Combined Abiotic and Biotic TCE Reduction Bench Study Using Local Organic Carbon and Iron Sources Conducted in Sao Paulo, Brazil

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Background/Objectives. An operating manufacturing facility in an industrial district of Sao Paulo, Brazil experienced releases of chlorinated ethenes, tetrachloroethene (PCE) and trichloroethene (TCE) in the 1980s. Site characterization and extensive groundwater monitoring and modeling has indicated off site migration of the dissolved phase TCE and daughter product plumes to the northeast and west of the facility boundary. The dissolved phase plume migrating to the west is impacting an adjacent property. Several remedial strategies have been identified and are under review to mitigate additional migration of the dissolved phase plume including a mulch biowall as a more sustainable remediation strategy. A bench-scale study was conducted in 2015 at a local laboratory in Sao Paulo to determine the effectiveness of using locally sourced carbon (sugarcane bagasse and eucalyptus mulch) and locally sourced iron particles to generate the complete abiotic and biotic reduction of PCE and TCE to ethene and ethane in a biowall configuration.

Approach/Activities. To conduct the bench study, 12 kilograms of soil and 16 liters of water were collected from the area of the site where a biowall design has been tentatively located along the western edge of the facility boundary to mitigate migration of the chlorinated ethenes to the adjacent property. The amendments for the bench study included local sugarcane bagasse, eucalyptus and pinus mulch, local iron particles, calcium carbonate with 0.5 centimeter pebbles and #2 sand as aggregate material. The bench study was then assembled with the combinations of the various amendments added to seven batches with seven duplicates that included an ambient site condition control with no amendments (only site soil and groundwater) and a killed control. The seven batches were developed to identify the optimum blend of amendments to generate anaerobic reducing conditions to reduce the chlorinated compounds to ethene and ethane either abiotically and/or biotically.

Results/Lessons Learned. The locally-sourced carbon/electron donors comprised of sugarcane bagasse, eucalyptus and pinus wood mulch, provided sufficient carbon and electron donor to stimulate the biotic anaerobic reductive dechlorination of the Site COCs as evidenced by the results of batches 5, 6 and 7. Also, the locally-sourced iron particles provided an effective amendment for the abiotic reduction of the Site COCs as evidenced by batches 4, 6 and 7. Data from the study also showed that the indigenous microbial population was capable of the complete anaerobic reductive dechlorination of the Site COCs within the six month period of the tests, as evidenced by the results of batches 1, 4, 5, 6 and 7. The combination of the mulch and ZVI amendments without addition of sulfate was the most effective treatment to stimulate the complete biotic and abiotic reductive dechlorination of the Site COCs to innocuous end products (ethene and ethane) as evidenced by the results of batch 7. Based on the favorable results of the bench-scale study and achieving the remedial objectives, the recommendation was made to move forward with the design of a mulch/iron biowall along the western impacted area of the Site to mitigate additional off-site migration of the Site COCs to the adjacent property.