Evaluation of ISCO Oxidant-Infused Wax Cylinders within a Tetrachloroethene-Impacted Fractured Bedrock Aquifer

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Background/Objectives. Camp Stanley Storage Activity (CSSA) is a small Army Post located in South Central Texas. Area of Concern (AOC) 65 has been identified as the source of vapor phase and dissolved phase chlorinated solvent contamination, including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and trans-1,2-DCE. The application of in situ chemical oxidation (ISCO) material is being used to treat dissolved phase contaminants in the deep fractured bedrock aquifer. Multiple injections of chemical oxidants have been conducted at AOC-65 to treat PCE-contaminated groundwater in a highly-fractured karst limestone bedrock aquifer and additional infiltration galleries and wells have been installed with each phase of ISCO treatment.

Approach/Activities. Six ISCO injections have been conducted with varying oxidant volume, type, and delivery locations. Pilot and field-scale treatability studies were performed using sodium persulfate applied to infiltration galleries in 2012, 2013, and 2014. Approximately 10, 22, and 66 tons of persulfate activated with sodium hydroxide were applied, respectively. Results from the persulfate injections revealed a general reduction in PCE concentrations; however, increasing PCE concentration to the east suggested the injection volumes may have resulted in pneumatic transport of contaminated groundwater to the east. In August and November 2015, two additional injections were performed, in which approximately 3,500 and 7,000 gallons of sodium permanganate were applied, respectively. The change from sodium persulfate to sodium permanganate was intended to reduce total volumes injected, and thereby reduce artificial mounding, and changes to the groundwater gradients and flow directions locally. In December 2016, twelve oxidant-infused wax cylinders were installed in six injection wells around the site. The cylinders consist of potassium permanganate, sodium persulfate, and paraffin wax in a ratio of 38:38:24. The cylinders were installed at the base of the screened interval in each well to maximize contact with groundwater and provide a persistent source of oxidant. This passive approach to oxidant application allows for a sustained release of ISCO chemicals into groundwater under varying hydrologic conditions encountered throughout the year. Quarterly sampling of drinking water and monitoring wells was conducted following each injection.

Results/Lessons Learned. Results from persulfate injections between 2012 and 2014 indicate that longer contact time in higher fractures increases the oxidation of chlorinated contaminants in the shallow fractured-bedrock aquifer. Results from permanganate injections in 2015 show that the distribution of ISCO solution was more widespread than anticipated given that injection volumes were much smaller than previous persulfate injections. Initial results from the oxidant-infused wax cylinders indicates that oxidation is occurring and that proximity to the cylinder is an important factor in reductive chlorination across the site. The cylinder life-span will provide a continuous oxidant source in the wells directly affected by contaminants and therefore may treat contamination under all of the varying hydraulic conditions encountered. Pending additional monitoring results, we plan to continue the evaluation of potassium persulfate and permanganate-infused wax cylinders as a viable oxidant in a shallow fractured-bedrock aquifer.