Source Removal and In-Situ Treatment of TCE and Cr+6 Towards Closure Under RCRA Corrective Action

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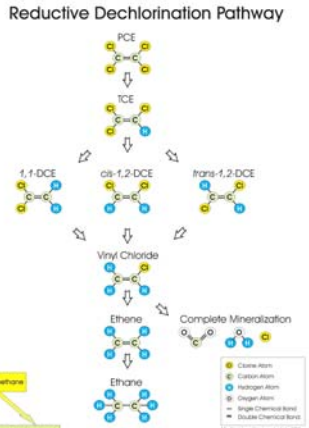
In-situ Reductive Bioremediation (ISRB)

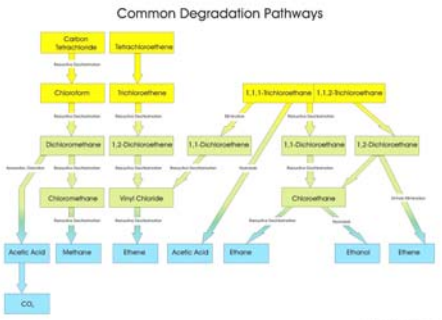
A manufacturing facility in East Tennessee was a former RCRA permitted treatment, storage, and disposal facility with surface lagoons, solvent degreasers, drum storage areas, a waste oil pit, and two TCE underground storage tanks (USTs). Multiple groundwater plumes extended off site and an ineffective groundwater pump and treat contaminant system suggested decades of cleanup operations ahead.

Insitu Reductive Bioremediation was selected as the remedial method that would get the site to closure more efficiently under the facilities RCRA Corrective Action Program.

Reductive Dechlorination

- Bench scale treatability studies performed in Earth Tech's Pueblo Colorado facility
- Optimized reductive substrate and defined engineering design parameters for effective reductive dechlorination process
- Field pilot testing in three areas, 150 foot long rows perpendicular to groundwater flow
- Drove the aquifer anoxic from oxygen reduction potential (ORP) levels of up to 270 to levels as low as –262 within the first 3 months
- Significant rainfall caused temporary re-oxidation of aquifer, which lasted several months
- Three additional injections: sodium lactate upgradient of the plant building to allow relatively rapid migration of the electron donor under the building, and HRC© along the property line and off site for longevity
- Implemented continuous feed injections inside of the building
- Cr+6 reduction in the area of the closed lagoons has been slower than anticipated
- Calcium polysulfide injections planned





TCE Source Investigation

- TCE releases attributed to three former TCE vapor degreasers
- Membrane Interface Probe (MIP) sampling confirmed vertical distribution of chlorinated VOCs: widespread under the building, extended to the water table at high concentrations, decreased at the water table, showed no increase with depth in saturated soils, and declined to below detection limits above bedrock
- No evidence of DNAPL below water table

TCE Source Removal

- Designed and installed Soil Vapor Extraction (SVE) through the building floor. Operated for a year, reducing the original impacted area to non-detects and removing more than 3,000 pounds of VOCs. (See graph below)
- The system operated until extracted soil vapor levels dropped to below 42 ug/L, a model derived trigger value protective of groundwater

Groundwater Remedial Action

- Injected Sodium Lactate and HRC
- ORP driver is negative
- Complete reduction noted

Groundwater Results

- Significant success in reducing the volume of the plume above 0.100 mg/L from combination of SVE, Pump & Treat (P&T), and ISRB. Graph below depicts P&T removal.
- Maximum TCE concentration reduced from 121 mg/L to 0.298 mg/L in just 4 years
- Figures at right depict the changes in the TCE groundwater plume since 1998, prior to source removal and reductive dechlorination activities, through January 2006

Chromium Source Identification/Remediation

- Two hexavalent chromium sources: a leaking pipe under the chrome plating sump, and a second source near the closed lagoons
- Sodium lactate and HRC substrate injections have created conditions to chemically reduce hexavalent chromium to trivalent chromium, but hydrogeologic conditions have not permitted complete remediation at the closed lagoons
- The maximum total chromium level immediately downgradient of the plating shop has been reduced from 6.01 mg/L to 0.05 mg/L.
- Remediation at the closed lagoons is occurring at a slower rate than at other portions of the site

Remedial Action Completion Strategy

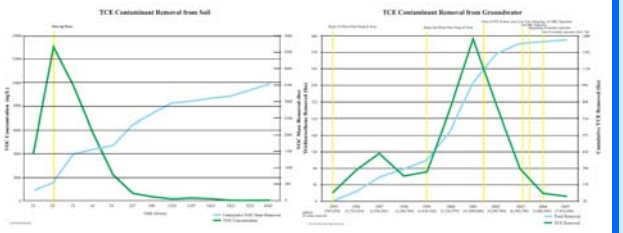
For TCE in groundwater:

- Continue substrate injections beneath building
- When TCE levels drop below MCLs, stop injecting and monitor until the aquifer reaches remedial goals, possible future MNH if necessary.
- Continued localized injections to address recalcitrant areas

For Closed Lagoons:

- Continue to monitor to await restoration of natural conditions
- Possible injection of recalcitrant areas, Calcium polysulfide injections being considered
- Reduce monitoring to biennial frequency

Contaminant Mass Removal



TCE Plume Reduction

1998-Plume Definition

2000-Addition of Pump & Treat

2002-Addition of SVE

2004-Addition of HRC© Injections

2005-Addition of Monthly Sodium Lactate Injections

2006-Addition of Continuous Sodium Lactate Injections