

## Integrated Approach to PCE-impacted Site Characterization, Site Management and Enhanced Bioremediation

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Tetrachloroethene (PCE) and trichloroethene (TCE) impacted sites pose significant bioremediation challenges even when site characterization activities suggest that biodegradation is occurring naturally. Although site-specific, regulatory, and economic factors play roles in the remedy selection process, evaluation of remedial alternatives should be science-driven and follow a tiered approach from small scale studies to screen bioremediation options (MNA, biostimulation, and bioaugmentation) to larger, more focused testing for design/scale-up purposes. This case study summarizes six years of routine biological testing at one site. *In situ* microcosms with Bio-Trap® samplers were used to evaluate bioremediation options, then to monitor a small scale biostimulation pilot test, and finally to routinely monitor the progress a large scale bioremediation since 2003. This biological data set represents one of the most comprehensive to date and provides insights on the value of integrating molecular biological testing into the bioremediation design processes and routine bioremediation progress monitoring.

The case study was performed at a PCE-impacted site at which naturally occurring reductive dechlorination of PCE and TCE had led to accumulation of *cis*-dichloroethene (*cis*-DCE) concentrations ranging from approximately 10 to 100+ mg/L. Bio-Trap® samplers and quantitative polymerase chain reaction (qPCR) enumeration of *Dehalococcoides* spp. were used to evaluate biostimulation with HRC®, and HRC-S. *Dehalococcoides* populations in HRC-S amended Bio-Traps deployed in impacted wells were on the order of  $10^3 - 10^4$  cells/bead but were below detection limits in most unamended and HRC amended Bio-Traps. Thus the *in situ* Bio-Trap study identified biostimulation with HRC-S as the approach to pilot study. After the pilot HRC-S injection, *Dehalococcoides* populations increased to  $10^6 - 10^7$  cells/bead and concentrations of *cis*-DCE and vinyl chloride decreased with concurrent ethene production. Based on these results, a large scale HRC-S injection was proposed as the site remedy and quickly approved by the regulator based on the pilot results. As with the pilot study, the large scale HRC-S injection promoted growth of *Dehalococcoides* spp. and stimulated reductive dechlorination of *cis*-DCE and vinyl chloride. Ongoing biological monitoring at the site has demonstrated that the bioremediation in place remains robust.