



# The Remediation Technologies Development Forum

## Major Accomplishments (1992–2006)

### The RTDF's Mission

The purpose of the RTDF is to identify what government and industry can do together to develop and improve the environmental technologies needed to address their mutual cleanup problems in the safest, most cost-effective manner. The RTDF fosters public- and private-sector partnerships to undertake the research, development, demonstration, and evaluation efforts needed to achieve common cleanup goals.

The U.S. Environmental Protection Agency (EPA) established the Remediation Technologies Development Forum (RTDF) in 1992 to enhance the development and application of innovative hazardous waste characterization and treatment technologies. One of the RTDF's defining features is that it fosters collaboration between the public and private sectors. Eight self-managed RTDF Action Teams have formed over the years. Each has brought together representatives from government, industry, and academia who wish to further develop and promote a specific technology or address a specific environmental problem area. Action Team members provide the knowledge and the resources (both in terms of monetary contributions and in-kind services) that are needed to conduct laboratory and field demonstrations and to develop reports, guidance documents, and training products related to their teams' topic of interest. The purpose of this factsheet is to highlight the RTDF Action Teams' major accomplishments. Additional details about each team's activities and access to their technical reports and other products are available through [www.rtdf.org](http://www.rtdf.org).

### The Bioremediation Consortium

Founded in 1993, the Bioremediation Consortium promotes the development of cost-effective *in situ* bioremediation technologies that degrade chlorinated solvents. Toward that end, the Consortium has been actively testing

bioremediation approaches since 1995. For example, the Consortium conducted Phase I and Phase II demonstration projects to examine the efficacy of natural attenuation, co-metabolic bioventing, and accelerated anaerobic biodegradation at field sites located at Dover Air Force Base in Delaware, Kelly Air Force Base in Texas, Hill Air Force Base in Utah, and the Bell Aerospace/Textron site in New York. These demonstration projects, all of which provide supporting evidence of bioremediation's efficacy, have been described in peer-reviewed publications and technical presentations. In 2004, the Consortium initiated Phase III of its research activities when it joined forces with a multinational team to launch the *In Situ* Source Area Bioremediation project (see [www.claire.co.uk/sabre.php](http://www.claire.co.uk/sabre.php) for details). This project, which is being conducted in the United Kingdom and is scheduled to be completed in 2008, is designed to examine the efficacy of accelerated anaerobic bioremediation as an alternative treatment for source areas contaminated with dense non-aqueous phase liquids (DNAPLs). In addition to field work, the Consortium is involved with communications activities. For example, the Consortium has partnered with the Interstate Technology and Regulatory Council (ITRC) to provide training on bioremediation technologies, and the industrial members of the Consortium have collaborated with ITRC and the Western Governors' Association to publish a manual on the principles and practices of natural attenuation.



## The Lasagna™ Partnership

The Lasagna™ Partnership was formed in 1994 and it completed its work in 1999. The Partnership—consisting of Monsanto, DuPont, General Electric, EPA, the U.S. Department of Energy (DOE), and others—developed a technology that reduces contaminants like trichloroethene (TCE) in deep clay formation soil in a manner that is faster, less costly, and more effective than traditional remedial approaches. This technology, referred to as the Lasagna™ process, uses an electric current to drive contaminants through a series of planar treatment zones of activated carbon and iron filings. The Partnership tested the technology in two phases at DOE's Paducah Gaseous Diffusion Plant (PGDP). The Phase I test showed that the technology was capable of removing over 99 percent of TCE from a test plot, and the Phase II test showed that the technology could treat large quantities of DNAPL. Given the success of these field studies, the technology earned regulatory acceptance and was selected as a remedial solution for a large contaminated cell at the PGDP site. In addition, the Lasagna process won an "R&D 100" Award from *R&D Magazine* in 1999. Licenses for use of the technology are available through Monsanto, which holds the patent.

## The In-Place Inactivation and Natural Ecological Restoration Technologies (IINERT) Soil-Metals Action Team

The IINERT Soil-Metals Action Team was established in 1995 to develop, test, and gain regulatory acceptance for soil remediation technologies that inactivate hazardous metals in the field. The Action Team's crowning achievement is the work that it performed at a lead-contaminated site in Joplin, Missouri. At that site, the Action Team hoped to show that applying reactive materials to the soil would convert lead into a less toxic form, reduce the contaminant's solubility and bioavailability, and render it less toxic to humans and the environment. To test their hypothesis, Team members applied phosphorus to several test plots in 1997 and collected samples from these plots (as well as from control plots) over several years. They used various methods to evaluate the impact of the treatments, including analyzing soil and plant samples, performing x-ray absorption fine-structure spectroscopy, and conducting animal-dosing studies with immature pigs and weaning rats. Interim results were presented in the January 2004 edition of *Environmental Science and Technology*. In summary, the results suggest that adding phosphorus to lead-contaminated soil in the field does indeed immobilize the contaminant and

reduce its bioavailability, a finding that supports the idea that IINERT technologies have the potential to be a viable and cost-effective alternative to traditional soil cleanup methods.

## The Permeable Reactive Barrier (PRB) Action Team

PRBs are *in situ* treatment zones of reactive materials that degrade or immobilize contaminants as ground water passes through them. The PRB Action Team formed in 1995 to accelerate the development and regulatory acceptance of PRB technologies. Early in its existence, the Action Team helped design a field study for a zero-valent iron (ZVI) PRB at the Dover Air Force Base and helped conduct research and a technology evaluation for a PRB installed near Elizabeth City, North Carolina. The Action Team also helped coordinate a tri-agency research project (involving EPA, DOE, and the Department of Defense) that involved evaluating the long-term performance of PRBs at eight different sites across the United States over a 4-year period. The results from that study have fostered further development of PRBs around the world. Stepping into the communication arena, the Action Team has developed reports that summarize the status of PRB technologies and created a PRB site-profile database that is routinely utilized by consultants, regulators, and others. The database, which is available at <[www.rtdf.org/public/permbarr/prbsumms](http://www.rtdf.org/public/permbarr/prbsumms)>, provides information on more than 60 installed PRBs—more than half of which represent full-scale applications. The Action Team has also partnered with ITRC to develop guidance documents and PRB training classes. As part of that effort, on-site PRB training was delivered to all 10 EPA regional offices and several state environmental offices between 1997 and 1999.

For the first 8 years of the PRB Action Team's existence, the group focused on ZVI PRBs that remediate the dissolved phase of chlorinated solvent plumes. Starting in 2003, however, the Action Team expanded its scope to encompass broader applications, such as using microscale or nanoscale iron as a remedial agent, treating source zones, and using PRBs to address a broader suite of contaminants. Currently, the Action Team is participating in a field project at the Marine Base at Parris Island, South Carolina. This project—a collaborative effort involving EPA, GeoSyntec Consultants, the National Aeronautics and Space Administration, and the U.S. Navy—is designed to examine whether nanoscale iron (delivered as an emulsion) can treat a chlorinated-solvent source zone at a drycleaning site. The Action Team's future goals will be discussed at an

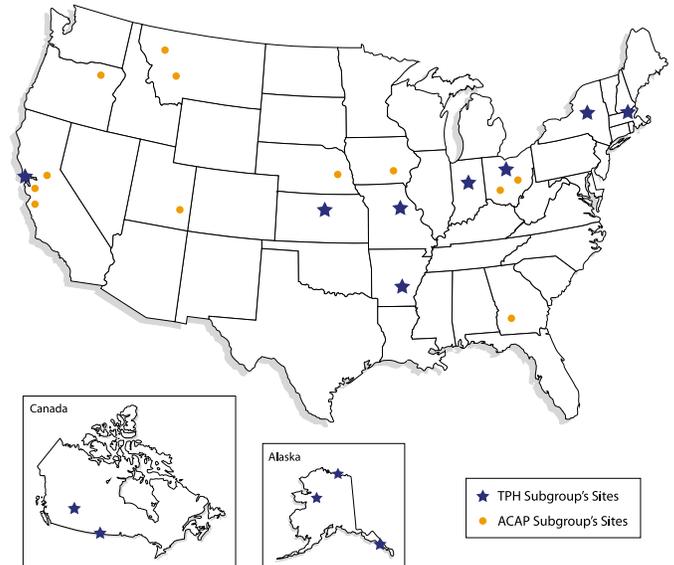
upcoming meeting, which is scheduled to take place in Charleston, South Carolina, on October 11–12, 2006.

## The Phytoremediation Action Team

The Phytoremediation Action Team formed in 1997 to promote the development and the regulatory acceptance of remedial processes that rely on plants. The following three subgroups have formed within the Action Team:

- **The Total Petroleum Hydrocarbon (TPH) in Soil Subgroup** convened to evaluate whether vegetation enhances the degradation of aged petroleum hydrocarbons in soil. Subgroup members developed a standardized test protocol, which called for the installation of three types of vegetative treatments, and applied the protocol at 13 field sites. Data collected from 11 of the 13 sites have been analyzed, and a final report is anticipated in 2006. The following are offered as preliminary conclusions: (1) the plants grew well in petroleum-impacted soils; (2) the plants enhanced hydrocarbon degradation at two sites; (3) the remedial impacts were more pronounced at sites that had not previously experienced extensive biodegradation or weathering; and (4) phytoremediation might be a viable treatment alternative to consider at sites where cost savings are needed, a long treatment time is acceptable, and risk can be effectively managed through vegetation.
- **The Alternative Cover Assessment Program (ACAP) Subgroup** formed to examine whether alternative covers (including vegetative covers) are viable substitutes for more costly conventional landfill covers. Toward that end, the subgroup established instrumented landfill cover research stations at 12 sites across the nation to test the performance of alternative covers against conventional covers. Data were collected at each of the demonstration sites for up to 5 years. Based on the results, some site owners chose to implement full-scale alternative covers, a decision that is projected to save millions in installation and operation and maintenance costs. The subgroup's results will be published in 2006. The report will provide a large body of data on design, construction, and monitoring of landfill cover systems, and it will advance the scientific, engineering, and regulatory community's understanding of how and why landfill cover systems work or fail across a range of climates, designs, and soil conditions. The report will also challenge some long-held assumptions about the performance of conventional landfill covers.

## The Phytoremediation Action Team's Field Demonstration Sites



- **The Chlorinated Solvents Subgroup** released a paper entitled *Evaluation of Phytoremediation for Management of Chlorinated Solvents in Soil and Groundwater* in January 2005. The paper identifies a variety of phytoremediation applications that can be used to control, transform, or manage chlorinated volatile organic compounds in soil and ground water. It also provides insight on how to determine whether phytoremediation is a viable option and how to design and monitor pilot- and full-scale projects. See [www.rtdf.org/public/phyto/ phytodoc.htm](http://www.rtdf.org/public/phyto/phytodoc.htm) for a copy of the paper.

## The Sediments Remediation Action Team

The Sediments Remediation Action Team formed in 1996 to address contaminated sediments—a medium that is often difficult to assess and remediate, typically impacted by more than one contaminant, and commonly associated with high remedial costs. When the Action Team formed, members set out to promote the development of cost-effective on-site sediments remediation technologies. Over the years, the Action Team's focus expanded to address assessment technologies and frameworks for evaluating and managing contaminated sediments sites. Serving in a consulting capacity, the Action Team has provided input on two Anacostia River field projects: one designed to evaluate the efficacy of innovative capping methods and another to evaluate tools that identify potential areas of ground-water impingement into surface water. In addition, a subset of RTDF Action Team members developed a “weight-of-evidence” approach to evaluate monitored natural

recovery at contaminated sediments sites, a project that culminated in the publication of five papers (see <[www.rtdf.org/public/sediment/seddoc.htm](http://www.rtdf.org/public/sediment/seddoc.htm)>). Furthermore, in an effort to elevate the dialogue about sediments-related issues, the Action Team held several workshops between September 2000 and February 2004 that addressed *in situ* treatment technologies, ground-water/surface-water interactions, rapid assessment techniques, and beneficial reuse of dredged materials. The workshops provided a valuable forum for presenting and discussing advances in contaminated sediment risk management and they facilitated the formation of funded research collaborations.

### The Non-Aqueous Phase Liquid (NAPL) Cleanup Alliance

The NAPL Cleanup Alliance, which formed in 2001, is comprised of individuals who share an interest in evaluating remediation technologies and management approaches for large-scale NAPL-contaminated sites. Since its inception, the Alliance has shared infor-

mation about innovative NAPL characterization and remediation methods and has produced a document (entitled *A Decision-Making Framework for Cleanup of Sites Impacted with Light Non-Aqueous Phase Liquids [LNAPL]*) that presents a consensus-based approach to LNAPL management. Alliance members have also developed a 4-hour training program that provides basic information about the way that LNAPLs behave in the subsurface (see [www.rtdf.org/public/napl/training](http://www.rtdf.org/public/napl/training)). This training has been presented at numerous locations across the country and delivered as an Internet seminar on two occasions. The Alliance has also published cost and performance case studies for two LNAPL-contaminated sites.

### The *In Situ* Flushing Action Team

The *In Situ* Flushing Action Team formed in 1997 and disbanded in 1999. Within that timeframe, this group held three meetings and succeeded in bringing together experts from a variety of organizations who were interested in furthering the development of *in situ* flushing technologies.



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