

Succession of Remediation Techniques for a Complex Site Impacted by Chlorinated Solvents

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Background/Objectives. A former small appliances manufacturing plant (22,000 m²) in São Paulo State (Brazil) used chlorinated solvents (CHCs) from the 1960s until it was sold to a construction company in 2008 for residential redevelopment. During the following 10 years, areas impacted by CHCs were identified with PCE concentrations around 4 mg/kg (soil) and 200,000 µg/L (groundwater). The plume purportedly extended from ca. 4 to 30 meters bgs and flowed off site to a residential area where PCE DNAPL was located beneath a commercial building. Hence, vapor intrusion concerns and restrictions were associated with the impacted areas. The objective was to remediate the site within 2 years to facilitate site redevelopment. Multiple remedial technologies and strategies were implemented, all with minimal success. These included: MPE, pump and treat along with ISCO (permanganate) and ISCR (EHC®) using various application methods (soil mixing, trenches, excavation and direct push injections). A revised remedial action plan was subsequently developed which consisting of a validated site model and the selection of a more appropriate remedial technology. These efforts resulted in a remedial program that met site expectations.

Approach/Activities. First, all the site characterization data along the corresponding geological and hydrogeological models were re-analyzed which identified important lithological features influencing the plume distribution. Namely, a compact clay lens interbedded by thin, non-interconnected layers of sand extended throughout the aquifer at a depth of 6 to 7 m bgs, and PCE DNAPL was associated with this confining layer. Furthermore, the presence of DNAPL was verified underneath a commercial building located off-site, which source was located on-site. A revised remedial action plan integrated the physical removal of the contaminated soil (clay) and remediating the groundwater using a more reactive ISCR amendment (Provect-IR®) that could be effectively injected under the site conditions. Due to the depth of the excavation (up to 30 m depth) a modified subsurface foundation technology was employed which entailed digging out and filling a borehole with cement simultaneously. After 6,000 metric tons of heavily contaminated soil were physically removed, ca. 200 metric tonnes of Provect-IR® antimethanogenic ISCR reagent were injected into the lower sand layers. Monitoring data to date document >90% CHC removal without the Stoichiometric accumulation of dead-end intermediates or the production of excessive methane. Obtainment of remediation targets (for future residential occupation) should be reached by Summer 2018.

Results/Lessons Learned. Inadequate site characterization resulted in an inaccurate understanding of aquifer lithology, hydrogeology and contamination. This led to the poor selection of remedial amendments and less than effective implementation. Given the site history it was understandably difficult to convince the site owners that remediation was possible. With the necessary understanding, the right reagents and technologies, the results are extremely positive and the remediation was concluded in 18 months.