Successful In Situ Anaerobic Biodegradation of Chlorinated Solvents

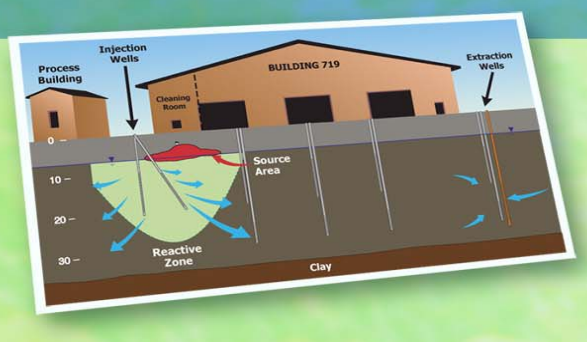
Building 719 Dover AFB Delaware

Aleisa C. Bloom
Oak Ridge National Laboratory
Base Technical Support Manager

George DeLong
Oak Ridge National Laboratory
Base Technical Support Manager

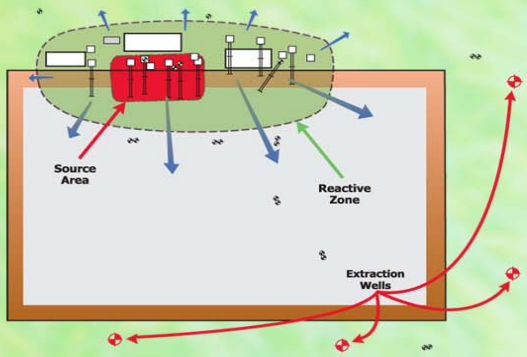
Robert Lyon
URS
Project Manager, Senior Hydrologist

Bert Buell
URS
Project Scientist



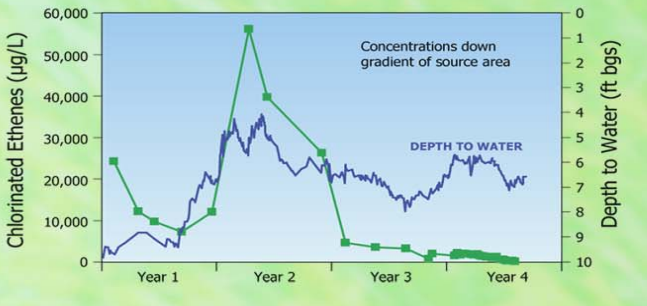
Conceptual Model

The AAB system establishes hydraulic control in the source area by recirculating groundwater through injection and extraction wells located upgradient and downgradient of Building 719. By adding a carbon substrate (sodium lactate) and metabolic nutrients (dibasic ammonium phosphate) to groundwater as it is reinjected, the AAB system enhances the natural microbial activity that reductively dechlorinates chlorinated solvent contaminants, thereby rendering them innocuous.



AAB Site at Dover Air Force Base

In a collaboration between Oak Ridge National Laboratory (ORNL), Environmental Science Division and URS, in situ accelerated anaerobic biodegradation (AAB) has been successfully demonstrated at the Building 719 site at Dover Air Force Base (DAFB), DE. Since February 2002, the system has treated a chlorinated solvent source area that contributed to a dissolved groundwater plume extending approximately 1 mile downgradient from the source. Trichloroethene (TCE) is the primary contaminant at the site, with concentrations as high as 280,000 parts per million in the shallow soil and 21,000 parts per billion in the shallow groundwater. Tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), and their breakdown products were also detected, but at lower concentrations.



Desorption of Source Mass

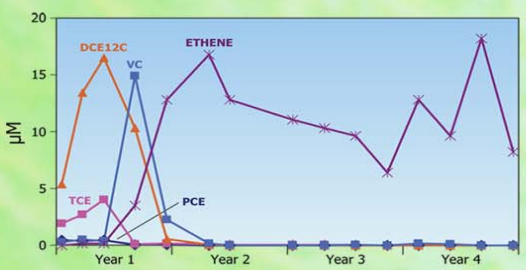
At the end of Year 1, high water table conditions raised water levels and increased the mass of chlorinated solvents partitioning into groundwater from the source area. Chlorinated ethene (PCE, TCE, cis-1,2-dichloroethylene (DCE), and vinyl chloride [VC]) concentrations in source area monitoring wells rose an order of magnitude in groundwater during this time. Seizing on this opportunity to enhance biological activity and the "biosurfactant" conditions generated by bacteria, ORNL and URS injected excess carbon substrate into the system while the water table was high. Biosurfactants promote solvent partitioning into groundwater from aquifer solids, thereby improving cleanup rates and efficiency.

An estimated 1,222 pounds (116 gallons) of TCE were desorbed from the source area during the first 4 years of system operations. When the water table rose again in Year 3, no increase in chlorinated solvent concentrations was observed; this provides evidence that a significant portion of the source mass was removed from the shallow source area in Year 1 and Year 2.

Reductive Dechlorination of Contaminants

Reductive dechlorination is a stepwise process of chlorine atom replacement with hydrogen via oxidation-reduction (redox) reactions. PCE degrades to TCE, which degrades to DCE, which degrades to VC, which degrades to ethene

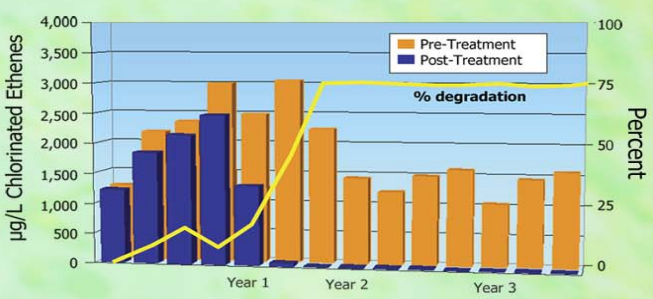
Stoichiometric Degradation



Molar concentration graphs of PCE, TCE, cis-1,2-DCE, VC, and ethene in the monitoring wells downgradient of the reactive zone demonstrate stoichiometric degradation of PCE and TCE by the end of the first year of system operation.

Mass Destruction Effectiveness

Comparison of contaminant concentrations in groundwater before and after treatment in the reactive zone provides a rate of contaminant destruction. After 1 year of system operations, more than 98 percent of the PCE, TCE, cis-1,2-DCE, and VC reinjected through the reactive zone was degraded to ethene. An estimated 24 gallons (294 pounds) of TCE was degraded to ethene during the first 4 years of system operation.



Oak Ridge National Laboratory
Environmental Sciences Division
Bldg. 1505, Rm. 222, MS-6036
P.O. Box 2008
Oak Ridge, Tennessee 37831

URS
200 Orchard Ridge Drive
Suite 101
Gaithersburg, Maryland 20878