Full-Scale Application of EHC® Liquid Technology for the ISCR and ERD Treatment of an Aquifer Contaminated with Tetrachloromethane and Chloroform in Italy

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Background/Objectives. EHC® Liquid Reagent is an in situ chemical reduction (ISCR) product for the treatment of impacted groundwater and is composed of two parts: EHC Liquid Reagent Mix, an organo-iron compound, and ELS® Microemulsion, which are easily combined and diluted for injection. Organic carbon addition in the saturated zone is well-known to promote conventional enzymatic reductive dechlorination reactions. This happens because the carbon in the subsurface will support the growth of indigenous microbes in the groundwater environment. As bacteria feed on the soluble carbon, they consume dissolved oxygen and other electron acceptors, thereby reducing the redox potential in groundwater. As bacteria ferment the ELS microemulsion, they release a variety of volatile fatty acids (VFAs) such as lactic, propionic and butyric, which diffuse from the site of fermentation into the groundwater plume and serve as electron donors for other bacteria, including dehalogenators. Lecithin itself is composed primarily of phospholipids, which have both hydrophilic and hydrophobic regions in their molecular structure. Further, phospholipids support remediation by providing essential nutrients (carbon, nitrogen, phosphorus) to bacteria. The soluble organo-iron compound is comprised of a ferrous iron (Fe+2) that can form a variety of iron minerals (e.g., magnetite, pyrite) that are capable of reducing contaminants as they oxidize further to the ferric (Fe+3) state via one electron transfer. The ferric ion can be “recycled” back to ferrous as long as other electrons from supplied carbon and indigenous carbon are available.

Approach/Activities. The site is situated in a highly-industrialized area of northern Italy, where groundwater is historically contaminated with tetrachloromethane (> 10 ppb), chloroform (> 10 ppb), hexavalent chromium and, to a lesser extent, PCE and TCE. In the intervention area and downstream of it, 10 standard pump and treat wells were located, designed to accelerate the removal of various contaminants. The presence of active pumps inside, or in the immediate vicinity, of the area affected by EHC® Liquid injections, however, could have compromised their effectiveness. This is due to the increase in groundwater speed and the removal of the injected emulsion. For this reason, a strategy has been planned to shut down some wells and reduce the flow rates of the others, in order to guarantee the maintenance of an adequate action of the latter. A detailed evaluation of the influence of P&T infrastructure, and the consequent action plan, was based on hydrogeological tests carried out in the field.

Results/Lessons Learned. After approximately 9 months from injection of EHC® Liquid into the groundwater in the main source area, the concentrations of CT and CF contaminants are rapidly reduced, compared to the pre-treatment concentrations, until the target values of treatment are reached in the main piezometers monitoring in the area, also highlighting the establishment of clear and enhanced biotic and abiotic reducing conditions.