Anaerobic Biodegradation of Chlorobenzene, Dichlorobenzene and Benzene in Shallow Saturated Soils

Amita Oka (aoka@langan.com), Steven Florkiewicz (sflorkiewicz@Langan.com), Howard Nichols (hnichols@langan.com), Stewart Abrams (sabrams@Langan.com), and Elana Seelman (eseelman@Langan.com)
(Langan Engineering and Environmental Services, Lawrenceville, NJ)

Background/Objectives. An active fuel storage tank facility in northern New Jersey is impacted primarily by chlorobenzenes and benzene. The site lithology consists of historic fill, organic silty clay (meadow mat), and an intermittent layer of sand and a red silty clay. Groundwater is encountered between 1 and 4 feet below ground surface and is mostly anaerobic. The impacts are found predominantly in the fill layer, extending to depths ranging between approximately 7 to 13 feet below surface grade. The impacts extend over approximately five acres with concentrations of benzene, chlorobenzene and dichlorobenzene up to 4,100, 52,000 and 20,000 µg/L, respectively. The remedial action goal for groundwater is to reduce the dissolved contaminant concentrations to less than 10X groundwater quality standards, such that monitored natural attenuation could be implemented. The remediation program needs to entail minimal infrastructure and disruption to the facility operations.

Approach/Activities. Initially, Langan conducted an in-situ microcosm study to evaluate the feasibility of aerobic bioremediation to address groundwater impacts of 1,2,4–trichlorobenzene, 1,4-dichlorobenzene 1,2-dichlorobenzene, chlorobenzene and benzene. While the microcosm study demonstrated that aerobic bioremediation would be effective, an in situ pilot test using oxygen infusion technology showed that the high organic content of the silty clay layer prevented the establishment of aerobic conditions in the aquifer. Because aerobic conditions could not effectively be established in the aquifer, Langan implemented an anaerobic bioremediation treatment program in July 2018 using sulfate as an electron acceptor. A contingent enhanced reductive dechlorination is also planned to address higher chlorinated benzenes, if their concentrations do not significantly reduce after sulfate injections.

Results/Lessons Learned. Despite the favorable results of the in situ microcosm study, an oxygen infusion pilot test showed that the oxygen demand of the organic silty clay layer was too high to establish and maintain aerobic conditions in the aquifer. The anaerobic biodegradation of benzene via sulfate reduction has been established in literature and has been implemented by Langan on several projects. Degradation of higher chlorobenzenes has been documented using sulfate reduction and enhanced reductive dechlorination.

Field Implementation: A phased injection program has been initiated at the site, with the Phase I injections conducted in July 2018. The Phase I program utilized 20 permanent injection wells to treat two areas of approximately 3,000 square feet. A total of 5,100 pounds of magnesium sulfate and 1,700 pounds of nutrients were injected with 6,500 gallons of water into the injection well network. The Nutrimens® and Nutrisulfate®, provided by Tersus Environmental Services, of Charlotte, North Carolina, were used as injection amendments. A contingent injection of sodium lactate may be implemented in the fall of 2018, based on post treatment monitoring results.