In Situ Remediation of TCE-Impacted Groundwater with Limited Water-Bearing and Low-Permeability Aquifer

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Background/Objectives. Volatile organic compounds (VOCs) are currently regarded as one of the most widely occurring environmental contaminants due to the widespread production and use of organic solvents and hydrocarbon fuels. Groundwater remediation technologies are limited by delivery of reactive chemicals or access to the contaminated plumes in particular with low water bearing and low hydraulic conductivity aquifers. The remediation possibilities are limited and innovative and site-specific methodology need to be devised.

The groundwater at the site is contaminated with trichloroethylene (TCE) that has long been identified as a likely human carcinogen. Traditional in situ remediation approaches cannot remediate contaminated sites with complex groundwater sites such as those with limited water-bearing and low-permeability aquifer and slow groundwater flow velocities. The potential for aquifer restoration decreases with increasing complexity of aquifer system. There has been recent recognition that a combination of two or more approaches, incorporating both active and passive and in situ and ex situ methods, are required (Roehl et al., 2005).

Approach/Activities. The site is located on the lower Adelaide Alluvial Plain with strongly weathered and fine-grained sediments of the Hindemarsh and Pooraka Formations. Laboratory column tests were conducted for selecting PRB reactive material and CRC CARE proprietary remMATTM was found effective for geochemistry of the site. Groundwater fate and transport model was set up as tools to design and upscale remediation technologies. Coupled active-and-passive remediation technology was implemented through large diameter permeable reactive barrier wells (PRBW) acting as pumping and injection wells. A large set of hydrogeological data was obtained, and a review of historical site investigation were conducted. Based on groundwater flow model result large diameter extraction and injection wells were installed

Results/Lessons Learned. Field test results demonstrated that the hydraulic conditions at study area were characterized principally as a low water bearing aquifer with the average hydraulic conductivity of 3.7*10-7 m/s. The hydraulic conductivity tests showed uniform values typical for clays and clayey silts and found spatially homogeneous. The groundwater model simulations showed that an extensive increase in the hydraulic gradient was only achieved with a great number of extraction/injection wells. The model results showed when the extraction wells were positioned only a little distance apart, the cones of depression formed a connected drawdown, which enhanced the hydraulic containment significantly

The extraction and injection wells of PRBW treated groundwater at the fringe of the plume promoted increased the hydraulic gradient, facilitated groundwater transport through the reactive media, and contained the plume. A reduction of the initial mass of TCE ~ 8.9 ppm by approximately 50% was achieved within four years after remediation commenced. Currently we have achieved the concentration close to site screening trigger value of Dutch intervention level of 500 ppb. The results of this study indicate that significant remediation is achieved despite the challenging hydraulic conditions of the aquifer.

Roehl, K.E., Czurda, K., Meggyes, T., Simon, F.-G. and Stewart, D., 2005. Permeable reactive barriers. Trace Metals and other Contaminants in the Environment, 7: 1-25.