

## Remediation for CVOCs by In Situ Chemical Reduction (ISCR) in Groundwater (Brazil Site)

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**Background/Objectives.** An industrial facility occupying 77.141,50 m<sup>2</sup>, located in São Paulo State (Brazil site), neighbor of an environmental protected area and one of the most important city's dam, whose waters are used for domestic supply of the Metropolitan Region of São Paulo. The site has been studied since the 1990s, indicating two main areas, former waste deposit (Plume 1) and emulsification tanks (Plume 2) in respect to chlorinated volatile organic compounds (CVOCs) anomaly concentrations. The conducted studies allowed the vertical delimitation of chlorinated compounds plumes in these areas which were found to be restricted to the superficial layers of the aquifer between 14 and 24 meters deep in the sandy silt layer of the weathered rock. The main receptor of these plumes is the Permanent Preservation Areas (APP), however, upstream areas also lacked of remediation actions since the mathematical modeling study showed that the plumes tend to intercept the APP region in concentrations above remediation targets. Thus, the definition of the remediation goals was based prior to the receivers' health risk considerations and the Reservoir waters protection. The approaches were designed aiming to restraint of the contamination, preventing the flow of contaminants in Reservoir

**Approach/Activities.** The preliminary remediation approach considered implementation of 3 PRBs in a Plume 1 region. Due to plume dimension originated by former emulsification tanks (170 m long x 80 m wide) the second area (Plume 2) considered 6 PRBs. The investigation for remediation allowed the best plume delineation and the remediation work plan was reviewed permitting to direct the efforts to the highest plume concentration. Between 2015 and 2017 were applied, in three steps, 81 tons of chemical reducer, Provect-IR<sup>®</sup>, in target areas 1,350 m<sup>2</sup> (former waste deposit) and 3,500 m<sup>2</sup> (emulsification tanks). The injection approach performed kept the PRBs concepts but adjusted using a more density injection points to cover the hottest chlorinated plume. The remediation product was introduced in the aquifer by means of a direct push injection and distributed between 91 injection points to establish a reducing reactive zone in groundwater promoting the degradation of CVOCs.

**Results/Lessons Learned.** The monitoring campaigns after injection demonstrates that the in situ chemical reduction (ISCR) process was efficient to establish reducing conditions of the groundwater maintaining a favorable environment for degradation of CVOCs. The ORP average was inverted from +179 mV to -242 mV as a result of reagent injection. The monitoring events showed significantly reduction of CVOCs (>80%) without the stoichiometric accumulation of byproducts. There are still two well that presents concentration above the targets for parameter VC and cis-1,2-DCE, however due to the maintenance of reductive environment shows favorable conditions to achievement the remediation targets at next months.