Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

# A Multi-Year Evaluation of Natural Attenuation of Chlorinated Ethenes and Methanes using CSIA

***Amy M. Wilson, PhD, PE*** (awilson@trcsolutions.com) and Elizabeth Schwartz, PG, CHG (TRC, Concord, CA, USA)

**Background/Objectives.** Historical disposal practices at a former landfill have resulted in groundwater impacts comprising multiple volatile organic compounds (VOCs), primarily chlorinated ethenes, chlorinated methanes, and 1,2-dichloropropene (1,2-DCP). Groundwater at the site is deep (approximately 100 feet on average) and the geology is heterogeneous, with migration controlled by discontinuous preferential high-permeability pathways. The plumes are large and diffuse, extending approximately one-half mile downgradient. A remedy consisting of containment and monitored natural attenuation (MNA) is being implemented.

**Approach/Activities.** In order to evaluate MNA, compound-specific isotope analysis (CSIA) has been performed annually since 2008 for tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), carbon tetrachloride (CT), chloroform, and 1,2-DCP. The nine wells used in the CSIA study are generally located along the centerlines of the VOC plumes, which enables data analysis with distance and travel time, while also generally representing the highest plume concentrations. Degradation trends and fractionation factors in individual wells over time are also evaluated. The CSIA data are used along with microbial studies and geochemical data in an ongoing demonstration of MNA, in support of the site remedy.

**Results/Lessons Learned.** The data over space and time reveal a complex degradation system likely involving multiple landfill sources and releases, and groundwater geochemistry that varies significantly throughout the plumes. Analysis of the CSIA data is confounded because daughter products (e.g., TCE, chloroform) may also be primary sources. Additionally, wells comprising the monitoring well network were installed over three decades, resulting in potentially inconsistent well screen construction intervals that may not capture the relevant interconnected flow channels. Finally, CSIA was initially incorporated into site monitoring to support the conceptual site model (CSM), but CSIA has also motivated unexpected potential updates to the CSM, including seasonal surface water dilution from a shallow creek.