

## In Situ Hydrolysis and Thermal Treatment of 1,1,1-TCA during Electrical Resistance Heating

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**Background/Objectives.** The site is a former industrial property in southern New York State. Past site activities included an automobile manufacturing plant and a printing/publishing business, both of which used chlorinated solvents. Additionally, a former chemical company operated a warehouse/distribution center on the adjacent property. As a result of a fire at the warehouse in 1963, releases of a number of volatile organic compounds (VOC) occurred. Due to fire-fighting efforts, a large amount of these chemicals impacted the site, which is down-gradient and down-slope from the former warehouse. The principle contaminant is 1,1,1-TCA, together with 1,1-DCA and 1,1-DCE. Dense non-aqueous phase liquids have also been observed. The site is listed as a NYSDEC Superfund Site, and the Record of Decision identified in situ thermal treatment as the selected remedy. Project objectives were to attain, to the extent practicable, the low level Class GA Ambient Water Quality Standards, as well as Protection of Groundwater Soil Objectives.

**Approach/Activities.** Hydrolysis of 1,1,1-TCA is a common reaction; however it is too slow of a process at ambient temperatures for consideration in environmental applications. With the advent of in situ thermal treatment, increased hydrolysis rates with increased temperatures have allowed this process to assist in site treatment. An electrical resistance heating (ERH) approach was implemented which consisted of 101 single and multi-segmented electrodes designed to treat the saturated overburden aquifer from 5 to 55 feet below ground. Treatment was performed within an existing building as well as outside the building.

**Results/Lessons Learned.** ERH increased subsurface temperatures in the treatment zone to over 100° C. This increase created steam and volatilized contaminants of concern that were collected and treated above ground. In addition, in situ hydrolysis occurred. Initial groundwater concentrations of 1,1,1-TCA and 1,1-DCA of 440,000 µg/L and 300,000 µg/L, respectively, were reduced to non-detectable levels. Based on results of pre-design investigations, approximately 13,000 pounds of contaminant mass were estimated to exist in both the sorbed and dissolved phases of the impacted zone. Of that, 9,000 pounds consisted of 1,1,1-TCA, 3,000 pounds were 1,1-DCA, and nearly 1,000 pounds were 1,1-DCE. At the end of ERH treatment, based on both soil and groundwater post-treatment monitoring, only 56 pounds of total contaminant mass remained, for an overall reduction of 99.6%. Of the 9,000 pounds of 1,1,1-TCA initially present, only approximately 900 pounds were recovered in the vapor form. Presumably the remainder was treated via in situ hydrolysis. Acetic acid is a known product from the hydrolysis substitution reaction. Acetic acid concentrations rose from non-detect levels to 620,000 µg/L during treatment. Challenges during treatment to be discussed included encountering shallow bedrock during electrode installation which affected ERH performance. Future site risk management will be discussed with regard to proposed activities for the site following ERH, together with the adjacent source property.