Use of Two Injection Techniques to Apply Enhanced Reductive Dechlorination at a VOC Plume Site

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Background/Objectives. Chlorinated and petroleum hydrocarbons were initially detected in groundwater during a 1989 investigation of a former oilfield service facility in the central United States. There are two groundwater-bearing zones identified in the alluvial deposits overlying the shale bedrock at the site. The Shallow Zone is present in the silty clay and the discontinuous interbedded sand and clay that occur at depths of about 20 to 25 feet below ground surface (bgs). This semi-confined, perched groundwater zone has a calculated average hydraulic conductivity of 6.8×10^{-5} centimeters per second (cm/s). The Deep Zone is present in the laterally continuous sand that occurs directly above the shale bedrock at a depth of 35 to 50 feet bgs. The overlying clays and underlying shale bedrock serve to confine the groundwater in this unit, which has a calculated average hydraulic conductivity of 4.9×10^{-3} cm/s. Following additional investigations that identified benzene, trichloroethene (TCE), cis-1,2-dichloroethene (DCE), vinyl chloride (VC), and 1,1-dichloroethane (DCA) in soil and groundwater near a former lagoon and acid plant, 2,200 cubic yards of impacted soil were excavated. Though total contaminant concentrations have been reduced from 1 to 2 milligrams per liter (mg/L) in groundwater because of the 1997 source removal and follow-on monitored natural attenuation, concerns about offsite plume migration and the projected remediation timeframe have persisted.

Approach/Activities. Enhanced reductive dechlorination (ERD) was selected to address residual the volatile organic compound (VOCs) in Shallow and Deep Zone groundwater. Because of the risk of off-site migration in the more permeable Deep Zone, that interval was addressed first. Beginning in 2014, emulsified vegetable oil (EVO) and a commercial bioaugmentation culture was delivered to the Deep Zone via 14 conventional injection wells screened from 40 to 50 feet bgs. With natural attenuation rates lagging and concern about recontamination of the Deep Zone, the use of hydraulic fracturing was selected to inject EVO into the low permeability Shallow Zone. The multi-phase application process is as follows: 1) inject proppant sand via hydraulic fracturing, 2) install ¾-inch diameter injection wells in the borings, and 3) inject EVO into the sand-filled fractures.

Results/Lessons Learned. Following two rounds of EVO injections, total VOC concentrations at the property boundary in the Deep Zone had decreased by up to 99 percent in two years. The hydraulic fracturing application for the Shallow Zone is scheduled for fall 2017. It is anticipated that findings from the injection process and four months of groundwater monitoring data will be available at the time of the presentation, which will include remediation objectives, a description of the field activities, reagent doses, costs, and results for both injection techniques.