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Phytoremediation of Organics Action Team

RTDF

Remediation Technologies Development Forum

Current RTDF Action Teams

- Bioremediation Consortium
- IINERT Soil-Metals Action Team
- Permeable Reactive Barriers Action Team
- Phytoremediation of Organics Action Team
- Sediments Remediation Action Team

The Phytoremediation of Organics Action Team, established in 1997, is one of the five current Action Teams under the Remediation Technologies Development Forum (RTDF). The U.S. Environmental Protection Agency (EPA) created the RTDF in 1992 to foster collaboration between the public and private sectors in developing innovative solutions to mutual hazardous waste problems. The Phytoremediation of Organics Action Team includes representatives from industry, government, and academia who share an interest in further developing and validating the of use of plants and trees to remediate organic hazardous wastes in soil and water.

Phytoremediation Processes

Phytoremediation is the use of certain plants to clean up soil, sediment, and water contaminated with metals and/or organic contaminants such as crude oil, solvents, and polyaromatic hydrocarbons (PAHs). It is a name for the expansion of an old process that occurs naturally in ecosystems as both inorganic and organic constituents cycle through plants. Plant physiology, agronomy, microbiology, hydrogeology, and engineering are combined to select the proper plant and conditions for a specific site. Phytoremediation is an aesthetically pleasing mechanism that can reduce remedial costs, restore habitat, and clean up contamination in place rather than entombing it in place or transporting the problem to another site.

Phytoremediation can be used to clean up contamination in several ways:

- **Degradation by plants.** Organic contaminants are absorbed inside the plant and metabolized (broken down) to non-toxic molecules by natural chemical processes within the plant.
- **Extraction.** Plant roots can remove metals from contaminated sites and transport them to leaves and stems for harvesting and disposal or metal recovery through smelting processes.
- **Microorganism stimulation.** Plants excrete and provide enzymes and organic substances from their roots that stimulate growth of microorganisms such as fungi and bacteria. The microorganisms in the root zone then metabolize the organic contaminants.
- **Volatilization.** Plants take up water and organic contaminants through the roots, transport them to the leaves, and release the contaminants as a non-toxic gas (called volatilization) into the atmosphere.

- **Stabilization.** Plants prevent contaminants from migrating by reducing runoff, surface erosion, and ground-water flow rates. "Hydraulic pumping" can occur when tree roots reach ground water, take up large amounts of water, control the hydraulic gradient, and prevent lateral migration of contaminants within a ground water zone.

Phytoremediation can be used in combination with other traditional and innovative remediation technologies. Cleanup can be accomplished to depths within the reach of plants' roots. Sites need to be maintained (watered, fertilized, and monitored) and results are slower (3+ years) than mechanical excavation methods. "Attractive nuisance" and food chain issues must be considered at each site and care taken to avoid unwanted exposure of wildlife. Cost savings compared to traditional remediation can range from 20 to 80 percent.

The Action Team's Mission

The Action Team's mission is to bring together technological, environmental, and regulatory interests to develop and demonstrate phytoremediation technologies that can clean up soils and ground water contaminated with organics, and to achieve regulatory and public acceptance of these technologies.

The Action Team's Goals

The Action Team's goals are to:

- Assess the status of current phytoremediation research
- Identify and determine ways to address key research gaps
- Facilitate validation of phytoremediation technologies
- Determine appropriate uses of phytoremediation

Accomplishments

The Action Team selected three contaminant/media combinations to explore as possible phytoremediation case studies and formed subgroups to investigate issues and develop strategies for addressing them. These are:

- Trichloroethylene (TCE) in Ground Water
- Total Petroleum Hydrocarbons (TPH in Soil)
- Alternative Covers (long-term, self-sustaining, low-maintenance plant covers, growing in or over materials that pose environmental risk, that serve to reduce this risk)

The Action Team has developed a large bibliography of peer-reviewed journal articles, presentations and posters from conferences, book chapters, and articles from newspapers and magazines. The bibliography contains nearly 1,450 citations on phytoremediation or closely related subjects. This bibliography is available in searchable format on the Action Team's home page on the RTDF World Wide Web site. It is updated quarterly.

In addition, the TPH in Soil Subgroup is creating a standardized field test protocol for determining the efficacy of agricultural and non-crop plants for degradation of petroleum hydrocarbons in soil at multiple locations and under varied climatic conditions. A working draft of the protocol, entitled "Phytoremediation Action Team Field Study Protocol, May 29, 1998 ," is available on the Action Team's home page on the RTDF World Wide Web site.

The Action Team's Plans

The Action Team plans to standardize protocols for phytoremediation site evaluation, designs for implementation, and monitoring for efficacy/risks; and determine what regulators need to know to approve phytoremediation.

Action Team Members

The Action Team includes representatives from industry, government, non-profit, and academic organizations, such as the following:

Industry

Amoco Research Center
ARM Group
Chevron
Exxon
Goodyear, Inc.
ManTech
Microbial Insights, Inc.
Phillips Petroleum Co.
PPG, Inc.
Rohm and Haas Company
Science Applications Intel Corp
ThermoRetec, Inc.
Union Carbide Corporation

Government

Argonne National Laboratory
California Environmental Protection Agency
California Integrated Waste Management Board
California Regional Water Quality Control Board
California Regional Water Resources Control Board
City of Cincinnati
Pacific Northwest National Laboratory (PNNL)
U.S. Department of Energy
U.S. Environmental Protection Agency
University of Wisconsin
U.S. Army
U.S. Air Force
U.S. Department of Energy
U.S. Environmental Protection Agency
U.S. Navy

Academia

Desert Research Institute
Kansas State University
University of Arkansas
University of Oklahoma
University of Tennessee
University of Washington
University of Wisconsin

OTHER PHYTOREMEDIATION RESOURCES

Phytoremediation Bibliography
http://www.rtdf.org/public/phyto/phytobib/biba-b.html

Phytoremediation of Petroleum Hydrocarbons in Soil Field Study Protocol
http://www.rtdf.org/public/phyto/protocol.htm

Phytoremediation of TCE in Groundwater using Populus
http://clu-in.org/products/phytotce.htm

Phytoremediation Research
U.S. Army Corps of Engineers, Waterways Experiment Station
http://www.wes.army.mil/el/phyto/

Phytoremediation Mailing List for the discussion of research and development of phytoremediation
http://www.engg.ksu.edu/HSRC/phytorem/

Phytoremediation Electronic Newsgroup Network (PHYTONET)
http://www.dsa.unipr.it/phytonet/

RTDF

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Would You Like More Information?

For more information about the Phytoremediation of Organics Action Team, please contact the Team Co-chairs:

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For information on the RTDF or other Action Teams, please visit the RTDF World Wide Web site at www.rtdf.org or contact:

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