Full-Scale In Situ Treatment of TCE in a Fractured Bedrock and Overburden through Reagent Injections that Promoted Biotic and Abiotic Dechlorination

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Background/Objectives. The Site is underlain by bedrock consisting of the Passaic Formation of the Brunswick Group, which forms a steeply sloping bedrock ridge along the western edge of the Site. Historic operations at the Site in 1970s and 1980s consisted of sheet-fed printing business during which industrial wastewater was discharged into two wastewater removal systems located on the Site. These operations led to trichloroethene (TCE) impact at the overburden and shallow bedrock at the Site. Bedrock underlying the Site is strictly sedimentary comprising of interbedded siltstone and sandstone. A pilot test was conducted in August 2012 to evaluate the enhanced in situ anaerobic biodegradation of TCE in the overburden and shallow bedrock. Based on the results observed at the pilot-scale, a full-scale in situ remedy was started in 2017 where reagents were injected that promoted biotic and abiotic dechlorination and treat TCE at the Site.

Approach/Activities. As a proof-of-concept, an in situ pilot test was conducted through the injection of electron donor 3-D Microemulsion™ (3DMe™) to enhance the reductive dechlorination of TCE. Following the promising pilot test results, full-scale in situ treatment was started in September 2017 with EHC-Liquid® mixture (EHC-L) serving as an electron donor. Approximately 5,200 lbs of the 25 percent strength EHC-L were injected into the overburden distributed through 10 direct push points, while about 4,700 lbs were injected into the shallow bedrock distributed through the eight injection wells. For the overburden injection, a direct-push rig was used to inject to a depth from 2 to 10 feet bgs. The injection wells were approximately 40 feet below ground surface (bgs) and screened from 20 to 40 feet interval. *Dehalococcoides* sp. was delivered along with the EHC-L.

Results/Lessons Learned. Pilot test results revealed 3DMe™ injections enhanced the native dechlorination activity in the shallow bedrock and overburden groundwater. This is based on the decline of TCE and the steady increase in the concentration of TCE daughter products, cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (VC). Trace amounts of ethene and ethane were detected, implying that TCE was dechlorinated to innocuous by-product, ethene, although dechlorination of cis-1.2-DCE appeared to be rate limiting.

Full-scale injection reagents included an iron component along with organic carbon to promote abiotic dechlorination through β-elimination (TCE to ethene by-passing cis-1,2-DCE and VC formation) along with biotic dechlorination (hydrogenolysis). Pre-injection baseline average TCE concentrations from three monitoring wells at the overburden and three monitoring wells at the shallow bedrock were approximately 317 µg/L and 100 µg/L, respectively. After 8 months of injections, TCE concentrations decreased to less than 4 µg/L. Likewise, cis-1,2-DCE average concentrations in the overburden decreased from a baseline of 190 µg/L to 69 µg/L after 8 months of injection, while the decline in bedrock was from 259 µg/L to 115 µg/L. The decreases in TCE and cis-1,2-DCE concentrations were followed with an increase in VC concentrations from 2-9 µg/L (baseline) to 23-25 µg/L (post-injection). A similar increasing trend was observed for ethene (from below the detection limit [BDL] to 17 µg/L) and ethane (from BDL to 47 µg//L).

These observations revealed that full-scale in situ treatment is promising in the remediation of contaminants at the Site.