

Post-Remedy Performance Results Comparing Soil Blending versus Direct Injection ISCR Source Area Treatment for 1,1,2-TCA

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Background/Objectives. Chlorinated volatile organic compounds (CVOCs), mainly 1,1,2 trichloroethane (TCA) and 1,1 dichloroethene (DCE) and their associated breakdown products, were present in soil and groundwater as a result of the historical operation of a process water holding pond at an active 38-acre rail car maintenance facility located in southeastern Kansas. Rail car servicing, cleaning and painting had been conducted at the Site since 1963. Spent car cleaning liquids were discharged to a five-pond recirculating system equipped with an oil recovery unit. The pond system was closed and decommissioned in 1987. A *Voluntary Cleanup Plan* was developed and approved to implement in situ chemical reduction source area treatment via soil blending and direct injection applications in accordance with Kansas Administrative Regulation (K.A.R.) 28-71-9(f) and the Kansas Department of Health and Environment (KDHE) *Voluntary Cleanup and Property Redevelopment Program Manual* (2011), and KDHE's *Risk-Based Standards for Kansas – RSK Manual – 5th Version* (2014).

The surficial soil types consist of a silt loam underlain by clay overburden, underlain by limestone and shale bedrock. The depth to bedrock in the plume area ranges from approximately 8 feet to 28 feet below ground surface (bgs). Groundwater occurs in the clay overburden and upper weathered bedrock, beginning approximately 8 feet bgs and the two hydrostratigraphic units are in hydraulic communication, discharging to the West Branch of the Walnut River. Site-specific hydraulic conductivities measured for the overburden and upper bedrock units were 2.9×10^{-4} centimeters per second (cm/sec) and 2.5×10^{-6} cm/sec, respectively. 1,1,2 TCA, 1,1 DCE, and vinyl chloride (VC) in groundwater in the overburden aquifer at the source area range from 166 micrograms per liter ($\mu\text{g/L}$) to 1,000,000 $\mu\text{g/L}$; 220 $\mu\text{g/L}$ to 50,800 $\mu\text{g/L}$; and 883 to 27,600 $\mu\text{g/L}$, respectively. Groundwater cleanup levels were KDHE Tier 2 maximum contaminant levels (MCLs).

Approach/Activities. Full-scale remediation was completed in Spring 2015 using Anaerobic BioChem® (ABC®) and zero valent iron (ZVI) [ABC+]. A total of 3,246 gallons of ABC® and 104,105 pounds of ZVI were introduced via soil blending. A total of 24,280 pounds of ABC+ (i.e. 10,767 gal of ABC+ solution) was injected at 147 Geoprobe® injection points in the source area adjacent to the soil blend area.

Results/Lessons Learned. Post-remedy performance monitoring was initiated November 2015 on a semi-annual basis. Temporal trends for VOCs and geochemical parameters in the blend and direct injection treatment areas indicate greater than (>) 85% to >99.9% VOC decreases comparing 2017 data to pre-remedy concentrations. Ethene concentrations have increased by up to two orders of magnitude, chloride has increased up to 180%, and oxidation-reduction potential (ORP) has decreased by over 300%.