optional magnet will remove metals before the soil particles are dumped onto a vibrating screen. From there, they drop onto a belt feed conveyor. They are moved directly into the primary treatment chamber filled with heated HP-80 solution.

Because of its plastic tendencies, sludge requires handling procedures different from that of soil. The 20-10 plant offers a sludge option, utilizing heated solution via a

"The solution is a new generation or modified tetrahedral polymer which is based on a non-toxic, organic and biodegradable silicon hydride compound."

Continues on page 84 ➞
Solution offers, from page 83

variety of nozzles and sprays to increase the temperature and viscosity of the sludge. When it is converted to a fluid state, the hydrocarbon separation process is begun using a vacuum system that injects the liquefied sludge into the primary treatment unit.

Contact with the hot HP-80 solution accelerates the separation process. Hydrocarbons in the soil and/or sludge rise to the top of the chamber, and soil particles settle to the bottom, where they are agitated again before being discharged onto a vibrating screen. The remaining solution is removed and the wastes are dumped into a receiver for disposal. The hydrocarbons skim off the top of the solution into a holding tank for removal into a storage unit. Highly contaminated products may need an extra large volume tank to receive separated material.

The HP-80 solution is then desalted via a cyclone separation system and is recirculated to the heater unit for reuse in the treatment process.

Processing sludge requires some additional equipment and handling. Sludge treatment is dependent on the site and physical conditions of the job.

With the sludge treatment option, a control room and power generator can be furnished to make the system self-contained. An additional solution tank and heater, and a concentrated HP-80 storage tank, contain pH monitor and automatic injection system to maintain pH are also part of of the sludge treatment option. Connected to the solution tank of the primary unit, this method can provide about 26 kiloliters of treatment solution. An additional trailer is needed for the vacuum and high pressure pump systems and hoses.

Water can be lost to spraying and evaporation. A skid-mounted

---

**HP-80 solution/Hydrocleaner unit**

Level of contaminants before and after use of HP-80 solution and Hydrocleaner cleaning unit on soil at a Mexican refinery site.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPH</td>
<td>85,342 ppm</td>
<td>173 ppm</td>
</tr>
<tr>
<td>Benzene</td>
<td>&lt;0.1 ppm</td>
<td>100.9 ppb</td>
</tr>
<tr>
<td>Toluene</td>
<td>3.28 ppm</td>
<td>100.6 ppb</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>9.09 ppm</td>
<td>100.1 ppb</td>
</tr>
<tr>
<td>Xylene (omp)</td>
<td>72.98 ppm</td>
<td>Xylene (m,p) 200.9 ppb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Xylene (o) 101.1 ppb</td>
</tr>
<tr>
<td>Lead</td>
<td>38 ppm</td>
<td>1.98 ppm</td>
</tr>
<tr>
<td>Chromium</td>
<td>200.5 ppm</td>
<td>1.98 ppm</td>
</tr>
<tr>
<td>Silver</td>
<td>4.0 ppm</td>
<td>2.1 ppm</td>
</tr>
<tr>
<td>Barium</td>
<td>600 ppm</td>
<td>100 ppm</td>
</tr>
</tbody>
</table>

Fig. 1 — Contaminant levels comparison before and after use of HP-80 and Hydrocleaner.

---

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Write in 237
Superfund XVI to focus on hazardous water
EIA to sponsor legislative sessions

Superfund XVI is expected to attract 7,000 industry vendors, buyers and innovators when it convenes Nov. 6, at the Sheraton Hotel, Washington D.C.

The focus of the three-day environmental trade show is hazardous water remediation management, policy and technology.

Sen. Bob Smith (R-New Hampshire), chairman of the Senate Subcommittee on Superfund, Waste Control and Risk Assessment, will address the opening session. The Environmental Industry Association will produce a legislative track addressing environmental issues, including the impact of the Republicans’ “Contract with America.” The EIA will also conduct its annual meeting in conjunction with the conference.

Exhibitors will include business, industry, education, legal and government representatives from variety of fields, including bioremediation, biofiltration, waste water treatment, sewage treatment, soil treatment, thermal treatment, building decontamination, hazardous wastes and materials transportation, nuclear weapons disposal, medical waste, risk analysis and management, site assessment, data acquisition and analysis, personnel protection, computer systems, environmental engineering and consulting, environmental law, and innovative technologies.

Superfund XVII will be held Oct. 15-17, 1996, at the Washington Convention Center. The move to the Convention Center is to accommodate the demand for increased space as the show continues to grow.

The event is sponsored by Hazardous Materials Control Resources Institute (HMRCRI) and organized by E.J. Krause and Associates Inc., Washington D.C.

HMRCRI is a non-profit organization dedicated to hazardous waste clean-up in the United States.

For information about attending or exhibiting, contact Susan Newman, E.J. Krause and Associates Inc., 7315 Wisconsin Ave., Suite 450 North, Bethesda, MD 20814, phone 301-986-7800 or fax 301-986-4538.
Many factors affect organic degradation
Mystery remains in the process of decomposition

By Alfred Conklin, Ph.D.

Organic matter is one of the many compounds that are primarily made up of carbon and hydrogen. These compounds also contain a considerable amount of oxygen and nitrogen. Other elements, such as phosphorus and various metals are also associated with organic molecules. In soil, the most important source of organic compounds is plants. A second important source is animals. All other sources are very small in comparison to these two. However, any organic compound that is found on or in the soil is referred to as soil organic matter whatever its source. The decomposition of these compounds depends on their complexity and water solubility. Soil air, moisture, pH and nitrogen are also important in the decomposition process.

A practical way to categorize soil organic matter is on the basis of how fast it decomposes. Materials like manure, plant and animal residue contain a large number of organic compounds that are rapidly decomposed by soil microorganisms. Sugars, amino acids and simple proteins are all rapidly decomposed in soil. Similarly, small organic molecules such as methanol, ethanol, acetic acid, ethylene glycol, acetone, glycerine, methylamine and many more are rapidly decomposed if they are not highly concentrated. Compounds such as those which contain oxygen or nitrogen, and are soluble in water, are subject to rapid decomposition. Note that sugars and amino acids are simple compounds from natural sources that contain oxygen and nitrogen and are soluble in water.

High concentrations of some compounds may decrease decomposition rates. Ethanol, for example, is a natural component of microbial metabolism and is therefore readily decomposed. However, it is also an anti-sieptic, so at high concentration, will kill microorganisms. Microorganisms can decompose toxic levels of compounds in soil by working around the edges of the high concentration, and eventually decompose all the compound. This naturally decreases the rate of decomposition.

The high concentration problem does not occur with natural organic sources. Very large amounts of manure, exceeding 20 metric tons per hectare, and plant residues can be added to soil. Such additions have beneficial effects on the soil. However, some farmers complain that when large amounts of crop residues are added to fields, there is a large buildup of worms. Worm populations can become so large that driveways and parking areas are often covered with dead and dying worms after rainsstorms.

Larger molecules, such as cellulose, fats, waxes and lignin are slow to decompose. In part, this is because these molecules are large and insoluble in water. They will decompose—as anyone with a wooded fence or deck constructed of untreated wood will tell you. Also, large complex, man-made organic molecules can also be expected to break down slowly in soil. Some man-made compounds which have particularly complex ring structures and/or contain many halogen atoms (as Fluorine, Chlorine, Bromine or Iodine) decompose very slowly.

When easily decomposed organic matter is added to soil, there are a number of immediate changes in soil conditions. One change is an immediate, rapid increase in the number and activity of soil microorganisms. The consequence of this activity is that the amount of oxygen in soil rapidly decreases. Thus, if one has a pile of soil and covers it with a readily decomposed organic material, the interior of the pile becomes anaerobic as in figure one, page 88. That is, all the oxygen is used up by the rapid microbial activity occurring on the outside of the pile. This would seriously slow the decomposition taking place in the interior.

If the organic matter is mixed with the soil, the aerobic zone would reach further into the pile, as in the illustration. However, the center would still become anaerobic. Piles of soil or organic matter experience more rapid breakdown of organic matter if the pile is turned frequently or if air is pumped into or out of the center. For the most rapid decomposition of organic matter, all the soil must always be aerobic.

In the absence of oxygen, organic matter is broken down by anaerobic microorganisms. It is generally acknowledged that this process is slower than aerobic decomposition. Anaerobic decomposition leads to the formation of methane, and a small amount of hydrogen. Simple alcohols and acids, along with carboxylic compounds are also produced. These types of compounds may build up to high

Alfred Conklin, Ph.D., is a professor in the agriculture department of Wilmington College, Wilmington, Ohio.
Plan to attend the Soil & Water Conservation Society's annual meeting in Des Moines, Iowa on August 6-9, 1995. The theme of the meeting is "Celebrate, Anticipate, Innovate: 50 More Years of Partnerships." Pre-register on/before July 10 for a discounted fee.

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levels under anaerobic conditions. Addition of oxygen to such systems leads to rapid decomposition of the simple alcohols, acids and carbonyl compounds.

Whether under aerobic or anaerobic conditions, decomposition involves all the organic matter added to soil. Decomposition results in the appearance of breakdown products. Some of these are simple compounds that result from the breakdown of complex carbohydrates, proteins and fats. Some remain complex. All are subject to further decomposition. The completion of this process may take weeks or months, depending on the complexity of the organic matter and environmental conditions.

Often overlooked is the synthesis of new compounds that occurs along with decomposition. Microorganisms are synthesizing new compounds needed to build new cells. They are also synthesizing extracellular enzymes that decompose organic molecules that cannot be taken into the cell. Extracellular enzymes may also catalyze the synthesis of compounds that have little to do with microbial growth or decomposition. Excess organic matter as well as waste products are exuded into the soil. This results in the production of gums and polysaccharides.

Microbial polysaccharides and gums are important in soil. They are essential for the formation of soil peds. Good ped formation results in better air and water movement through soil. This, in turn, helps to prevent the soil from becoming anaerobic.

Water is also important. There is an inverse relationship between water and air in soil. Air content of soil decreases as water content increases—and vice versa. On the other hand, microorganisms cannot function in a soil that is too dry. Soil must be maintained in a moist condition for active microbial degradation of organic matter. To maintain high air content, water content must be carefully controlled. In addition to oxygen and water, pH and nitrogen are particularly important in the decomposition process. Each type of microorganism has a pH range where it functions optimally. In addition, enzymes have specific pHs where they function optimally. Organic matter usually decomposes most rapidly at a pH near 7, which is neutral. Thus, adding lime (CaCO₃) to acid soils increases decomposition. Acidification of basic soils has a similar beneficial effect. A common agent for acidification of basic soils is elemental sulfur. Microorganisms oxidize sulfur to sulfenic acid, thus acidifying the soil. In either case, the closer the pH is to 7, the better.

Nitrogen is often a limiting nutrient when organic materials high in carbon are being decomposed in soil.

Microorganisms need nitrogen as part of their cell structure. Thus, if nitrogen is lacking, they cannot grow. Nitrogen is usually considered in terms of its ratio to carbon, C:N. Microorganisms need a C:N ratio of about 10:1. That is, 10 carbon atoms require one nitrogen atom for decomposition. Organic matter with a high C:N ratio, say, 100:1, will require the addition of nitrogen for optimum decomposition. The addition of 100 kg of organic matter with a C:N ratio of 100:1 to soil would require 10 kg of nitrogen for complete decomposition.

However, great care must be exercised in using C:N ratios. Nitrogen added to the soil cycles through several stages of decomposition. During each stage, carbon is lost. Thus, after several stages of decomposition, some inorganic nitrogen compounds are released back into the soil. Rigorously following the above example would result in a soil that is high in nitrates when all the organic matter is decomposed. These nitrates could then be a potential source to contaminate the groundwater.

The tangle of breakdown products and synthesized products resulting from organic matter decomposition in soil has never been fully characterized. Indeed, one would expect that variations in applied organic matter, soil and soil conditions would lead to variations in the compounds one might find upon analysis. However, the final products of the decomposition process are very well known. Under aerobic conditions, carbon dioxide and water are the main products. About 10 percent of the organic matter eventually is converted humus.

When considering the decomposition of organic matter in soil, it is important to control oxygen, water, pH and nitrogen concentrations. But, no single prescription for achieving optimum organic matter decomposition can be made for all soil and environmental conditions. Each soil and soil contaminant requires a prescription specific to the characteristics of each soil situation, and the contaminant present.
W.E.S. Inc. Vacu-Point™ Technology

- The patented Vacu-Point Technology, developed by the Environmental Division of W.E.S. Inc., Sarasota, Fla., is designed to accelerate the cleanup time at contaminated sites, and to reduce total project costs. The Vacu-Point technology removes large amounts of groundwater and air simultaneously from the subsurface in a short period of time. Where a traditional pump and treat system may take several years to clean up a contaminated site, Vacu-Point technology has cleaned up contaminated sites in a 90 day period. Control of the surrounding water table is established and maintained throughout the process.

This is important to ensure that the contamination does not migrate off site or result in a larger contaminated area. Monitoring controls and systems are integrated into the system design to ensure stabilized conditions throughout the clean-up process. These controls ensure that the system operates efficiently, to the needs of the particular site, and has automatic shut-down. Removing the groundwater at such a dramatic rate exposes the saturated area of contamination. The air, saturated with contaminants, is treated with an air stripping tower, carbon filter media or thermal treatment process. The water is treated and discharged in accordance with applicable regulations. The technology can remove hydrocarbons and chlorinated solvents from contaminated groundwater and soil. Pilot studies are underway to determine its ability to remove other types of contamination. The technology has proved to be useful in third party liability situations, as it can draw back a contaminated plume from a neighboring property, says the company. Multiple systems can be added to accomplish cleanup at the desired rate of speed. The process is mounted as a mobile system, and can be used for multiple cleanup projects.

Write in 792 for more information.
Survey shows mixed growth for environmental industry

A survey of publicly-traded environmental firms by Farkas Berkowitz & Co., Washington DC, indicates mixed results among different sectors of the industry. Water and wastewater goods and services gained 16 percent in revenues, while environmental consulting and remediation construction firms showed a 9 percent increase in revenues, and 30 percent in operating income. Joan Berkowitz, Ph.D., characterizes the $60 billion U.S. water and wastewater market as being in a period of competitive change, where, “The rules of competition are being rewritten; and over the next five years, new alliances and new entrants will add to the turbulence.”

According to Alan Farkas, the solid waste consulting market showed no growth in 1994, while wastewater consulting and engineering grew by 5 percent. The survey estimates that remediation services (both consulting and construction) grew by 2 to 3 percent during 1994 to $8 billion. “The market reveals a definitive shift to remediation construction,” says Farkas.

The full report is available by sending a check for $200 to Danny Collier, Farkas Berkowitz & Co., 1220 Nineteenth St., NW, Ste. 300, Washington DC 20036. Or call 202-833-7530 for more information.

EPA updates technology evaluation guide for regulators

EPA’s Office of Underground Storage Tanks has completed work on an insert package for the document: “How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers.” As reported in last month’s issue, this guide is designed to help regulators review corrective action plans that propose alternatives to traditional cleanup technologies. The insert adds three new chapters: In Situ Bioremediation, Dual-Phase Extraction and Abbreviations and Definitions. Each chapter includes a comprehensive description of the technology, including an explanation of how it works and a flowchart illustrating the decision points in the process, information to help evaluate the appropriateness of the technology for a given site, a checklist and a list of references. During this summer, OUST intends to provide everyone who purchased the original guide with a free insert package containing the three new chapters.

The complete, revised guide, over 440 pages, and including the new chapters, will be available for sale later this summer. To add your name to a waiting list to order, please call the EPA/RCRA Hotline, 800-424-9346.

Remediation of hydrocarbon-contaminated soils.

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Write in 318
Foundex Pacific Inc. Percussion Hammer Drilling System

- Foundex Pacific Inc., of Pacific, Wash., says their Becker Hammer-based percussion hammer drill can penetrate alluvial conditions such as cobbles and rocks. The Becker Hammer drill was designed and built in Canada in the late 1950s to drill seismic shot holes in open gravel formations. In recent years, the drill has found increased application to drill groundwater monitoring wells. The Becker Hammer is a double-wall drive pipe with a large hollow center, driven by a diesel-operated pile hammer. Pressurized air or drilling fluids are forced down the annulus of the drive pipe. Material cut by the drill bit is removed to the surface through the inside pipe via drilling medium. Since the center of the drive pipe is always clear, and the bit remains at the bottom of the hole, samples can be taken at any interval. Material up to 75 mm in diameter can enter the drill bit, where it is lifted instantly. Air circulation is provided by a rig-mounted air compressor which directs air flow into and above the open face of the bit to lift cuttings at a speed of approximately 18 meters per second. The drill bit consists of a crown of tempered, cast steel welded on a 300 mm length of the dual wall pipe. The bit is open in the center to channel air flow into and above the face of the borehole. The double-acting pile-driving hammer, mounted on the mast, generates a maximum of 8,100 foot pounds of force with each blow and delivers up to 95 blows per minute. There is no rotational component to the drilling action. The rate and depth of penetration depend on the nature of the subsurface. The drill is most effective and reaches its highest penetration rate—up to 30 meters an hour to depths ranging to 135 meters deep—when drilling unconsolidated gravels and cobbles. When drilling is completed, the drive pipe is retracted as annular materials are added.

Write in 793 for more information
SMW Seiko Inc. Soil Mixing Technology

The S.M.W.™ cutoff wall technique, from SMW Seiko Inc., Hayward, Calif., is an in situ soil mixing technology to install soil-bentonite cutoff walls and repair highly permeable zones which plague traditionally installed slurry trench cutoff walls. The system uses hollow-shaft, three-axis augers to penetrate the soil while pumping bentonite slurry through the auger heads. Auger flights and mixing paddles mounted on the auger shafts homogeneously mix the bentonite slurry with the soils in situ as the augers penetrate and withdraw. Successive overlapping auger strokes form a continuous soil bentonite cutoff wall free of high permeable zones. The base machine has a vertical lead, to which a top-drive, electrically driven auger and triple axis gear box are mounted. The augers are powered by electricity from a generator. The batch plant weighs the bentonite, mixes it with water and holds the bentonite slurry. While the bentonite slurry is in the holding tank, it is tested routinely throughout the operation. The bentonite slurry is then pumped by positive displacement pumps that deliver a constant controlled volume of bentonite slurry to each individual auger on the base machine during the stroke. The three augers overlap one another so that the soil is intermeshed while the augers rotate, and together, they form an area of three overlapping circles. Upon completion of a penetration and a withdrawal, they have completed one stroke. By overlapping consecutive strokes, a row or a continuous cutoff wall is installed. Soil-bentonite cutoff walls can be installed or repaired to depths greater than 60 meters, says the company. This technology, developed in Japan, has been used on over 4,500 sites worldwide in environmental and civil construction projects.

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