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NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

Performance Evaluation of Organic Carbon Substrate and Limestone-Based PRB for Treatment of Heavy Metals, Arsenic, and Acidity

Problem Definition

The Delatte Metals site is a former battery recycling facility. The disposal of spent batteries buried on site over many years has resulted in the formation of a large dissolved-phase heavy metal and arsenic plume, migrating toward a nearby creek. A pilot permeable reactive barrier (PRB) (consisting of a combination of cow manure, wood chips, and limestone gravel) and a full-scale PRB (consisting of cow manure and limestone gravel) were installed in the path of the plume in May 2003. The two PRB systems are designed to remove heavy metals and acidity from solution through the process of microbially mediated sulfate reduction.

Background

Sulfate reduction-based PRB systems are increasingly being recognized as an effective means of removing heavy metals from ground water. In the process of sulfate reduction, sulfides are produced; they combine with the metals to produce relatively insoluble metal sulfides. In addition, during the microbially mediated sulfate reduction process, carbonate alkalinity is produced, which serves to help neutralize acidity and maintain circum-neutral pH conditions. Although promising, organic carbon-based PRB systems have not yet been fully evaluated in the field. Issues of key interest include the longevity of organic carbon-based systems, the ability of organic carbon-based PRB systems to maintain their hydraulic conductivity properties over time, and the types of organic carbon substrate most suitable for use in PRBs.

Objectives

- Determine whether the two PRB systems are effective in removing heavy metals, arsenic, and acidity from ground water
- Determine whether the hydraulic conductivity properties of the PRBs are maintained over time
- Determine how long the PRBs remain sufficiently reactive to remove the heavy metals and neutralize the acidity

Approach

Transects of monitoring wells were installed through each of the two PRBs, allowing for collection of samples within, upgradient, and downgradient of the PRBs. Ground water samples are being analyzed for multiple parameters, including cations, anions, total organic carbon/dissolve organic carbon, total inorganic carbon/dissolved inorganic carbon, sulfide, alkalinity, oxygen-reduction potential, pH, conductivity, and ferrous iron. Comparison of data upgradient, within, and downgradient of the PRB are being used to evaluate performance of the PRB. Hydraulic conductivity testing within and outside the PRB is being used to evaluate hydraulic conductivity changes, if any, during the course of the study. Solid-phase analysis is being conducted on core samples collected from the PRB to determine the types of precipitates being deposited and their potential impact on the long-term performance of the PRB.

Accomplishments to Date

Performance monitoring has been conducted on the pilot and full-scale PRBs on a semi-annually for six years. The two PRB systems have thus far performed effectively.

Near-Future Tasks

Performance monitoring will continue to determine whether performance of the PRB systems is sustained.

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