Innovative Applications of Surfactants for Successful Combined Remedy Remediation

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Background/Objectives. The presence of non-aqueous phase liquids (NAPLs) complicates in situ remediation. In situ remediation technologies, including in situ chemical oxidation (ISCO) and bioremediation, actively react with organic contaminants in the aqueous phase. A large fraction of contaminant mass be present as NAPL. In addition, other organic contaminants can dissolve into a NAPL. Surfactants can be used enhance the solubility of organic contaminants and reduce the contaminant mass present as NAPL. This presentation will focus on two sites where surfactants were incorporated into the remediation design to optimize the performance of in situ treatment. Both sites are located within active, urban properties, and identifying a remediation approach that would not interrupt operating businesses was vital.

Approach/Activities. Former operations at Site 1 resulted in PCE impacts to groundwater, including NAPL being present. ISCO using sodium permanganate was selected as the in situ remediation technology to be facilitated by a surfactant where PCE NAPL and highest soil concentrations were detected. Variable oxidant and surfactant dosages were applied across the site based on PCE concentration distribution. Injections were performed into 40 saturated zone injection points and 67 unsaturated zone injection points.

At Site 2 soil and groundwater are impacted with cutting oil NAPL along with trichloroethene, cis-1,2 dichloroethene, and vinyl chloride. Groundwater is slightly reducing, and reductive dechlorination was observed to be occurring to varying degrees. The selected remediation approach is to enhance the naturally occurring biodegradation. Within the delineated LNAPL area, a customized sodium lactate solution was designed to include nutrients, pH buffer, and a low surfactant dosage, to enhance dissolution of the cutting oil to use the oil as an additional carbon substrate. Outside of the LNAPL area, emulsified vegetable oil (EVO) was selected as the electron donor. Injection was performed into 29 direct-push points and 9 injection wells.

Results/Lessons Learned. Post-remediation sampling at both sites has observed concentration reduction of chlorinated VOCs. Nine months after injection of permanganate and surfactant at Site 1 PCE concentrations decreased in all 18 wells in the monitoring program, and PCE concentration in the most impacted well reduced from 27,000 µg/L to <20 µg/L. A focused injection was performed one year after the first injection for polishing treatment where PCE still exceeded regulatory criteria. Post-injection of carbon substrate electron donors with surfactant at Site 2 groundwater monitoring indicates molar concentrations of chlorinated ethenes have decreased markedly. Additional LNAPL recovery has been achieved since the injection. A follow-up injection event is being planned for Fall 2018 to extend the treatment to the eastern portion of the contaminated area where access was previously not available. Updated performance monitoring data will be included in the presentation.