New Application of the Grout Bomber Technology to Remediate Low-Permeability Contaminated Media

Stephen D. Richardson, Charles J. Newell, Justin A. Long, Michael L. Schofield, and Luz Rocha (GSI Environmental, Inc. Austin & Houston, TX, USA)

Background/Objectives. A critical challenge preventing many chlorinated solvent sites from reaching groundwater cleanup goals is the persistent release of residual contaminants from low permeability (low-k) clays and silts. To address this challenge, this project aims to demonstrate an innovative application (or "repurposing") of a widely-used geotechnical technology, the "Grout Bomber", to improve delivery of remedial amendments at sites with contaminants trapped in low-k zones. Specific objectives include demonstrating that:

- conventional "Grout Bomber" equipment can be repurposed to efficiently install hundreds of closely-spaced vertical reaction columns containing remedial amendment (i.e., zero valent iron [ZVI], vegetable oil);
- the remedial amendment stimulates degradation processes and generates concentration gradients that drive contaminant diffusion from low-k zones into the reaction columns; and
- by having closely-spaced (every 2 to 3 ft) vertical reaction columns, chlorinated solvent concentrations in low-k zones can be reduced, thus, significantly shortening the "long tail" of contaminant flux from matrix diffusion processes.

Approach/Activities. The "Grout Bomber" is a subsurface stabilization technology that uses an excavator equipped with specialized equipment (a "stitcher" mast) to quickly "push" 3.5" diameter vertical columns into the ground, subsequently filling them with cement grout (from bottom to top) via an in-line grout delivery system. For our environmental application, a remedial amendment mixture of ZVI, vegetable oil, and sand was used (instead of cement grout) to create hundreds of biotic/abiotic reaction columns for degradation of chlorinated solvents.

The field demonstration was conducted at Site 17, Naval Support Facility Indian Head, Maryland. The treatment area consists primarily of silts, sandy clays, and lean clays with TCE concentrations in soil and groundwater of up to 250 mg/kg and 400 mg/L, respectively. The demonstration focused on a 4,700 ft^2 area defined by the 1 mg/L TCE groundwater contour.

Results/Lessons Learned. Eight hundred reaction columns (consisting of ZVI/sand or oil/sand), were installed 2-3 ft apart, to a depth of 30 ft below ground surface at the site. Despite some weather-related delays, ~100 reaction columns were installed per day, with our most productive day totaling 180 columns. During operation, installation time for each reaction column was on the order of 1-2 minutes. A baseline geophysical survey of the treatment area and groundwater sampling of existing monitoring wells was performed prior to installation of the reaction columns. Subsequent monitoring will be conducted 1, 6, and 12 months after column installation to evaluate distribution of amendment and overall system performance.

Although several operational improvements were identified (e.g., improved pumpability of ZVI/sand mixture; minor equipment modifications; improved site prep practices), the Bomber technology appears to be a viable alternative for amendment delivery at low-permeability contaminated sites.