

# Use of a Deep Horizontal Injection Well for In Situ Hexavalent Chromium Groundwater Plume Treatment – Applications and Lessons Learned

**Angela Mason** (angela.n.mason@usace.army.mil), Phil Rosewicz, and Vicki Murt (USACE, Kansas City, MO, USA); Jon Gorin (USEPA, NY, NY, USA); Lucinda Pype and Frank Tsang (CDM Smith, Fairfax, VA, USA)

**Background/Objectives:** As contaminated groundwater sites increasingly use in-situ remedies, logistical challenges have arisen (i.e., site access and lack of open space) for injection of chemical treatment solutions. Use of horizontal wells instead of vertical wells for chemical injection decreases the potential logistical challenges. This presentation focuses on the design, installation, operation, and lessons learned from an innovative approach to inject lactate in a deep aquifer using horizontal wells to promote hexavalent chromium [Cr(VI)] reduction. The Puchack Well Field Superfund Site is located in Pennsauken Township, NJ. Metal plating operations caused Cr(VI) groundwater contamination in three aquifer units at depths ranging from 90 to 200 feet bgs and resulted in closure of a public water supply well field. EPA selected in situ geochemical fixation through reducing agent injection to treat groundwater with total chromium concentrations exceeding 70 ppb. The reducing agent (lactate) changes the aquifer's geochemistry to iron reducing conditions. The Cr(VI) is reduced to and forms an immobile and stable trivalent chromium precipitate. The remedy is being implemented in two phases – treatment in an industrial area followed by treatment in a residential area. Phase I included installation of 166 vertical wells in parking lots and on public roads. Phase II will occur in a neighborhood with access limitations including small lots, narrow streets, and overhead and underground utility lines that make vertical well installation extremely difficult. To overcome these limitations, horizontal injection wells were considered. Horizontal injection wells haven't been attempted at the depths required for this application. In 2014, a horizontal injection well was pilot tested to determine the feasibility of using horizontal injection wells at greater depths.

**Approach/Activities:** The goals of the pilot study were to determine the effectiveness and implementability of horizontal injection wells for treatment of the deep Cr(VI) contaminated groundwater plume and to provide design parameters for full scale implementation. Review of available case studies yielded limited information for use of horizontal injection wells at depths encountered at this site or for the injection of reducing agents. One 4-inch diameter horizontal injection well was installed at a depth of 90 feet to 100 feet bgs. The well was approximately 830 feet long, with the last 450 feet having variable slots to deliver the lactate solution into the aquifer. Approximately 260,000 lbs of 60% sodium lactate were mixed with extracted groundwater to form a 16,100 mg/L solution and injected into the horizontal well at 150 gpm.

**Results/Lessons Learned:** The pilot study demonstrated that a horizontal injection well could successfully be installed and used to inject and distribute lactate. Specific lessons learned throughout the pilot study include:

- limitations of horizontal well design and application
- well screen design for uniform distribution of lactate throughout the total length of the screen
- staging areas for various drilling completion techniques
- use and limitations of bit tracking technologies (gyroscopic steering tool and walk-over tracking tools)
- use of vertical wells to monitor lactate distribution, changes in chromium concentrations over time (through 2018), and changes in aquifer geochemistry.