Evaluation of a Sustainable Approach to Treat Large, Dilute Chlorinated VOC Groundwater Plumes

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Background/Objectives. Chlorinated volatile organic compounds (cVOCs) continue to be primary contaminants of concern, even though many suitable treatment technologies have been developed and verified. One of the greatest challenges remaining for remediating these contaminants at DoD sites and protecting downgradient receptors is the treatment and/or control of large dilute plumes. Current approaches to address large, dilute plumes are typically long-term and have high capital, operation and maintenance costs. Achieving clean-up levels for cVOCs and other organic pollutants in plumes that only have low part-per-billion concentrations is a difficult technological challenge. Cometabolism is showing significant promise in this area because organisms grow aerobically on a supplied substrate (e.g., propane or methane) rather than the trace contaminant, allowing good degradation kinetics, minimal impacts to aquifer geochemistry, and the ability to achieve part-per-trillion contaminant concentrations. However, to meet current remedial needs, the treatment of a large, dilute plume using this technology needs to be demonstrated in a sustainable, cost effective manner. The key objective of this ESTCP-funded project is to demonstrate effective in situ cometabolic treatment of a large, dilute cVOC plume using an approach that is sustainable and has minimal O&M requirements.

Approach/Activities. This project entails cometabolic biosparging using a line of vertical biosparging wells installed perpendicular to groundwater flow across the width of a large, dilute cVOC plume downgradient of Building 324 at the former Myrtle Beach Air Force Base in SC. The groundwater plume, with *cis*-DCE and vinyl chloride concentrations in excess of federal MCLs, will be treated as it flows through a biologically active zone (i.e. bio-curtain) created by biosparging air and an alkane gaseous substrate (propane) and gaseous nutrients. Gases will be pulsed into the aquifer through approximately 30 vertical sparging wells at a rate of approximately 3-5 CFM per well, with between 3 and 5 wells being sparged at a time. Air and propane gas will be added in short (5-20 minute) pulses as needed to provide sufficient dissolved oxygen and substrate to maintain target dissolved gas levels within the treatment zone. Gaseous methylamine will be added to the gas stream as a source of nitrogen to sustain biological activity. The biosparging system process control and monitoring equipment will be powered by solar energy. Methods to cost effectively and efficiently supply air and electrical power to the biosparging system are currently being evaluated.

Results/Lessons Learned. Detailed site characterization activities conducted indicate that the downgradient portion of the plume is approximately 200 feet wide, 34 feet deep, and up to approximately 15 feet thick. Dissolved contaminants exceeding MCLs are present within permeable layers consisting of sand and shell hash and fine sand within the aquifer. These layers are underlain by a silty clay confining unit at the base of the plume. Laboratory microcosm studies were conducted with aquifer samples obtained during site characterization activities. These studies evaluated the efficacy of oxygen and various alkane/alkene gases (propane, methane, ethene, and natural gas) to stimulate co-metabolic treatment of target cVOCs by indigenous microbial populations, and estimated oxygen and substrate gas utilization rates. Based on results of the microcosm testing results, propane and ethene gases were selected and investigated in further detail. Batch kinetic studies were conducted with these gases and mixed enrichment cultures derived from the microcosm study. During these studies we; 1) examined individual compounds of concern (cis-DCE and vinyl chloride) with a focus on the utilization of the selected substrate gases for biodegradation of these compounds, and 2) assessed inhibition of the alkane/alkene gas on cVOC degradation and potential inhibition of cVOCs upon each other. The information derived from the batch kinetic studies will be used to inform design (particularly, substrate gas sparging frequency and duration) of the demonstration system to maximize treatment efficacy. Results of site characterization activities and laboratory testing, as well as preliminary design details developed during the first year of this 3½-year project will be presented.