Multiple Lines-of-Evidence Approach for Optimizing Operation of a TCE Remedial System in a Karstic Aquifer

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Background/Objectives. As required by a USEPA 2006 Record of Decision (ROD), a Groundwater Extraction and Treatment System (GWETS) was installed to pump from the most contaminated part of the groundwater plume with TCE above 500 µg/L using a series of extraction wells near the downgradient edge of the suspected soils source areas. The objective of operation of the GWETS is to limit migration and ultimately reduce the footprint of the subsurface TCE plume within the limestone/dolomite bedrock underlying the Site. The GWETS commenced operation in March 2016 and has been in operation since. The purpose of this study is to evaluate the hydraulic performance of the GWETS through different lines of evidence including review of groundwater level data, both on- and off-site groundwater contaminant concentrations, and modelling results to assess whether the current pumping rates can be optimized to achieve the overall objectives of limiting migration and reducing the TCE footprint.

Approach/Activities. The overall approach involved evaluating three lines of evidence to assess the efficacy of the GWETS system:

1. Gradient analysis: A gradient analysis was developed using existing groundwater elevation data collected before and after the GWETS system start-up to identify whether a sufficient gradient was established through initial operation of the GWETS within the TCE area to effect capture.
2. Review of contaminant concentrations: TCE concentration isopleths were developed within the TCE area to identify whether the footprint of impacts to groundwater from TCE changed over time. In addition, other contaminants such as 1,4-dioxane were evaluated to assess the risk of capture of other impacted areas of the valley from other plumes beyond the TCE area.
3. Groundwater modelling: A groundwater model, initially developed in 2013 to support the original design of the GWETS, was updated to simulate longer-term changes in groundwater elevations based on the transient water level results obtained during operation of the GWETS. This groundwater model was applied to assess a series of injection/extraction rates in terms of effecting capture within the TCE area.

Results/Lessons Learned. The gradient analysis showed that the GWETS system was performing as intended within the TCE area. The GWETS operation was able to maintain a sustained inward hydraulic gradient towards the extraction wells at all times when the wells were in operation. TCE concentrations exhibited a progressive decline within the TCE area further confirming the effectiveness of the remedy. Groundwater modelling indicated that capture can be maintained within the TCE area even after a 50% reduction from the current extraction rates. The next steps are to propose a phased evaluation of reduced pumping rates to assess whether the model findings can be confirmed through field observations.

Conservative design is necessary at the planning and construction phases. Once a remedy is implemented and additional data are available it is important to reassess the assumptions and operational parameters. Adaptive management and optimization of a remedial system is essential to sustain long-term performance while minimizing unintended consequences (such as minimizing the risk of migration of contaminants from other groundwater plumes, in this case).