

In Situ Remediation Technologies and Site Reuse

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**Carlos Pachon
U.S. Environmental Protection Agency
pachon.carlos@epa.gov**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Technology Innovation Program Technology Transfer Efforts

EPA Innovative Treatment Technology Developer's Guide to Support Services (Fourth Edition)

EPA Read Up to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup, Second Edition

EPA Treatment Technologies for Site Cleanup Annual Status Report (Sixth Edition)

EPA Technology Innovation Office
Clean-Up Information
Welcome to EPA

EPA Welcome to the Federal Remediation Tech



Why Innovate?

- Key drivers in contaminated site restoration:
 - » Cost
 - » Uncertainty
- Still a relatively young industry experiencing change in several areas, mainly:
 - » Technology innovation
 - » Advances in project management
 - » Shifting market drivers
- This presentation touches on each of these areas
 - » Snap shot of the drivers for innovation
 - » The Triad: Synthesizing practitioner experience in smart project management to reduce cost and uncertainty
 - » Technology innovation: Demand and supply side information
 - » Brownfield Technology & Redevelopment Support Center

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Innovative Site Management Approaches & The Land Reuse Equation

Purchase Costs + Redevelopment Costs

- Transaction costs
- Site prep
- Construction
- Development
- Taxes/admin.
- Marketing
- Etc., etc., etc.

vs.



Clean Value

- Revenues
- Resale/asset value
- Social/political



Innovative Site Management Approaches & The Land Reuse Equation

Purchase + Redevelopment

- Transaction costs
 - Site prep
 - Construction
 - Development
 - Taxes/admin.
 - Marketing
 - Etc., etc., etc.
- +**
- Assessment
 - Cleanup
 - Liability issues

vs.



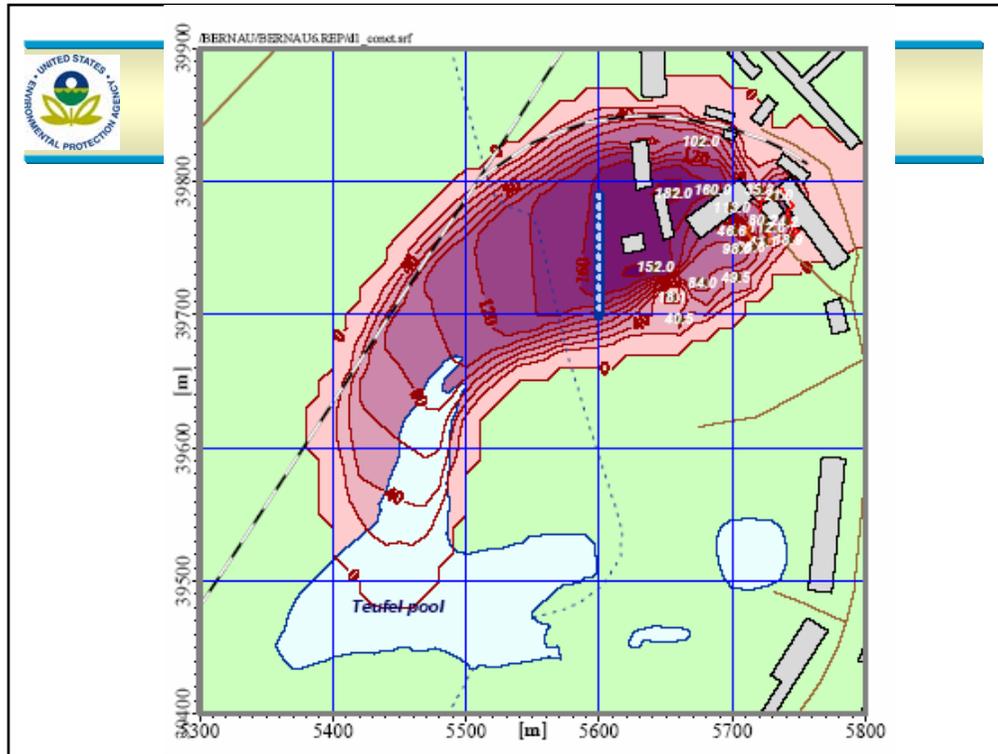
Clean Value

- Revenues
- Resale/asset value
- Social/political



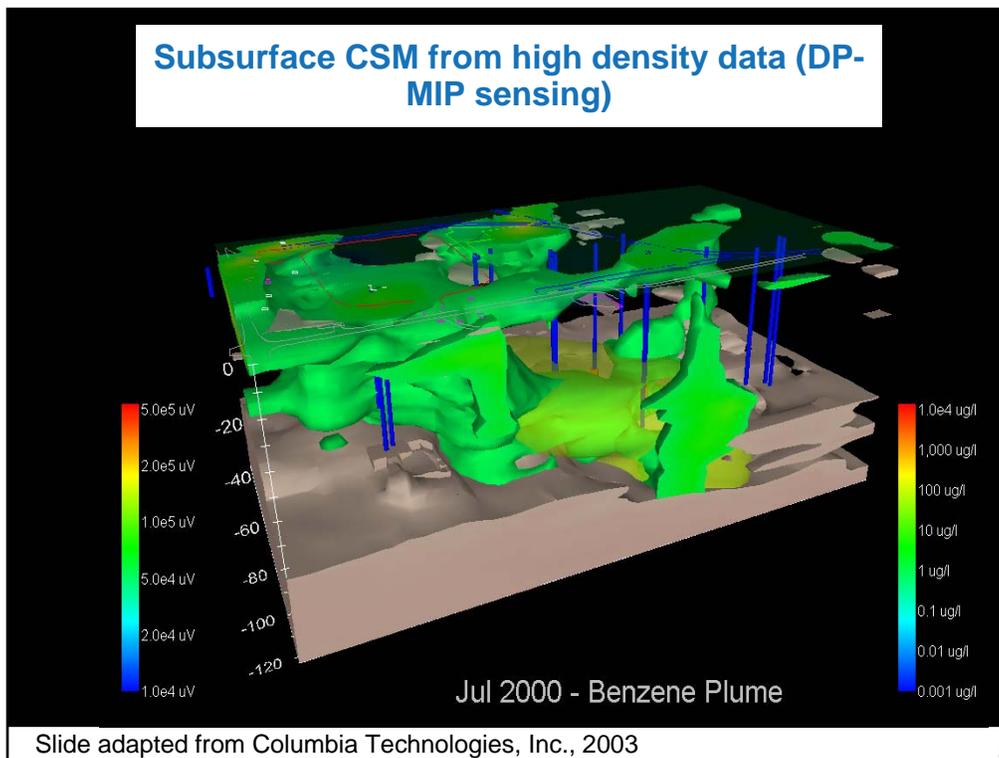
Real-Time Analytical and Sampling Technologies

- Field analytical, rapid sampling, mobile labs, quick turnaround off-site all allow real-time or near real time analysis
- Rapid turnaround results support dynamic decision making
- Lower costs of field methods support increased density (address sampling uncertainty)
- Field results guide confirmation (address analytical uncertainty)
- Decision support software can help organize and process data, plan field activities

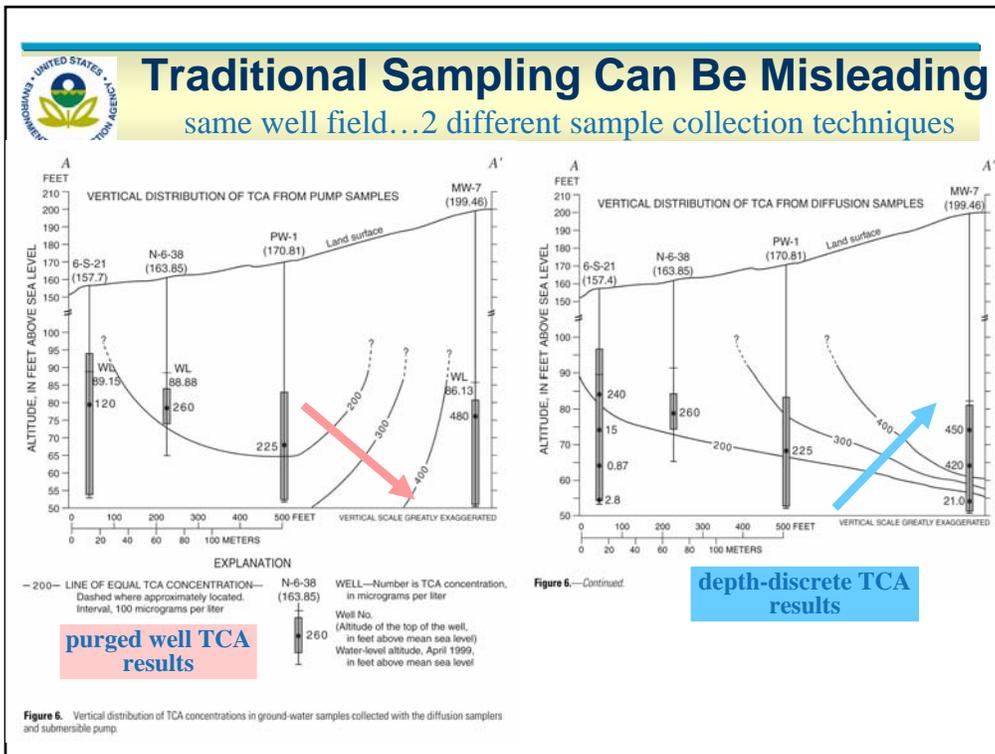


Common representation/depiction of a contaminant plume (TCE in this instance)

We are used to taking widely spaced samples and modeling groundwater plumes like this.

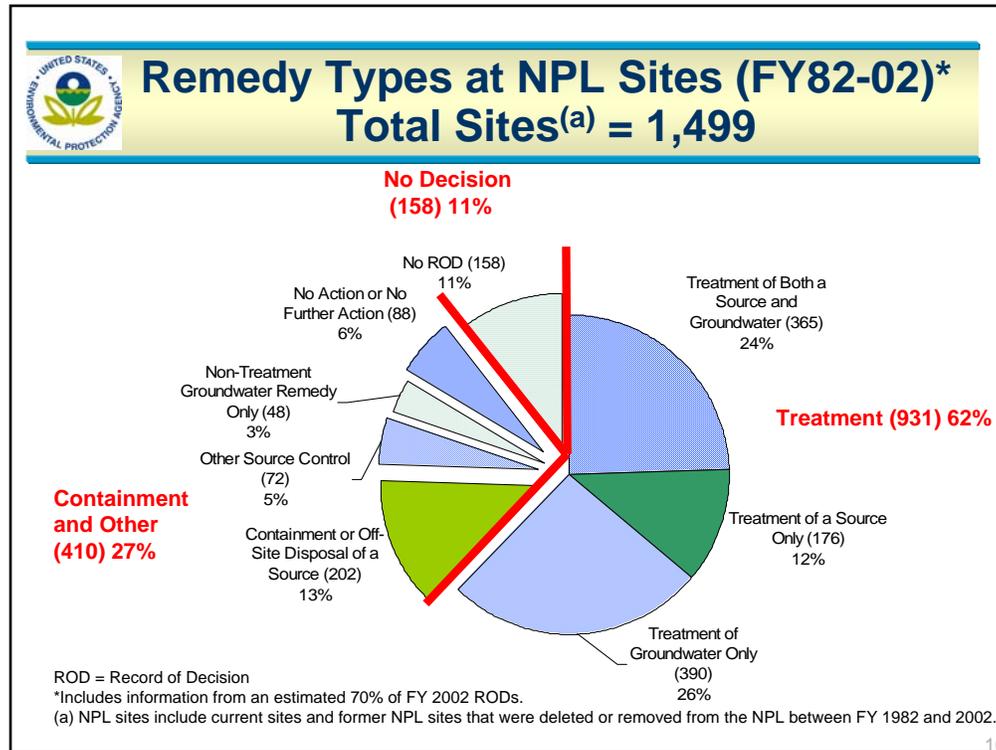


What the MIP technology is capable of in the hands of a sophisticated user.



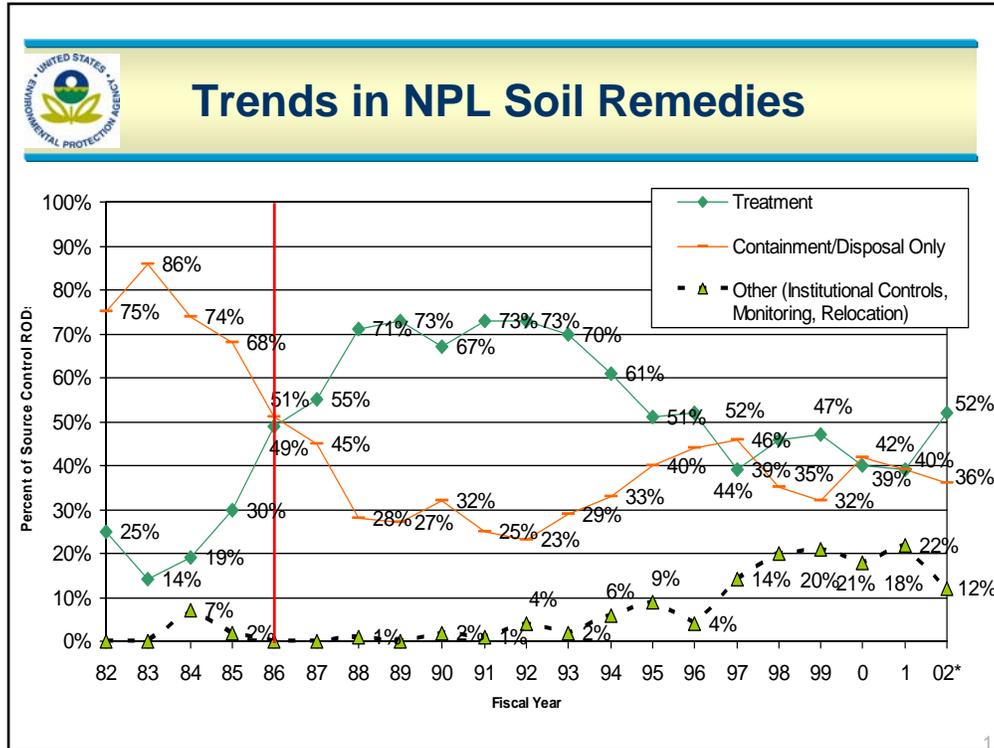
Huffman, R.L. (2002) Comparison of Passive Diffusion Bag Samplers and Submersible Pump Sampling Methods for Monitoring Volatile Organic Compounds in Ground Water at Area 6, Naval Air Station Whidbey Island, Washington. U.S. Geological Survey Water-Resources Investigations Report 02-4203. Available on-line at <http://water.usgs.gov/pubs/wri/wri024203/>

CSM based on traditional sampling is very different from CSM based on more detailed, spatially accurate sampling that preserves the integrity of vertical stratification.

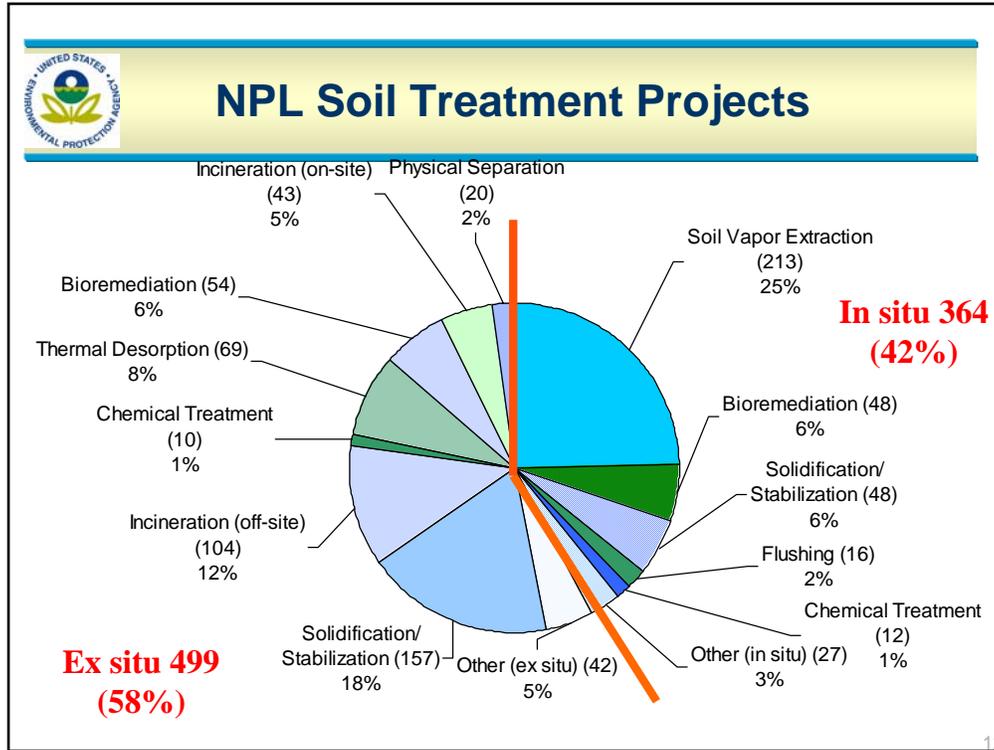


- Some 62% of sites have treatment as part of the remedy
- At 24% of sites both soil and groundwater are being treated
- 13% have selected containment but not treatment. Some of the “off’site disposal” may include treatment, but it is not counted as such due to lack of supporting data. Additionally, removal actions may have taken place at these sites, but are not counted either due to limitations in the available information.
- Only 8% have selected only non-treatment and non-containment remedies, such as institutional controls or alternative water supply

This slide shows information on a site basis, and presents a snapshot of the current state of Superfund remedial actions. The remedies shown for treatment are actual remedy types implemented or currently planned. Treatment remedies that have been changed to another remedy type are not shown.



- The percent of source control RODs selecting treatment climbed to 52% in 2002
- Treatment and containment RODs have held steady at about 40% each between 1997 and 2001
- 2002 saw a drop in RODs selecting “other” remedies, mainly IC’s, as the **sole** remedy
- 31% of the newly selected treatment remedies are innovative technologies (Bioremediation, chemical treatment, phytoremediation, etc.)
- Cumulatively, 50% of source control RODs have selected treatment

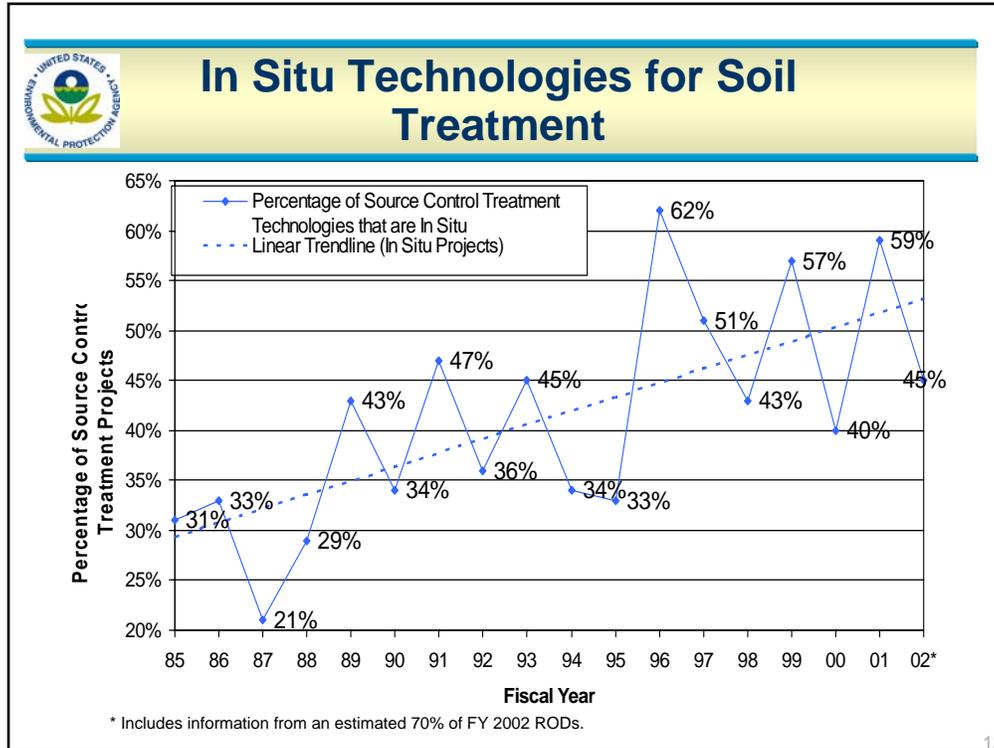


Most Common

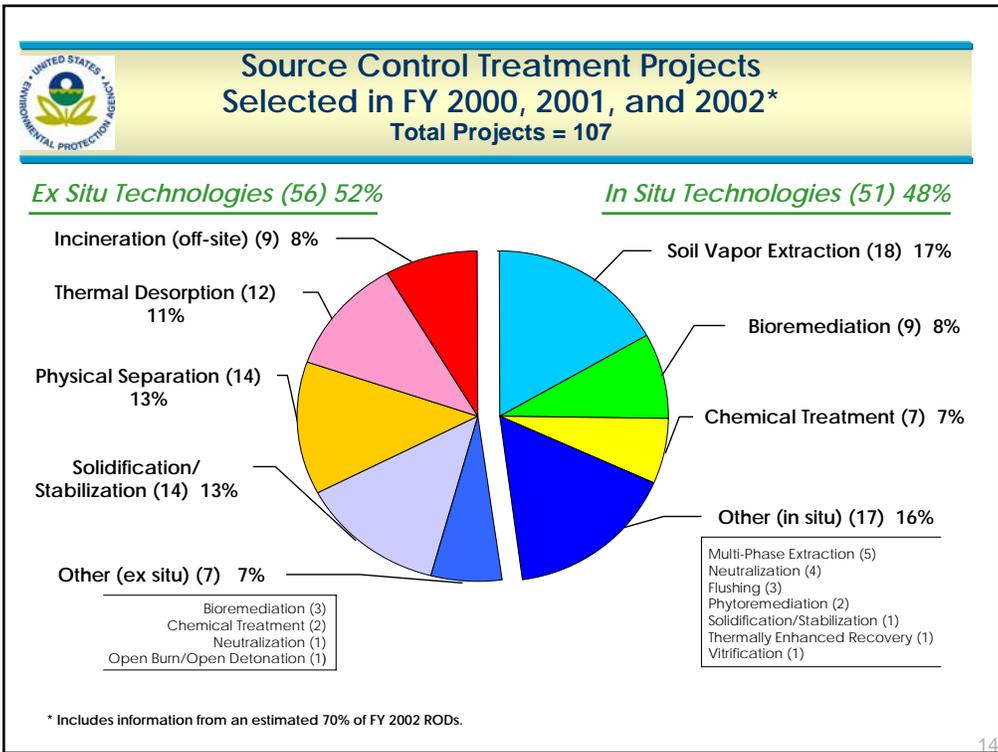
Most Innovative

Soil vapor extraction (213 projects, 25%)	Chemical treatment (12 projects, 1%)
Solidification/ stabilization (157 projects, 18%)	Phytoremediation (6 projects, <1%)
Incineration (104 projects, 12%)	Thermally enhanced recovery (8 projects, 1%)
Bioremediation (102 projects, 12%)	Multi-phase extraction (8 projects, 1%)
Thermal desorption (69 projects, 8%)	Flushing (16 projects, 2%)

- Two of the most commonly selected remedies, SVE and thermal desorption, were once considered “innovative” technologies.
- SVE is used most frequently for volatile organics, S/S is used most frequently for metals
- Incineration, bioremediation, and thermal desorption are used to treat organics
- Chemical treatment, thermally enhanced recovery, and flushing are being used more frequently to treat chlorinated volatile organic compounds and DNAPLs. There is currently some disagreement in the literature about whether chemical treatment is effective for DNAPLs or only for soil and dissolved-phase contaminants
- Phytoremediation is being used more frequently as a low-cost alternative to more aggressive technologies
- Multi-phase extraction is used most often to treat sites with LNAPLs (BTEX, petroleum hydrocarbons)



- 124 soil treatment projects have been selected since the last report (17 older projects were deleted)
- Figure 2.6 represents source control remedies, NOT groundwater remedies (covered in following slides)
- In situ remedies often address complex contamination problems such as contamination under buildings, deep underground, or over large extensions, in addition frequent cost advantages

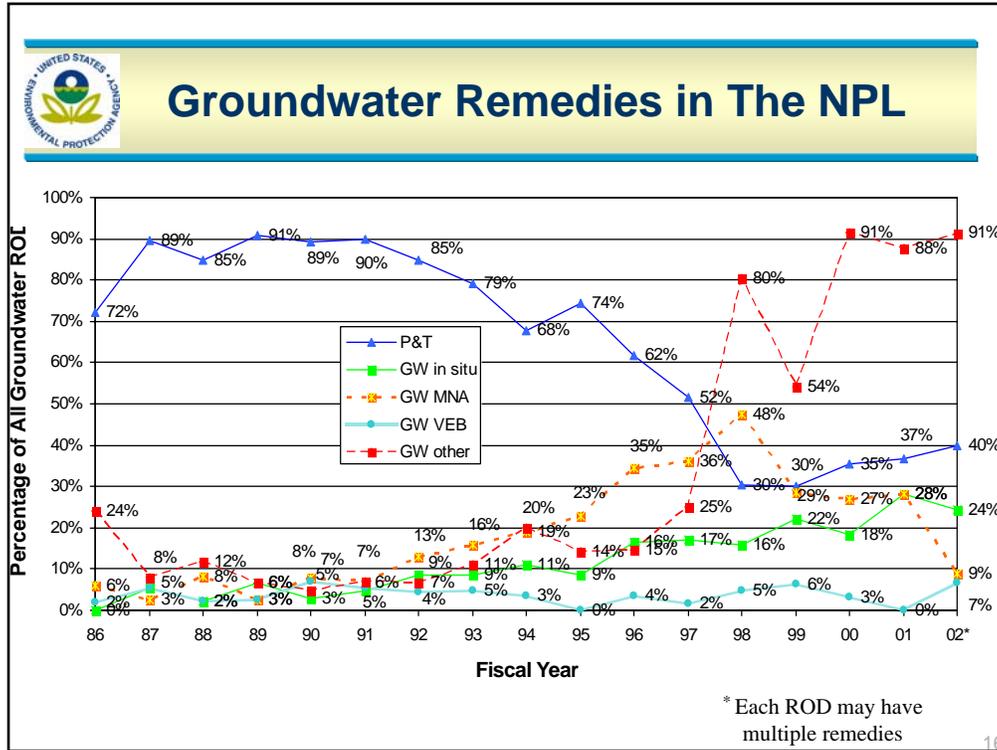




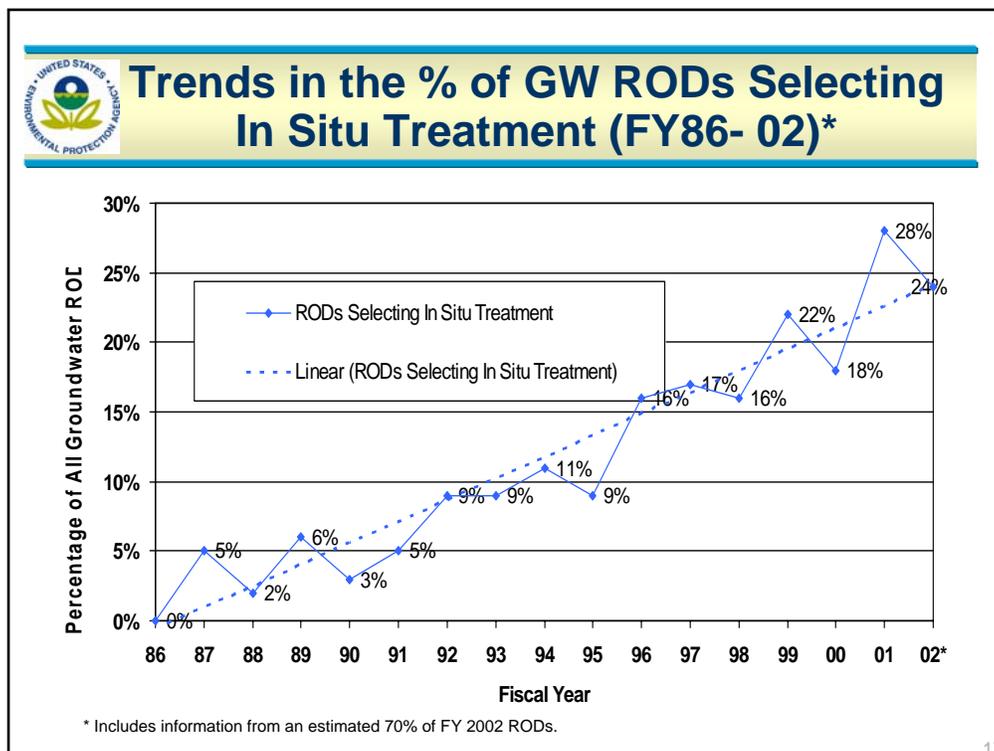
Groundwater Remedies

We've broken the P&T "monopoly"

- » In situ remedies are more mature, diverse and specific
 - In 1991, 5% in situ GW remedies; in 2002, 24%
- » Time, experience, and technology are allowing us to optimize the pumping, treating, and monitoring components of long term P&T systems.
- » As with source control, we are using a "rich" mix of remedies, with a more robust tool box to address each scenario



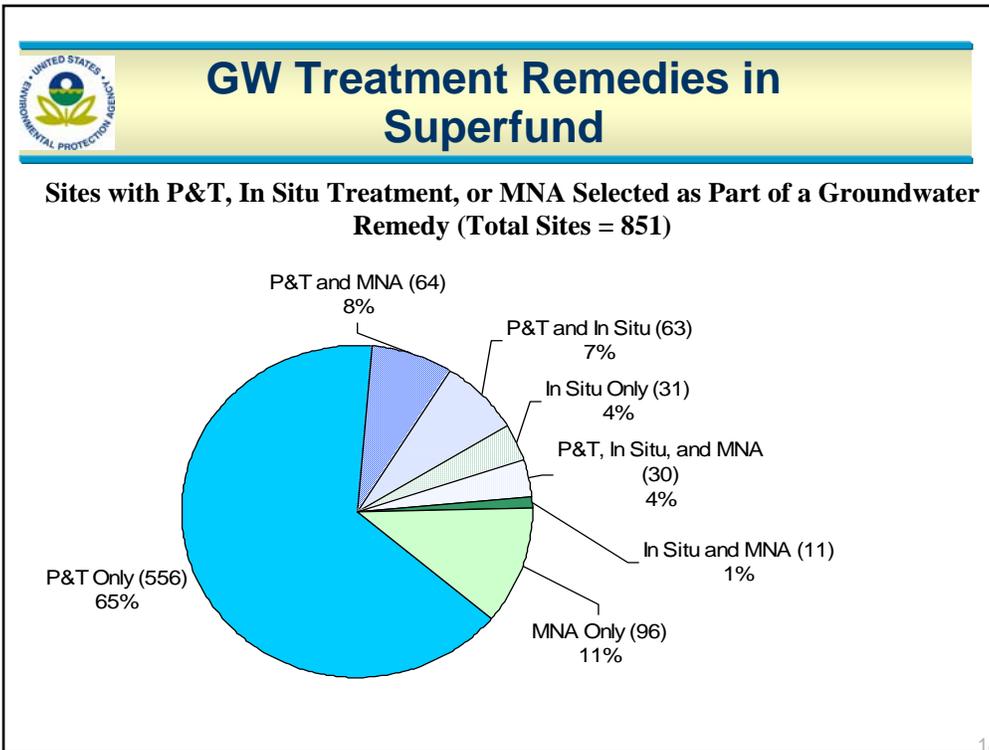
- P&T has declined as the sole remedy in RODs from 83% in 1991 to 27% in 2002
- In recent years, Groundwater RODs have a richer mix of remedies than in early years of the program
- “Other” remedies, mainly Institutional Controls, were selected in 91% of RODs in 2002, up from 20% averages before 1997
- In 2002 56% of GW RODs had some form of treatment
- Cumulatively, 73% of GW RODs have selected groundwater treatment



• In situ treatment has been experiencing a healthy growth, and stood at 24% of all GW RODs in 2002

Most common In situ Groundwater treatment technologies

- Air sparging
- Bioremediation
- Chemical treatment
- Permeable reactive barriers
- In-well air stripping





Becoming "Main Stream"; In Situ Groundwater Treatment Remedies Selected in 2000 -- 2002* N= 66

<i>Technology</i>	<i>Number of New Projects</i>
Bioremediation	21
Chemical Treatment	15
Air Sparging	10
Permeable Reactive Barrier	7
Multi-Phase Extraction	4
In-Well Air Stripping	3
Phytoremediation	3
Flushing	2
In Situ Thermal Treatment	1

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In Situ Treatment Technologies Groundwater

- Established
 - » Air Sparging (fuels, organics)
 - » Bioslurping (fuels, organics)
 - » Enhanced Bioremediation (organics, fuels)
 - » Multiphase Extraction (fuels, organics)

Permeable Reactive Barriers (metals, organics)

- Emerging
 - » Chemical oxidation (fuels, organics)
 - » Electrokinetics (metals)
 - » Phytoremediation (organics)
 - » Recirculating Wells (fuels, organics)
 - » Steam stripping (fuels, organics)



EPA REACH IT System

- Meant to be a screening tool to identify potentially applicable innovative technologies and vendors
- Open online database released in 1998
- Combined VISITT, VendorFACTs, & ITT systems into a web-based, searchable system (www.epareachit.org)
- Remediation And Characterization Innovative Technologies
- Ongoing updates and periodic streamlining efforts



Characterization/Monitoring Technologies Listed In EPA REACH IT

Acoustic Wave Chemical Sensors	Ion Mobility Spectroscopy
Air Measurement (Weather Measurement Technologies Excluded)	Laser-induced Fluorescence
Air/Gas Sampling Technologies	Magnetometry
Analytical Detectors (Stand Alone Only)	Mass Spectroscopy (may include GC/MS)
Analytical Traps	Multimedia Sampling
Borehole	Non-Specific Screening Tests
Chemical Reaction-Based Indicators (Colorimetric)	Physical Characterization
Chromatography	Resistivity/Conductivity
Direct-push	Seismic Reflection/Refraction
Downhole Sensors-Vadose Zone	Software
Electrochemical-based Detectors	Soil Gas Analyzer Systems
Electromagnetic	Soil Sampling Technologies
Fiber Optic Chemical Sensors	Solid Phase Extraction
Fourier-Transform Infrared (FTIR) Spectroscopy	Spectroscopy
Graphite Furnace Atomic Absorption	Thermal Desorption (Characterization)
Ground Penetrating Radar	Water Monitoring Technology
Immunoassays	Water Sampling Technologies
Infrared Monitors	X-Ray Fluorescence Analyzers

 Remediation Technologies Listed In EPA REACH IT	
Acid Extraction	Flushing (in situ)
Adsorption (in situ)	Fracturing - Hydraulic
Air Sparging (in situ) - Groundwater	Fracturing - Pneumatic
Bioremediation (in situ) - Lagoon	In Situ Thermal Treatment
Bioremediation (ex situ) - Biopiles	In Well Air Stripping
Bioremediation (ex situ) - Composting	Magnetic Separation
Bioremediation (ex situ) - Land Treatment	Materials Handling/Physical Separation
Bioremediation (ex situ) - Slurry Phase	Mechanical Soil Aeration
Bioremediation (ex situ) - Solid Phase	Multi-Phase Extraction
Bioremediation (in situ) - Biosparging	Off-Gas Treatment
Bioremediation (in situ) - GW	Permeable Reactive Barrier
Bioventing	Phytoremediation
Chemical Immobilization	Pump and Treat
Chemical Treatment - Groundwater	Pyrolysis
Dechlorination	Soil Vapor Extraction
Decontamination of Debris	Soil Washing
Delivery/Extraction Systems	Solidification/Stabilization
Chemical Treatment - Oxidation/Reduction	Solvent Extraction
Electrical Separation/Electrokinetics	Thermal Desorption (ex situ)
	Vitrification

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Vendor data

287 vendors

437 technologies

702 vendor projects using remediation technologies

EPA-verified data

1,811 projects at Superfund sites using remediation technologies
(ASR Data)

EPA REACH IT
REmediation And CHaracterization Innovative Technologies

EPA REACH IT, sponsored by EPA's Office of Superfund Remediation Technology Innovation (OSRTI), is a system that lets environmental professionals use the Internet to search, view, download, and print information about innovative remediation and characterization technologies.

Search EPA REACH IT

[Remediation Technologies](#)
[Site Characterization Technologies](#)

Remediation Technologies

- 289 technology vendors
- 456 technologies
- 668 vendor projects
- 1,811 Superfund projects

Characterization Technologies

- 161 technology vendors
- 243 technologies
- 186 vendor projects

Search Options

- **New Users!** [Conduct a Guided Search](#) to find specific technologies, vendors or sites quickly.
- [Conduct a Custom Search](#) to create a customized search of multiple database elements to find information on technology, vendor, and site characteristics.

For more information about searching EPA REACH IT, please go to the [Search Help](#) page.

EPA REACH IT Information Snapshots

- [Technologies by type](#)
- [Vendors by technology type](#)
- [Technologies by contaminant group](#)
- [Technologies by media type](#)

Spotlight

- [124 DNAPL treatment sites](#)
- [47 DNAPL characterization technologies](#)
- [25 in situ thermal treatment vendors](#)
- [8 New technologies added in the last 6 months](#)
- [14 Technologies updated in the last 6 months](#)

Most Common Searches

Top five technologies queried last month

- [Chemical Treatment - Oxidation/Reduction](#)
- [Thermal Desorption](#)
- [Bioremediation \(in situ\) - Groundwater](#)
- [Phytoremediation](#)
- [Solidification/Stabilization](#)

Top five contaminant groups queried last month

- [Heavy Metals](#)
- [BTEX](#)
- [PCBs](#)
- [Halogenated Volatiles](#)
- [Polynuclear Aromatic Hydrocarbons \(PAHs\)](#)



EPA REACH IT

REmediation And CHaracterization Innovative Technologies



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Data Entry

Select search criteria using the picklists, then click on the "Search >>" button to view the results. Hold down the Control (Ctrl) key to select more than one item from a list. The search logic is < OR > within a picklist, < AND > between pick lists. Use the check box to limit search results to technologies with example projects. Use the radio buttons to limit your search to EPA-Supplied or Vendor-Supplied data only. Click on the "Show More Criteria" button to search by technology trade name, vendor name, site name, or site type. Click on the "Reset" button to clear your selections.

Technology
Acoustic Wave Chemical Sensors
Air Measurement (Weather Measurement Technologies Excluded)
Air/Gas Sampling Technologies
Analytical Detectors (Stand Alone Only)
Analytical Traps
Bio-uptake Sampling
Borehole

Scale
Full Scale
Pilot Scale

Contaminant Group
Acetonitrile (organic cyanide)
Asbestos
BDD/COO
Bedrock Stratigraphy
Benzene-toluene-ethylbenzene-xylene (BTEX)
Buried Ferrous Materials
Buried Non Ferrous Materials

Contaminant
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene (DCE)
1,2,3,4-Tetrachlorodibenzo-dioxin (TCDD)
1,2,4-Trichlorobenzene

Media
Air particulates and aerosols
Air vapors
Aqueous sample (ex situ)
Debris (buildings, structures, or equipment)
Dense nonaqueous phase liquids (DNAPL) [in situ]
Fractured rock
Groundwater (ex situ)

Include only technologies with project data

Include only EPA-supplied data
 Include only vendor-supplied data
 Include both EPA-supplied and vendor-supplied data

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http://www.ttclients.com/www_reachit_new/ - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www.ttclients.com/www_reachit_new/

EPA REACH IT
REmediation And Characterization Innovative Technologies

Jump to CLU-IN

SUMMARY: 56 Vendors 67 Technologies Downloadable Spreadsheets
101 Vendor Source Sites 23 EPA Source Sites [-select report-]

SEARCH CRITERIA: (Media = "Dense nonaqueous phase liquids (DNAPL) (in situ)")
Modify Search New Search Save Search

Click on a checkbox to delete a search criteria.

Filters: Include technologies without project data
Include both EPA-supplied and vendor-supplied data

Click on a vendor, technology, or site to view detailed information.

Vendor	Technology	Site
ARS Technologies, Inc.	Air Sparging (in situ) - Groundwater-Pneumatic Fracturing Extraction (PFE)	Electroplating Industrial Site
		Former Manufacturing Facility
		Military Base
	Bioremediation (in situ) - Groundwater-Pneumatic Fracturing Extraction (PFE)	Electroplating Industrial Site
		Former Manufacturing Facility
		Military Base
	Bioremediation (in situ) - Lagoon-Pneumatic Fracturing Extraction (PFE)	Confidential - Manufacturing Site

Start Con... Carl... par... Wor... EPA... Micr... Yah... htt... http... Internet 6:00 PM

The screenshot shows a Microsoft Internet Explorer browser window displaying the EPA REACH IT website. The address bar shows the URL: http://www.ttclients.com/www_reachit_new/. The website header features the EPA logo and the text "EPA REACH IT" with the subtitle "REmediation And CHaracterization Innovative Technologies". A navigation menu on the left includes links for Home, Search, EPA REACH IT, About EPA REACH IT, What's New, Help, F.A.Q.s, Definitions, Feedback, Website Stats, Related Links, Disclaimer, Download Fact Sheet, Vendors Index, Technologies Index, Site Index, and Data Entry. The main content area is titled "Verification Program Information" and contains three checkboxes: "This technology is being tested, or has been tested, in EPA SITE Emerging Technology Program." (with "EPA Project Manager: Information not available" and "SITE Document Number(s): Information not available"), "This technology is being tested, or has been tested, in EPA SITE Demonstration Program.", and "Other Verification Program." Below this is the "Description of Technology:" section, which describes Pneumatic Fracturing Extraction (PFE) as a process developed by Accutech Remedial Systems, Inc. (ARS) and the New Jersey Institute of Technology (NJIT). It details how PFE uses controlled bursts of high pressure air to create fractures in the ground, allowing for more efficient removal of contaminants. A paragraph below states that PFE has been used in conjunction with various in situ remediation technologies such as soil vapor extraction, dual vapor extraction, bioremediation, bioventing, hot-gas injection, free product recovery, ground water pump and treat systems, and infiltration gallery enhancement. The "Technology Limitations:" section is partially visible at the bottom of the page. The browser's taskbar at the bottom shows several open applications and the system clock indicating 6:07 PM.

Hazardous Waste Clean-Up Information (CLU-IN): Providing information about innovative treatment - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://clu.in.org

EPA United States Environmental Protection Agency Technology Innovation Program

Comments Site Map EPA Home Home

CLU-IN Search

Hazardous Waste Clean-Up Information Friday September 16, 2005 76 Active Users

CLU-IN Spotlight

Permeable Reactive Barriers for Inorganic and Radionuclide Contamination

This document was prepared by Kate Bronstein, a National Network of Environmental Management studies grantee, under a fellowship from the U.S. Environmental Protection Agency. This paper is meant to be an updated reference for project managers, engineers, students, and others interested in a review of case studies of the instances where permeable reactive barriers have been used to remediate sites contaminated with inorganics and radionuclides. This paper mainly focuses on case studies, but a brief overview is given on topics such as: treatment media types, reactive processes, site characterization, configuration, and the nature of contamination.

Download (753K/63pp/PDF)

View All 5 Items in the CLU-IN Spotlight

CLUIN.org

Start Disconnected - BlackBerry... Hazardous Waste Clea... Pachon Consol Briefing.ppt 3:54 PM

TechDirect

Technology Information Service

Highlights

- Broadcasts monthly e-mail messages to a list of over 21,000.
- Highlights events of interest to site remediation and site assessment professionals.
- Describes new products and provides instructions on how to obtain them.

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