

Surfactant-Enhanced Extraction to Expedite Remediation of a Carbon Tetrachloride Source Zone at an Active Grain Elevator Facility

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Background/Objectives. The site is located in Kansas City, Kansas and currently operates as an active grain elevator facility. The site entered into the Voluntary Cleanup and Property Redevelopment Program (VCPRP) in 2000 following groundwater and soil detections of grain fumigant constituents of concern (COCs), including carbon tetrachloride (CT), in the vicinity of a former fumigant aboveground storage tank (AST). Following source area investigation and groundwater plume delineation activities, dual-phase vacuum extraction (DPVE) was implemented in 2007 for the removal of COCs in source area soils and groundwater. Groundwater is encountered at the site approximately 7 to 8 feet below ground surface (bgs). Lithology within the targeted source zone generally consists of well sorted, loose, silty-sand to depths ranging from approximately 13 to 17 feet bgs, underlain by silty clay.

After approximately 6 years of DPVE operation, resulting in the removal of over 9,000 pounds (lbs) of total VOCs, a subset of source area extraction wells continued to exhibit elevated COC groundwater concentrations. Additional investigation was conducted using high-resolution site characterization (HRSC) techniques to assess the nature and extent of residual COC mass in the source area and provide data required for the evaluation of alternatives that could expedite source area remediation. The investigation results indicated significant sorbed-phase COC mass, generally limited to the shallow, sandy interval of an area bound by the DPVE wells exhibiting elevated COC concentrations. Light non-aqueous phase liquid (LNAPL) heavily impacted with the site COCs was also identified. Surfactant enhanced extraction (SEE) was subsequently identified as the optimal source zone remedial alternative because of the technology's ability to quickly and efficiently remove a concentrated, but relatively isolated and shallow zone of contaminant mass with relatively low surfactant application concentrations. In addition, the existing DPVE infrastructure could be utilized to implement SEE at the site, thereby minimizing cost and intrusive activities.

Approach/Activities. Burns & McDonnell conducted a SEE pilot study at the site in April and May 2015 to evaluate the efficacy of the technology under site-specific conditions. The pilot study results indicated CT groundwater concentration reductions of up to 99 percent. Consequently, full-scale SEE was conducted in Fall 2016 to address remaining COC mass within the source zone. The full-scale SEE approach consisted of multiple phases, each consisting of point-to-point surfactant delivery to the core source area within the shallow saturated zone, followed by concurrent groundwater extraction ("pull") events from the wells initially used for surfactant injection. This approach proved most effective in maximizing COC mass removal during the SEE pilot study.

Results/Lessons Learned. The pilot and full-scale SEE remedial efforts have resulted in the recovery of approximately 700 lbs of total VOCs, and CT groundwater concentrations in the source area have been reduced by 80 to 99-percent. Based on these results, permanent shutdown of the DPVE system is anticipated to occur in 2019, resulting in significant project life-cycle cost savings. The presentation will include the SEE basis of design, including the HRSC-

refined conceptual site model, SEE design discussion, and key performance monitoring results and trend presentations.