

## Targeted Small Source Zone In Situ Thermal Treatment: Lessons Learned from Two Chlorinated VOC Applications

**Darren Croteau** (darren.croteau@terrphase.com)(Terraphase, Irvine, CA, USA)  
Grant Geckeler (grant@georemco.com) (GEO, Orange, CA, USA)  
Chris Voci (Terraphase, Conshohocken, PA, USA)

**Background/Objectives.** Chlorinated solvent remediation strategies for low permeability settings include in situ thermal treatment (ISTT) methods. However, there have been a rather limited number of applications of ISTT to reduce VOCs from targeted source zones smaller than 1,500 cubic yards performed in that last several years. This case study presents two separate tetrachloroethene (PCE) impacts in a low permeability saturated formations that were remediated using “surgical” ISTT applications. We explore how ISTT can overcome treatment challenges at small source zones in active, urban environments beneath buildings.

**Approach/Activities.** At the first ISTT application, PCE was released at a commercial site resulting in soil and groundwater contamination to approximately 35 feet below ground surface (bgs). The objective of the remediation was to treat the entire 800 ft<sup>2</sup> source area (1,040 yards<sup>3</sup>) to rapidly return the space to commercial lease. A thermal conduction heating (TCH)-based ISTT system with multiple-phase extraction (MPE) was installed inside the 2,800 ft<sup>2</sup> space. At the second ISTT application, PCE was encountered in soil and groundwater to approximately 40 ft bgs. The 1,100 ft<sup>2</sup> source area (1,400 yards<sup>3</sup>) was treated via ISTT while the commercial tenant retained active business operations in a portion of the building.

**Results/Lessons Learned.** After three months of ISTT treatment at the first site, groundwater PCE concentrations decreased >98%. Of 36 post-treatment soil performance samples collected to measure performance, two samples from one boring had PCE exceedances > 0.7 mg/kg. Focused heating and effluent extraction was performed for one additional month to complete treatment. A second round of soil sampling demonstrated that PCE concentrations were below the laboratory reporting limit of 4 µg/kg at all locations. Regulatory closure is currently being pursued. At the second ISTT application, which is currently operating through December 2017, several enhancements were implemented based on the experience at the first site. These enhancements and lessons learned include: installation of slanted thermal remediation wells to access some saturated zone volumes, installation of multi-segmented subsurface pressure monitoring points at various depths, and modifications to the construction and installation of shallow vadose zone soil vapor extraction wells. The results from this second application will be presented and compared to the previous application. Recommendations for future design and operation of ISTT installations for small source zone settings will be presented.