

## Evaluation of Monitored Natural Attenuation to Address Legacy Contamination along a Tidal Estuary

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**Background/Objectives.** As part of the redevelopment of a former chemical plant in Elizabeth/Linden, New Jersey, GZA was tasked to support activities under the New Jersey Licensed Site Remediation Professional (LSRP) program and to prepare a Remedial Action Outcome (RAO) for soil and a separate RAO for groundwater to address legacy contaminants. The Site was located along an unnamed tidal creek. The soil RAO was issued in 2012. The groundwater RAO was more complicated and required a longer timeframe to achieve as the groundwater to surface water pathway needed to be addressed. The metal contamination (including arsenic and lead) in the groundwater was attributed to either background or historic fill at the Site and was addressed through institutional controls as a Classification Exception Area (CEA). The dissolved volatile organic compounds (VOCs) in groundwater consisted of 1,4-dioxane, benzene, ethylbenzene, toluene and xylenes and were related to legacy releases at the former chemical plant.

**Approach/Activities.** In order to address the source of dissolved VOCs in groundwater several groundwater remedies were applied to the Site including injection ORC, injection of TPH<sub>ENHANCED</sub>, and enhanced fluid recovery. However, dissolved concentrations of VOCs remained above standards but at lower concentrations than prior to the above remedial actions. Based on these results, GZA evaluated the use of monitored natural attenuation (MNA) as the final remedy for dissolved VOCs. However, due to the proximity of the Site to a surface water body, the groundwater to surface water pathway needed to be thoroughly evaluated prior to the issuance of a remedial action permit for MNA. The evaluation consisted of the following studies: evaluation of the groundwater to surface water pathway using sediment, surface water and pore water samples; a tidal survey; analysis of biogeochemical indicator compounds; long-term contaminant trend analysis; and the fate of the dissolved VOCs in the environment.

**Results/Lessons Learned.** The tidal survey indicated that although tidally influenced, only minimal tidal influence of the groundwater level elevations was observed in groundwater. The large differences in temperature and conductivity between tidal creek and Site groundwater indicated that infiltration of tidal waters was not likely. The results from GZA's surface water to groundwater pathway study found no elevated levels of dissolved VOCs or VOCs in the pore water, sediment, or surface water samples. GZA concluded that the elevated levels detected in the groundwater did not impact the quality of the surface water/pore water or the mudflat sediments in the tidal creek. Therefore, MNA could be considered as a long-term remedial approach given the biogeochemical conditions favoring anaerobic biodegradation and the long-term decreasing to steady contaminant trends. Site-specific contaminant trends indicated that benzene would reach the groundwater standard in 16 years.