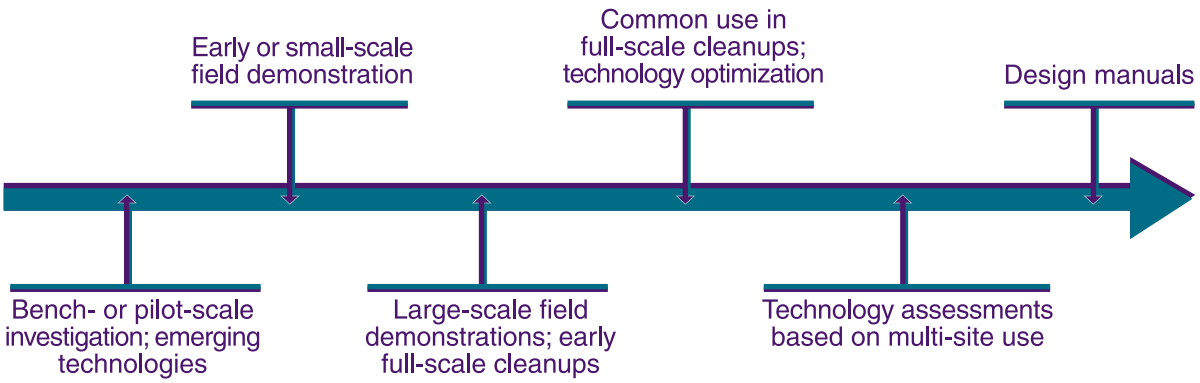
# SUMMARY OF SELECTED DOCUMENTS

This fact sheet identifies documents prepared by federal and state agencies to assist project managers in selecting and designing remediation technologies. Remediation technologies are typically developed through successive testing from the laboratory to the field-scale, as illustrated in the timeline below. When technologies have been implemented at full-scale, technology assessment reports are prepared to document the use of the technologies at multiple sites. Design manuals are then prepared to provide technical guidance based on technology assessments and lessons learned.

### TIMELINE FOR DEVELOPMENT OF REMEDIATION TECHNOLOGIES




Member agencies of the Federal Remediation Technologies Roundtable (FRTR) are conducting an ongoing effort to document large-scale demonstration projects and full-scale cleanups in order to capture cost and performance data and other lessons learned. The FRTR works to promote cooperation among federal agencies in order to advance the use of remediation technologies for cleaning up hazardous waste sites. Primary members of the FRTR include the U.S. Departments of Defense, Energy, and Interior; the National Aeronautics and Space Administration; and the U.S. Environmental Protection Agency (EPA). Currently, the Web site (*www.frtr.gov*) has approximately 375 technology case studies available in a searchable format. As experience has been gained from applications of new technologies, federal agencies and states (through the Interstate Technology and Regulatory Council [ITRC]*) have been preparing broad technology assessments and design manuals based on these site-specific case studies. This fact sheet highlights some of these documents that may be among the most useful to project managers.

## WHAT INFORMATION DOES THE WEB SITE CONTAIN?

The Remediation Technology Assessment Reports Web site (*http://costperformance.org/remediation*) contains documents that are based on practical field experience with either specific technologies (such as permeable reactive barriers) or, in a few instances, specific contaminants (such as arsenic). As of August 2005, the Web site included 68 remediation technology assessment reports. New documents are identified and added to the collection every year. The table on the next page lists the technologies and contaminants addressed by the documents in the compilation; documents addressing the technologies listed in **bold** are highlighted in this fact sheet.

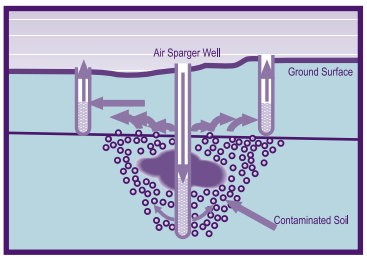
* The ITRC is a state-led coalition of regulators, industry experts, citizen stakeholders, academicians, and federal partners that work together to achieve regulatory acceptance of environmental technologies. Additional information about the ITRC is available at *www.itrcweb.org*.

**http://costperformance.org/remediation**

- **Air Sparging**
- Arsenic
- **Bioremediation**
- **Containment – Barrier Walls**
- Containment – Caps
- **Dense Nonaqueous-Phase Liquids**
- Flushing
- **In Situ Chemical Oxidation**
- **In Situ Thermal Treatment**
- Incineration (on-site)
- In-Well Air Stripping
- **Monitored Natural Attenuation**
- **Multi-Phase Extraction**
- **Permeable Reactive Barriers**
- Phytoremediation
- **Soil Vapor Extraction**
- Soil Washing
- Solidification/Stabilization
- Thermal Desorption
- **Underground Storage Tank Sites/Fuel-Contaminated Sites**

For the technologies listed in bold above, the following documents are considered to be among the most useful for project managers.

## AIR SPARGING

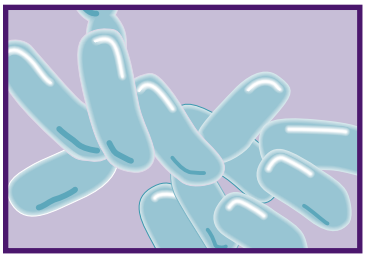



***Cost and Performance Report: Multi-Site In Situ Air Sparging (Navy, April 2005)***

The objective of the project discussed in this report was to implement the Air Sparging Design Paradigm at a number of existing air sparging sites in order to determine whether the Paradigm was effective for evaluating air distribution and whether other design guidelines were valid. The Paradigm provides details on air sparging principles; site characterization; pilot testing; system design, installation, and operation; and system monitoring. Another goal of the project was to modify the Paradigm as necessary based on results obtained from 10 field sites. Using the Paradigm to evaluate and design air sparging systems should result in applications that are more cost-effective and have better performance.

*In addition to the above-mentioned report, the U.S. Army Corps of Engineers (USACE) is working on an update to its Engineer Manual on Air Sparging that will be posted on the website when it is complete.*

## BIOREMEDIATION

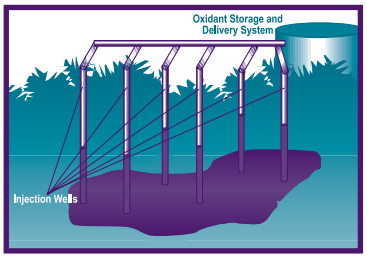


***Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents (Environmental Security Technology Certification Program [ESTCP] and U.S. Air Force, Navy, and Army, August 2004)***

This report contains information that can help project managers (1) make more informed decisions about enhanced bioremediation as a remedial alternative, (2) select specific enhanced bioremediation approaches that are suitable for achieving cleanup goals, and (3) track bioremediation cost and performance. Although this process has been shown to enhance the destruction of chlorinated solvents in situ at certain sites, there are conditions that may limit or even preclude its use. The report can help project managers identify conditions under which the technology may not be successfully applied.

*In addition to the above-mentioned report, the ITRC is working on a document addressing in situ bioremediation of dense nonaqueous-phase liquids (DNAPL) that will be posted on the website when it is complete.*

## IN SITU CHEMICAL OXIDATION




***Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater – Second Edition (ITRC, January 2005)***

This document outlines the technical and regulatory requirements associated with in situ chemical oxidation. The primary oxidants addressed are hydrogen peroxide, potassium and sodium permanganate, sodium persulfate, and ozone. The document should prove useful to regulators, stakeholders, consultants, and technology implementers. It is divided into sections that provide a technology overview and discuss its applicability, remedial investigations, safety concerns, regulatory concerns, injection design, monitoring, stakeholder concerns, and case studies.

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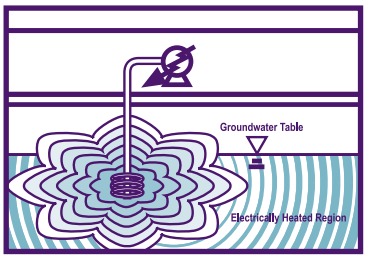
## In Situ Thermal Treatment

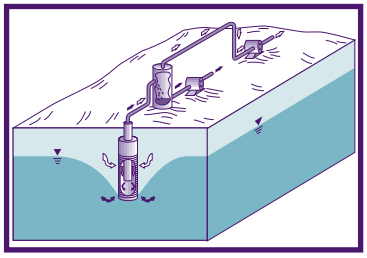



***In Situ Thermal Treatment of Chlorinated Solvents: Fundamentals and Field Applications (EPA, March 2004)***

In situ thermal treatment technologies have proven to be effective in remediating source zones contaminated with chlorinated solvents and are increasingly being used for that purpose. This report provides an overview of the principles and science behind the technology; its applicability and general engineering considerations; and applications of the technology through site-specific examples and case studies. Specific technologies addressed include steam-enhanced extraction, electrical resistive heating, and thermal conductive heating.

*In addition to the above-mentioned report, USACE is working on a design document for in situ thermal treatment that will be posted on the website when it is complete.*

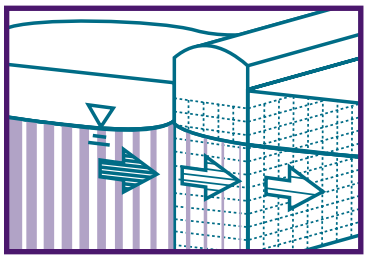
## Multi-Phase Extraction (MPE)



***Multi-Phase Extraction (USACE, June 1999)***

This engineering manual provides practical guidance for evaluating the feasibility and applicability of MPE for remediation of contaminated soil and groundwater and describes design and operational considerations for MPE systems. The document is primarily intended to present USACE technical policy on the use of the technology and to help prevent incorrect MPE application or MPE use in unfavorable settings.

## Permeable Reactive Barriers (PRB)



***Capstone Report on the Application, Monitoring, and Performance of Permeable Reactive Barriers for Ground-Water Remediation: Volumes I and II (EPA, August 2003)***

This report builds on work done in previous studies conducted by ESTCP. It evaluates the long-term performance of zero-valent iron PRBs at several sites, including sites in Elizabeth City, North Carolina, and Denver Federal Center, Colorado. The evaluation focuses on changes in iron reactivity and reaction zone permeability over time. The parameters used for the evaluation are trends in geochemistry (for example, pH and oxidation-reduction potential); microbiological activity within and around the barriers; and surface precipitation forming over time in the barriers. The report discusses how these parameters may be evaluated to predict barrier longevity and performance over time. The evaluation will be useful to project managers who are constructing remedial designs and developing performance-monitoring programs.

***Permeable Reactive Barriers: Lessons Learned/New Directions (ITRC, February 2005)***

This document updates previous guidance issued by the ITRC. The goal for this document was to compile information on PRBs that has been generated over the last 10 years of technology development and research as well as to provide information on non-iron-based reactive media that can be used in PRBs. The document also provides an update on a developing technology related to PRBs in which source zone contamination is treated with iron-based reactive media.

***Permeable Reactive Barrier Technologies for Contaminant Remediation (EPA, September 1998)***

This issue paper contains information on PRB-treatable contaminants; treatment reaction mechanisms; feasibility studies for PRB implementation; site characterization; and PRB design, emplacement, and monitoring for both compliance and performance as well as summaries of several field applications. It also includes a summary of significant findings of PRB research through 1997 and scoping calculations used to estimate the amount of reactive media required.

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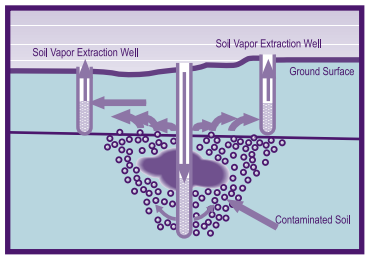
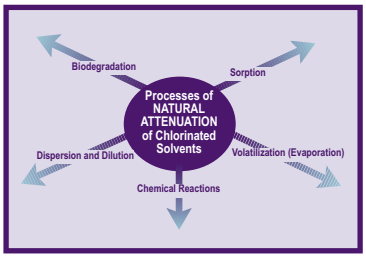
## Soil Vapor Extraction (SVE)




***Engineering and Design – Soil Vapor Extraction and Bioventing (USACE, June 2002)***

This engineering manual provides practical guidance for design and operation of SVE and bioventing (BV) systems. It addresses all aspects of the engineering of SVE and BV systems, including site characterization, technology selection, bench- and pilot-scale testing, design, installation, operation, and closure.

## Monitored Natural Attenuation (MNA)



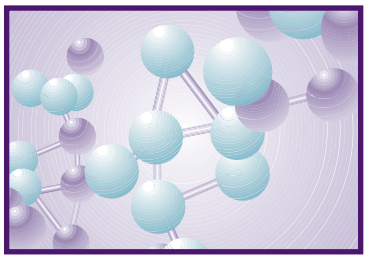

***Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater (U.S. Air Force, March 1999)***

This document presents a technical protocol for data collection and analysis in support of MNA with long-term monitoring for restoration of groundwater contaminated with fuel hydrocarbons. It describes the processes associated with MNA, the site characterization activities that may be performed to support evaluation of the MNA option, MNA modeling using analytical or numerical solute fate and transport models, and the post-modeling activities that should be completed to ensure successful support and verification of MNA.

***Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (EPA, September 1998)***

This document presents a technical protocol for data collection and analysis to evaluate MNA through biological processes for remediating groundwater contaminated with mixtures of fuels and chlorinated aliphatic hydrocarbons. It identifies parameters that are useful for evaluating natural attenuation of chlorinated solvents (chlorinated aliphatic hydrocarbons and/or fuel hydrocarbons) and provides recommendations for analyzing and interpreting the data collected during the site characterization process. It also provides suggestions for integrating MNA into a remedial approach that includes an active remedy.

## Dense Nonaqueous-Phase Liquids

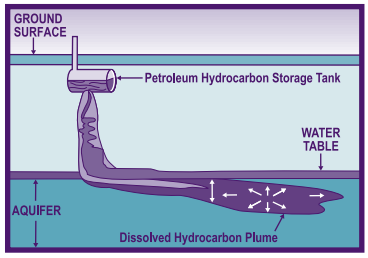


***Strategies for Monitoring the Performance of DNAPL Source Zone Remedies (ITRC, August 2004)***

The purpose of this report is to serve as a tool to educate regulators and stakeholders about performance monitoring of various in situ technologies for treating DNAPLs. The document discusses issues related to DNAPLs, including the challenges of accurately characterizing DNAPL sites, health and safety issues, and regulatory concerns. The document also describes methods for quantifying the performance of a treatment technology and ways to evaluate the efficiency and effectiveness of a remedial action in attaining remediation objectives. Case studies are presented that highlight the various performance assessment approaches used in recent DNAPL source zone treatment projects as well as the remedial goals and objectives, performance monitoring and verification activities, and lessons learned.

**http://costperformance.org/remediation**

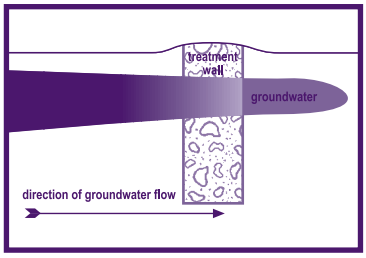
## Underground Storage Tank Sites/Fuel-Contaminated Sites




***How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers (EPA, May 2004)***

The purpose of this manual is to provide guidance for reviewing corrective action plans that propose alternative cleanup technologies for the remediation of leaking underground storage tank sites. The manual does not advocate the use of one technology over another; rather, it focuses on appropriate technology use with consideration of site-specific conditions and the nature and extent of contamination. A chapter discussing MNA as a technology alternative is included in the manual.

## Containment – Barrier Walls




***Evaluation of Subsurface Engineered Barriers at Waste Sites (EPA, August 1998)***

The objective of the study discussed in this report was to address the performance of subsurface engineered barriers installed throughout the United States over the previous 20 years to remediate hazardous waste sites and facilities. The study focused on vertical barriers; evaluation of caps was a secondary objective. The overall approach to the study was to assemble existing performance monitoring results from a number of sites and examine those results in light of remedial objectives and factors that may influence barrier performance. The factors considered included barrier design, construction quality assurance and quality control; types of monitoring programs; and operation and maintenance efforts. Although the report was published in 1998, the information it contains is still relevant and useful for construction of subsurface engineered barriers.

## How do I submit new reports or provide feedback?

To propose adding new reports to the compilation or to provide feedback on existing reports, please contact Martha Otto of EPA's Office of Superfund Remediation and Technology Innovation at (703) 603-8853 or *otto.martha@epa.gov*.

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Solid Waste and
Emergency Response
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National Service Center for
Environmental Publications
P.O. Box 42419
Cincinnati, OH 45242



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