

# Effectiveness of an Advanced Electron Donor Application at a Dry Cleaner Site

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## SITE DESCRIPTION

Operations at a dry cleaning facility in Illinois resulted in elevated levels of chlorinated ethenes in the subsurface. In particular, downgradient of the source, total chlorinated compounds were over 6,400 micrograms per liter (ug/L) in MW-4. Sampling revealed no trace of cis-1,2-dichloroethene (cis-DCE) or vinyl chloride (VC) indicating that reductive dechlorination was not occurring within the subsurface.

- **Contaminated Thickness** - 10 feet
- **GW Velocity** - <0.1 ft/day
- **Soil Type** - Clay
- **Depth to GW** - 10 feet

Table 1. MW-4 Pre-Treatment Concentrations and Cleanup Goals (ug/L)		
Contaminant	Concentration	Cleanup Goals
PCE	5,680	5
TCE	301	5
Cis-DCE	474	70
VC	Non-Detect	2

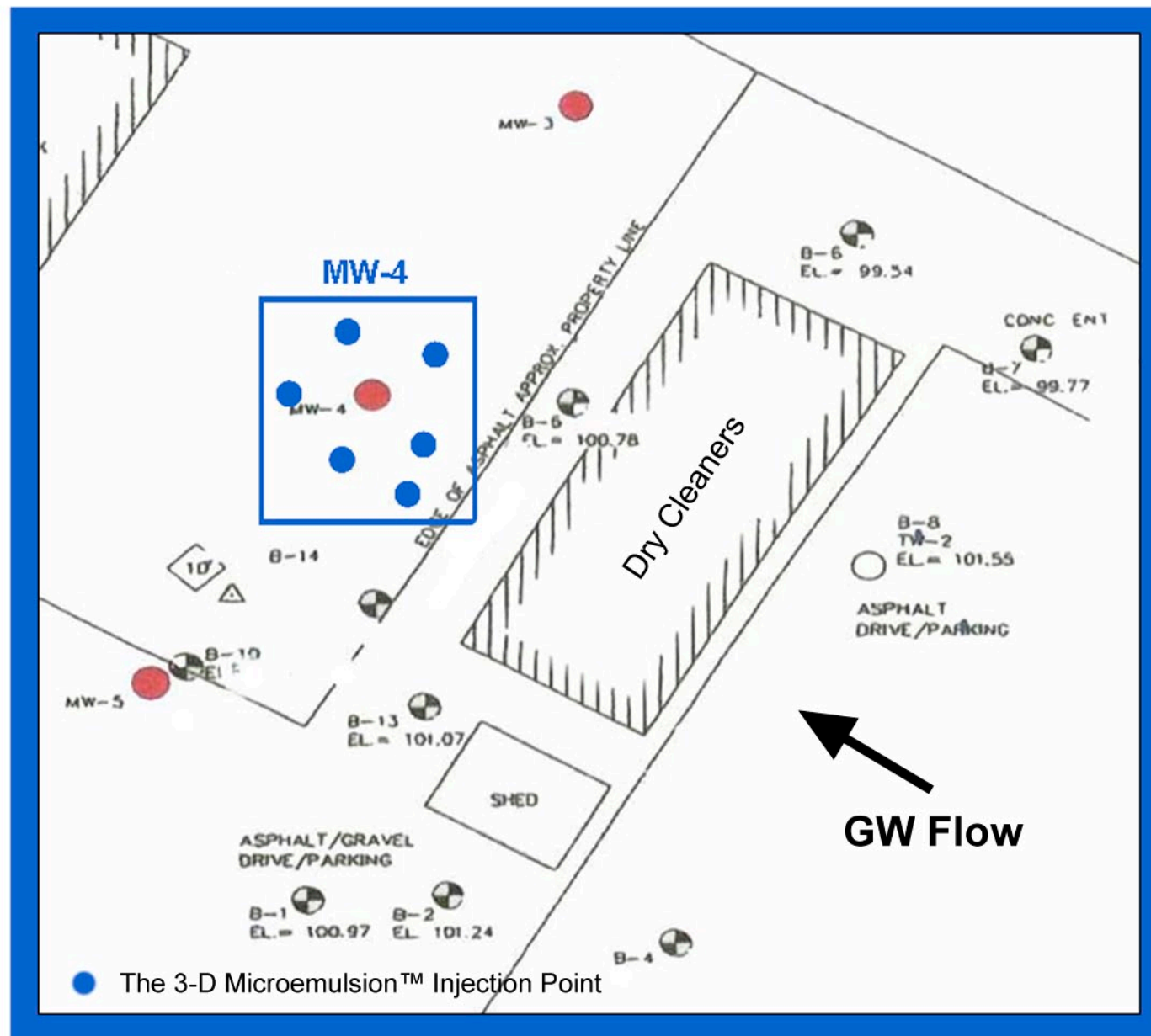


Figure 1. Pilot Test Application Design Around Well MW-4

## REMEDIAL DESIGN

A pilot test design was completed to reduce chlorinated solvent concentrations around well MW-4. A new formulation of HRC<sup>®</sup>, 3-D Microemulsion<sup>™</sup>, was applied as a microemulsion with water for enhanced distribution. The microemulsion solution was created using a ratio of 10:1 (water:3-D Microemulsion<sup>™</sup>). This microemulsion was injected from 10–20 feet bgs into 6 injection points encircling MW-4. Each injection point was placed about 10 feet away from the monitoring well (Figure 1).

The 3-D Microemulsion<sup>™</sup> pilot was conducted 18 months after a standard HRC application was mistakenly applied to a treatment zone twice the size it was designed to treat. Consequently, the under-dosed treatment area only showed moderate performance and was carbon deficient in September 2005.

## TECHNOLOGY DESCRIPTION

### Hydrogen Release Compound (HRC<sup>®</sup>)

HRC<sup>®</sup> is a controlled-release, polylactate ester mixture formulated to slowly release lactic acid upon hydration. When placed into a contaminated aquifer, the lactic acid from HRC<sup>®</sup> enhances a multi-step process known as reductive dechlorination.

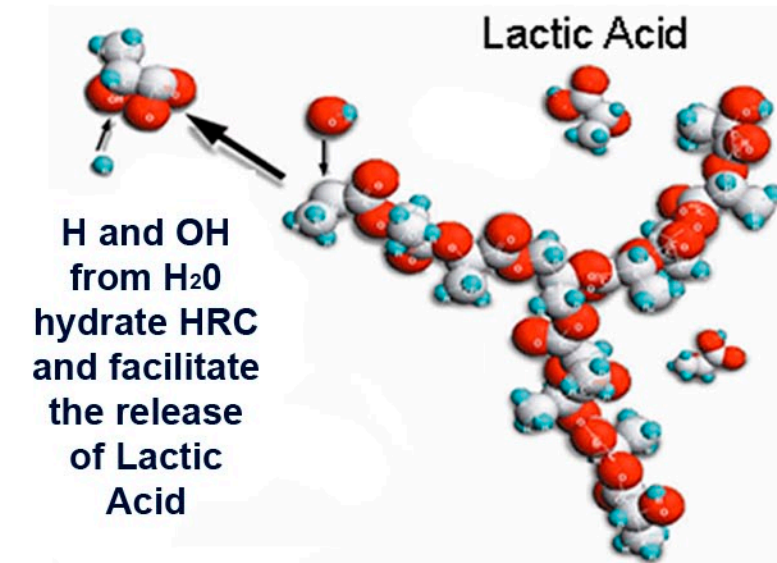


Figure 2. The HRC Molecule Structure

### 3-D Microemulsion<sup>™</sup>

3-D Microemulsion<sup>™</sup> is composed of free lactic acid, controlled-release lactic acid (polylactate) and certain fatty acid components. The immediately available free lactic acid is fermented rapidly while the controlled-release lactic acid is metabolized at a more gradual rate. The fatty acids are converted to hydrogen over a mid to long-range timeline giving the 3-D Microemulsion<sup>™</sup> an exceptionally long electron donor release profile. This staged fermentation provides an immediate, mid-range and very long-term, controlled-release supply of hydrogen to fuel the reductive dechlorination process.

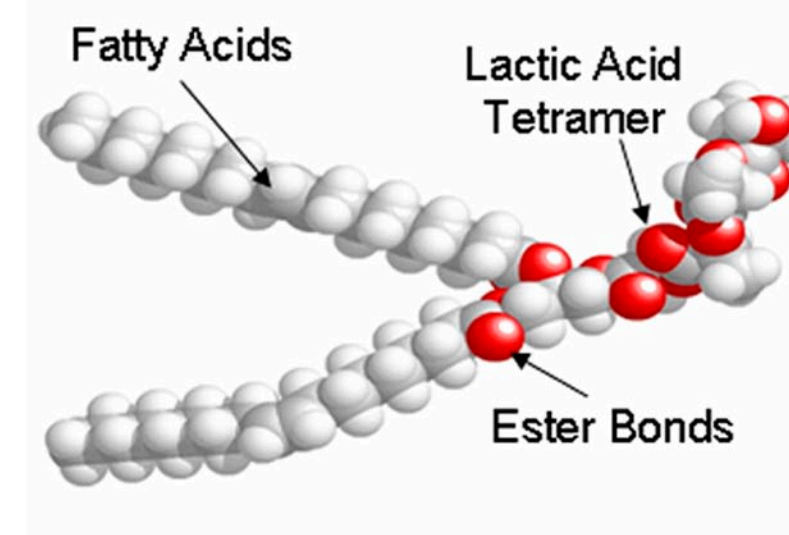
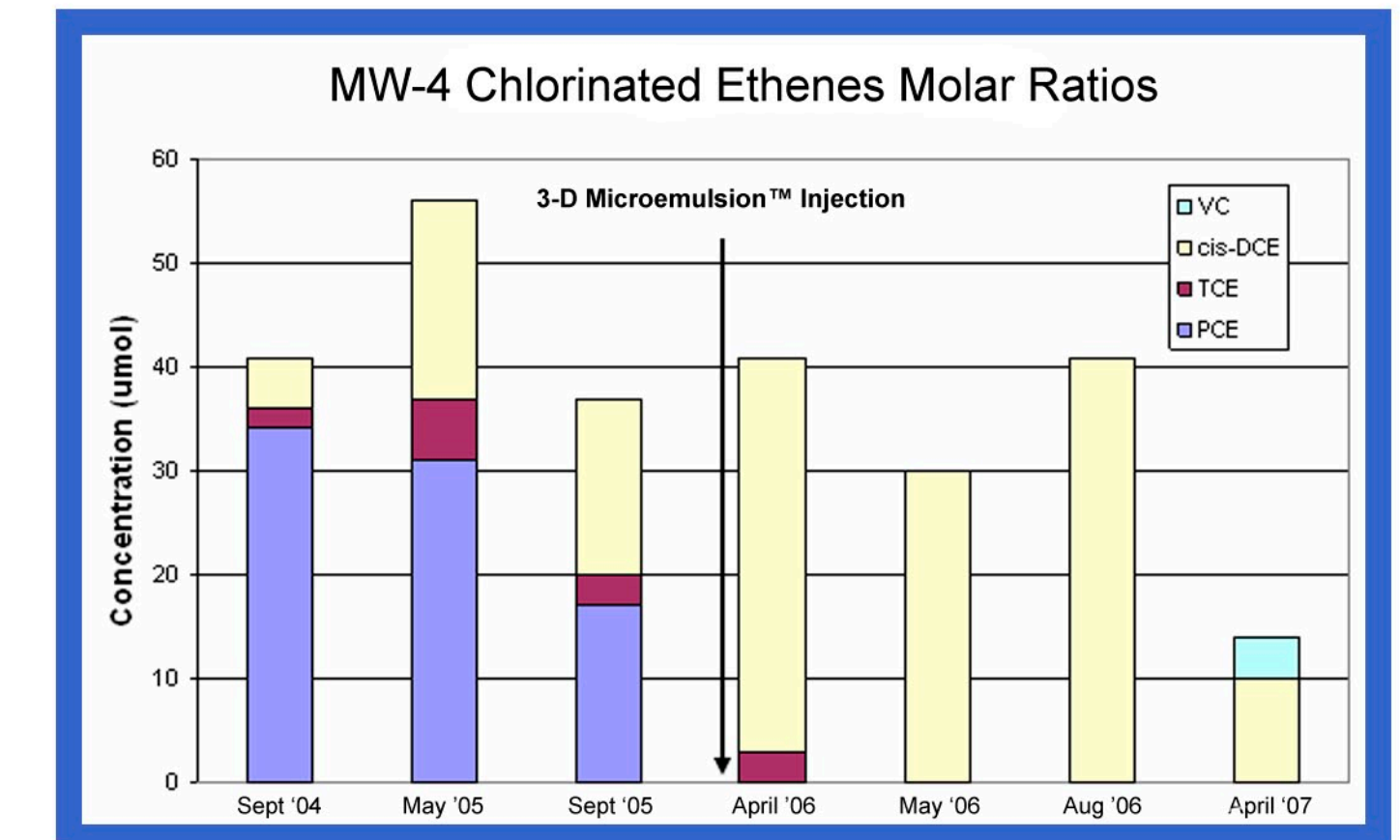


Figure 3. The 3-D Microemulsion<sup>™</sup> Molecule Structure

## RESULTS

As indicated by the molar ratio graph (Graph 1), within 30 days of the 3-D Microemulsion<sup>™</sup> application, tetrachloroethene (PCE) was reduced to non-detect levels followed by trichloroethene (TCE). A reduction of 77% was observed in cis-DCE between the months of August '06 and April '07. Slight increases in vinyl chloride (Table 2) and ethene (Table 3) indicate complete dechlorination is occurring with no stalling effect.

Biostimulation using 3-D Microemulsion<sup>™</sup> achieved adequate distribution in clay soils and has successfully created optimal conditions within the saturated zone to facilitate reductive dechlorination. Biogeochemical parameters such as ferrous iron, sulfate and methane (Table 3) all support this fact. The site has progressed through iron and sulfate reducing conditions and is generating moderate levels of methane.



Graph 1. Under-Dosed HRC<sup>®</sup> Results Followed by 3-D Microemulsion<sup>™</sup> Results

Table 2. Chlorinated Solvent Reduction in MW-4 (ug/L)							
	Sept '04	May '05	Sept '05	April '06	May '06	August '06	April '07
PCE	5,680	5,100	2,800	Non-Detect	6.1	Non-Detect	Non-Detect
TCE	301	780	390	360	58	Non-Detect	Non-Detect
DCE	474	1,800	1,600	3,700	2,900	4,000	930
VC	Non-Detect	Non-Detect	Non-Detect	Non-Detect	17	25	270

Table 3. Geochemical Parameters Indicating a Sustained Anaerobic Environment (ug/L)				
	April '06	May '06	August '06	April '07
Iron	27	23	NA	29
Sulfate	24	16	NA	0.84
Methane	330	360	NA	10,000
Ethene	3	3	NA	13