Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

More Than a Decade of Challenges and Success: Enhanced In Situ Reductive Dechlorination of Trichloroethene/1,1,1-Trichloroethane Source Area in Fractured Bedrock

Christine Fogas (christine.fogas@obg.com), Michael S. Kozar, P.G (michael.kozar@obg.com), and Megan Hepner (megan.hepner@obg.com)
(OBG, East Norriton, PA, USA)

Background/Objectives. In 2003, a pilot test was initiated to demonstrate situ reductive dechlorination (IRD) of chlorinated volatile organic compounds (VOCs) at a Pennsylvania Superfund site with a fractured carbonate aquifer, using methanol, ethanol, and lactate amendments and a commercial microbial culture KB-1. By 2005, pilot injections were suspended due to excess levels of nutrients nearly toxic to the microbial community. The inefficient degradation rates led to more extensive laboratory microcosm studies. A microbial culture capable of degrading trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) was grown in Site groundwater, and initial bioaugmentation was conducted in 2006. Based on the success of the resumed pilot with nutrients and lactate only, a full-scale biorecirculation system was implemented in 2010. After achieving within two years the complete IRD of high concentrations of TCE, cis-1,2-dichloroethene (cDCE) and TCA to end-products, challenges posed by variable groundwater flow conditions and precipitation/biofouling on well screens resulted the near complete loss of in situ electron donor concentrations. As a result, additional diagnostic testing and well rehabilitation efforts were employed in an attempt to restore biostimulation, confirm the robustness of the dehalorespiring culture, and restore IRD rates.

Approach/Activities. The system consists of a central anaerobic amendment mixing tank connecting 7 injection and 5 extraction wells, sodium lactate as the electron donor, and mineral nutrients to supply ammonia and phosphate that are metered into the tank. The amended groundwater is reinjected within the source area to promote the IRD of chlorinated VOCs and to enhance natural attenuation in downgradient groundwater. A sustained decline in groundwater elevations and total flow throughout the system was experienced from May 2012 to March 2013, and again in Summer 2015. An optical televiewer inspection was conducted and revealed the likely presence of biological fouling on the extraction well screens. A microcosm study was conducted in December 2013 to May 2014 to confirm the health of the site-specific *(Dehalococcoides [Dhc] mccartyii)* strain in the system extraction wells.
Redevelopment of the extraction and injection wells was completed using both physical and chemical treatment methods to restore system flow. Following well redevelopment activities, a trace mineral distribution study was conducted, as prompted by the results of the December 2013 – May 2014 microcosm study. Adjustments in system operations were made to optimize the distribution of electron donor and mineral nutrients and enhance the rate of dechlorination. The IRD treatment system is operating continuously and monitored at monthly intervals.

Results/Lessons Learned. The work will be described in terms of its engineering, hydrogeological and microbiological components. Monitoring data for chlorinated compounds, mineral nutrients, and electron donors will be presented. Diagnostic microcosm testing results as they apply to changes in microbial conditions in the aquifer over time, which identified the absence of trace mineral concentrations as a limiting factor. Field observations during well redevelopment will be presented, as well as adjustments in operations that were made to continue VOC reduction, maintain appropriate redox levels, and mineral nutrient and electron donor levels.