United States
Environmental Protection
Agency

Office of Research and Development (481)
Office of Solid Waste and
Emergency Response (5102G)

EPA 542-F-98-019
Decmeber 1998
www.epa.gov

RTDF Update

RTDF
Remediation Technologies
Development Forum

A Progress Report on the Remediation Technologies Development Forum (RTDF)

INSIDE

About the RTDF

The Remediation Technologies Development Forum (RTDF), established in 1992, is a consortium of partners from industry, government, and academia working to develop safer, more effective, and less costly characterization and treatment technologies for remediation. For information on RTDF and Action Teams visit the RTDF World Wide Web site at ***http://www.rtdf.org***

SEDIMENTS REMEDIATION TEAM

Focus:
- **PAHs, chlorinateds, metals**
- **Degradation/containment**
- **In surface water**

Sediments Remediation Action Team Revitalized

About 40 participants attended a meeting of the Sediments Remediation Action Team on September 16-17 in Cincinnati, the first since 1996. Team Co-Chairs Dennis Timberlake (U.S. EPA) and Richard Jensen (DuPont) pointed out that interest in sediments has risen dramatically since 1996, and industry is placing more resources into sediment remediation efforts. These factors have provided impetus and opportunity for re-energizing the Team's efforts.

The goals for this meeting were to:
- Re-define the Action Team's objectives based on the interests of the participating members;
- Encourage active participation by new members;
- Coordinate with other related organizations; and
- Launch self-empowered subgroups to formulate and carry out independent sediment remediation strategies.

The agenda featured briefings on concurrent sediment remediation programs by a variety of interests, including the U.S. Army Corps of Engineers (USACE), U.S. Navy, EPA National Risk Management Research Laboratory (NRMRL); EPA Great Lakes National Program Office (GLNPO), and EPA Hazardous Substance Research Center/ South and Southwest, a consortium involving Louisiana State University, Rice University, and Georgia Institute of Technology. Speakers also provided participants with an overview of the industry-sponsored Sediment Management Work Group and EPA's Contaminated Aquatic Sediment Remedial Guidance Workgroup (CASRGW).

Industry Work Group

The Sediment Management Work Group was formed earlier this year primarily from among representatives of the regulated community with responsibility for remediation of contaminated sediment sites, including the aerospace, automotive, chemical, paper, petroleum refining, and utilities industries, as well as major industry associations. The group addresses a wide range of contaminants and sediment issues and indicated its interest in coordinating efforts with the Action Team, particularly in technology transfer and information exchange.

Multi-Agency Workgroup

EPA's Contaminated Aquatic Sediment Remedial Guidance Workgroup is a multi-agency work group that currently includes representatives of the USACE, the U.S. Department of Interior's Fish and Wildlife Service, the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and EPA's Office of Water (OW), Office of General

Council (OGC), Office of Research and Development (ORD), and Technology Innovation Office (TIO). The group wishes to develop a unified strategy for EPA to use in addressing contaminated aquatic sediment sites. Because considerable guidance is available on sediment remediation, part of CASRGW's goal is to collect, assemble, and integrate existing guidance information developed throughout the English-speaking world.

Subgroups

During its 1996 meetings, the Action Team had formed three subgroups—Assessment, Capping, and Treatment (*In Situ*/CDFs). At the 1998 meeting, the Treatment and Assessment Subgroups met in separate sessions to identify objectives and began to develop a work plan for the future. Representatives from the U.S. Army Waterways Experiment Station who chair the Capping Subgroup were unable to attend, so capping issues were addressed in the Treatment Subgroup meeting.

The Assessment Subgroup, led by Ralph Stahl (DuPont), reported that it has two major roles: to support the Treatment Subgroup; and to "push the envelope" on new techniques and applications. The Subgroup will address both human and ecological issues as they pertain to chemical processes, exposure risk, natural recovery, and system processes. Members plan to conduct a pilot demonstration and are looking at a range of potential sites. A government co-chair for the Subgroup is being sought.

The Treatment Subgroup, led by Karen Miller (U.S. Navy), reported that it is seeking an industry co-chair. The Subgroup identified the Philadelphia and Charleston Navy Yards as possible investigation sites for natural recovery and natural attenuation. Although the Subgroup did not identify specific locations to test other remediation methods, members indicated that the ideal would be a well-characterized site at a federal facility that has regulatory and regulated community acceptance, a flexible timeframe, ongoing initiatives, and high potential for transferability and applicability of data.

Future Activities

Meeting participants made tentative plans for a number of conference calls and activities, including meetings in January 1999 on the East Coast and in April in conjunction with the *In Situ* and On-Site Bioremediation: The Fifth International Symposium in San Diego, sponsored by Battelle Memorial Institute.

A complete summary of the meeting is available on the Action Team's home page on the RTDF World Wide Web site.

PERMEABLE REACTIVE BARRIERS TEAM

Focus:

- **Chlorinated solvents, metals**
- **Degradation/immobilization**
- **In ground water**

Coordination Research on Long-Term PRB Performance Receives Funding Support

The Permeable Reactive Barriers (PRB) Action Team has been successful in coordinating funding for research on the topic of long-term performance of PRBs. The Action Team's Steering Committee began in January 1997 to promote the development of a coordinated research approach by EPA, the Department of Energy (DOE), and the Department of Defense (DoD) for addressing the issue of long-term performance, because the Committee views it as the primary factor restricting further acceptance and deployment of this technology.

During the last year, PRB long-term performance research proposals to EPA's National Risk Management Research Laboratory (NRMRL), DoD's Environmental Security Technology Certification Program (ESTCP) and DOE's Office of Science and Technology (EM-50) were submitted simultaneously to ensure maximum coordination and cost-effectiveness. The proposed coordination will ensure that data collected from site-to-site are comparable while allowing each agency to focus on its unique needs and strengths. The Principal Investigators (PIs) for each agency will ensure that common techniques and monitoring approaches are used at the locations within each agency's purview. Data will be shared among the agencies through regular conference calls and mutual dissemination of routine project reports. Final reports prepared by each agency to meet specific milestones also will be peer-reviewed by the PIs and their designees from the other agencies.

EPA's portion of the project will focus on the U.S. Coast Guard Support Center site in North Carolina and the Denver Federal Center site in Colorado. The DOE portion will focus on the installations at theY-12 Site at Oak Ridge National Laboratory in Tennessee, the Rocky Flats Environmental Technology Site (joint project with EPA) in Colorado, and at the Kansas City Plant in Missouri. DoD's portion will include the Moffett Federal Airfield in California and other sites.

State-of-the-Science Summary To Be Issued

The RTDF's Permeable Reactive Barriers Action Team, in cooperation with EPA/ORD, has published "Permeable Reactive Barrier Technologies for Contaminant Remediation" (EPA/600/R-98/125), a state-of-the-science summary of PRB technology. Its purpose is to provide the most recent information on PRB technologies in a format useful to stakeholders, including implementors, state and federal regulators, Native American tribes, consultants, contractors, and other interested

parties. The document includes information on treatable and non-treatable contaminants, barrier wall design, feasibility studies, construction options, site characterization needs, and compliance and performance monitoring, as well as summaries of several current installations. The Action Team expects the document to be a valuable technical resource for all parties with interest in using this innovative, passive, remediation technology. "Permeable Reactive Barrier Technologies for Contaminant Remediation" is available on the Action Team's home page on the RTDF World Wide Web site. A copy also is available on the EPA Web site at www.epa.gov/ada/sric.html. A hard-copy edition of the document is expected to be available before the end of the calendar year.

PRB Training Course

The Permeable Reactive Barriers Action Team and the Interstate Technology Regulatory Cooperation (ITRC) Permeable Barriers Working Group are developing a training course and an associated document that will assist regulatory professionals in overseeing design, implementation, and monitoring of ground-water remedies involving deployment of PRBs. The new course will be offered, beginning next year, in or near the 10 cities where EPA's Regional offices are located. The courses will be held at approximately 2-month intervals.

Although some PRBs existed earlier, the main push to deploy PRBs began in late 1994. Since then, 10-15 full-scale systems using zero-valent iron as the treatment medium have been deployed, and an equal number of field demonstrations have been conducted. Several other types of PRB systems (for example, granulated carbon walls) also have been implemented. Published accounts suggest that more than 500 sites may be suitable for PRB deployment over the next 10 years. Compared to conventional remedies for contaminated ground water, such as pump-and-treat systems, PRBs could save more than $1,000,000 per site over long-term operation if properly designed, constructed, and monitored.

The training sessions will be geared toward state and federal regulators, but industry representatives and consultants also will be encouraged to attend. An objective of the program is to consolidate the many efforts that have provided design and regulatory guidance on PRB deployment. Several state, federal, and private organizations have contributed to the promotion of this technology. The goal of the training is to provide a single, high-quality, highly effective program that has the backing of state and federal groups responsible for the ultimate application of the technology.

Training elements will include:

- the remediation process
- the type and distribution of chemicals in the affected ground water
- hydrogeologic conditions including ground water velocity, hydrostratigraphy, and hydraulic gradient information
- hydrochemistry
- ground-water monitoring objectives
- regulatory issues
- constructability of the PRB
- future land use and economic issues

The training program will be designed to demonstrate the importance of the above eight factors and provide some background and experience in assessing each through a series of lectures, case study presentations, and classroom exercises. The RTDF and ITRC believe that both regulators and designers must be knowledgeable about these factors to ensure that decision-making processes affecting PRB deployment are efficient and technically accurate. Deployment of PRBs that are technically deficient or monitored incorrectly not only could negate the potential long-term cost savings in site remediation, but also could end up costing more than conventional remediation.

The training sessions will be led by a panel of instructors with specific expertise in PRB development, design, deployment, and monitoring. The panel will include expertise from regulatory agencies, academia, and industry and will participate directly with the RTDF and ITRC committees during course development/ delivery.

Additional details about the course and registration information will be posted on the PRB Action Team home page on the RTDF World Wide Web site as they become available.

LASAGNA™ PARTNERSHIP

Focus:

- **TCE**
  - **Degradation**
    - **In low-permeability soils**

Lasagna™ Selected for Paducah Site; Available for Licensing

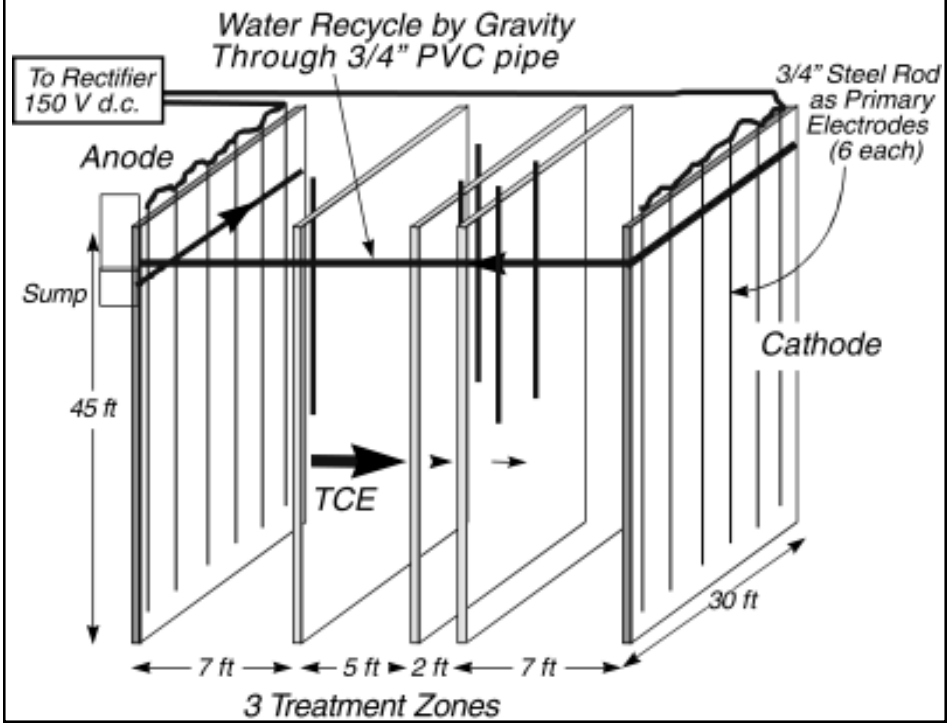
With approval of a Record of Decision (ROD) in mid-summer of 1998, the U.S. Department of Energy (DOE) has selected the *Lasagna*™ Remediation Technology for the commercial cleanup of a large contaminated cell at its Paducah Gaseous Diffusion Plant (PGDP) in Kentucky. The selection of the *Lasagna*™ process culminates a multi-year research and development effort conducted by the RTDF's *Lasagna*™ Partnership.

The *Lasagna*™ technology was tested and developed under a federal Cooperative Research and Development Agreement (CRADA) signed in the early 1990's. The CRADA involved a consortium made up of the DOE, EPA, the Monsanto Company, DuPont, and General Electric (GE). The CRADA was later followed by a cost-sharing research and development contract award by DOE, which included support from several heavy equipment subcontractors.

How It Works

Lasagna™ treats contaminated soil *in situ* by coupling electrically-driven transport of contaminants with *in situ* treatment processes. In a configuration that has been successfully tested in the field, the planar electrodes consist of a mixture of granular carbon and iron filings, and are emplaced in the soil at the outer perimeter of the embedded contaminant. Several planar treatment zones are also emplaced at various intervals between the electrodes, directly into the contaminated zone (see Figure 1). The contaminant is picked up in water and transported through the treatment zones in a process known as "electro-osmosis." The technology has been determined to be effective for remediation or "dechlorination" of trichloroethylene (TCE) in either low-permeable or mixed soils, and it is believed it will be effective for other contaminants as well. Other configurations of electrodes and treatment zones could also be effective, but have not been tested on a large scale.

Figure 1. Schematic Diagram of Lasagna™ Installation at Paducah Gaseous Diffusion Plant Showing Electrodes (Anode and Cathode) and Treatment Zones.



Field Tests

Field tests of the *Lasagna*™ process were conducted in test plots located at the PGDP. This site was chosen because a specific plot of soil there had been contaminated with TCE, and the soil was low-permeable clay, for which *Lasagna*™ is uniquely suited. Operations were conducted in two phases. In Phase I, the treatment zones contained activated carbon in order to trap TCE from the soil. The operations began in January 1995 with a 10' X 15' X 15' deep test cell. Phase I lasted several months, and more than 99% of the TCE was successfully removed from the soil.

In Phase IIa, which began operations in the summer of 1996, a larger test cell was treated. The cell measured 21' X 30' X 45' deep. Also, iron filings were utilized in the treatment zones to dechlorinate TCE *in situ* instead of just trapping it, as in Phase I. During Phase IIa, it is believed that one or more zones that contained unexpectedly large quantities of Dense Non-Aqueous Phase Liquid (DNAPL) were encountered. Because these very high concentrations significantly slowed the treatment process, it was decided to extend the operations period of the contract for six months. During the extended period, the technology proved effective in treating the heavy concentrations of DNAPL, with most test sample locations cleaning up either below the required standard of 5.6 ppm or only marginally above it before power was shut down for soil sampling. EPA and DOE concluded that *Lasagna*™ had once again demonstrated that it was an effective technology for decontamination of TCE in low-permeable soils, even under heavy DNAPL conditions, which had been a key project objective.

With the research and development phase of the contract complete, DOE sought regulatory approval to use the *Lasagna*™ process for cleanup.

Licensing Opportunities

The Monsanto Company currently holds two patents on the process and is offering *Lasagna*™ through license agreements for treating soil at other locations contaminated with TCE or other chlorinated aliphatic organics. Prospective licensees or owners of contaminated sites may contact Dr. Sa V. Ho at Monsanto, 314-469-5179, or Mr. John Merz at Monsanto Enviro-Chem, 314-275-5738.

Technical reports on the research, development, and testing of the *Lasagna*™ process are available on the Partnership's home page on the RTDF World Wide Web site.

***In Situ* Flushing Team**

Focus:

- NAPLs
- Solubilization/mobilization
- In ground water

In Situ Flushing Action Team Meets

The *In Situ* Flushing Action Team held its third meeting on September 14-15, 1998, in Dallas. Action Team Co-Chairs Dr. Lynn Wood (EPA) and Steve Shoemaker (DuPont) explained that the majority of the agenda was devoted to working sessions for the Subgroups established by the Team earlier this year.

Technical Practices/Protocol and Full-Scale Design Subgroup

Formerly separate subgroups on Technical Practices and Full-Scale Design were consolidated. The new Subgroup will focus on preparing a technical guide on surfactant and cosolvent flushing processes and steps in designing a full-scale *in situ* flushing system. In addition, the Subgroup will establish linkages with ongoing full-scale flushing projects and distribute information about them on the Action Team's home page on the RTDF World Wide Web site.

Subgroup members reviewed and revised the outline for Volume I of the Technical Guide. In general this volume will address "What We Know Now" about *in situ* flushing technology. Volume I will contain eight sections: (1) Screening, (2) Conceptual Approach, (3) Site Characterization, (4) General Evaluation Step, (5) Design Processes, (6) Pilot-Scale Testing, (7) Performance Assessment, and (8) Full-Scale Design.

Volume II of the Technical Guide will focus on "What We Still Need To Do" and will address such factors as technology limitations, site characterization needs, and design process issues, including heterogeneity, access limitations, surfactant recovery, and integration with other technologies in a "treatment train." The volume will be developed by a small workgroup and will build on a base of information about laboratory-, pilot-, and full-scale *in situ* flushing projects compiled by the Ground Water Remediation Technologies Analysis Center (GWRTAC) and released earlier this year.

Endpoint Assessment/Technical Performance Criteria Subgroup

This Subgroup has three major objectives: 1) develop guidelines for establishing target endpoints for *in situ* flushing technologies; 2) develop protocol/guidelines for predicting the ability to (a) reach target endpoints and (b) identify potential negative outcomes; and 3) develop a framework for performance assessment.

In order to move toward target endpoint guidelines, the Subgroup drafted a letter requesting regulatory guidance in defining target endpoints for *in situ* flushing technologies. The letter contains a statement of the problem and background information on the use of *in situ* flushing technologies, discusses possible approaches for defining target endpoints other than using Maximum Contaminant Levels (MCLs), and offers recommendations of the most useful and meaningful target endpoints to use for *in situ* flushing technologies. The Subgroup currently is refining the draft and circulating it for review within the Action Team. When finalized, the letter will be sent to the directors of EPA's Office of Research and Development, Office of Emergency and Remedial Response, and Technology Innovation Office with the Action Team's request for feedback within a specified timeframe.

As an initial step in establishing a framework for assessment of the performance of *in situ* flushing, the Subgroup compiled a list of hydrogeological, geochemical, and microbiological parameters that should be monitored before, during, and after use of the process and identified measurement tools and "error bars" for each. The Subgroup prepared a table displaying these parameters and addressing when data should be collected (before, during, or after), the importance of the various data relative to determining the success of an *in situ* flush, how the data can be used (for design, process control, success criteria, compliance monitoring, etc.), and the matrix tested. The Subgroup will circulate the draft table for review and comment by Action Team members before finalizing it.

Economic Assessment and Remedial Agent Recovery/Reuse Subgroup

This Subgroup's efforts are focused on (1) determining the best way to perform an economic analysis for *in situ* flushing technologies and (2) comparing costs against those generated by other types of technologies. During its meeting, the Subgroup compiled a list of contaminant removal and surfactant reconcentration technologies and discussed their status and relative costs. The Subgroup's draft

list is being circulated for review and comment by all Action Team members.

Subgroup members also evaluated existing economic analyses. The Subgroup found that many available and pending economic analyses overestimate costs, because they fail to account for recovering and reusing surfactants, using an incremental approach, and using skid-mounted units and temporary piping. Subgroup members plan to coordinate with the Technical Practices/Protocol and Full-Scale Design Subgroup to conduct their own cost analysis for a full-scale design.

The Action Team received reports on activities from several organizations with common interests. Dr. David Ellis (DuPont Specialty Chemicals) described the RTDF Bioremediation Consortium's study of natural attenuation of chlorinated solvents and plans for future studies. In addition, he discussed the potential benefits of combining surfactant flushing and natural attenuation in treatment trains.

Nancy Worst (Western Governors Association) summarized the activities of the Interstate Technology Regulatory Cooperation (ITRC) Working Group, an organization founded to remove the barriers imposed by state agencies to the development of innovative technologies. She indicated that the ITRC is interested in future collaboration with the *In Situ* Flushing Action Team.

Dr. Thomas Early of the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory provided an update on the Interagency Dense Non-Aqueous Phase Liquid (DNAPL) Consortium's planned demonstration of innovative technologies. The Consortium has selected a site at Cape Canaveral to demonstrate remediation of DNAPLs using thermal technologies, *in situ* chemical oxidation, and surfactant flushing. Demonstrations are scheduled for Spring 1999.

The meeting agenda also included briefings on *in situ* flushing field work being conducted at a number of sites throughout the country. This information and a summary of the proceedings of the meeting are available on the Action Team's home page on the RTDF World Wide Web site.

The Action Team made tentative plans for another meeting early in 1999.

United States
Environmental Protection
Agency

Office of Research and Development (481)
Office of Solid Waste and
Emergency Response (5102G)

EPA 542-F-98-019
December 1998
www.epa.gov

EPA

RTDF Update

RTDF
Remediation Technologies
Development Forum

A Progress Report on the Remediation Technologies Development Forum (RTDF)