CHARACTERIZATION OF SHALLOW GROUND-WATER SEEPS - IMPLICATIONS FOR DESIGN OF ENHANCED BIOREMEDIATION OF CHLORINATED SOLVENTS

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Monitored natural attenuation has been shown to be a feasible ground-water remediation method for chlorinated ethanes and ethenes in the majority of the West Branch Canal Creek tidal wetland discharge area, Aberdeen Proving Ground, Maryland; however, undiluted ground-water discharges from a contaminated aquifer to the surface in distinct zones or seeps, resulting in elevated concentrations of chlorinated ethanes and ethenes in surface waters throughout the wetland. Targeted, enhanced bioremediation using biostimulation and/or bioaugmentation in the seeps is being designed to maximize natural processes and minimize impact to the wetland ecosystem. Seep delineation and seep water quality, hydrologic, and microbial characterization provides insight into controlling factors of contaminant breakthrough from ground water to surface water and dictates unique design criteria for targeted bioremediation in the wetland environment.

Seep areas were delineated using high-resolution, aerial thermal infrared imaging surveys and were characterized for volatile organic compound (VOC) and methane concentrations using passive sampling devices in the upper 1.5 ft of the wetland sediments. Distinct, consistently observable seeps were identified along stream channel boundaries, at the interface between uplands and the wetland, and within the wetland vegetation. Combined maximum concentrations of 1,1,2,2-tetrachloroethane, tetrachloroethene, trichloroethene, and carbon tetrachloride and their degradation products were most commonly observed along channel boundaries and were detected at total concentrations exceeding 20 mg/L in shallow ground-water, suggesting these seeps have the strongest component of vertical discharge. Contaminant distribution was similar to those detected in nearby upgradient piezometers screened in the aquifer. Currently, seepage meters are being used to characterize the discharge rate. Stratigraphic and lithologic sediment properties are also being evaluated. These flow characteristics will determine whether the targeted bioremediation design must accommodate an increased residence time in the wetland sediments. Although most of the seep areas contain methane concentrations indicative of methanogenesis, the seeps with maximum concentrations of VOCs correspond to the lowest methane concentrations. Genetic analyses of the seep sediments are being conducted to compare the microbial communities of seep areas with known dechlorinating microbial communities already identified in other portions of the wetland. Positive identification of microbial communities will determine the need for biostimulation or bioaugmentation in the seeps. Preliminary results of the characterization suggest the primary factors controlling contaminant breakthough and factors that will dictate the design of the targeted enhanced bioremediation include increased ground-water velocity and discharge and decreased microbial diversity.