Remediating 1,2-Dichloropropane Contaminated Groundwater in Low Permeability Media Using Micro-scale ZVI and Organic Carbon Amendment

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Background/Objectives. In situ chemical reduction (ISCR) combined with bioremediation via enhanced reductive dechlorination (ERD) are effective and widely applied remediation methods for chlorinated solvent contaminated groundwater. In situ groundwater remediation is often accomplished by injecting liquid or particulate reactive amendments to stimulate biological and/or abiotic degradation mechanisms. In situ remediation of low permeability soils using common reagents is often complicated by at least two factors: (1) clayey formations generally contain a higher proportion of constituents sorbed to the soil matrix, and (2) it is often difficult to achieve effective distribution of remedial reagents in tight soils. As a result, contaminant destruction is often limited and concentration rebounds are commonly observed. Use of rapid-releasing and short-lived reagents under these conditions can further exacerbate these challenges. Once the reagent has been consumed, further desorption of chlorinated volatile organic compounds (cVOCs) still present in the soil will predictably recontaminate the groundwater. Because degradation reactions are aqueous-based, removal kinetics are ultimately limited by desorption rates, and total removal rates are hence largely governed by the longevity of the remediation reagent.

Approach/Activities. Following a truck accident on one of the main motorways in northern Italy, about 3,000 liters of 1,2-dichloropropane were released into the ground, causing an immediate contamination of soils and groundwater. As an emergency response remedial action, approximately 900 m3 of shallow soils were excavated and disposed into a landfill. Secondly, the contaminated aquifer was physically delimited by emplacing metal sheet piles to a depth of 6 meters below ground level (bgl) to limit further contaminant migration. Lastly, a total of 55,000 kg of EHC reagent was injected into a triangular grid of 42 injection points between 1 m and 6 m bgl. EHC is comprised of a synergistic mixture of micro-scale ZVI and controlled-release organic carbon, stimulating both abiotic and biotic dechlorination mechanisms. The target goal for the grid set forth in the Clean-up Plan developed for the site was to obtain a removal efficiency of at least 90% reduction in 1,2-dichloropropane compared to baseline concentrations at compliance points located in the treatment area.

Results/Lessons Learned. The reagent was successfully injected into a low-permeability formation using high-pressure grout pump equipment. Contaminantremoval rates peaked 15 months after the start of remediation activities, at > 89% removal. Two years post-application, these rates increased to 96% removal, and remained at that level for nine months continuously supporting treatment of groundwater. Site closure was accomplished in 2015. Diffusion was the primary hydrogeological factor supporting distribution, considering the low-permeability formation and slow groundwater velocity.A significant increase in dissolved iron and total organic carbon, coupled with low redox (ORP) conditions were measured in the treatment area during the first 1 to 2 years. The EHC reactive zone constitutes a “green remedial solution”, having produced a low carbon footprint during application, use of few energy requirements, and with minimal maintenance costs limited to groundwater monitoring over the life of the treatment.