Optimization of a Passive Enhanced In Situ Bioremediation (EISB) Remedy by Biobarrier and Source Injection Approach

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Background/Objectives. Enhanced in situ bioremediation (EISB) was selected to treat chlorinated volatile organic compounds (CVOCs) in groundwater (primary trichloroethene [TCE] > 10 mg/L]) in an urban setting located in the northeastern United States. The remedial objectives were to treat the residual groundwater CVOC source and reduce the extent of the CVOC dissolved plume to enhance monitored natural attenuation (MNA) as a final remedy. The 900-ft long plume originated in an on-site source area in the upper portion of the glacial till aquifer and follows a downward gradient to the deeper portion of the aquifer off site. A permeable layer of uniform clean sand is present in the deeper portion of the aquifer creating a preferential flow pathway for horizontal migration of CVOCs in the deep overburden. The CVOCs have also migrated into the fractured bedrock aquifer which begins at approximately 100-ft below the site. Microcosm studies and a pilot test demonstrated that addition of electron donor and bioaugmentation can achieve complete reductive dechlorination of TCE to ethene in Site groundwater.

Approach/Activities. EISB was initiated in September/October 2014 with the injection of emulsified vegetable oil (EVO) and bacteria. Treatment was focused in the upper portion of the till to address the on-site source area (where evidence of residual DNAPL has been observed) and in the deep till at an off-site L-shaped “biobarrier” to intercept the dissolved CVOC plume. Rotary sonic drilling techniques were employed to install permanent injection wells given the difficult drilling environment (glacial till consisting of dense sand/silt mixed with gravel and cobbles). EVO was selected as the electron donor due to its longevity/applicability in a more passive approach for this challenging urban setting. A total of 25,937 pounds of EVO was injected over a period of fourteen days. In May 2015, OBG injected 336 L of the TSI-DC Bioaugmentation Culture® (TSI-DC) containing (*Dehalococcoides* [Dhc] *mccartyii*) into the biologically active treatment zones. Groundwater performance monitoring was conducted on a dynamic basis to assess the performance of the EISB technology.

Results/Lessons Learned. Performance monitoring results through April 2018 indicate that the injection of electron donor and microbes has been highly successful in stimulating biodegradation within the targeted treatment areas, as evidenced by the reduction of TCE (94.9% average), 1,1,1-TCA (87.9% average) and the production of daughter products, including ethene and ethane. The EVO mass and resultant volatile fatty acid (VFA) concentrations have now become depleted and fallen below target levels in the treatment zones, so that a second EVO injection event is planned for September 2018 to replenish donor within the source area and downgradient biobarrier.

This presentation will include: an evaluation of performance monitoring data collected to assess EISB effectiveness, as well as a comparison of 2014 and 2018 injection performance data. Problem solving approaches and lessons learned will be shared with respect to chase water injections for donor distribution efficiency, control and prevention biological fouling, monitoring for methane production and mitigating associated risk, and evaluation of impacts from commingled plumes. Initial results of the second injection event will be provided and strategic considerations for transitioning EISB to the ultimate remedy of MNA will be discussed.