High-Resolution Investigation and MIP Visualization to Optimize In-Situ Bioremediation of VOCs in Groundwater and Aquifer Sediments

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Background

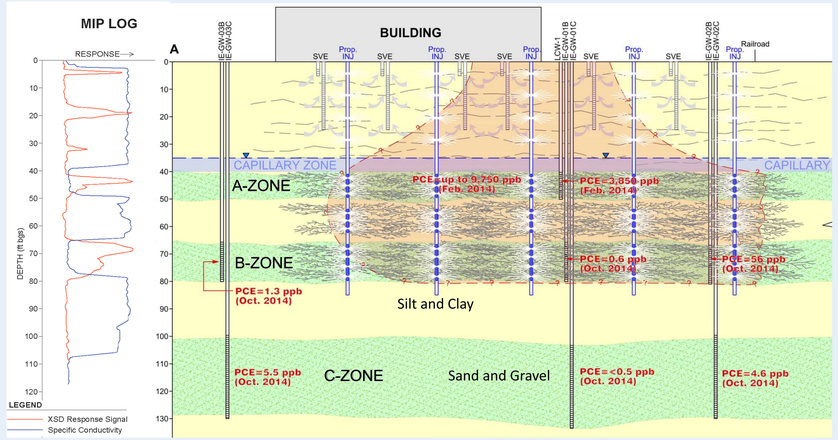
A former dry cleaner located in California used tetrachloroethene (PCE) as a cleaning solvent. Releases throughout decades of operations resulted in impacts to soil, soil vapor, and groundwater. Early investigations were limited in scope and did not result in adequate characterization. Extended litigation and lack of funding further limited the scope of investigations. A change in 2016 led to funding of one comprehensive investigation to support remedial design and allow settlement of all lawsuits which provided a lump sum fund for remediation and site closure. This poster presents the investigation approach and successful remediation program that benefited from the high resolution data and 3-dimension (3D) model.

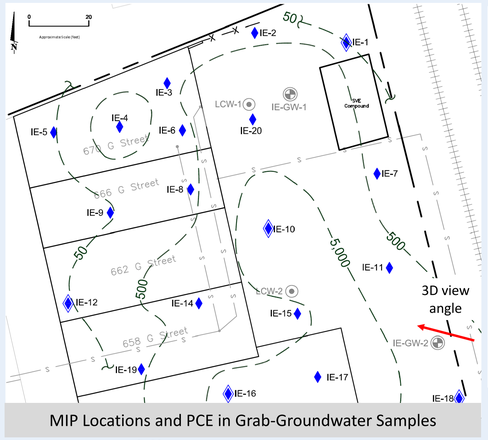
Objectives

- Combine historical and incomplete investigation data into one comprehensive conceptual site model (CSM) and update the model with more consistent sample results for all media. The updated CSM supported a more complete understanding of the PCE mass distribution and formally defined the source areas for remediation.
- Design and implement an insitu bioremediation program to reduce the mass of PCE and chlorinated daughter products in the lower vadose zone and impacted aquifers.
- Modify vadose zone permeabilities to enhance performance of an existing soil-vapor extraction (SVE) system operating in fine-grained soils and sediments.
- Achieve regulatory-approved remedial goals to support a No Further Action (NFA) designation.

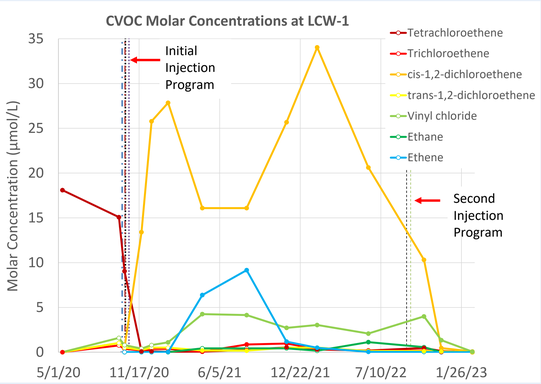
Approach

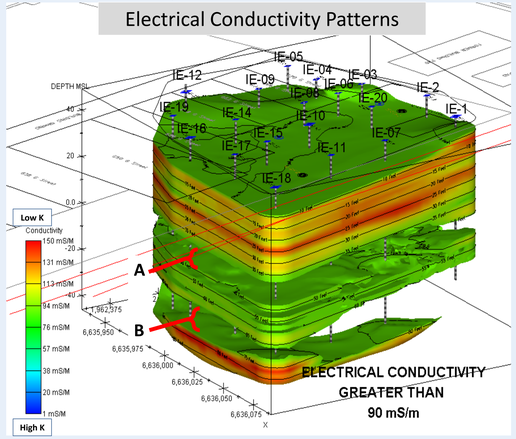
- 19 membrane interface probe (MIP) borings advanced to 85 feet below ground surface (bgs) on 40-foot grid over estimated source area. Corelate MIP and soil conductivity data (SCP) with visual logging records.
- Create a 3-D visualization model using SCP and MIP data to depict the qualitative concentrations of VOCs as it relates to soil/sediment permeability/stratigraphy.
- Bench scale microcosm and amendment studies to optimize bioremediation program.
- Work with injection contractor (FRx, Inc.) to design a hydraulic fracturing injection program for bioremediation and vadose zone permeability enhancements.
- Regulatory concurrence for points of compliance well monitoring and target remedial goals.
- The successful bioaugmentation program utilized jet injection techniques to emplace liquid amendments into the saturated, interbedded low- and high-permeability sediments between 25 and 80 feet bgs within the source area. Ten injection casings were jetted at five-foot intervals. Air-permeability enhancement injections at nine borings hydraulically fractured with guar gum slurry and sand proppant into the vadose zone to increase the performance of existing SVE wells.
- A supplemental amendment injection one year later to complete groundwater remediation.

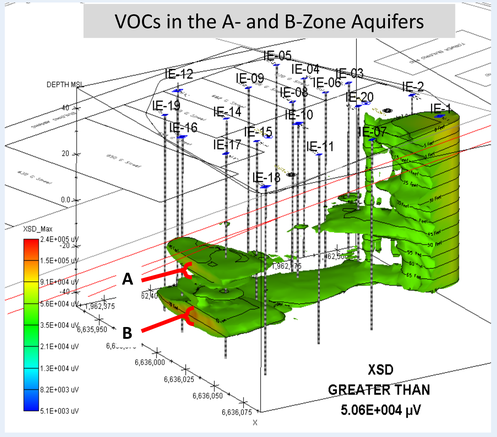


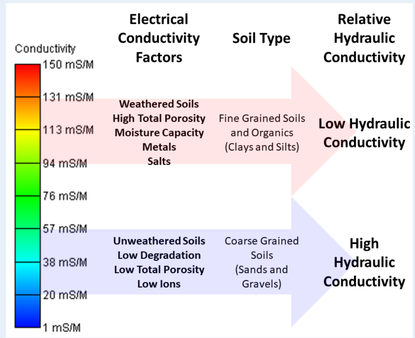


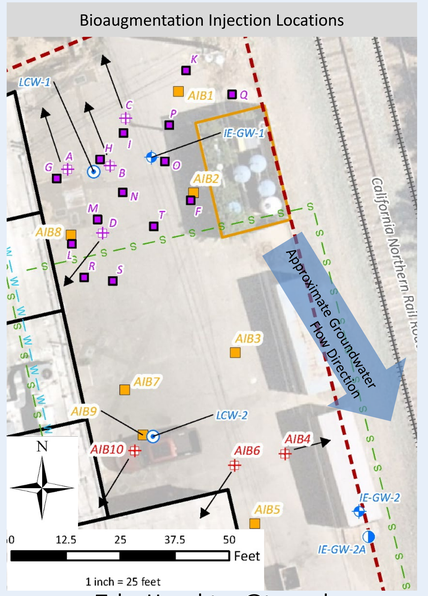
MIP Locations and PCE in Grab-Groundwater Samples







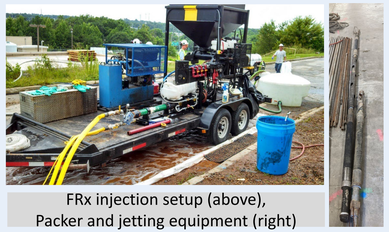




Results/Lessons Learned

- The jetting method of amendment emplacement was successfully tuned to target sediments and transport zones identified in the 3-D investigation. The visualization model was particularly useful for communicating with stakeholders and regulatory agencies.
- Sand injection in the vadose zone resulted in a doubling of air flow to the SVE system.
- Using the targeted approach resulted in achieving regulatory goals and the site is moving to NFA status and redevelopment all under the set budget and time schedule.

Sonic drill rigs advancing boreholes for injections



FRx injection setup (above), Packer and jetting equipment (right)

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