Electrically Induced Redox Barriers for the Treatment of Ground Water – Warren AFB Field Experiment

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Abstract. Many groundwater contaminants are sensitive to oxidation-reduction (redox) conditions. In select instances, in-situ redox conditions result in natural attenuation of contaminant plumes over short distances. Unfortunately, favorable redox conditions are not always present. In these cases engineered systems may be needed to achieve favorable attenuation of target compounds. Ideally such systems should have low capital, operations, and maintenance costs. Operations and maintenance costs are a particular concern in that subsurface sources of groundwater contaminants may persist for long periods of time. With these goals in mind, this project focuses on development of electrolytic permeable reactive barrier technology (e-barriers).

An e-barrier utilizes planar mesh electrodes emplaced perpendicular to ground water flow in a contaminant plume. Oxidation and reduction reactions are imposed at the anode and cathode respectively. Potential advantages of this technology over similar barrier technologies include treatment via both oxidative and reductive pathways, adjusting treatment by controlling the applied voltage to the electrodes, and an ability to manage inorganic precipitates via changes in electrode polarity.

Initial laboratory column and tank treatability studies have lead to a field demonstration at F.E. Warren Air Force Base in Cheyenne, Wyoming. The objective of the effort is to resolve the efficacy and cost of e-barriers for chlorinated ethenes.. Trichloroethene (TCE) has been detected in the subsurface near Crow Creek at ~300 µg L⁻¹. The aquifer is composed of mixed eolian and fluvial deposits. Laboratory studies using site ground water and soils indicated greater than 90% removal of TCE at a load of 33 mg m⁻² day⁻¹. This is approximately four times the mass flux to the barrier in the field.

Building on the laboratory results a field scale barrier was installed in August 2002. The barrier is approximately 2 m high and 10 m long (20 m²). The base of the barrier is completed to a depth of ~5.5 m below grade. The top of the barrier coincides with the observed seasonal low water table depth. Prior to startup the barrier was allowed to equilibrate within the formation for a period of 4 months. Pre-power conditions were characterized using 144 discrete sample points. Power was applied in January 2003 at a setting of 3 V. Performance criteria will be documented throughout the 1-year evaluation period including VOC, inorganic, geochemical, and electrochemical data. During that time the voltage will be increase stepwise after steady state has been reached. This presentation will cover construction details and performance data from the field demonstration to date along with results of the preliminary laboratory studies.

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