

## EVALUATING NATURAL ATTENUATION AS A CLEANUP REMEDY

*Natural attenuation refers to a collection of processes (such as biodegradation, diffusion, dilution, sorption, volatilization, chemical or biological stabilization) that reduce the toxicity, mobility, or volume of contaminants to a level that protects human health and the environment. EAD is evaluating the use of natural attenuation as a cleanup remedy at U.S. Department of Energy (DOE) and U.S. Department of Defense (DoD) sites.*

### ■ PROBLEM/OPPORTUNITY

Even under ideal circumstances, the operation of “engineered” remediation systems can reach a point of diminishing returns. For example, it becomes increasingly difficult to capture and treat a groundwater plume the farther it gets from the contamination source. Under certain contamination scenarios, natural attenuation can function as a cost-effective complement to the more active remediation technologies and address the recalcitrant portions of a migrating plume. Before natural attenuation can be proposed and accepted for a site, critical soil and groundwater data must be collected and evaluated to document that intrinsic remediation processes are occurring and to predict the effectiveness of contaminant reduction over time.

### ■ APPROACH

EAD is evaluating the efficacy of using natural attenuation to clean up groundwater contaminated with chlorinated and nonchlorinated organic compounds. The subjects of the natural attenuation studies include contaminated groundwater at the J-Field site, Aberdeen Proving Ground in Maryland, Fuel Bladder Testing Site at Yuma Proving Ground (YPG) in Arizona, and Weldon Spring Chemical Plant Area in Missouri.

To determine if natural attenuation is occurring, EAD studies two lines of evidence. It determines if contaminant concentrations are decreasing

along flow paths downgradient from the contamination source, and it determines if the contaminant mass at the site is decreasing. To ensure that the mass is getting smaller as a result of biodegradation and not just dilution, EAD examines chemical and geochemical analytical data to see if parent compound concentrations are decreasing, progeny compound concentrations are increasing, electron acceptors and donors are being depleted, and metabolic by-product concentrations are increasing.

Selecting natural attenuation as a remedy requires a comprehensive understanding of the mechanisms that act on the contaminant plume. To obtain data on these mechanisms, EAD collects samples from selected monitoring wells and analyzes them to discern ongoing chemical, physical, and microbial processes. Special groundwater purging and sampling techniques are used to minimize any perturbations these activities might cause in natural attenuation parameters. For example, key dissolved gases (including hydrogen, oxygen, carbon dioxide, ethane, methane, and ethene) are typically collected from a gas sampling bulb or in a flow-through sampling device and analyzed.

### ■ RESULTS

At J-Field, EAD collected samples that showed that under anaerobic conditions in freshwater marsh sediments, contaminants and chlorinated organics (ethanes and ethenes) are dechlori-

nated (biodegraded) into harmless ethylene and ethane gases. Because the contaminated groundwater in these organic-rich, sulfate-reducing marsh sediments and underlying aquifer undergoes seasonal flow reversals (flowing upward in spring and downward in summer and fall), it resides for a longer time than it would in the absence of such flow reversals. The natural dechlorination process could be used to complement a pump-and-treat system at the site.

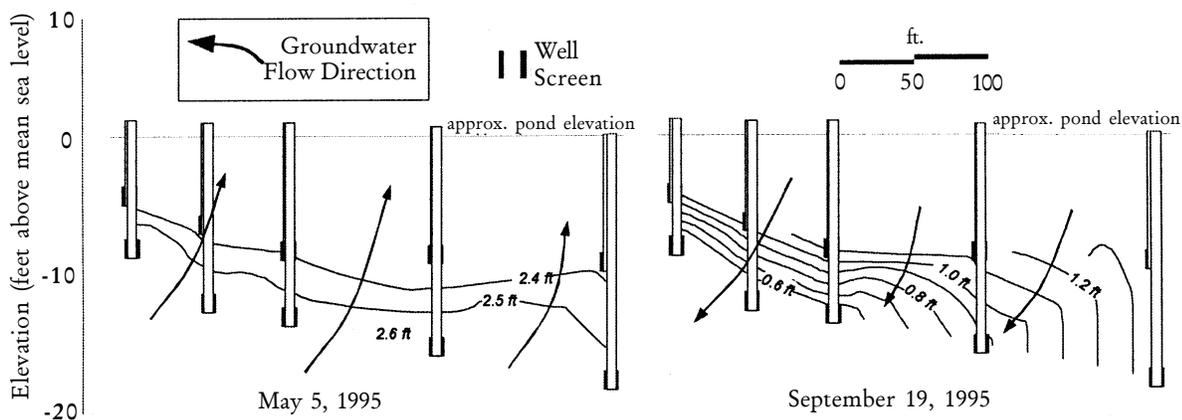
At YPG, studies are under way to determine if natural attenuation could be part of a remedial action to clean up a gasoline spill under dry aerobic conditions. At the Weldon Spring Chemical Plant Area, monitored natural attenuation is being considered as a remediation alternative in a feasibility study for DOE. Preliminary results for site-specific conditions indicate that natural attenuation of trichloroethane (TCE) at this site may not be appropriate because of low degradation rates.

## ■ FUTURE

EAD intends to continue developing data collection and visualization techniques for determining the presence of natural attenuation and predictive natural attenuation models. EAD also expects to continue helping DoD and DOE demonstrate the efficacy of natural attenuation at other sites in the weapons and defense complex.

## ■ COMMUNICATION OF RESULTS

Reports describing EAD's natural attenuation work have been provided to the DOE and DoD sponsors. An EAD staff member conducted a session at DOE's 10th National Technology Information Exchange (TIE) Workshop on Marsh Hydrology and Its Effect on the Natural Attenuation of Solvents. A paper was presented at the American Society of Civil Engineers Water Resources Planning and Management Conference.



Groundwater in freshwater marsh sediments flows upward in a typical wet spring season (left) and downward in typical dry summer and fall seasons (right).

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