Treatability Studies and Pilot Test Program for Remedial Selection in a NAPL-Impacted Site in Brazil

Paola Barreto (paola.barretoquintero@ch2m.com) (CH2M, Philadelphia, PA, USA)
Carol Mowder (CH2M, Baltimore, MD, USA)
E. Erin Mack (DuPont, Wilmington, DE, USA)
James Henderson (DuPont, Charlotte, NC, USA)

Background/Objectives. Treatability studies were conducted for an industrial facility in Brazil with a complex mixture of constituents of concern (COCs) in soil and groundwater, including chlorobenzenes, chloronitrobenzenes, chloroanilines and benzene, toluene, ethylbenzene, and xylenes (BTEX). The main objective was to evaluate remedial technologies for the treatment of NAPL-impacted soil, groundwater, and concrete from former manufacturing units. The technologies selected for treating soil and concrete were thermal desorption (in situ and ex situ), soil washing, soil flushing, steam-enhanced stripping and ex situ self-sustaining treatment for active remediation (STARx). Biosparging and biostimulation were tested for treating groundwater. The project seeks to integrate remediation of impacted media with demolition and removal of former manufacturing units, and is driven by sustainable metrics that maximize environmental, social and economic benefits. Sustainability aspects are key screening criteria for remedial selection.

Approach/Activities. A multi-disciplinary team consisting of client, consultants and universities in the United States, Canada, and Brazil led the development of a comprehensive treatability studies program. Using contaminated media from the site (spiked and unspiked soils, groundwater and concrete), eight remedial technologies were evaluated in laboratories to assess their ability to remove contaminants. In situ thermal desorption at 260ºC and 100ºC and ex situ thermal desorption at 510ºC were tested for treating soil and crushed concrete. Soil flushing was tested with tap water, and non-ionic and ionic surfactants; soil washing was tested with tap water. In situ steam enhanced stripping was tested at 140ºC. Aerobic and anaerobic microcosms were assembled with and without pH adjustment and nutrient addition using contaminated soil and groundwater and testing the most representative contaminant mixtures found onsite.

Results/Lessons Learned. In situ thermal desorption test results indicate that elevated removal rates can be achieved at 100ºC, or greater. Ex situ thermal treatment effectively removed COCs (greater than 99%) from both soil and concrete. The results obtained from these two tests suggest that treated material may be used for backfill or unrestricted re-use. Soil washing with water alone can reduce the mass of soil with elevated contaminant mass by approximately 62%. The most effective of the surfactants tested (1% surfactant) performed only marginally better than the tap water control. The heat value of contaminants present in soils did not sustain the combustion front for STARx; however, vegetable oil as a surrogate fuel yielded good contaminant removal. Anaerobic treatment achieved limited removal of target contaminants and accumulated metabolites over time. Aerobic treatment resulted in mineralization of COCs, including dichloronitrobenzenes. Biodegradation mechanisms for dichloronitrobenzenes had not been reported before in the literature.
The treatability study results provided the basis for the pilot testing program to be implemented in 2018. The challenges associated with the presence of mixed contaminants (>30 COCs detected over time), site conditions and project sustainability drivers led to the selection of ex situ thermal desorption treatment and STARx as the preferred technologies for treating NAPL-impacted vadose zone soil. Groundwater treatment will be pilot tested with bio-sparging, recirculation and engineered wetlands. Synergies between the pilot tests will be identified to maximize sustainability benefits.