In Situ Bioremediation of Chlorinated Solvents at a Low pH Site

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Background/Objectives. Enhanced reductive dechlorination (ERD) is a proven, effective approach for remediation of chlorinated ethenes. Removal of chlorinated solvents such as tetrachloroethene (PCE) and trichloroethene (TCE) through enhanced reductive dechlorination (ERD) requires the establishment of acceptable conditions for organohalide-respiring bacteria (OHRB). The optimum pH range for biological processes, particularly related to reductive dechlorination, is typically between 6 and 8 SU. The growth of OHRB such as Dehalococcoides spp. is inhibited at values below 6 SU. In this project, we use a combination of pH buffer, carbon substrate, and bioaugmentation to treat a low pH sand and gravel aquifer contaminated with high concentrations of PCE and TCE.

Approach/Activities. Soil and groundwater at an industrial facility became contaminated through inadvertent release of PCE to a storm sewer. A shallow silty-clay layer extended from 0 to 10-18 feet below ground surface (ft bgs) and was contaminated with up to 3,000,000 µg PCE/kg and 149,000 µg TCE/kg. Underlying the clay was a sand and gravel aquifer with up to 140,000 µg/L PCE and 22,000 µg/L TCE. Depth to the piezometric surface varied from 1 to 10 ft bgs, indicating the aquifer was confined. At some areas, the aquifer pH was as low as 3.2 SU due to the migration of an off-site sulfuric acid plume to the site and dechlorinating bacterial populations were below detection. In situ bioremediation approach was applied to address the dissolved PCE and TCE that has already reached the confined aquifer and low levels that could enter the aquifer in the future. The confined aquifer has been treated by injecting a colloidal pH buffer/potassium bicarbonate, quick release soluble substrate, emulsified vegetable oil substrate, and bioaugmentation culture through a network of about 95 permanent injection wells.

Results/Lessons Learned. The field results demonstrated that the implementation of in situ bioremediation has thus far been effective in reducing PCE and TCE concentrations by over 99% in some areas via dechlorination of PCE and TCE to breakdown products cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC). However complete dechlorination of VC to non-toxic end-products ethene and ethane is still ongoing. Recently, additional nutrients (nitrogen, phosphorus, amino acids, and vitamin B12) were injected into the areas where the accumulation of toxic intermediates observed to support and enhance the growth of the microbial population and complete the reductive dechlorination. In this work, we demonstrate that in situ bioremediation with proper pH adjustment and control can be a viable option to treat chlorinated solvents in an efficient and affordable way, even when the conditions do not initially seem favorable for bioremediation such as low pH and high contaminant concentrations.