In Situ Treatment for Hexavalent Chromium Using ISCR Enhanced Bioremediation in Saturated Clay Soils Results in No Further Action

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Background/Objectives. Hexavalent chromium was present in the unconfined clay aquifer at a former midwestern plating facility. Impacts of hexavalent chromium were significant with concentrations exceeding 300 mg/L in groundwater, prompting remedial action. However, the depth of contamination, alongside the tight clay lithology limited the use of excavation and pump and treat to fully address these impacts. Therefore, an in situ remediation treatment along with a limited soil excavation was chosen for the site. A pilot test program was then carried out for two treatment options. The first pilot test utilized in situ chemical reduction (ISCR) via zero valent iron (ZVI) slurry. The second pilot test employed an engineered staged released electron donor to facilitate anaerobic bioremediation in combination with a soluble divalent iron (DVI). The results of the pilot testing indicated that the ZVI-based approach attained faster reductions when compared to the electron donor but was less effective overall than the electron donor and DVI combination. The full-scale remedy was optimized by utilizing the same electron donor but incorporating a superior ISCR reagent consisting of a colloidal suspension of a sulfidated ZVI. The switch to using the sulfidated ZVI was to increase the reagent reductant longevity and reactivity. The full-scale application treated a range of contaminant concentrations as high as 300 mg/L.

Approach/Activities. A series of field pilot test studies was performed simultaneously to compare the use of an ISCR only approach (ZVI) or a bio-enhanced ISCR approach (Electron Donor/DVI) for remediating saturated clay soils and groundwater. The reagents were injected using direct push technology (DPT) methods. Results demonstrated that both approaches were adequate, but the combination of the electron donor and DVI yielded better results over the course of the study. The full-scale application used the same proven, staged electron donor but the ISCR reagent was switched out to a colloidal suspension of a sulfidated ZVI to increase the ISCR longevity and reactivity. Through 126 DPT injection points, approximately 18,000 gallons of the ISCR/donor solution was applied at the site over a nearly 9,000 square foot treatment area generally between 7 feet and 22 feet below ground surface into a saturated clay aquifer. The post-application performance sampling began within a few months and continued for two years.

Results/Lessons Learned. Results from the pre-remediation testing showed performance was significantly better using a bio-enhanced ISCR approach with a self-distributing electron donor and a sulfidated ZVI. Post-application results demonstrated >99% reduction of hexavalent chromium to below laboratory detection limits in groundwater for over two years resulting in a No Further Action (NFA) Letter to be issued for the site. The outcome of these efforts confirmed that high concentrations of hexavalent chromium (>300 mg/L) can be treated using reductive technologies, and that the low permeability aquifer can accept sufficient fluids for in situ remediation.