Pneumatic Fracturing and Proppant Injection Enables Successful Enhanced Biological Recirculation System for BTEX, MTBE, TBA, 2-Methylnaphthalene and Naphthalene Remediation in Groundwater

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Background/Objectives. Significant concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX), MTBE, TBA, 2-methylnapthalene, naphthalene and other constituents of concern (COCs) were detected in soil and groundwater in the source area, where former service station USTs had been removed at a site in New Jersey. Impacts were found beneath the adjacent street as well as under several buildings on the site. Two remedial technologies were pilot tested in the source area (location of the former USTs) at the site. Due to a maximum 5 feet radius of treatment observed during the first pilot test, a second, more aggressive, remedial strategy was pilot tested in conjunction with formation permeability enhancement (sand proppant injections). The overburden soil at the site consists of red/gray silty clay with sand and fine gravel underlain by weathered shale. Competent bedrock is generally encountered at a depth of 45 feet and consists of red shale (Passaic Formation). Vertical recovery and injection wells were installed at varying depths up to 100 feet below land surface and utilized ETEC's DO-IT™ System for the injection and recirculation of 40-ppm+ concentrations of a dissolved oxygen (DO) as well as the biological amendments the petroleum and MTBE degrading bacteria need to thrive.

Approach/Activities. The DO-IT™ System operated during a pilot period of six months, treating contamination within the source area. An estimated radius of influence of at least 50 feet from the injection wells was observed during the pilot phase. The increased radius of influence is attributed to the pneumatic fracturing and sand proppant injections that were completed to increase the permeability of the subsurface. For the pilot test, approximately 30,000 pounds of sand was injected and for the full-scale implementation, over 60,000 pounds of additional sand was injected. During the DO-IT™ System pilot test, total volatile organic compound (VOC) concentrations were reduced from 25,000 parts per million (ppm) to below 4,000 ppm in the test area (over 60,000 ppm at start of full-scale after product liberation). Toluene, ethylbenzene and xylenes were above clean-up criteria prior to the start of the DO-IT™ pilot test and were below target remediation criteria at the completion of the 6-month test. Based on the results from the DO-IT™ pilot test, an expansion of the treatment system to a full-scale remediation was deemed appropriate and was implemented across the 1.6-acre treatment area.

Results/Lessons Learned. Following full-scale sand injections, trapped and previously unknown free product was liberated and observed in four monitoring wells in the source area, showing that the sand injections successfully linked pockets of contamination to the wells, thereby enhancing the ability to contact and remove/degrade the contamination. Release of free product was not expected as free product had not been observed at the site for nearly 10 years. Implementation of the permeability enhancements combined with ETEC's DO-IT™ Recirculation technology has shown to produce accelerated degradation of target COCs. This technology was implemented to address the impacts in the source area and the downgradient plume area, as well as limit further migration of the off-site plume by creating artificial hydraulic

gradients while maintaining optimal geochemical conditions in groundwater long enough to reduce contaminant mass on site.