

## **Enhanced In Situ Reductive Bioremediation of Trichloroethene in an Aerobic, Fractured Bedrock Aquifer, MCB Camp Pendleton, San Diego, California**

Natalie Rothell, (natalie.i.rothell.civ@us.navy.mil) (US Navy RPM, San Diego, CA, USA)

Mark Cutler, (mark.cutler@tetrattech.com) (Tetra Tech EC, Irvine, CA, USA)

**Dan Leigh**, (daniel.leigh@evonik.com), (Evonik Corporation, Walnut Creek, CA, USA)

**Background/Objectives.** Groundwater at IR Site 1116 at MCB Camp Pendleton, San Diego, California had been affected primarily by trichloroethene (TCE). The resulting plume is approximately ½ mile long, 300 feet wide, up to 30 feet deep, and covers approximately 17 acres. Subsurface geology consists of weathered granitic rock overlying a consolidated and fractured granitic bedrock aquifer. Dissolved oxygen (DO) was in excess of 3 mg/L, and oxygen reduction potential (ORP) was correspondingly oxidizing. TCE had been detected in the fractured bedrock aquifer at concentrations in excess of 2,000 µg/L. Groundwater remediation was determined to be required to protect nearby building occupants from potential vapor intrusion. Enhanced in situ bioremediation (EISB) via injection wells was selected as the preferred remedial option for the plume area and the contaminant source area.

**Approach/Activities.** Full-scale remediation of the dissolved plume began on September 10, 2018. The remedial process was conducted by application of an easily distributed and long-lasting organic substrate (ELS™, Evonik Corp), and a proven dechlorinating microbial consortium (SDC-9™, Aptim) and a soluble buffer (KHCO<sub>3</sub>). Hydrant water for substrate mixing was deoxidized and dechlorinated prior to mixing using sodium ascorbate. The concentrated ELS was emulsified on site and the microbial culture was added to the injection wells after the emulsified substrate was injected. The emulsion was distributed through the aquifer through more than 200 groundwater injection wells screened in the fractured bedrock aquifer. A trailer with a 1,000-gallon poly tank was used to transfer the substrate from the substrate mixing area to the injection wells for pressure injection through a 10-well manifold system. Distribution of the reagents by a gravity flow system was also applied at several locations. A total of over 95,000 gallons of reagents were applied at this site.

**Results/Lessons Learned.** Groundwater monitoring confirmed that the reagents were effectively distributed in the fractured granitic bedrock aquifer. Following distribution of the reagents, anerobic and highly reducing conditions conducive to biologically mediated reductive dechlorination were established in the treatment zone. Complete reductive dechlorination of the TCE was confirmed by the presence of non-toxic ethene in treatment area wells. The project demonstrated that EISB using slow-release emulsified substrates is an effective process for treatment of chlorinated organics in aerobic, fractured granitic bedrock aquifers.