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Long Duration Test for Phenol Oxidation in High Salinity Water

Detailed Chemical Fingerprinting of Gasoline for Environmental Forensic Investigations Part 1. Selection of Appropriate Target Compounds

Organic Compounds in Soil

And more
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March 17-20, 2003
Mission Valley Marriott, San Diego, California

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- Environmental educators and students
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Cover photo of the Moulin du Nouchon, France site showing a thermal desorption treatment plant. Courtesy of Joel Farrier, URS France in Paris, France.

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Edited by Ellen Moyer and Paul Kostecki

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Dear Editor:

I recently read the July/August 2002 issue of your magazine. I appreciate the information and new technology presented in your publication. As I reviewed several articles, I noticed that most articles mention EPA as the sole regulatory entity. It seems that the regulatory authority of state or local agencies may have been overlooked. In Nebraska, there are several state and local agencies that have regulatory authority over different aspects of remedial activities.

For example, the Nebraska Department of Environmental Quality (NDEQ) has primacy for the Underground Injection Control (UIC) program, which is a Federal program under the SDWA. The UIC program regulates anything that is injected into the subsurface. Activities regulated by Nebraska’s UIC program include most ISCO activities and the construction of any associated injection well. Additionally, the Nebraska Health and Human Services System (HHSS) has a program that regulates and licenses any person that constructs a water well in Nebraska including injection, monitoring and recovery wells.

While I noticed that most articles described the remediation process, no regulatory aspects were mentioned for the process itself. My concern is that a consultant will read an article and assume that the described remedial activity has the blessing of every regulatory agency. I think it would be helpful to all readers if the articles discussed any "regulatory pitfalls" that were encountered during remedial activities. A brief discussion of regulatory requirements encountered during the remedial process may help inform the reader to be aware of Federal, State and Local regulations that may apply to certain remedial activities.

David L. Miesbach
UIC Program Coordinator
Nebraska Department of Environmental Quality

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Remediation of Contaminated Sites in France

By Everett Wakai

The French market for remediation of contaminated land sites and related equipment and services is estimated to be worth $350 million (350 million Euros at the current exchange rate -- September 2002). Although the French remediation market is relatively new, it is extremely competitive and sophisticated. From 1992 to 2000 the market grew by 9 percent annually. The French Ministry of Environment is currently surveying thousands of land sites. It is expected that approximately 300,000 former industrial sites will be surveyed by 2005 and identifying a market worth $5 to 7.5 billion over the next 10 to 15 years.

In addition, France has created the Réseau de Mesures de la Qualité des Sols (RMQS), the soil quality monitoring network, based on a 16 by 16 Km grid with 2000 sampling plots. This initiative has been designed to prevent soil pollution and measure a number of environmental parameters such as diffuse pollution and organic matter every five years.

The French contaminated site remediation industry consists of two principal activities:

1) research, risk assessment, characterization, feasibility studies, engineering, consulting and project management;
2) engineering and actual remediation of polluted soils and land sites. Products and services used n this market include monitoring equipment and analytical instrumentation, heavy construction equipment, water pipes and pumps, and construction of facilities.

Currently, best prospects for this industry include competitive, low cost remediation technologies; environmental due diligence and consulting services; portable easily deployable treatments and equipment; monitoring equipment. Hydrocarbons and PAH represent the two major pollutants found in contaminated land sites throughout France. The majority of the contaminated sites are located in the Paris area, the Nord-Pas-Calais region and the Rhone-Alps region.

Market Trends

The French market for remediation of contaminated sites and related services is estimated at $350 million (350 million Euros). Remediation services account for 55 percent of the market while characterization and remediation investigation and feasibility studies (RI/FS) account for 45 percent of the market. Currently, there are 1300 sites that are expected to undergo risk assessment, characterization and RI/FS studies over the next year.

The market saw a steady increase in revenues from 1992 to 2002. In spite of a drop in certain market segments, the overall market has remained consistent with close to 9 percent growth over the last two years. The forecast for the next three years is highly favorable with over ten percent expected growth. This optimistic outlook is largely due to recent developments in European Union (EU) regulations, and the French Ministry of Environments initiative to create a national register of all industrial sites dating back to 1800.

Demand for Remediation and Related Services

Future EU directives and legislation are expected to create a big demand for risk assessment, engineering, and remediation services over the next ten years.

Small to medium-sized enterprises (SMEs) will be especially affected by these future directives, which will create rigorous standards. The cost to comply with these directives may be so great that French SMEs could be compelled to sell or go out of business. Therefore, environmental consulting firms that can advise these firms on how to comply at lower costs will be in big demand.

Key Developments in the Marketplace

Many of the companies unable to comply (either by remediation or changing industrial manufacturing processes) will be acquired by larger firms. However, these larger companies will be in need of environmental due diligence and risk assessment services before any purchases take place. In some of the more serious cases, remediation services will also be required. Furthermore, those companies that are unable to comply or are not acquired by larger firms will most likely go out of business or into bankruptcy, thus increasing the number of brownfields. In most cases the burden to remediate these abandoned land sites will fall on the regional or local government.

Current urban development trends are also expected to have a strong impact on the site assessment and remediation market. There are still a significant number of outdated factories in the middle of urban and residential areas that will have to modernize or relocate. In addition, as urban developments expand outward, an increasing number of industrial plants will be in closer contact with residential and commercial zones. These plants will have to comply
with urban living standards or move to industrial zones. Therefore, many of these companies will sell their property situated in the middle of these residential zones to relocate to industrial areas. These corporate and business real-estate transactions will generate a need for environmental due diligence and RI/FS services. Furthermore, most of this land will be converted into residential and light commercial zones, which have much stricter ground soil quality standards. This will most likely create additional opportunities in the remediation market.

In addition, recent events such as the explosion at the Toulouse chemical plant AZF in September 2001 have highlighted the dangers of exposing the general public to industrial risks. Consequently, new safety standards are expected to be put into place in the near future to reduce these risks. It is likely that most companies will choose to relocate to more remote industrial zones rather than try to comply with costly regulations. Once again this is expected to lead to an increase in the number of corporate real-estate transactions, and hence the need for environmental due diligence and consulting services.

GDP: A Market Indicator

GDP growth is a good indicator for characterization studies, RI/FS and contaminated site remediation market growth. The brownfields market is largely financed by the national, regional or local governments. However, most of their funding comes from the “industrial hazardous waste tax.” As a result, as the economy grows, revenues from industrial hazardous waste tax tend to increase, which in turn can fund brownfield remediation. Moreover, most companies will postpone outlays for site remediation as long as possible and especially if the country is experiencing little to no growth. The government will tend to be more lenient during a recessionary period, preferring to extend the remediation deadline than to risk companies filing for bankruptcy. Increased real estate and land development activities, which are often tied to GDP growth have a strong impact on demand for site assessment and remediation services. Most companies will require some type of site assessment and due diligence prior to investing in real estate. Lastly, as the economy grows, industry will increase output and potentially increase land site pollution, thus creating a need for remediation services.

Pricing

Due to technological advances market prices have decreased over the last ten years. Similarly, the number of technologies available has also increased over the past decade, which has -- in effect-- increased competition and hence lowered prices. Moreover, with an increase in technological choices, the relative price of certain processes has become extremely high. For example, incineration was frequently used in the past but has now been replaced by thermal desorption at a much lower price. Further, public opinion and French legislation has made it politically costly to use incineration. Other technical and process improvements such as separation of mixed contaminated soils prior to treatment have also been effective in reducing costs.

It is also believed that as prices go down, the opportunity cost not to remediate will be greater than the price to clean up a contaminated site (cost to remediate versus not using land, potential lawsuits or poor company image). Therefore, decreases in prices and increases in choices will also drive market demand.

Market Concentration

The market is composed of approximately 30 to 40 companies, which vary in size and market share. Presently, there is no single company that dominates the market. However, some companies have developed an expertise within a specific sector and as a result have become market leaders. In addition a few large companies are present in the market but the remediation business represents a very small percentage of their overall sales revenue or core competence and thus these firms do not have a large share of the market. At the same time, as the French market is not big enough to allow companies to expand, many of them work on a European level.

Best Prospects

The Ministry of Environment is expected to complete its survey of approximately 300,000 former industrial sites dating from 1800 to the present by the year 2005. It is expected that ten percent of these sites will be contaminated and will

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Table 1. Costs of different remediation technologies.

<table>
<thead>
<tr>
<th>Polluted Area</th>
<th>Pollutants</th>
<th>Treatment Technology</th>
<th>Estimated Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Organic and Metallic</td>
<td>Landfill (Class 1)</td>
<td>E 80 - 200 per ton</td>
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<tr>
<td></td>
<td>Substances</td>
<td></td>
<td>$ 70 - 176 per ton</td>
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<td></td>
<td>Floating Hydrocarbons</td>
<td>Pump and treat</td>
<td>E 20 - 80 per ton</td>
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<td></td>
<td>Volatile Hydrocarbons and</td>
<td>Venting</td>
<td>$ 18 - 70 per ton</td>
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<tr>
<td></td>
<td>Solvents</td>
<td></td>
<td>E 10 - 40 per ton</td>
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<tr>
<td></td>
<td>Hydrocarbons</td>
<td>Bioventing</td>
<td>$ 9 - 35 per ton</td>
</tr>
<tr>
<td>Ground Water</td>
<td>Volatile Hydrocarbons and</td>
<td>On-site Stripping</td>
<td>E 5 - 50 per ton</td>
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<tr>
<td></td>
<td>Solvents</td>
<td></td>
<td>$ 4 - 44 per ton</td>
</tr>
<tr>
<td>Soil / Ground Water</td>
<td>Several pollutants and</td>
<td>Containment</td>
<td>E 25 - 50 per ton</td>
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<tr>
<td></td>
<td>forms of pollution Heavy</td>
<td></td>
<td>$ 22 - 44 per ton</td>
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<tr>
<td></td>
<td>Metals</td>
<td>Water Purification</td>
<td></td>
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<tr>
<td>Soil</td>
<td>Organic Products</td>
<td>Solvent Purification</td>
<td>E 50 - 200 per ml</td>
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<tr>
<td></td>
<td>(PCBs / Pesticides)</td>
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<td>$ 44 - 176 per ml</td>
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<tr>
<td>Soil</td>
<td>Organic Products</td>
<td>Off-site Incineration</td>
<td>E 25 - 100 per ton</td>
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<tr>
<td></td>
<td>PCBs</td>
<td></td>
<td>$ 22 - 88 per ton</td>
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<tr>
<td></td>
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<td>Off-site Incineration</td>
<td>E 100 - 300 per ton</td>
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<td>$ 88 - 264 per ton</td>
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<td>E 300 - 500 per ton</td>
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<td>$ 264 - 440 per ton</td>
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<td>E 60 - 250 per ton</td>
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<td>E 55 - 120 per ton</td>
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<td>E 48 - 106 per ton</td>
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<td>E 50 - 80 per ton</td>
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<td>$ 44 - 70 per ton</td>
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The explosion of the chemical plant AZF in Toulouse. Stricter safety regulations to reduce these risks are imminent. Companies in residential zones will have to choose between complying with costly regulations or relocating to more remote industrial zones. These regulations are expected to drive the corporate real-estate market and in turn increase the demand for environmental due diligence and consulting services.

The small to medium-sized firms will be most affected by this future legislation. Consequently, easily deployable remediation treatments, clean production processes and cost-reduction environmental consulting services will be in high demand by these firms.

While this market offers enormous potential, several challenges will have to be overcome before any significant growth can occur. Firstly, the cost of remediation is still relatively high. Secondly, there is still a lack of political will to establish and enforce stricter regulations. Liability and polluter pays principle have yet to be unequivocally defined. Consequently, many companies or landowners will refuse to pay for the environmental clean-up services and leave it to the state. Lastly, financing is still difficult to obtain for remediation services.

Competitive Analysis

The majority of the companies in this industry are small to medium-sized firms that have sales revenues of between 2 to 10 million Euros and 15 to 100 employees. Major groups such as Vivendi Environnement (GRS Valtech), Bouygues (Brezillon and Pollution Services), Teris (ATE Geoclean), also have subsidiaries active in this market that operate much more like SMEs than major corporations.

As mentioned earlier, many companies have concentrated on developing a competitive advantage or expertise within a specific sector. Following is a list of the principal land site study and remediation services companies within each market sector.

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Risk assessment and feasibility studies: Bureau Veritas is the market leader in risk assessment and feasibility studies.

Engineering and consulting: Burgeap, Sogreah, HPC Envirotec and Gester are major environmental engineering and consulting firms for soil remediation.

Biocenter Remediation: Biogenie is a major player in biocenter treatment. One hundred percent of its sales revenue comes from biocenter treatment. France Dechet and Groupe Seche are leaders in the hazardous waste treatment market but use their waste treatment platforms to treat a small percentage of contaminated soils in their treatment centers.

Thermal desorption: GRS Valtech, Geoclean and Serpol all own portable thermal desorption units and can therefore treat polluted soils on-site or in-situ. ICF Environnement and Duke Engineering both offer off-site thermal desorption remediation.

Containment/solidification: Soletanche Bachy is a leader in containment but is also very active in civil engineering and public works.

Public Works: Brezillon, a subsidiary of Bouygues is the largest public works and remediation service company in the industry.

Groundwater remediation: Sondalp is specialized in soil and ground water remediation.

While most of these firms are specialized in a particular treatment process, they generally offer a broad spectrum of services and cover most sectors. Moreover, many of the firms that conduct remedial investigation and feasibility studies have started to move into the engineering and remediation market. Similarly, engineering firms have begun to offer a "total solution" package RI/FS, remediation and site closure. Remediation companies have also moved upstream to offer risk assessment and feasibility studies and engineering services.

In addition, greater emphasis has been placed on value-added services such as risk assessment, cost-benefit and decision analysis to help clients define the best use of land and determine most appropriate remediation technologies (defining land-use determines type and degree of remediation necessary).

Most firms in the industry consider the market a "reference market". Many companies will aggressively pursue highly visible projects in order to get industry recognition even at potentially lower profit margins. Hence, companies can use these past successes to demonstrate a solid track record and their ability to provide high quality services. The sports stadium in Paris used for the World Cup final in 1998 (Stade de France) is a good example of this business practice. ICF Environment, the remediation contractor was able to build on its reputation by successfully remediating this sight.

Much of the industry is composed of small and medium-sized firms, which are subsidiaries of large companies. However, there are also several small independent firms with two to five highly skilled employees that have been successful in the market by focussing on highly customized services. These firms have also cultivated strong ties with local and regional governments. Most of these firms have

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also created a network throughout France and have established informal strategic partnerships to develop business in other French regions. These informal partnerships can entail temporary joint ventures, outsourcing or client referrals. Most of the clients also tend to be small and medium-sized firms.

On the other hand, the larger environmental consulting, RI/FS and remediation firms generally target large clients. In addition, these consulting and site assessment firms have been successful in offering turnkey solutions (RI/FS, engineering, remediation and closure) to grow their business.

Most companies that are successful in this market have strong technical and field experience, an ability to communicate with clients, strong ties with government regulators (referenced in government guides and official bulletins) and a working knowledge of the environmental standards and regulations.

### Third-Country Market Presence

France has had a late start addressing contaminated land site issues relative to most developed countries. Consequently, the French remediation sector is still considered by many an emerging one. Furthermore, much of the technology has come from the United States, the Netherlands and Germany.

Most foreign companies doing business in this sector have a local partner or have invested in a local subsidiary to demonstrate their long-term commitment and maintain a constant dialogue with their clients. These companies have also hired competent local staff with vast industry and government networks. Dutch, Belgian, German, Swiss and U.S. companies have all used this strategy to enter the French market.

As a result, foreign companies have made important inroads in the contaminated soil market. Excavated and biologically treated soils in off-site bio-centers and "thermal cleansing," with soil utilization for ground filling two areas of some success for Belgian and Dutch firms. These two types of treatment require heavy investment in capital equipment and therefore limit the number of players in the market. Most companies form purchasing alliances to procure costly products and equipment needed to service this industry.

The Dutch and Belgians have been successful in this market for several reasons.

First, due to geographical proximity, the Dutch and Belgians can excavate contaminated soils, transport them, and treat them in their own countries. As most of the treatment is done outside of France, these companies do not pay the French general tax on polluting activities, customs tax or Value Added Tax, thereby reducing the costs and maintaining competitive prices. Geographical proximity has also played a critical role in Belgian and Dutch competitiveness, as one of the most polluted regions in France is located close to these two countries borders.

Second, these countries are much more advanced in contaminated land site remediation due to a historical shortage of usable land. Moreover, as the Dutch and Belgian markets are much more mature most of these remediation companies capital equipment investments have been paid off. Therefore these companies have lower costs.
operating costs and hence can offer high quality services at competitive prices.

German companies have also had some success in this market for similar reasons. The German market has historically been more developed than the French market due to a strong Green political influence. Consequently, German firms acquired expertise early on and have managed to enter the French market with their technological know-how. Moreover, the geographical proximity has also enabled German companies to be competitive in this market.

U.S. Market Presence

The U.S. firms, Group URS (Woodward Clyde and Dames & Moore) and Duke Engineering, as well as a former U.S. company, Environmental Resources Management (ERM), are very competitive in the environmental due diligence, consulting, engineering and remediation market. These services were in big demand as a number of U.S. and Anglo-Saxon firms entered the French market through mergers and acquisitions. These three U.S. firms initially followed their American and Anglo-Saxon clients to France but now have established themselves as major players in the environmental due diligence and auditing and environmental remediation consulting market segments. Combined these companies have sales revenue of approximately $12 million in France.

As with any foreign company, U.S. firms interested in penetratng the French market will need to establish a very close working relationship with a local company. This could include investing in a local company or developing a strategic alliance in which each firm possesses complementary services and technologies. Alternatively, an U.S. firm should consider establishing a local subsidiary either by creating a new company or through acquisition. Finally, competitive pricing will distinguish U.S. companies from their competitors as most clients consider remediation and related services an added expense, which detracts from a firms bottom line.

Lastly, U.S. companies or equipment suppliers that want to do business with city governments will often have to work through city cooperatives or "syndicates". Often this implies working directly with local politicians and city government officials to address environmental policy issues and procurement needs. This also requires a long-term commitment and relationship-building strategy, as this system can appear to be extremely complex and bureaucratic, especially for outsiders.

End-User Analysis

The three main end-user groups in the contaminated land site remediation market include private companies and industrial plants; the Ministry of Environment and local governments; real estate and land developers.

France has the fourth largest GNP in the world and an enormous manufacturing capacity. As such, there are approximately 500,000 registered industrial sites and 64,600 industrial sites with operating licenses in France. Many of the companies on those sites are in need of remediation services or will be compelled to remediate their sites once stricter environmental regulations are implemented. This sector represents nearly 55 percent of the market.

Secondly, since 1993 the Ministry of Environment has maintained a National Register of all polluted or potentially polluted land sites. Approximately 3000 polluted industrial sites have been identified by the Ministry to date. Of those 3000 sites, 1300 are still in operation. It is expected that 300,000 industrial sites will have been identified and registered by 2005. Many of those sites will include abandoned land sites. Most brownfield remediation is financed by either the French Ministry of Environment (Environmental and Energy Control Agency) or municipal governments, and account for approximately 12 percent of the market.

A third area of importance is the corporate real estate and land development sector, which represents approximately 30 percent of the market. Most companies looking to invest in proper-

Market Access

Labels and Literature

All labels, operators manuals and other literature must be in French. If this regulation is not adhered to, heavy fines may be imposed and products may be confiscated by customs or denied entry into France. In addition, as of January 1, 1997, all electrical equipment sold in the European Union (EL) must carry the European Community CE ("conformite europeenne") marking, indicating compliance with EU standards.

Additionally, all chemical and biological substances must be referenced in...
the EINECS (European Inventory of Existing Commercial Chemical Substances) or ELINCS (European List of Notified Chemical Substances) inventory guide. Any hazardous or toxic substance must be labeled toxic if it appears on the European Union toxic substance reference list. However, even if the substance does not appear on the European Union toxic substance list but is known to be toxic, the product must be labeled as such.

**Government Monitoring Authorities**

The Regional office for Industry, Research and the Environment (Direction Regional de l’Industrie de la Recherche et de l’Environnement, DRIRE) and local authorities are the principal monitoring and regulating government bodies for contaminated site and soil remediation. Therefore, a strong rapport with these local officials as well as a keen understanding of French/European legislation, regulations and standards are essential to working in this market.

Water quality control is monitored by the following government agencies: Departmental Office for Sanitary and Social Affairs (Directions des Affaires Departementales de l’Action Sanitaire et Sociale, DDASS); Departmental Procurement Office (Direction Departementale de l’Equipement, DDE); Departmental Agriculture and Forest Office (Direction Departementale de l’Agriculture et de la Foret); Regional office for Research and the Environment (Direction Regionale de la Recherche et de l’Environnement, DRIRE).

**Certifications**

The industry has felt a need to standardize the profession and has therefore created a working group consisting of remediation companies, industrialists, real-estate companies, local government officials and Ministry of Environment representatives to address this issue. The outcome of this working group has been the creation of a bill, which would formally establish three categories of business activity within the industry: RI/FS, Engineering and remediation services. Further, the bill would set training, equipment and technical standards as well as offer detailed descriptions of services. It is believed that the industry would benefit greatly from this, as clients would have a better understanding of the industry and a clearer choice of services.

Although no mandatory registration procedures exist, it is highly advisable that equipment sold in France be tested and approved by AFNOR, Francs standards agency. U.S. exporters should, therefore, contact AFNOR to get norms and specifications. Most importers, agents or distributors should be able to provide information on certification of products (Please see list below for address).

Another important accrediting organization is the Laboratoire National d’Essais (LNE), or national testing laboratory, which issues certifications for various products, materials and techniques. The LNE can also provide information on recommended certifications (Please see list below for address).

ISO 14000 has become an integral part of doing business in France and Europe. In fact, many of the EU environmental regulations are related to the ISO 14000 norms. Therefore, U.S. companies that are ISO 14000 certified will generally have an easier time entering the French and European markets.

**Tax and Custom Duties**

Value Added Tax for RI/FS, engineering and remediation services may vary between 5.5% and 19.6%.

**Contacts**

The Commercial Service  
American Embassy  
2, Avenue Gabriel  
75382, Paris Cédez 08  
Tel: (33) (1) 43.12.20.45  
Fax: (33) (1) 43.12.21.72

Senior Commercial Officer: Robert A. Kohn/Commercial Specialist: Everett G. Wakai

**Regulatory organizations**

Association Francaise de Normalisation/AFNOR (National Institute for Standards)  
11 avenue Francis de Pessessé  
93571 Saint Denis La Plaine  
Tel: (33) (1) 41.62.76.60  
Fax: (33) (1) 49.17.91.91

**Laboratoire National d’Essais (LNE)**  
(National Testing Laboratory)  
Zone Artisanale Trappes-Elancourt  
5, avenue Enrico Fermi  
78190 Trappes  
Tel: (33) (1) 30.69.10.00  
Fax: (33) (1) 30.69.12.34  
www.lne.fr, info@lne.fr

**Trade Events**

Name: POLLUTEC  
Industry: Pollution Control  
Location: Paris Nord Exhibition Center, Villepinte, Paris, France  
Date: December 2-5, 2003  
Organizer: Reed Exhibition France  
Contact: Ilse Dapper, International Sales Director  
Reed-Exhibition France  
70, rue Rivay  
92532 Levallois-Perret, France  
Tel: (33-1) 47 56 21 12,  
Fax: (33-1) 47 56 21 10  
Email: Ilse_Dapper@reedexpo.fr  
Frequency: Annual

This is France’s premier environmental trade show and Europe’s second largest exhibition, covering all sectors of
environmental technologies. This show is a highly reputable, well-attended, international trade exhibition, which grows in size each year. The 2000 exhibition, which was held in Lyon, drew over 2100 exhibitors and 60,000 international visitors. The Commercial Service in France organized an U.S. pavilion in 2000 and provided a series of matchmaking, marketing and promotional services.

Each year, the show alternates between Lyon and Paris, shifting focus from specifically industrial in Paris to overall market applications in Lyon (including municipal buyers). The 2002 show will take place in Lyon and target private and government (municipal) buyers.

Name: INTERSOL
Industry: Pollution Control
Location: Palais des Congres, Paris, Porte Maillot, Paris, France
Date: APRIL 1-3, 2003
Organizer: Association Interchimie
Contact: Victor Limousin
Association Interchimie
39/41, rue Louis Blanc
F-92038 Paris La Defense Cedex-France
Tel: (33-1) 47 17 62 91
Fax: (33-1) 47 17 63 71
Email: limousin@worldnet.fr
Internet: www.interchimie.com

Intersol 2003 is the first-ever trade show and conference dedicated solely to contaminated soil and land site remediation in Europe. Approximately 1000 visitors from 30 countries are expected to attend this highly focus event. The trade show will be organized in conjunction with the Association for the Chemical Industry, Association Interchimie, Ministry of Environment, Economy, Finance and Industry, the French Soil Remediation Association, UPDS and the United Nations. Topics covered and sectors represented will include contaminated soils and groundwater remediation, land use planning, protection of water resources and management of contaminated sites and human and environmental risks evaluation. The U.S. Commercial Service will be recruiting for this event and providing support services to the American exhibitors at the show. American companies interested in participating in this event and benefiting from Commercial Service programs and support should contact the Commercial Service office at the U.S. Embassy in Paris.

For additional information regarding market research specific to your products and services, ask about our Flexible Market Research and Customized Market Analysis programs by contacting us at 1-800-USA-TRAD(E) or www.usatrade.gov. Both reports provide timely, customized, reliable answers to your inquiries about a market and its receptivity to your products and services.

To the best of our knowledge, the information contained in this report is accurate as of the date published. However, the Department of Commerce does not take responsibility for actions readers may take based on the information contained herein. Readers should always conduct their own due diligence before entering into business ventures or other commercial arrangements. The Department of Commerce can assist companies in these endeavors.

Please fill out our questionnaire/survey at the following website address:

http://csfrance.amb-usa.fr/survey.pdf

Everett Wakai is a trade specialist with the Commercial Service, American Embassy, Paris.

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aehsmag.com Contaminated Soil Sediment and Water November/December 2002 15
Fuel releases from underground storage tanks and associated delivery equipment constitute over 70% of all active remediation in the United States. These releases often impact both soil and groundwater, and are especially troublesome after contacting groundwater. Through the fate and transport processes of dilution, advection, dispersion and sorption, the fuel compounds form a plume that can migrate away from the source zone and impact a large groundwater area; this migration often results in movement of contaminants off-site, making capture and cleanup of these compounds very difficult. In situ bioremediation has been increasingly successful as a remedial application for fuel releases in general, especially as new products and systems are being developed to better support the biological degradation process. Bioremediation systems are usually cost-effective when compared to other technologies, and can offer significant application flexibility. This flexibility extends to treatment of off-site contaminants, where focused bioremediation systems can target these remote zones.

The enzyme-catalyzed Dissolved Oxygen In Situ Treatment (DO-IT) process is a specialized bioremediation technology that optimizes in situ degradation of organic compounds, including a range of petroleum contaminants as well as difficult compounds like methyl tertiary butyl ether (MTBE). This article discusses the problems associated with off-site treatment, and summarizes the application of the DO-IT technology for bioremediation of an off-site plume from a gasoline station. Using this unique bioremediation approach, significant dissolved BTEX and MTBE reductions within an off-site contaminant plume were achieved in less than nine months.

Off-site Plume Discussion
Like anything else, the strength of a plume diminishes with distance. In other words, contaminant concentrations within a plume are reduced the farther the plume migrates from the source area. While it is not true in every case, usually the off-site plume zone contains a much smaller contaminant mass when compared to the source zone. Therefore, from a bioremediation perspective, the required treatment timeframe is shortened due to reduced microbial requirements (oxygen, nutrients, etc.). This makes bioremediation an ideal off-site treatment option.

Off-site impact is an especially important issue when dealing with gasoline releases, which often contain both benzene and MTBE. Benzene is readily soluble in groundwater, and is a regulated contaminant of concern because of its carcinogenicity, while MTBE is of special concern because of its unique physical and chemical properties. Specifically, MTBE is capable of traveling rapidly through soil (with very little adsorption), is much more soluble in water than other petroleum constituents (20 times more soluble than benzene), and is considered more resistant to biodegradation. Because of its solubility in water and, consequently, its tendency to form large contaminant plumes, MTBE is often the primary off-site contaminant from gasoline releases, making it a prime threat to public and private drinking water wells. While MTBE is not a known carcinogen, its health effects are still not fully known, and it causes significant aesthetic problems (primarily odor and taste) in groundwater.

Treatment of off-site contamination is usually complicated by the presence of roads, utilities, and structures that limit access to the groundwater contaminants. Furthermore, releases within residential areas, property restrictions, and concerns about public perception restrict the treatment options for off-site contaminants. However, bioremediation using Dissolved Oxygen In Situ Treatment technology can facilitate active remediation of off-site contaminants using non-intrusive or low-profile application systems. The specifics of Dissolved Oxygen In situ Treatment are summarized below.

How the Technology Works.
Bioremediation is the process of using bacteria and other biological enhancements under controlled conditions to convert organic compounds (including petroleum hydrocarbons) to carbon dioxide, water and energy for cell production. The enzyme-catalyzed DO-IT process optimizes this process by using proprietary biological products in combination with a highly specialized in situ oxygenation equipment platform to obtain rapid reduction of petroleum contaminants. The DO-IT process is successful because it is a complete system; the technology includes application of all the primary components necessary to support the bioremediation process, including
enzymes, TPH-specific bacteria, nutrients, and extremely high levels of dissolved oxygen.

With most in situ bioremediation efforts, contaminant degradation is usually limited by the amount of available dissolved oxygen (the electron acceptor in aerobic biological processes). Therefore, the DO-IT technology includes a unique equipment platform, the Super-Ox, which contains a specialized pure-oxygen mixing process that generates high-dissolved oxygen water at concentrations of approximately 40 ppm. These dissolved oxygen (DO) levels are not only four times greater than what conventional systems can provide, the dissolved oxygen is also very stable; due to the proprietary oxygen mixing technology, the steady-state dissolved oxygen half-life is greater than 20 days. This allows the oxygenated water to influence a large plume area, resulting in faster, more complete contaminant degradation. The Super-Ox injects this oxygenated, biologically-enhanced water into the subsurface to support continuous microbial activity.

The DO-IT technology has significant advantages when targeting off-site plume treatment, including:
- Stable, oxygenated treatment water that can migrate at distance from an injection point, maximizing contact with remote contaminants.

Figure 1. Optimized in situ bioremediation.

Figure 2. Bioremediation of off-site plume.
**BENZENE REDUCTIONS**
DO-IT Treatment, Western PA

![Graph showing reductions in benzene levels over time.]

90% average reduction in 8 months!!!

**MTBE REDUCTIONS**
DO-IT Treatment, Western PA

![Graph showing reductions in MTBE levels over time.]

70% average reduction in 8 months!!!

**Associated graphs.**

- Liquid-liquid contact from oxygenated water injection that facilitates treatment of both dissolved and adsorbed (soil smear zone) contaminants. The consistent supply of necessary DO, nutrients, and bacteria accelerates contaminant mass removal.
- Oxygenated treatment water that can follow the same contaminant pathways of the original plume. In effect, the treatment water can "pursue" the off-site contaminants. This is critical when performing treatment beneath roadways and structures.

Whether treating an off-site plume or the primary source area, the ideal DO-IT application approach (Figure 1) is a closed-loop extraction/enhancement/re-injection scenario, which recycles the oxygenated treatment water throughout the plume zone. This layout provides constant micro-

**Off-Site Treatment: A Unique Challenge**

The gasoline release originated from an active gasoline station property located in a rural town, with an adjacent park downgradient from leaking underground storage tanks. Subsequent site characterization activities indicated that the BTEX and MTBE had migrated beneath a roadway and across a portion of the adjacent park property (see Figure 2). A pump-and-treat system was installed at the gasoline station property to control further offsite migration and to reduce the contaminant mass in the source area. Initially, the off-site plume was just monitored, using wells installed on the park property. As the contaminant concentrations in the source area decreased, treatment of the off-site plume became a priority. As a result, the DO-IT system was applied to the off-site plume to mitigate the BTEX and MTBE contaminants and reduce liability for the gasoline station property owner.

The off-site contaminant plume covered approximately 30,000 square feet, with five main groundwater monitoring wells, MW-A, MW-B, MW-C, MW-D, and MW-E, exhibiting benzene and MTBE contamination. Benzene concentrations prior to DO-IT system ranged as high as 800 ppb, while MTBE concentrations as high as 200 ppb were present. The groundwater occurred within a silty sand matrix at approximately 6-8 feet bgs. The hydraulic zone of fluctuation, or "smear zone," was approximately 2-3 feet annually. Cleanup goals for this offsite plume were the Pennsylvania Statewide Health Standards (SHS), which include a 5 ppb benzene limit and a 20 ppb MTBE limit.

Groundwater (and soil) monitoring was the independent responsibility of the environmental consultant on the project. Groundwater sample collection was performed quarterly for most
monitoring points, and all sample analyses were completed by an accredited, licensed environmental laboratory.

The Ideal Off-Site Treatment System

Since the off-site plume was beneath a recreational park, the resulting treatment system layout had to be inconspicuous and unobtrusive. The site consultant installed three extraction wells and a series of horizontal injection trenches in a single day; piping from these wells and trenches ran underground to a small concrete pad surrounded by trees. The Super-Ox equipment was supplied in a weatherproof, heated, walk-in enclosure which was set on the concrete pad and surrounded by chain link fencing. The extraction wells fed groundwater into the Super-Ox system, which treated, oxygenated, biologically-enhanced, and re-injected this water via the injection trenches.

This layout allowed for both hydraulic control of the dissolved-phase contaminants and continuous recycling of oxygenated treatment water throughout the site. The existing monitoring wells within the contaminated plume were used to measure remedial progress. No injection into the monitoring wells was performed, ensuring that representative groundwater data could be collected throughout treatment.

System Operation

An initial biological inoculation with enzyme complexes, nutrients, and specialized TPH-degrading microbial consortia was performed in early 2002. Since that time, the DO-IT system has performed automatic oxygenated water injection into the injection trenches on a consistent basis. Additionally, bacteria is regularly metered into the oxygenated water to maintain a healthy subsurface microbial population. Water samples are collected monthly to monitor various parameters that affect bioremediation, including DO, pH, nutrients, microbial plate counts, and specific inorganic compounds. The resulting data is used to verify biological degradation as the primary contaminant removal mechanism, and to make regular system adjustments to maximize microbial activity.

Treatment Results

Significant degradation of the benzene and MTBE was reported after the first 90 days of treatment, and over the first nine months of system operation, the system has achieved over 90% reduction of benzene, and over 70% of MTBE constituents (see associated graphs). Currently, benzene and MTBE levels in all wells except MW-A are below the Statewide Health Standards for groundwater. Treatment completion is anticipated by the first part of 2003.

With the DO-IT system, MTBE is being successfully degraded. The groundwater sampling results from this site show rapid and complete degradation of dissolved-phase MTBE. This MTBE degradation with the DO-IT process has been verified in both laboratory and field studies, and is being successfully utilized at other facilities.

Conclusions

In situ bioremediation, through the use of the DO-IT system, has achieved remarkable treatment of dissolved-phase benzene and MTBE compounds. The success of this in situ bioremediation project can be attributed to a number of factors, including:

- A well-designed injection/extraction system by the site consultant.
- The integrated application of the DO-IT technology has resulted in rapid and effective MTBE and BTEX cleanup in an offsite groundwater plume. The resulting treatment is destroying harmful contaminants and significantly reducing liability for the responsible parties. The DO-IT process is a proven bioremediation system that can be used to achieve a myriad of different treatment goals, including mitigation of migrating contaminants.

David Laughlin and Randy Mueller are with Enzyme Technologies, Portland, Ore.
Forensics

Detailed Chemical Fingerprinting of Gasoline for Environmental Forensic Investigations

Part 1. Selection of Appropriate Target Compounds

By Richard M. Uhler, Edward M. Healey, Kevin J. McCarthy, Allen D. Uhler and Scott A. Stout

Releases of automotive gasolines into the environment, for example, leaking underground storage tanks (UST), pipelines, or bulk fuel storage facilities are a persistent environmental problem facing environmental investigators. Often, the environmental forensic investigator is asked to identify and characterize the nature of gasoline found at a contaminated site. Sometimes this information, in combination with historical records, geology, and hydrogeology, can be used to assess the source(s) or age(s) of this contamination, two common objectives of forensic investigations. Regardless of the objective of an investigation, any defensible assessment of the type(s) of gasoline contamination at a given site requires, at its heart, detailed molecular characterization of the contamination.

Widely accepted analytical methods for the molecular characterization of contamination derived from automotive gasoline rely upon high-resolution capillary gas chromatography. The standard method adopted by the compliance-driven U.S. Environmental Protection Agency (EPA) for the characterization of volatile organic compounds in solid wastes, SW-846 Method 8260 (Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry)[1], provides inadequate detail for the characterization of gasolines. For example, EPA Method 8260 includes only eight hydrocarbons among the target analytes, namely benzene, toluene, ethylbenzene, m- and p-xylene, styrene, and naphthalene. Similarly, EPA Method 8021 (Aromatic and Halogenated Volatiles by Gas Chromatography Using Photoionization and/or Electrolytic Conductivity Detectors)[2] targets only the BTEX compounds (benzene, toluene, ethylbenzene and the sum of o-, m-, and p-xylenes). However, gasoline contains hundreds more hydrocarbons than these few aromatic compounds[3-4]. Alone, these few BTEX aromatic compounds are of limited use in forensic investigations requiring detailed fingerprinting of gasoline due to their ubiquity in different types of gasoline. Thus, existing U.S. EPA Methods are generally inadequate to provide the level of molecular characterization necessary in ‘fingerprinting’ gasolines in environmental matrices.

Environmental forensic investigators have previously recognized the shortcomings of existing EPA or ASTM methods in distinguishing gasoline types[5-6]. Thus, there has been the incentive to modify or develop new analytical methods that provide the degree of molecular detail necessary to address most forensic objectives related to gasoline contamination.

The authors of this paper have developed and published a modified EPA Method 8260 for the detailed molecular characterization of gasoline-derived contamination using purge-and-trap gas chromatography/mass spectrometry (GC/MS)[7]. This installment of Environmental Forensics presents an overview of that method, highlighting the modifications of the method’s target compound list that makes this method a powerful tool for “fingerprinting” gasoline in environmental media. Future installments will describe method performance and applications of the data produced using this method in environmental forensic investigations.

Strategies for Developing an Appropriate Target Analyte List

The most impactful modification to the standard EPA Method 8260 toward developing a useful environmental forensic chemistry analytical technique is a revision to the methods target analyte list. Not surprisingly, this revision aims to develop a target analyte list that contains a larger number of compounds based on the actual composition of gasoline. Gasoline contains hundreds of chemical compounds that include both hydrocarbons and non-hydrocarbons[8]. The hydrocarbons that are present in gasoline occur within five compound classes: Paraffins, Isoparaffins, Aromatics, Naphthenes, and Olefins -- often referred to by the acronym 'PIANO'. The major non-hydrocarbon classes in gasolines can include oxygen-containing ethers (e.g., methyl-tert-butyl ether, tert-amyl-methyl ether, etc.)[9], alcohols (e.g., tert-butyl alcohol, methanol, ethanol, isopropyl
alcohol)\textsuperscript{[9]}, sulfur- (e.g., mercaptans, thiophenes, disulfides, thiolanes, thianes)\textsuperscript{[10-12]}, and nitrogen-containing chemicals (e.g., pyroles, indoles, anilines, etc.)\textsuperscript{[13]}.

Three major factors form the rational for selecting compounds from within these classes for inclusion in a target compound list for a modified EPA 8260 analysis of gasoline:

- The target compounds should collectively comprise a significant mass of most gasolines, e.g., most or all of the major compounds that are normally present in gasolines should be included in the target analyte list. Compounds that meet this requirement include a variety of PIANO chemicals.

- Compounds useful for recognizing peculiarities that may be inherited from refinery processes that may be useful in forensic investigations are included in the target analyte list. For example, the relative proportions of various minor iso-alkanes, not just the major iso-alkane (2,2,4-trimethylpentane a.k.a. iso-octane), can reveal differences in the nature of the alkylate blending stock used in the production of gasoline\textsuperscript{[8]}.

- Gasoline additives amenable to accurate measurement by purge-and-trap GC/MS are considered as target analytes because of their utility in distinguishing gasoline types\textsuperscript{[14]}. These compounds included the oxygenate additives (alcohols and ethers) used in oxygenated gasolines, lead scavengers (1,2-dichloroethane and 1,2-dibromoethane)\textsuperscript{[9]}, and methylcyclopentadienyl manganese tricarbonyl (MMT).

An overarching prerequisite for selecting target analytes for this method is their availability as authentic standards, and their ability to be quantitatively purified and recovered using the modified 8260M method. The availability of standards is necessary in order to both (1) confirm the identification of individual compounds in authentic samples via mass spectral and retention time matches, and (2) develop response factors for each target analyte that can be used in the quantitative measurement in authentic samples.

Given the considerations and prerequisites discussed above, a suite of 109 target analytes were selected as the basis for the modified Method 8260 target analyte list for analysis of automotive gasolines (Table 1). The target analyte list includes representatives from the five hydrocarbon compound classes (PIANO) as well as selected oxygen- and sulfur-containing analytes. The oxygenated compounds include five ethers that have been used in gasoline, as well as the alcohol TBA. Methanol, ethanol, and isopropyl alcohol were not included due to the difficulty of purging these compounds and other analytical constraints, particularly with water matrices. Sulfur compounds include various \( C_{10} \) \(-\) \( C_{1} \) thiophenes and benzothiophene.

It is important to note that the 8260M target analyte list presented in Table 1 is not intended to be all inclusive or 'fixed'. In the spirit of flexibility inherent in performance based methods, analytes can be added or removed from the list if sufficient reason exists to do so. The goal of this method is to include a target analyte list both useful and practically achievable, and therefore provides a good first step in the characterization of environmental samples impacted by volatile petroleum products.

**Analytical Considerations**

Accurate analysis of the wide range of target compounds presented in Table 1 requires certain modifications of the
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Table 1. Target analytes, their associated mass spectral quantification ions, and reporting limits (RL) used in the characterization of gasoline in environmental samples.

22 November/December 2002 Contaminated Soil Sediment and Water aehsmag.com
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P: Paraffins; I: Isoparaffins; A: Aromatics; N: Naphthenes; O: Olefins; S: Sulfur-containing; ADD: Additive

**Table 1 continued.**

standard EPA Method 8260 GC/MS method used for their analysis in nonaqueous phase liquid (NAPL), soil or water samples. Sample introduction is accomplished using standard purge-and-trap methodologies. However, a very slow, almost 80-minute long gas chromatography program is employed to facilitate optimal resolution of the target compounds of interest (Figure 1).

The modified EPA Method 8260 method is quantitative, employing a 5-level calibration standard containing all 109 of the target analytes. A calibration solution that contains all of the target analytes and appropriate internal standards allows for the development of compound-specific response factors for quantitative analysis.

Appropriate quality control samples -- including procedural blanks, laboratory control standards, are included as an integral part of the modified analytical method. Replicate analyses (duplicates or triplicates) within each analytical batch are highly recommended as a means of demonstrating analytical precision.
Conclusions
The detailed chemical characterization of gasoline and its residues in environmental samples can be accomplished by purge-and-trap GC/MS following a modification of U.S. EPA Method 8260. The principal modification of the method includes development of a target analytes list appropriate for 'fingerprinting' automotive gasoline, and optimized techniques that promote gas chromatographic separation of these compounds. The quantitative approach to gasoline fingerprinting inherent in this method is advantageous over qualitative fingerprinting due to the ability to analyze the quantitative results using numerical or statistical methods.

In future installments of this column, a summary of the performance of this purge-and-trap GC/MS method for the detailed analysis of gasoline will be presented. Case studies demonstrating the utility of the data generated using this method toward identifying and differentiation among gasolines at contaminated sites will be offered in order to amplify the utility of the purge-and-trap GC/MS method for environmental forensic investigations at sites contaminated with gasoline.

References
Richard M. Uhler, Edward D. Healey, Scott A. Stout, Ph.D., Kevin J. McCarthy and Allen D. Uhler, Ph.D., are senior consultants in Battelle Memorial Institute's Environmental Forensics Investigation Group in Duxbury, Mass.
Soils

Organic Compounds in Soil

By Alfred R. Conklin, Jr.

Soil organic matter might be thought of as all organic matter in soil regardless of its origin or its state of decay. Ultimately, organic matter in soil comes from one of three sources. Plants provide the greatest and most frequent addition of organic material. These additions occur both through the tops, leaves and branches, falling to the soil surface and through dead and decaying roots. Animals, either through manure or death, also add organic matter to both the surface and subsurface of soil. Microorganisms add organic matter throughout the bulk of the soil. This diversity of sources of organic matter means that a diversity of bio-and organic molecules are constantly being added. All sources are important in maintaining soil organic matter and all lead to the occurrence of a variety of simple organic molecules in soil.

We can refer to organic matter by the letter R. In organic chemistry, R refers to a molecular fragment composed of carbon and hydrogen. Sometimes R may contain other groups, but in this case, the other groups must be specifically identified. A common method of representing organic molecules is shown in figure 1. These represent from left to right an acid, alcohol, ether and aldehyde. In each case, the molecule has a hydrocarbon chain of indeterminate length represented by R. Another way to look at this is to say that the R group is not as interesting or important in the discussion as is the group containing oxygen. Compounds containing nitrogen, sulfur, phosphorous and other atoms can be represented in a similar fashion.

Fresh organic matter added to soil quickly begins to decompose. Its most common fate is aerobic decomposition. That is the microbial oxidation of organic matter using atmospheric oxygen.

A second possibility is anaerobic degradation. This is decomposition of organic matter without oxygen, and it occurs in several steps. Anaerobic microorganisms carry out these decomposition reactions. One product of these reactions is methane, which is the simplest of organic compounds.

Methane along with all organic compounds containing only carbon, hydrogen and single bonds is the most reduced form of organic compounds. It is considered the basic unit from which all organic molecules are built. Methane is the first example of a simple organic compound in soil. Although it is a reduced form of carbon, methane is commonly found in soil even under aerobic conditions.

The reactions above provide more information than is generally given. This is to emphasize several important facts. Soil microorganism breakdown organic matter to obtain energy. Secondly, the decomposition process releases minerals, inorganic cations and anions, into the soil solution. Thirdly, a by-product of the decomposition of organic matter is humus.

The rate at which organic matter decomposes depends on many factors. The most important of these are temperature, moisture, nutrient availability, type of compound and a quantity called the carbon to nitrogen ratio (C/N ratio). The most favorable temperature is between 20 and 40°C. Ideal moisture levels are between visibly moist and saturated. Decomposition is also favored in soils which have adequate levels of nutrients. Simple water soluble compounds are more easily decomposed than complex water insoluble compounds such as cellulose and lignins.

Soil organic matter has a C/N ratio between 12/1 to 10/1. This means

\[
R-\text{CH}_2\text{CH}_3 + O_2 \xrightarrow{\text{aerobic microorganisms}} \text{CO}_2 + \text{H}_2\text{O} + \text{Energy} + \text{Minerals} + \text{Humus}
\]

Figure 2.

\[
R-\text{CH}_2\text{CH}_3 + O_2 \xrightarrow{\text{anaerobic microorganisms}} \text{CH}_4 + \text{H}_2\text{O} + \text{Energy} + \text{Minerals} + \text{Humus}
\]

Figure 3.
that there are 12 carbons atoms for every one nitrogen atom. If the ratio is higher than this nitrogen is taken out of the soil solution by soil microorganisms to allow them to use the carbon source. This leads to a depletion of soil nitrogen, and plants growing under these conditions will suffer a nitrogen deficiency. If the ratio is lower than this, nitrogen is released into the soil solution.

Composting is a method of removing carbon from organic matter. The C/N ration is brought closer to 12/1 as the organic matter is decomposed releasing carbon dioxide. At the same time nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and micronutrients, are retained in the compost. Thus, the final compost material is higher in plant nutrients than is the original organic matter. Usually compost is not yet humus, but is well on its way to this eventual fate.

Humus is frequently described as a dark colored polymeric material. There are several problems with such a description. Humus is made of three components, fluvic acid, humic acid and humin. Of these, fluvic acid is the lowest in molecular weight and lightest in color. Humic acid is darker in color and higher in molecular weight. Humin is indeed dark in color and is the highest in molecular weight. The second problem is that none of these materials is a polymer in any sense of the word. Polymer means many (poly) and units (mer), i.e. many units. Thus, a polymer is made up of many units. No one has found a repeating unit associated with fulvic acid, humic acid or humin. For this reason, they cannot be true polymers.

Humus is an extremely important soil component. Its particles are colloidal in size, typically less than 0.002 mm in diameter. Its surface is hard to define because of its highly branched complex structure. However, because of its small size, it has high sorptive capacity for both water and organic compounds. It also has a high cation exchange capacity, which is highly dependent on the pH of the surrounding solution. As the pH of the solution increases (becomes more basic), the cation exchange capacity also increases. Thus, both organic molecules and cations, but not anions, are attracted to humus.

In addition to increasing a soils sorptive and cation exchange capacities, humus also has an effect on the physical characteristics of soil. Sand, silt and clay particles in soil do not act independently of each other. They are cemented together to form secondary structures called peds. One of the important constituents in holding the particles together is humus. Soils with strong ped formation have increased pore space, infiltration and percolation.

Simple organic compounds are released into the soil solution during organic matter decomposition and humus formation. Compounds such as simple amino acids, sugars and fatty acids (shown in figure 4 from left to right respectively), along with almost all other cellular components, are released during decomposition. Because they are small and soluble in water, these molecules are rapidly decomposed. It might be argued that these are not simple organic molecules, but rather bio-molecules, since they are common cellular constituents and are produced by enzymatic reactions. There are however, many other examples of simple organic molecules derived from soil organic matter which may be found in soil.

Benzoic acid is an example of a simple organic compound which is associated with soil organic matter. In addition, numerous compounds derived from benzoic acid, such as methoxybenzoic acid, are also found. These are simple organic compounds, but are not recognized as common cellular constituents. In addition to these compounds, various chlorinated derivatives have also been found.

There are a great variety of organic compounds in soil derived from biological or biochemical origin, and from other reactions in the soil. In analyzing soil for organic contaminants, it is important to make sure that the component being investigated is not a normal constituent of that soil. Attempting to remediate a soil below its natural level of a component is not a fruitful undertaking.

Alfred R. Conklin, Jr. Ph.D. is professor of agriculture and chemistry at Wilmington College in Ohio.

Figure 4.

![Figure 4](image)

Figure 5.

![Figure 5](image)
TREATABILITY OF MGP SOILS WITH CLEANUP PENTANONIC

By Andreas Jazdanian, Donald Schilling, Larry Milner, Christopher Szela, Steve Matuszak, Krishna Reddy and Bob Psaradellis

The treatment of soils impacted with tar from former Manufactured Gas Plant (MGP) operations poses a major challenge, due to the recalcitrance of its major constituents to degradation and desorption. Polyaromatic hydrocarbons (PAHs) are the recalcitrant and major constituents of MGP-tar and can be degraded in chemical and biological oxidative processes or removed from the soil with surface-active solutions or thermally desorbed. Processes have been utilized that successively treat PAH impacted soils with oxidizing reagents, biological media and surface-active solutions [e.g. 1; 2; 3].

A treatability study was conducted to evaluate the treatment of tar impacted soils from a former MGP site with Cleanup Pentanonic. Pentanonic has successfully converted free phase and sorbed petroleum hydrocarbons in soil matrices [4; 5]. The objective of the study was to test the effectiveness of aqueous Pentanonic solutions in removing and chemically converting polyaromatic hydrocarbons (PAHs) and benzene, toluene, ethylbenzene and xylene (BTEX). A further objective of the study was to determine Pentanonic/Soil Mass (gal/ton) ratios for the design of a pilot-scale study.

Materials and Methods

Pentanonic is manufactured by Surface Technology Company, Inc. and was introduced for this study by Mitsubishi International Corporation. It is a viscous, water-soluble and biodegradable product. The tar impacted subsurface soils used for this study were collected from the former Crawford Station MGP in Chicago, Illinois. Three types of impacted soil were collected for this study. The geotechnical properties of the soils that were used for testing are presented in Table 1.

The clay composite consists of clay overburden and clay with tar in fractures in a 1:1 mass ratio. The granular composite consists of granular overburden and clay with tar in fractures in a 1:1 mass ratio. The concentration of total PAH, benzo(a)pyrene, total BTEX and benzene of the soils are presented in Table 2.

Testing was performed by the geotechnical and environmental laboratory of the University of Illinois at Chicago. Treatment of soil with Pentanonic solution was conducted in batch tests. All batch tests consisting of homogenized soil and Pentanonic solution were prepared in conical flasks.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>GRAB SAMPLES</th>
<th>COMPOSITE SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay Overburden</td>
<td>Clay with Tar</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.43</td>
<td>2.59</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>16.40%</td>
<td>18.10%</td>
</tr>
<tr>
<td>Total Organic Matter</td>
<td>3.89%</td>
<td>3.23%</td>
</tr>
<tr>
<td>pH</td>
<td>7.23</td>
<td>7.21</td>
</tr>
<tr>
<td>Grain Size Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Gravel</td>
<td>10.8%</td>
<td>4.9%</td>
</tr>
<tr>
<td>-Sand</td>
<td>26.3%</td>
<td>45.4%</td>
</tr>
<tr>
<td>-Fines</td>
<td>62.8%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Atterberg Limits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Liquid Limit</td>
<td>33%</td>
<td>31%</td>
</tr>
<tr>
<td>-Plastic Limit</td>
<td>21%</td>
<td>23%</td>
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<tr>
<td>-Plasticity Index</td>
<td>12%</td>
<td>8%</td>
</tr>
<tr>
<td>USCS Classification</td>
<td>CL</td>
<td>CL/SC</td>
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</table>

Table 1. Geotechnical properties of soils.

<table>
<thead>
<tr>
<th>Analysis (mg/kg)</th>
<th>GRAB SAMPLES</th>
<th>COMPOSITE SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay Overburden</td>
<td>Clay with Tar</td>
</tr>
<tr>
<td>TOTAL BTEX</td>
<td>&lt;0.0092</td>
<td>61.7</td>
</tr>
<tr>
<td>Benzene</td>
<td>&lt;0.0092</td>
<td>6.7</td>
</tr>
<tr>
<td>TOTAL PAHs</td>
<td>27.4</td>
<td>100%</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>1.4</td>
<td>14</td>
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</table>

Table 2. Chemical analytical data of soils.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water/Pentanonic Ratio</td>
<td>5:1</td>
</tr>
<tr>
<td>Solution/Solid Ratio</td>
<td>4:1</td>
</tr>
<tr>
<td>Solution Volume</td>
<td>200 mL</td>
</tr>
<tr>
<td>Pentanonic Volume</td>
<td>33.3 mL</td>
</tr>
<tr>
<td>Pentanonic Concentration</td>
<td>16.67 %</td>
</tr>
<tr>
<td>Soil Mass (moist)</td>
<td>50 g</td>
</tr>
<tr>
<td>Pentanonic/Soil Ratio</td>
<td>189 gal/ton</td>
</tr>
</tbody>
</table>

Table 3. Initial testing parameters.
Table 4. Solution properties for treatment in several passes.

<table>
<thead>
<tr>
<th>Pentanonic Solution Properties</th>
<th>Pass Number</th>
<th>Pentanonic Concentration (%)</th>
<th>Cumulative Solution Volume (mL)</th>
<th>Cumulative Pentanonic Volume (mL)</th>
<th>Cumulative Pentanonic/Soil Ratio (ml/g)</th>
<th>Cumulative Pentanonic/Soil Ratio (gal/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Volume High Strength</td>
<td>1</td>
<td>16.67</td>
<td>200</td>
<td>33.33</td>
<td>0.79</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16.67</td>
<td>400</td>
<td>66.67</td>
<td>1.57</td>
<td>378</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>16.67</td>
<td>800</td>
<td>100.00</td>
<td>2.36</td>
<td>567</td>
</tr>
<tr>
<td>High Volume Medium Strength</td>
<td>1</td>
<td>8.33</td>
<td>400</td>
<td>33.33</td>
<td>0.79</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8.33</td>
<td>800</td>
<td>66.67</td>
<td>1.57</td>
<td>378</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8.33</td>
<td>1200</td>
<td>100.00</td>
<td>2.36</td>
<td>567</td>
</tr>
<tr>
<td>Medium Volume Medium Strength</td>
<td>1</td>
<td>8.33</td>
<td>200</td>
<td>16.67</td>
<td>0.39</td>
<td>94.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8.33</td>
<td>400</td>
<td>33.33</td>
<td>0.79</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8.33</td>
<td>600</td>
<td>50.00</td>
<td>1.18</td>
<td>283.5</td>
</tr>
<tr>
<td>Low Volume Low Strength</td>
<td>1</td>
<td>4.17</td>
<td>200</td>
<td>8.33</td>
<td>0.20</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.17</td>
<td>400</td>
<td>16.67</td>
<td>0.39</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4.17</td>
<td>600</td>
<td>25.00</td>
<td>0.59</td>
<td>141</td>
</tr>
</tbody>
</table>

Table 5. Testing parameters for tests simulating soil washing.

<table>
<thead>
<tr>
<th>Pentanonic Concentration (%)</th>
<th>Dry Soil Mass (g)</th>
<th>Solution Volume (mL)</th>
<th>Pentanonic Volume (mL)</th>
<th>Pentanonic/Soil Ratio (ml/g)</th>
<th>Pentanonic/Soil Ratio (gal/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.08</td>
<td>127.2</td>
<td>200</td>
<td>4.17</td>
<td>0.0328</td>
<td>7.9</td>
</tr>
<tr>
<td>0.5</td>
<td>127.2</td>
<td>200</td>
<td>1.00</td>
<td>0.0079</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Figure 1. BTEX distribution of initial batch tests.

Figure 2. PAH distribution of initial batch tests.

After 24 hours of shaking on a reciprocating shaker the slurry was filtered. The filtrate and solids were analyzed according to EPA method SW 8260 B for BTEX and SW 8170 (SIM) for PAH by STAT Analysis Corporation. The batch tests were prepared with water to Pentanonic ratios ranging from 5:1 to 199:1, resulting in aqueous Pentanonic concentrations ranging from 16.67 to 0.5%. Further, the batch tests consisted of 50 g moist soil and solution to solid ratios of 4:1 (200 mL solution) and 8:1 (400 mL solution). The Pentanonic concentrations and solution to solid ratios of each round of batch testing are presented in Tables 3, 4 and 5.

Results and Discussion

The initial batch tests were prepared with Pentanonic concentrations recommended by Surface Technology Company, and were intended to ensure contaminant reduction. The testing parameters for the initial round of batch tests are presented in Table 3. All five soil types were tested during the initial round of batch testing.

The removal in total BTEX in the five soils treated with the conditions presented in Table 3 ranged from 40.7 to 98.5 % and the reduction in benzene ranged from 60.0 to 93.4 %. Furthermore, the removal in PAH and benzo(a)pyrene ranged from 24.3 to 76.1 % and 0 to 48.3 %, respectively. The mechanisms identified for removal of target contaminants were desorption and chemical conversion. The proportion of converted target contaminant was determined by calculating the difference between total mass removed and mass in solution. The proportions of total BTEX and PAHs remaining in solution and total BTEX and PAHs converted are presented in Figures 1 and 2.

Following the initial round of batch testing only the clay composite soil was treated in several passes to determine if further removal of target contaminant is possible by repeating treatment with fresh Pentanonic solution. The procedure consisted of mixing impacted soil with Pentanonic solution (Pass 1) and filtering the slurry, and then mixing the soil with fresh Pentanonic solution (Pass 2). The soil was treated in three passes. The solution properties for the batch tests are presented in Table 4.

The removal of BTEX and PAHs after treatment in one, two and three passes is presented in Figures 3 and 4. In certain instances removal of BTEX and PAHs was less in two and/or three passes than in one
pass. These results may be due to the heterogeneity of the soil samples resulting in higher concentrations of BTEX and PAHs in the sample that was analyzed for baseline concentrations than the samples that were treated.

Finally, batch tests were conducted that simulate a pilot-scale soil washing operation. A typical pilot-scale soil washing process is operated by continuous addition of impacted soil to Pentanonic solution in a bath (e.g. a hopper). The soil is mixed within the bath and the wetted soil is then removed from the bath (e.g. by using an inclined auger conveyor). The solution is continuously replenished. The final batch tests attempted to assess the minimum Pentanonic concentration (volume) required for soil washing. The testing procedure consisted of mixing clay composite soil with Pentanonic solution, decanting the solution onto untreated soil and mixing, and again decanting the solution onto untreated soil and mixing. A composite soil sample of all the treated soil (total of three soil samples) was analyzed for BTEX and PAHs. The testing parameters for the batch tests are presented in Table 5.

The treated samples had a higher PAH concentration than the untreated baseline sample. This result is due to the heterogeneity of PAH distribution in the samples and the insufficient strength of the solution to remove PAHs from the soil. The results for total BTEX and benzene removal are presented in Figure 5.

Conclusions

Aqueous Pentanonic solutions are more effective in removing BTEX than PAHs from soil. The study shows evidence that removal is due to both desorption and chemical conversion of hydrocarbons. The Pentanonic solution concentrations and procedures used in this study could not reduce target compound concentrations (e.g. benzo(a)pyrene) to the tentative remediation objectives for the site (e.g. risk-based statistical mean of 1.7 mg/kg for benzo(a)pyrene). With respect to product requirements, it seems that treatment of tar impacted soil from the site requires higher volumes of Pentanonic per unit mass of soil (gal/ton) than petroleum impacted soil (e.g. 55 gal/1000 tons).

References


Figure 3. BTEX removal for treatment in several passes.

Figure 4. PAH removal for treatment in several passes.

Figure 5. BTEX removal for tests simulating soil washing.


Andreas Jazdani, Donald Schilling and Larry Milner are with Burns & McDonnell Engineering Company. Christopher Szela and Steve Matuszak are with The Peoples Gas Light and Coke Company. Krishna Reddy is with the University of Illinois. And Bob Psaradellis is with Mitsubishi International Corporation.
Aerobic Groundwater Remediation at an Illinois Demonstration Site

By Jerry Kellgren

Oxygen is usually the rate-limiting factor in any aerobic remediation of petroleum contaminated groundwater, especially in low flow (10^3 ft/day) clay sites like the demonstration site in Wayne, Ill.

The O₂Tube system maintained approximately 15 ppm dissolved oxygen in the test well. The O₂Tube low head, high flow pneumatic draft pump gently increased the dissolved oxygen in the test area groundwater from 0.5 ppm to 2.0 ppm in 100 days. The horizontal groundwater area impacted was over 700 square feet surrounding the test well. The area included 10 feet upstream, 12 feet to the sides and over 20 feet downstream.

The BTEX contamination dropped from 10 ppm to below 1 ppm during the test without the addition of anything except oxygen. The O₂Tube pre-cell absorption section minimized the formation of gases other than oxygen. The average energy usage for the test was 1.5 volts and 1.0 amps direct current. This energy usage is the same as a 1.5 watt light bulb.

The remainder of this article will describe the O₂Tube system, the Wayne demonstration site and what was observed during the field test.

The System

The O₂Tube system is essentially two components (control-power center and O₂Tube cells) connected via a power cord and air line.

Control-Power Center. The custom built centers are designed to meet the needs of each site. Each control-power center provides the variable DC power, compressed air, variable on/off timer, volt and amp meter required to operate the cells.

The O₂Tube Cell. The cell can be made in any diameter required. The standard cell fits into any screened groundwater well four inches or larger. The direction of flow through the tube is from the bottom to the top. Water first flows through the absorption sock (optional) which can be filled with activated carbon. The carbon limits the amount of chlorine producing dissolved road salt that pass through the oxygen generating cell. The water next passes through the O₂Tube electrolysis section, where pure oxygen bubbles evolve on the anode plates. The bubbles grow in size until they are pulled from the anodes into the water stream where the gas bubbles dissolve into the groundwater. The third and final section which water flows through, contains the pneumatic draft pump which creates the high volume (50 gph), low head (1.5 inch) flow required for recirculating the > 15 ppm oxygenated water through any saturated soil.

The Wayne, Illinois Site

The Wayne property consists of a parking lot and historic building that currently houses a custom home builder, travel agency and a limousine service. The site was a gas station during the 1950s and 1960s. Petroleum products left in the soil years ago have dissolved into the groundwater. Due to typical Illinois silty clay and its affinity to hold gasoline, the plume hasn't moved off-site.

During a 2000 phase II investigation, it was discovered that the groundwater in the area associated with where the tanks and pump isolation were located was contaminated. Testing done at the time indicated that the groundwater flowed Northeast at a rate of 10^- feet per day. Further investigation indicated that over 1,200 cubic yards of soil and groundwater had been impacted. Land Chek Inc., approached the property owner with a bioremediation proposal that incorporated its patent pending O₂Tube Technology.

The System is Installed

Land Chek Inc., hired Rock & Soil Drilling, St. Charles, Ill., to install a four inch 25 foot screened PVC well as the O₂Tube test location in the most contaminated area. Three two-inch PVC monitoring wells were located 10 feet upstream, 12 foot side stream and 20 foot downstream of the O₂Tube test well. The soil lenses were logged during the installation of the wells. They indicate the layers starting with the surface were; two inches asphalt, two inches compacted gravel, one to two feet of topsoil, 4-8 feet of brown/green clay with pebbles, and grey/grey silty clay with sand to end of boring. Groundwater was observed at around 10 feet in each boring.

After installing the wells, trenches were dug to bury the PVC pipes that carry the power and air line between the control center and the test well. The area was compacted and covered with new asphalt. The control center was installed on the wall behind the bushes where a 110 volt, 10 amp AC outlet had been installed. The air and power lines were connected between the control-power center and
O₂ Tube cell. The system was tested.

Initial Site Oxidation began June 22, 2001. All sites which are low in dissolved oxygen will have materials that must be initially oxidized before the dissolved oxygen levels will stabilize. The Wayne site, specifically, has free iron and organic material in the groundwater and soil. The first few days of operation (without the carbon sock installed) allowed excess calcium and other minerals in the groundwater to be absorbed on the electrolysis plates. The on/off timer was set to energize the cell for 30 minutes at the beginning of each hour.

During break-in, the plates were easily cleaned of minerals by first inflating a balloon in the space below the electrolysis cell to prevent leakage. White Vinegar (weak acid) was poured into the top of the O₂ Tube housing until the electrolysis cell was completely submerged (about 1 quart for a 3 inch O₂ Tube cell).

After about 45 minutes, the cell plates were completely cleaned and returned to the test well.

After three days of checking and cleaning, the test well stabilized at 16.0 ppm DO, 3.0 ppm Cl₂ and a pH of 8.2. The odor from the well had a slight chlorine smell. The bacteria count was 10⁶ bacteria/ml. The timer was reset to run 15 minutes at the beginning of each hour. The S1, S2, S3 monitoring wells dissolved oxygen levels were 1.2, 0.9 and 0.6 respectively.

### Discussion of the Results

**Dissolved oxygen.** The DO in the test well averaged 15 ppm during the field test. The time it did drop below 15 ppm were associated with mineral deposits on the cells. The DO in the monitoring wells steadily increased from 0.5 ppm to over 2.0 ppm. The even distribution of DO in the monitoring wells indicate the flow from the well to be in a circular pattern, with some influence from the slow moving groundwater. This information will be used to design systems for sites with any groundwater flow. The rapid distribution of DO throughout the clay was achieved by constantly recirculating the soils groundwater through the well.

**Free chlorine.** Patent searches related to electrolysis and dissolved oxygen indicated that every time this technology was tried in the lab, it wasn't considered viable due to the formation of chlorine. The researchers observed that the bacterial counts decreased even though the DO increased.

During the O₂ Tube bench studies, free chlorine evolved from the test water, which had passed through a water softener. What if the chlorine could help control algae and bacterial growth within and near the well installations? The plugging associated with air sparging, oxygen injection and OCR projects would be a thing of the past.

During the field testing, at no time did the chlorine or pH rise in any of the monitoring wells, even during periods when the carbon absorption sock was not in place and the test well developed 3.0 ppm chlorine. During the periods of time when the carbon absorption sock was in place, the

<table>
<thead>
<tr>
<th>June 8, 2001</th>
<th>Dec. 4, 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O₂ Tube</strong></td>
<td><strong>S1</strong></td>
</tr>
<tr>
<td>Oxygen (ppm)</td>
<td>0.5</td>
</tr>
<tr>
<td>Bacteria (#/ml)</td>
<td>10⁸</td>
</tr>
<tr>
<td>Benzene (ppb)</td>
<td>8.9</td>
</tr>
<tr>
<td>Toluene (ppb)</td>
<td>1,980</td>
</tr>
<tr>
<td>Ethyl Benzene (ppb)</td>
<td>17.3</td>
</tr>
<tr>
<td>Total Xylenes (ppb)</td>
<td>13,300</td>
</tr>
</tbody>
</table>

Note: The increased levels of contaminants in well S3 are due to a rising groundwater table (15") in the winter months and its location immediately downstream and below the original source of contamination.

**Figure 1. Wayne, Ill. demonstration site.**

aeohsmag.com Contaminated Soil Sediment and Water November/December 2002 31
Figures 2 and 3.

chlorine in the O₂Tube well never rose above 2.0 ppm Cl₂.

The chlorine actually aids the process by keeping the well and its casing algae free, just like a swimming pool.

Pneumatic draft pump. The pneumatic draft pump is designed to create the low head (1.5 in. H₂O) and high flow (50 gph), which is required for saturated soil re-circulation in tight soils. The petroleum products that contaminate modern clay sites took years to dissolve into the groundwater. The dissolved petroleum moved slowly with the groundwater deep into the clays micro-channels. O₂Tubes unique pneumatic draft pump simulates the natural groundwater flow.

Typical well pumps are not designed to recirculate groundwater, rather they lift water with pressure to the surface. Any technology which uses a pressure type pump will bypass areas of contaminant contained within the clay matrix.

With the addition of only dissolved oxygen, the average reduction of total BTEX was 91% in 85 days.

Olfactory observations. The break down of contaminants by bacteria emits odors. These odors are indicative of the different types of anaerobic and aerobic bacteria acting on the contaminants and their daughter products. The monitoring wells S1, S2, S3 each followed the same pattern with regards to odors, starting approximately three days after the wells first showed an increase in dissolved oxygen: Strong petroleum odor > strong weathered odor > weak weathered odor > fishy odor > slight odor > no odor.

The O₂Tube well started with the same strong petroleum odor that the other wells exhibited. The electrolysis cells which generate oxygen at the anode, also generates chlorine gas due to road salt used on the road next to the site during the winter. The chlorine odor was strong when the carbon absorption sock was removed and weak when the sock was in place.

Hydroxyl Radicals. During the formation of oxygen, hydroxyl radicals are continuously traveling between the cathode and the anode. Hydroxyl radicals have the ability to chemically oxidize organic molecules at a rate 1,000 times faster than oxygen. These radicals only form for a fraction of a second and therefore only break down organic molecules between the plates. The O₂Tube system contributes to the decontamination process by acting directly on the organic molecules which pass directly between the plates via hydroxyl radicals.

Engineering and safety. To assure proper recirculation during high water periods, O₂Tube wells should be screened at least five feet above the current groundwater level. The depth of the well below the groundwater level is based on the area being oxygenated; the deeper the cell is placed below the water level, the bigger the area affected. The bigger the area affected, the longer the time will be to saturate it with oxygen. The O₂Tube generates 0.6 liters of pure oxygen per amp-hour. The Wayne well was placed 10 feet below the groundwater level and influenced over 700 square feet after 100 days. Since the O₂Tube generates oxygen and hydrogen, any well containing an O₂Tube cell must be vented to prevent an accumulation of gases. During the Wayne tests, the head space above the groundwater was tested many times with a combustible meter. At no time did the meter measure more than a 30% lower explosive limit.

Conclusion

The O₂Tube system is simple, effective, inexpensive and it really works. Combining 300 year old electrolysis technology discovered by Michael Faraday with today’s metal and plastic technologies, the O₂Tube efficiently generates oxygen. The O₂Tube pneumatic draft pump uses the expansion of compressed air to create the low pressure, high flow required for recirculation in tight soils. The absorption pre-treatment is used in many water softeners and demineralizers. An O₂Tube system can help any property with contaminated groundwater that can be degraded with aerobic bacteria, regardless of soil type.

Jerry Kellgren, Ch.E. is with O₂Tube Technology Inc., Batavia, Ill.
REMEDIATING CHLORINATED SOLVENT PLUME USING ISCO TECHNOLOGY

By Jerry F. Vorbach

This article discusses two sites being remediated utilizing an innovative in situ chemical oxidation (ISCO) technology. Both sites involved a a chlorinated solvent-contaminated groundwater plume.

In the first site, the Nine Mall Plaza property in Poughkeepsie, N.Y., perchloroethylene (PCE) levels were reduced by 74%. In the second site, The Waters Edge brownfields property in Port Jervis, N.Y., chlorinated volatile organic compounds (CVOCs) were reduced in groundwater by 92%.

Poughkeepsie Site

Groundwater contamination was attributed to an on-site dry cleaning establishment that has operated on the site since 1972. Previous environmental reports indicated that the dry cleaner historically disposed of sludge and spent filter cartridges saturated with PCE in a dumpster located at the edge of a paved area of the site, north of the dry cleaning establishment. The PCE apparently leaked out of the dumpster where it impacted the groundwater under the site.

Prior to 1998, a total of six previous environmental investigations were conducted at the site, commencing in 1992. The results of these investigations identified PCE contamination originating from the on-site dry cleaner. The results of these investigations identified PCE contamination in several monitoring wells at concentrations exceeding its NYSDEC Groundwater Quality Standard (GQS) of 5 microns per liter (μg/L), as defined und 6 NYCRR Part 703.5. In 1998, IIVI Environmental, White Plains, N.Y., conducted a baseline groundwater sampling event to delineate the groundwater plume. The results of this sampling event indicated that a PCE-contaminated plume in excess of its NYSDEC GQS of 6 μg/L existed over an approximate horizontal area of 4.3 acres. Additionally, the data indicated that the horizontal extents of PCE contaminated groundwater in excess of 50 μg/L and 100 μg/L covered areas of 1.9 and 0.25 acres, respectively. The highest concentration of PCE was 650 μg/L found in monitoring well MW-5 installed near the dumpster, the original source of the contamination.

Feasibility studies were conducted in 1998 to demonstrate the effectiveness of ISCO remediation in destroying the PCE groundwater contamination at the site. A bench scale test was conducted on a groundwater sample obtained from well MW-5 using the same chemical reagents used in the full scale remediation process. These results showed a 100% reduction in the PCE concentration. Following the receipt of these results, two injection wells were installed for use in a pilot scale test. The results of the pilot scale test indicated an approximate 60% reduction in PCE concentration in the injection wells with up to a 23% reduction in PCE concentrations in the surrounding monitoring wells sampled.

In October 1999, IIVI conducted an additional baseline groundwater sampling event at the request of NYSDEC as a prerequisite to their approving the proposal for using ISCO remediation at the site. Laboratory results of this groundwater sampling event indicated that, although the size of the hot spot of the groundwater contamination plume (the area of PCE concentration >500μg/L) had increased since the 1998 sampling event, the overall size of the PCE plume greater than its NYSDEC GQS of 5 μg/L had decreased approximately 14%. In May 2000, a Phase II Environmental Site Assessment was performed at the site to better investigate potential sources of the groundwater contamination (i.e. potentially contaminated soils north of MW-5). This assessment concluded that there is no source of PCE in the soils that is impacting on-site groundwater.

A Remedial Action Workplan (RAW), which summarized the results of the site investigation activities and detailed the remedial action plan was prepared and submitted to NYSDEC in April 2001. NYSDEC gave approval of the RAW in March 2002. The plan proposed the application of ISCO technology to address the PCE groundwater plume. ISCO activities were conducted between May 13-29, 2002. The following tasks were performed as part of this remedial action:

- the installation of ISCC injection points,
- the conductance of full scale ISCO, and
- the performance of post-remediation groundwater sampling.

Two 2" ID injection points were advanced into the water table within the 100μg/L PCE concentration contour area. These injection points were advanced to a depth of 30' below ground surface (bgs). The injection point placement was designed to achieve the maximum distribution of the treatment chemical reagents into groundwater contamination to ensure the most effective and efficient contamination
<table>
<thead>
<tr>
<th>Project Item</th>
<th>Data Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services Provided and Associated Costs</td>
<td>Remedial Investigation/Remedial Action Workplan</td>
</tr>
<tr>
<td></td>
<td>Preparation- $165,000</td>
</tr>
<tr>
<td>Soil Type</td>
<td>Phase III Groundwater Remediation-$60,000</td>
</tr>
<tr>
<td>Depth to Bedrock</td>
<td>Permeable Silty Sands</td>
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<tr>
<td>Maximum Total PCE Concentration in Groundwater</td>
<td>&gt;40' below ground surface</td>
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<tr>
<td></td>
<td>1,000 ug/L</td>
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<tr>
<td>Area of Groundwater Contamination Above Applicable NYSDEC GQS</td>
<td>2.37 acres</td>
</tr>
<tr>
<td>Range and Average Percent Reduction of PCE in Groundwater</td>
<td>Range=34 to 96%</td>
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<tr>
<td></td>
<td>Average=71%</td>
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<tr>
<td>Percent Reduction of Total Mass of Contamination</td>
<td>74%</td>
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<tr>
<td>Percent Reduction of Area of Contaminated Groundwater &gt;100 µg/L</td>
<td>74.5%</td>
</tr>
<tr>
<td>Remedial Costs/Cubic Yard</td>
<td>$12.75</td>
</tr>
</tbody>
</table>

Table 1. Summary of Nine Mall Plaza ISCO remediation results.

destruction. Following the advancement of the injection points, their respective drive points were dislodged for the creation of propagations for transference of chemical reagents associated with the ISCO process into the groundwater and saturated zone soils.

As part of this remediation, one round of chemical injection was conducted from May 13-31, 2002. A mixture of proprietary acid and hydrogen peroxide solution, as well as a proprietary catalyst solution, was injected into each injection point. Total VOCs, water-quality parameters, combustible gas indicator parameters, and groundwater elevation were analyzed in the groundwater and/or vapor in surrounding monitoring wells periodically throughout the course of the ISCO remediation to monitor the real time progress of the remediation, make any necessary adjustments, and to ensure that the remedial goal was achieved. During chemical injections, the volume of chemicals injected, the pump pressure, manifold pressures on the injection points, and flow rates were recorded.

One round of post-remediation sampling was conducted approximately two weeks following the chemical injection round on June 11, 2002. The results of the post-remediation groundwater sampling indicated the percent reduction of PCE concentrations ranged from 34-96%, with an average of 71%. Additionally, the total mass of contamination was reduced by 74% from 3.22 lbs in October 2001 to 0.84 lbs. Further, the area of contaminated groundwater in excess of 100 µg/L was reduced by 74.5%, from 12,705 SF to 3,240 SF.

A summary of the most relevant data obtained as part of this remediation is presented in Table 1.

Port Jervis Site
At the Waters Edge brownfield site, CVOCs were reduced by 92%. The residual concentrations in the groundwater are at least 25' below ground surface (bgs) and do not pose a potential inhalation exposure risk. Further, the on-site groundwater is not used for drinking water purposes. Finally, additional monitoring events will be performed to ensure the remaining groundwater contamination will not migrate into the nearby Neversink River. As a result, the New York State Department of Environmental Protection in the process of issuing a Certificate of Remedial Completion designating that no further remedial action is required for this site. Further, the recently abandoned and contaminated brownfield property has been redeveloped as an affordable senior housing facility.

The site’s groundwater was contaminated as a result of historical manufacturing operations conducted by Barrier Industries. Barrier manufactured industrial janitorial chemicals from 1978 until December 1993.

IVI first became involved with the site in 2000, when retained to perform a Phase I Environmental Site Assessment of the property. Subsequently, site investigation activities were conducted on the site between September 2000 and October 2001, to delineate the horizontal and vertical extent of contamination in the groundwater at the site.

The results of the investigations indicated that a chlorinated VOC contaminated groundwater plume containing levels of 1,1,1 trichloroethane (TCA), trichloroethylene (TCI) and cis-1,2-dichloroethylene (DCE), all above their respective NYSDEC Groundwater Quality Standards (GQS), was identified beneath the site. This plume was approximately at 4.43 acres in size and appeared to be migrating in the direction of groundwater flow towards the Neversink River. The area of highest concentration was located on the north central portion of the site. A pre-remediation baseline
<table>
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<th>Project Item</th>
<th>Data Results</th>
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<tr>
<td>Phase III Groundwater Remediation Costs</td>
<td>$219,700</td>
</tr>
<tr>
<td>Soil Type</td>
<td>Silty Sand</td>
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<tr>
<td>Depth to Bedrock</td>
<td>&gt;33’ below ground surface</td>
</tr>
<tr>
<td>Maximum Total VOC Concentration in Groundwater</td>
<td>8,290 ug/L</td>
</tr>
<tr>
<td>Area of Groundwater Contamination Above Applicable NYSDEC GQSs</td>
<td>0.81 acres</td>
</tr>
<tr>
<td>Range and Average Percent Reduction of Total VOCs in Groundwater</td>
<td>Range = 77 to 100% Average = 92%</td>
</tr>
<tr>
<td>Percent Reduction of Total Mass of Contamination</td>
<td>92%</td>
</tr>
<tr>
<td>Percent Reduction of Area of Contaminated Groundwater &gt;500 ug/L</td>
<td>81%</td>
</tr>
<tr>
<td>Percent Reduction of Area of Contaminated Groundwater &gt;5,000 ug/L</td>
<td>100%</td>
</tr>
<tr>
<td>Remedial Costs/Cubic Yard</td>
<td>$16.81</td>
</tr>
</tbody>
</table>

Table 2. Summary of Waters Edge ISCO remediation results.

A groundwater sampling event conducted on October 19, 2001 found total CVOC concentrations ranged from two micrograms per litre (µg/L) to 8,287 µg/L. TCE was the predominate CVOC identified, followed by 1,2 DCE and tetrachloroethylene (PCE).

A combined Voluntary Investigation Report/Remedial Action Workplan (VIR/RAW), which summarized the results of the site investigation activities and detailed the response action plan, was prepared and submitted to the NYSDEC in April 2001. NYSDEC gave formal approval of the RAW in November 2001.

The RAW proposed the application of an ISCO technology to address the chlorinated solvent groundwater plume. ISCO activities were conducted on the site between February 2002 and July 2002. The following tasks were performed as part of this remedial action:
- the installation of ISCO injection points,
- the conductance of full scale ISCO, and
- the performance of post-remediation groundwater sampling.

Four 2” ID injection points were advanced into the water table within 500 ppb total CVOCs contour area. These injection points were advanced to a depth of 30’ below ground surface (bgs). The injection point placement was designed to achieve the maximum distribution of the treatment chemical reagents into the groundwater contamination to ensure the most effective and efficient contamination destruction. Following the advancement of the injection points, their respective drive points were dislodged for the creation of propagations for tranferrence of chemical reagents associated with the ISCO process into the groundwater and saturated zone soils.

As part of this remediation, three rounds of chemical injection were conducted. During each round, a mixture of a proprietary acit and hydrogen peroxide solution, as well as a proprietary catalyst solution, was injected inot each injection point. Total VOCs, water quality parameters, combustible gas indicator parameters, and groundwater elevation were analyzed in the groundwater and/or vapor in surrounding monitoring wells periodically throughout the course of the ISCO remediation to monitor the real time progress of the remediation, make any necessary adjustments, and to ensure that the remedial goal was achieved. During chemical injections, the volume of chemicals injected, the pump pressure, manifold pressures on the injection points, and flow rates were recorded.

Three rounds of post-remediation sampling were conducted approximately one to two weeks following each injection round on March 15, May 21, and July 17, 2002. The results of the post-remediation sampling indicated the range of percent reductions of total CVOCs in the groundwater was from 77-100% with an average reduction of 92%. Additionally, the total mass of contamination was reduced by 92%, from 52.75 lbs in October 2001 to 4.34 lbs. Further, the area of contaminated groundwater in excess of 500 ug/L was reduced by 81%, from 35,085 SF to 6,752 SF. Finally, the area of contaminated groundwater in excess of 5,000 ug/L was reduced 100%, from 11,469 SF to 0 SF.

A summary of the mos: relevant data obtained as part of this remediation is presented in Table 2.

Jerry F. Vorbach, P.E. C.H.M.M., is vice president of IVI Environmental, White Plains, N.Y.
Efluent containing high contaminant levels, such as phenols, sulfides, mercaptans, mercury and ammonium, should be treated until their complete removal.

One of the removal treatments, for high salinity effluents with aggressive contaminants, consists in adding hydrogen peroxide (H₂O₂) as an oxidant agent, followed ferrous sulfate (FeSO₄) as a catalyzing and floculant agent. This process causes the oxidation of sulfides into colloidal sulfur; mercaptans into sulfones whenever immersed in an alkaline medium or sulfonic acids in neutral or acid medium; and phenol becomes catechol, hydroquinol and resorsinal.

Although, hydrogen peroxide is known as an energetic oxidant agent when catalyzed with ferrous sulfate, it renders the hydroxyl (OH) free radical that, in turn, has an oxidation power 60% greater than the peroxide. Thus, it is possible to decrease the peroxide consumption, making the operation economically feasible, increasing the oxidation reaction speed of the contaminants, and considerably reducing the effluent residence time and the dimensions of the treatment tanks.

Description of the Treatment Station
The water associated to the petroleum produced is initially stored in petroleum tanks. After segregation in these tanks, it is pumped to the Effluent Treatment Station (ETS). The first step in the ETS consists in the removal of oil and sludge through API separators, for decreasing the oil amount from 500 ppm to 150 ppm. Water is then flowed to water-oil separators of crinkled plates transformed into air-induced floaters, for further decrease below 20 ppm.

At the outlet, the flow of treated water is measured via Parshall drip pans and then sent to the oxidation treatment. The oil recovered in the two separation phases is sent to the tank of recovered oil from where it is pumped to petroleum storage tanks.

The oxidation treatment, which consists of four tanks (A, B, C and D) with stirring, is restricted to the removal of phenols and sulfides through the dosage of hydrogen peroxide. After this chemical treatment, water is pumped via submarine emissary.

Purpose
A long duration test was run in the Cabiúnas Terminal (Rio de Janeiro/Brazil) aiming at the phenol oxidation by hydrogen peroxide catalyzed with ferrous sulfate. This test was designed for replacing a previous procedure where the phenol oxidation was realized by an initial pH reduction with sulphuric acid (H₂SO₄), oxidation itself (still with hydrogen peroxide), followed by adding sodium hydroxide (NaOH) for pH correction before discarding. The final goal was to comply with strict environmental specifications regarding the amount of phenol allowed whenever discarding the effluent: 0.5 ppm. This change even made the process more efficient and economic, eliminating chemicals pumps, stirrers and reducing the number of products involved.

Operational Part
Used Reagents: Hydrogen Peroxide (H₂O₂): 50%, Ferrous Sulfate (FeSO₄·7H₂O)

The dosages utilized during the entire test, were:
- Hydrogen Peroxide (H₂O₂)
- Tanks A and B - 150 ppm, Tanks C and D - 125 ppm
- Ferrous Sulfate (FeSO₄·7H₂O)
- Tanks A and B - 20 ppm, Tanks C and D - 10 ppm

Analytical technique used for phenol determination: Colorimetry - Riedel phenol kit.

Results
Premises
ETS processing capacity: 4800 m³/day;
Usual waterflow received for treatment: 3600 m³/day;

Benefits
The major benefit is the phenol oxidation at the original water pH level, eliminating, hence, the two steps needed for reducing and later on recovering the pH initial level in the current process. Consequently, besides reducing peroxide consumption, the new method also eliminates the need for sulfuric acid and sodium hydroxide, which means decreasing the residence time. It can be said that a more energetic, economic and efficient oxidation was obtained.

Comments
From the oxidation results shown, it can be stated that, in the three first days comprising the start and pre-oper-
Figure 1. Chemical-physical characterization of the original water.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
<td>Dark</td>
</tr>
<tr>
<td>Oils and Greases</td>
<td>50 ppm</td>
</tr>
<tr>
<td>Phenol</td>
<td>2 ppm</td>
</tr>
<tr>
<td>pH</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Table 1. Costs that are due to the chemicals.

Annual expenditure with chemicals before changes: 
\[(\$900,000 + \$85,333 + \$40,000) = \$1,025,333\]

Annual expenditure with chemicals after changes: 
\[(\$720,000 + \$8,000) = \$728,000\]

Difference in favor to changes: \$297,000 / yearly

ation, there was some flow variation and interruption in the products dosage, due to pump oscillation, explaining the initial results, somehow irregular. After the fourth day it can be noticed a constancy in the process related to the chemicals consumption.

Concerning the suspended solids that were generated in the system by the ferrous sulfate, it is known that each 10 ppm of FeSO damaged FeSO to stoichiometrically added, generates approximately 4 ppm of solids. Such results have been confirmed in laboratory.

Conclusion and Recommendations

The tests performed in the laboratory and reproduced in the field during the three days of the short duration test, as well as the long duration one, have all confirmed the feasibility of the oxidation process via catalyzed peroxide for the treatment of high salinity effluents containing aggressive contaminants as phenols.

It should be added that the economy of \$297,000/year was achieved taking into account only the reduction in chemicals consumption. The elimination of operational costs (pumps, stirrers, etc.) and utilities (water, electrical power) resulting from such changes were not computed yet.

Therefore, it is recommended the implantation of the catalytic process, along with the required engineering pertinent changes, both in the chemicals storage, dosing system and in the oil treatment plant.

Figure 2. Assessment of the phenol amount after the oxidation test with hydrogen peroxide catalyzed with ferrous sulfate in the ETS tank. Samples were collected at an interval of 2 hours, in two different positions: at point 4, before treatment; and at point 5, after treatment.

Oswaldo de Aquino Pereira Jr. is with Petrobras/Cenpes and Rosana Coutinho Guerra Moutaury Pimenta is with Foundation José Bonifácio, both in Rio de Janeiro, Brazil.
New Products and Announcements

Long-Term Cutoff Wall Applications for Waste Sites with Highly Corrosive Contaminants

Crane Products, Columbus, Ohio, has added the Perma-LOC® X-CR thermoplastic sheet piling panels to the Perma-LOC line of environmental barrier walls. This product brings the highest chemical resistance to date (close to HDPE) of any sheet piling products on the market -- be it vinyl, fiberglass or metal -- for cutoff wall applications to prevent the migration of contaminants in sensitive, highly corrosive waste sites that contain aromatic hydrocarbons, or industrial effluent containment ponds with similar waste.

Crane Products 614-449-0942

Fully Automatic Gas Chromatograph

Trace Analytical, Menlo Park, Calif., offers the Chromachrom • S as a fully automatic gas chromatograph designed for the determination of common sulfur gases H2S, SO2, COS, CS2, mercaptans and others with parts per billion sensitivity in various matrices. Detection of the sulfur species is accomplished with a selective detector, the dual Flame Photometric Detector (FPD). Because of its unique design, the detector is not affected by the sample hydrocarbon matrix and selectively determines the sulfur compounds of interest.

Chromachrom • S is a compact 19-inch rack mount system ideally suited for installation in a mobile laboratory for field surveying or as an on-line process control monitor. The unit is fully automatic from sampling to reporting and uses a PC based data handling and instrument control software.

Trace Analytical 650-364-6895

Paper on Plant Cost Savings With Mechanical Seal Tracking System Highlighting 78% Drop in Seal Costs at U. S. Steel Facility

Anchor Seals, Coraopolis, Penn., has announced the availability of a new white paper that outlines how manufacturing plants can reduce costs through the use of a mechanical seal tracking system. Entitled "Effective Mechanical Seal Performance Monitoring; A Key Component to Reducing Fixed Plant Costs," the paper is written in an easy-to-understand, "question and answer" format.

Divided into four sections, the paper discusses the basics of mechanical seals, how they relate to pump failures, and how to set up a tracking system that helps manufacturing and maintenance personnel identify root causes to process problems. The final section of the paper provides a case history regarding the success of mechanical seal tracking at U. S. Steel's Clairton, Penn., coking facility.

The white paper provides a glimpse at new mechanical seal tracking software. The new software, called AnchorSoft, will help plant managers and maintenance managers monitor and report on information critical to managing a mechanical seal tracking system. AnchorSoft is being designed as a robust database program specifically designed to highlight and target process problems within a manufacturing facility.

Anchor Seals 800-441-8193
Hoists Make Wastewater Treatment Plants More Efficient

Thern, Inc., Winona, Minn. offers that placing and pulling pumps in wastewater treatment plants can be labor intensive, time consuming and costly. Thern davit cranes and hoists, equipped with a quick-disconnect feature, make these jobs fast and easy. The quick-disconnect allows operators to remove the cable from the hoist while leaving it attached to the submerged pump. No awkward, underwa- ter disconnecting and reconnecting.

The hoists, too, are designed for easy relocating. Portable and powerful, they can be moved easily from station to station and quickly fitted into fixed bases. Like all Thern products, they’re made to meet the conditions of their particular environment - corrosion resistant finishes, galvanized or stainless steel throughout.

Thern, Inc., 507-454-2996

Protective Clothing Meets ANSI/ISEA 107-1999 Standard

Wells Lamont Industry Group, Morton Grove, Ill., offers the Jomac® Brand Premium Protective Clothing in lime green fabrics, which meet ANSI/ISEA 107-1999 for high visibility safety apparel. The new lime green color signals the wearer’s presence conspicuously in many types of hazardous conditions, either by day or under illumination by vehicle headlights in the dark.

Jomac protective rainwear also offers flame and arc resistance, features non-conductive hardware, and meets the ASTM F-1891 standard establishing physical and thermal performance criteria and applicable test methods.

All seams are guaranteed not to leak, split, tear or pull apart through normal use. Their non-conductive hardware will not tear, split or separate from the garment. Fabrics are guaranteed not to peel, crack or oxidize. Many custom options and style variations are available, such as hoods, concealed snap closures, snaps or buttons on collars, inner storm cuffs and FR reflective striping.

Wells Lamont Industry Group 800-247-3295

Sand Removal and Dewatering in Contaminated Sediment Dredging Projects

Del Tank Filtration Systems, Scott, La., introduces the Total Clean System (patent pending) for the removal of solids from drilling mud and slurries that are common in the oilfield, HDD and microtunneling industries. It has also been designed for use in contaminated sediment dredging projects where high volumes of sand must be removed and dewatered.

The Total Clean System is not just another version of the same old cleaning system that everyone else offers. The system incorporates a v-shaped tank, a tilted plate baffle system, and a shaftless screw to create a clarifier. Instead of attempting to suspend the solids with the use of jets and agitators, the system lets nature take its course and allows the solids to settle to the bottom of the v-tank portion of the unit. The settling is enhanced by the tilted plate baffle system, which the slurry must flow through as it passes through the v-tank.

The shaftless screw steadily moves the settled solids to the suction of the hydrocyclone feed pump. Varying the speed of the shaftless screw with a VFD regulates the concentration of the slurry that is then pumped to the hydrocyclones. The heavy sands and silts are removed by the hydrocyclones and then dewatered over a linear shaker. The hydrocyclone/shaker units and pumps are sized appropriately so that the hydrocyclone feed rate is three to four times the flow rate through the system. This redundancy allows for maximum solids removal from the drilling mud or dredged slurry. The cleaned fluid that passes through the v-tank then flows into the mix tank portion of the system where additional mud may be mixed or chemical treatment may take place.

Del Tank Filtration Systems 800 GO TANKS
HIGH-LEVEL FEDS SPEAK AT ITRC ANNUAL MEETING

Speaking at the annual fall meeting of an organization of state regulators, three high-level federal officials emphasized the importance of working cooperatively with the Interstate Technology and Regulatory Council (ITRC) to meet their agencies' environmental cleanup challenges. ITRC met in early November in Washington, D.C. to strengthen its members' commitment to innovative cleanup technologies and to broaden its ties to federal partners.

The centerpiece of a plenary session on November 7 was addresses by Marianne Horinko, Assistant Administrator for the Office of Solid Waste and Emergency Response with the U.S. Environmental Protection Agency; Jessie Roberson, Assistant Secretary for Environmental Management with the U.S. Department of Energy; and Maureen Koetz, Deputy Assistant Secretary of Environment, Safety & Occupational Health with the U.S. Air Force. Marianne Horinko called on ITRC's assistance in addressing two EPA priorities: the One Cleanup program and land revitalization. The One Cleanup program, which strives to clarify and standardize cleanup policies across federal agencies and among states, can benefit from ITRC's experience in testing new ideas, bringing states and tribes together to focus on the regulatory issues involved in the adoption of new environmental technologies, and integrating lessons learned. On the land revitalization front, Horinko said that EPA needs to work in partnership with ITRC and other groups to ensure that contaminated sites have a realistic path toward return to economic productivity.

Maureen Koetz emphasized the Department of Defense's challenge to meet its national security mission in the face of competing environmental and financial risks. She identified technologies as critical in managing the environmental risks inherent in maintaining the country's national defense capability. Declaring that increased knowledge is the goal of both the Air Force and the ITRC, Koetz said, "We need your tech-
ology application knowledge and look forward to your help in guiding us in getting cleanup expedited. We want to turn dirt." Koetz expressed appreciation that two current teams, the Remedial Process Optimization Team and the Diffusion Samplers Team, are focusing on DoD needs.

Jessie Roberson also acknowledged several ways ITRC has benefited DOE. In redefining the EM mission to close sites and to develop alternative baselines for reducing risks, Roberson credited the cooperation of state regulators, who are vital to EM's new approach. She also credited ITRC's technical and regulatory guidance documents with streamlining decision making, especially with regard to groundwater. ITRC analysis provides a "basis upon which to conclude that a technology is cost-effective and a worthwhile expenditure of taxpayers' dollars." Roberson asked ITRC to expand its guidance to include a clear delineation of cleanup objectives, performance metrics, and treatment technology end points and to clarify exit strategies -- "to inform us when we should transition from treatment to monitoring, and even when to stop monitoring."

ITRC is a state-led group that works to overcome regulatory barriers to the deployment of innovative environmental technologies. ITRC participants come from the ranks of state regulatory agencies, federal agencies concerned with environmental cleanup, environmental consulting firms, and technology vendors. These diverse ITRC participants work together in technical teams to develop documents and training to help regulators develop a consistent and streamlined approach for regulating innovative technologies. ITRC products also help environmental consultants improve the way innovative technologies are deployed.

RESPOND TO SPILLS BEFORE THEY GO DOWN THE DRAIN

UltraTech International, Jacksonville, Fla., offers the new Ultra-DrainSeals and DrainSeals WallMounts to allow for quick response to spilled chemicals and liquids. The Ultra-DrainSeals are molded with a reinforcing mesh between layers of polyurethane. Low cost, durable units are far more tear-resistant than competitive products. Unique, urethane construction allows the pad to deform and seal off most drains on contact. Ultra-DrainSeal WallMounts are constructed of rugged polypropylene. Non-slip handle and lightweight design makes unit easy to manage. Caps on either side of the WallMount are kept secure with Veloce® fasteners, but quickly removed when necessary. Ultra-DrainSeals and WallMounts are a valuable addition to any emergency response plan, spill kit or Stormwater Management Program.

UltraTech International 800-353-1611
NSF Announces Conference on POU and POE Technology


The conference will feature state and federal regulatory officials, public and private water utility officials and industry leaders in water supply and water treatment to discuss the latest developments on regulations, product standards, cost considerations, technologies and public education. Topics include current EPA and AWWARF pilot projects, the advantages and disadvantages of POU and POE technologies in water utility operations and the implementation of a sustainable centralized POU/POE drinking water system for compliance. Discussions will focus on performance, costs, monitoring and community acceptance.

The demand for improved water quality by both consumers and regulators has never been greater, said Tom Bruursema, General Manager, Drinking Water Treatment Unit Certification Program. This demand is driving both central treatment operations and the POU/POE industry to better and more cost-effective solutions. The question now is how can these two major segments of water treatment work together to better meet consumer needs and tightening regulations. The conference will address this central question and devise solutions to ensure safe drinking water.

Sponsors include U.S. Environmental Protection Agency, American Water Works Association Research Foundation (AwwaRF), Canadian Water and Wastewater Association and the Association of State Drinking Water Administrators (ASDWA).

NSF International, a not-for-profit, non-governmental organization, is the leading global provider of public health and safety-based risk management solutions. NSF provides product certification and safety audits for the food and water industries.

New Technology Provides "Breakthrough" in Material Flow Pluggage Prevention

A.V.C. Specialists, Moorpark, Calif. offers a technological new spin on a successful product that has been on the market since 1980. A.V.C., maker of the SR-A1 High Intensity Rapper, is now launching the patented Hopper Hammer for any dry bulk-material process application. The Hopper Hammer is a totally enclosed, electro-mechanical device used to generate discrete impacts to dislodge dry material from the sides of hoppers, bins and bunkers. Usually, flow-enhancing and pluggage prevention products are high frequency, low-impact vibrators, either electrical or pneumatically operated. These devices tend to compact the material rather than dislodge it and require considerable maintenance. A.V.C.'s Hopper Hammer is based on a proven, reliable rapper design and can operate in any position in order to strike a material flow problem area.

The Hopper Hammer has greater acceleration than standard vibrators, overcoming a material's natural adhesive forces and causing a more fluid release of the material pluggage or residue.

The high impact capabilities of the Hopper Hammer can duplicate the blow of a sledgehammer. A.V.C.'s new technology is a direct spin-off of its successful Model SR-A1 precipitator rapper. The Hopper Hammer incorporates its own controller, allowing the operator to set its intensity (1 - 25 ft. lbs.), duration, and operating intervals. Unlike most other rappers, the Hopper Hammer runs on 110 VAC and can operate in any position -- making it ideal for hoppers, chutes, conveyors and any area where problems are experienced in moving dry material.

Another unique aspect of A.V.C.'s product line is the Hopper Hammer System, which is capable of incorporating hundreds of these devices within a facility and utilizing artificial intelligence to interface with associated equipment such as level detectors, evacuation systems, alarms, etc. -- all in one central control unit.

A.V.C. Specialists 888-803-5865

Chemetall Oakite and DMP Corporation Announce a New Strategic Partnership

Chemetall Oakite, Berkeley Heights, N.J., announces a strategic partnership with DMP Corp., Fort Mill, S.C. DMP provides systems of the highest level of excellence to meet the new wastewater treatment regulations. Large or small, DMP has a system to meet your needs. This new partnership, along with Chemetall Oakite's New Enpro® Water Treatment Chemistries, strengthens the company presence in the wastewater treatment chemical marketplace.

Chemetall Oakite has been developing, manufacturing and supplying state-of-the-art specialty chemical products since 1909. The QS9000/ISO 9001 certified company offers a wide spectrum of products and systems to meet the needs of many industries. Chemetall Oakite's integrated products, chemical management systems, process equipment and service programs facilitate the achievement of many industries' processing needs.

Chemetall Oakite 800-526-4473
INTERNET BASED MONITORING PACKAGE

Comprehensive Controls, a Division of Carbonair Environmental Systems, New Hope, Minn., announces their Internet-based Monitoring Package (IMP) for remote sites. IMP combines alarm notification (via voice message, pager or email) with the added benefits of Internet-based monitoring. IMP utilizes wireless communications technology, which allows monitoring where it normally would not be possible due to geography. Other features include multi-level security, optically isolated inputs, archiving and exporting of data for documentation and ten alarm/event inputs. IMP offers many other high-technology features at an affordable price.

Carbonair Environmental Systems 763-512-4939.

ASCE ANNOUNCES PRESIDENT BUSH SIGNS NATIONAL DAM SAFETY AND SECURITY ACT INTO LAW

President George Bush signed into law the National Dam Safety and Security Act of 2002 (HR 4727). Enactment of the landmark bill solidifies the nation’s commitment to maintain all U.S. dams safe and secure. Sponsored by Congressman Bill Shuster (R-Penn.), the law calls for the reauthorization of the National Dam Safety Program, an important national program, administered by Federal Emergency Management Agency (FEMA) that seeks to improve the safety and security of the nation’s dams.

Through the program, FEMA will continue to lead national efforts including research, technology transfer, communication between state and federal agencies, and much needed training for state dam safety engineers. The grant assistance component of the act provides vital support for the improvement of state dam safety programs, which regulate 95% of the more than 78,000 dams in the United States.

The enactment of the National Dam Safety and Security Act comes at a critical point in our nation’s history as we collectively work to minimize the potential security risks threatening our infrastructure, said Thomas L. Jackson, P.E., F.ASCE. The Bush administration should be commended for their valued leadership in the maintenance and safety of our nation’s dams.

Dams provide many benefits including flood protection, drinking water, hydroelectric power, irrigation and recreation. However, without proper maintenance, dams can be hazardous structures. Their failure or improper operation can result in loss of human life, economic loss, lifeline disruption and environmental damage. In order to provide safe continuing service, dams require ongoing maintenance, monitoring, frequent safety inspections and rehabilitation.

Dams have recently been listed as potential targets of intentional acts of terrorism. This law will provide federal leadership and assistance to the state-level programs that shoulder the enormous burden of assuring the safety of our nation’s dams.

Founded in 1852, ASCE represents more than 130,000 civil engineers worldwide and is America’s oldest national engineering society. The Society is now celebrating its 150th anniversary.

NEW YORK GOVERNOR AND PACE UNIVERSITY ANNOUNCE THE LAUNCH OF THE PACE ACADEMY FOR THE ENVIRONMENT

New York Governor George E. Pataki and Pace University President David A. Caputo announce the launch of the Pace Academy for the Environment.

Pace is a comprehensive, independent University with campuses in New York City and Westchester County, and a Hudson Valley Center located at Stewart Airport in New Windsor. Nearly 13,500 students are enrolled in undergraduate, graduate and professional degree programs in the Dyson College of Arts and Sciences, Lubin School of Business, School of Computer Science and Information Systems, School of Education, Lienhard School of Nursing and Pace Law School.
2004 Winter Conference on Plasma Spectrochemistry Call for Papers

The 13th biennial international Winter Conference will be held at the Wyndham Bonaventure Resort and Spa (www.wyndham.com/bonaventure) in Fort Lauderdale, Fla. More than 600 scientists are expected, and over 300 papers on modern plasma spectrochemistry will be presented.

Symposium Features
- Elemental speciation, speciation sampling and sample preparation
- Excitation mechanisms and plasma phenomena
- Flow injection and flow processing spectrochemical analysis
- Glow discharge atomic and mass spectrometry
- Inductively coupled plasma atomic and mass spectrometry
- Laser ablation and breakdown spectrometry
- Microwave atomic and mass spectrometry
- Plasma chromatographic detectors
- Plasma instrumentation, microplasmas, automation, and software innovations
- Sample introduction and transport phenomena
- Sample preparation, treatment, and automation; high-purity materials
- Spectrochemical chemometrics, expert systems, and software
- Spectroscopic standards and reference materials, databases
- Stable isotope analyses and applications

Preliminary abstracts (50 words) are solicited on original plasma spectrochemical methods and applications. Abstract deadline is July 3, 2003. Manufacturers of spectrochemical instrumentation and accessories also are invited to exhibit equipment, glassware, publications, and software. Early-bird registrations received before July 3, 2003, will be offered at 2002 Winter Conference rates.

- Continuing Education Short Courses, Friday - Sunday, January 2 - 4
- Manufacturer’s Seminars, Friday - Sunday, January 2 - 4
- 5th Annual Golf Tournament, Sunday, January 4
- Five Daily Provocative Panel Discussions
- Workshop on New Plasma Instrumentation, Tuesday - Thursday, January 6 - 8

Ramon M. Barnes, Ph.D., Director 413-256-8942

U.S. Air Force Selects Worldwide Environmental Services Supplier

AMEC, Phoenix, Ariz., has been selected among others by the U.S. Air Force Center for Environmental Excellence (AFCEE) for negotiation of worldwide environmental-services contracts with a combined ceiling of more than $1 billion.

Services to be covered include environmental restoration, conservation, planning, compliance, and pollution prevention at U.S. military installations worldwide. The initial AFCEE program spending ceiling, covering AMEC and all other pre-qualified firms, is $1.1 billion. Provisions allow the Air Force to raise that amount to $2.75 billion. The program will have a five-year ordering period.

The contracts will include support to traditional AFCEE projects and also to emerging program areas. Existing project areas include environmental cleanup work, environmental impact investigations and permitting, hazardous material and waste management, human health risk assessment, water and air quality monitoring, threatened and endangered species surveys, storage tank management, wastewater and stormwater quality management, bird-strike hazard assessments, and preservation of cultural and historic resources, among others.

Examples of emerging areas include homeland defense, Geographical Information System (GIS) database management support, and remediation of unexploded ordnance at firing ranges. Also included are architecture and engineering services for infrastructure design and construction, fuel facilities, force protection, information technology, military family housing and military construction.

AMEC operates 90 Earth & Environmental offices in North America and abroad that specialize in environmental, geotechnical, water resources and materials engineering. AMEC has provided a range of environmental services at military installations around the world. The company also played a prominent role in the emergency recovery operations at the World Trade Center and the Pentagon.

AMEC 602-272-6848

Contribute your company or organization Press Release to AEHS Contaminated Soil Sediment & Water Magazine by e-mailing copy and photos to editor@aeubmag.com.

aehs.com Contaminated Soil Sediment and Water November/December 2002 43
New Wastewater Treatment Technology Emerges From Nevada Desert

Premier Wastewater International (PWI™) Las Vegas, Nev., has developed an economical wastewater treatment process that can remove more than 90% of the organic matter. The Enhanced Solids Reduction (ESR™) process accomplishes this by conditioning the waste stream. This "Conditioning Factor" is a process that changes the wastewater characteristics in a way that promotes superior processing efficiencies.

As with many technological breakthroughs, the success of the ESR process comes from some unique innovations. Chief among these is the patented Multi-Action Conditioner (MAC®) system. Violently mixing atmospheric air and waste stream under pressure, the MAC system creates a toroidal vortex and cavitation action that fractionizes the solids and homogenizes the waste stream. Because the solids are broken into smaller particles, their total surface area is increased which enhances the metabolic processes.

The MAC system also shears atmospheric air into microbubbles, which are delivered into intimate proximity to the microorganisms and nutrients. The microorganisms are then taken to a high level of endogenous respiration. The result is an extremely high decay coefficient.

During 10-months of operation, this ESR plant treated over 14 million gallons of municipal wastewater and has yet to require any intentional wasting. The plant was also designed to remove nitrogen and phosphorus. Effluent during the tests exceeded California's stringent Title 22 standards for reuse quality.

The ESR system requires significantly less equipment than traditional systems, takes up 25% to 50% less valuable land and capital costs range from 20% to 40% less than traditional systems. In addition, by lowering sludge-handling processing and disposal costs, doing away with energy intensive blowers and high maintenance diffuser systems, and having less equipment to maintain, operational costs can be reduced 10% to 30%.

The ESR process is environmentally superior to any treatment facility on the market today. Besides significantly reducing the amount of sludge that is produced, it eliminates the need for lagoons, uses no toxic chemicals, reduces energy consumption, generates less noise and minimizes odors and misting. Due to the reduced capital and operating costs, many communities and countries can now, for the first time, afford to properly treat their wastewater, which will help clean up our lakes, rivers and oceans.

Wastewater Storage Tanks

Highland Tank, Stoystown, Penn., manufactures above and below ground protected steel storage tanks for use in water and wastewater applications. Factory applied NSF interior coatings and rugged exterior corrosion protection systems are available. Sizes range in volume from 300 to 50,000 gallons with custom engineered designs available.

Highland Tank
814-893-1109
EXPANDED SAFETY 2003 PROFESSIONAL DEVELOPMENT CONFERENCE SLATED FOR JUNE IN DENVER

American Society of Safety Engineers, Des Plaines, Ill., announces the Safety 2003 Professional Development Conference. Protecting industrial sites from terrorist attacks, “training that rocks”, promoting safety and health in an aging workforce, tips and techniques for addressing and presenting to a Hispanic workforce, mold in commercial buildings, risk perception, and a wide variety of sessions in ergonomics are just a few of the over 140 sessions to be offered at Safety 2003 -- Advancing the Environmental, Safety and Health Profession -- the American Society of Safety Engineers (ASSE) annual Professional Development Conference (PDC) & Exposition to be held June 22-25, 2003 at the Colorado Convention Center in Denver, Colo.

This year’s conference has continued to grow, with expanded tracks and sessions in safety and health management, construction, ergonomics, technical standards development, risk management, the environment, transportation and industrial hygiene included in this year’s program. The goal of the conference is determining the key issues facing safety, health and environmental professionals and helping attendees gain the skills and knowledge to deal with the challenges in the workplace arising from those key issues.

In response to membership feedback, new this year to the PDC are ‘key issue roundtables.’ Five roundtables will be conducted during the concurrent session periods. Attendees will have the opportunity to share their ideas, challenges and successes in a moderated session. Although space will be limited, the results of the discussions will be made available on the ASSE web site.

The general session speakers include former CEO of Southwest Airlines Howard Putnam on leading an organization recognized worldwide for its safety reputation; Assistant Secretary of Labor for the Occupational Safety and Health Administration (OSHA) John L. Henshaw; and a leading strategic thinker Andrew J. Razeghi who will address safety as a competitive advantage and lead a plenary workshop to focus attendees on the challenges they face.

Adding to the value of PDC attendance are the ASSE Technical Tours held in conjunction with the conference. This year’s off-site technical tours in Colorado for attendees include the Lockheed Martin Space Systems, the National Renewable Energy Lab, the Coors Brewing Company and the United Airlines Flight Training Center, where attendees will learn about changes that have impacted the aviation industry since the terrorist attacks of September 11, 2001 at this state of the art training facility.

The conference exposition will feature hundreds of companies and organizations offering thousands of products and services and allow attendees to test the latest tools and techniques of the safety, health, and environmental industries through hands-on demonstrations.

Additionally, ASSE will hold pre- (June 19-22) and post- (June 25-28) conference seminars in Denver on a wide variety of topic areas. These seminars offer management and technical education for credit toward the ASSE Certificate in Safety Management, Executive Program in Safety Management and support progress toward the Associate Safety Professional (ASP®) designation and the Certified Safety Professional (CSP) and Certified Hazardous Materials Manager (CHMM) certifications.

Founded in 1911, the non-profit ASSE is the oldest and largest professional safety organization and is committed to protecting people, property and the environment. Its more than 30,000 members manage, supervise, research and consult on safety, health, transportation and environmental issues in all industries, government, labor and education.

Register at www.asse.org

OVER-THE-TOP BAG FILTER

Rosedale Products, Ann Arbor, Mich., announces the “OT” bag filter. Accepting all major brands of filter bags, the filter flows over the top and guarantees customer confidence with positive sealing. The cover is secured to the body of the housing compressing the bag as it seals, eliminating bypass. The inside-out flow path ensures that the dirt is trapped inside the bag. The cover is hinged and fastened with swing bolts for quick access and easy bag change-over. Over-the-top filters are constructed in carbon steel, stainless steel and hastelloy materials. The filters are available in eight sizes and built to ASME Code requirements.

Rosedale Products 734-665-8201
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We invite you to submit an abstract for consideration for the 19th Annual International Conference on Contaminated Soils, Sediments and Water, October 20-23, 2003.

The conference attracts attendees from almost every state covering every region of the United States. Past conferences have had an international presence as well, with attendees from Canada, South Africa, United Kingdom, Germany, Kuwait, Australia, Columbia, Mexico, Switzerland, France, Italy, Greece, Russia, Chile, New Zealand, Korea, Japan, China and Taiwan.

Attendees include representatives from state and federal agencies, military, industries including railroad, petroleum, transportation, utilities, environmental engineering, consulting community and academia.

**GENERAL TOPICS**
Contributed Papers and Posters are invited for presentation in the general sessions in the following areas:
- bioremediation
- chemical analysis
- cleanup standard setting
- environmental fate and modeling
- hazard exposure and risk assessment
- hydrocarbon identification
- innovative technologies
- regulatory programs and policies
- site assessment/field sampling
- soil chemistry
- standard remedial technologies/corrective actions
- case studies on any of the above

**SPECIAL TOPICS**
Presentations for special sessions related to the following areas are encouraged:
- arsenic
- chlorinated hydrocarbons, pesticides (PCBs, etc.)
- containment
- contamination at military installations
- dioxin
- ecological risk assessments
- environmental forensics
- heavy metals
- jet fuel contamination
- MTBE
- phytoremediation
- radionuclides
- railroad sites
- risk based cleanups (RBCA)
- state regulatory programs
- sediments
- UXOs

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For Further Information Contact Conference Coordinator
Denise Leonard 413-545-1239

**PUBLICATION**
Accepted abstracts will be posted on the conference web site. Publication of manuscripts from both platform and poster presentations will be considered for the general proceedings. Contaminated Soils Vol. 8, Soil & Sediment Contamination: An International Journal. International Journal of Phytoremediation, Contaminated Soils, Sediments and Water Magazine

**SUBMISSION GUIDELINES**
Please submit a one page abstract containing: title, 300 word narrative; and for each author, name, degree, affiliation, complete address, telephone number and email address. Indicate whether you wish your abstract to be considered for platform presentation, poster presentation or either. Email submissions are welcome. Hard copies must be accompanied by a disk and postmarked not later than February 10, 2003. Faxed copies will not be accepted. Visit our website for more details: www.UMassSoils.com

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