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Multiple Large-Scale Biobarriers for Multi-Contaminant, High-Concentration Plume in Brackish Water, Naval Air Station North Island

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Background/Objectives. Hexavalent chromium [Cr(VI)] and volatile organic compounds (VOCs) have been detected at elevated concentrations in groundwater (both over 100 milligrams per liter) proximal to the Bay in Operable Unit 20 (OU 20) at Naval Air Station North Island (NASNI) in Coronado, California. The VOC plume is ½ mile long, and the Cr(VI) is at the leading edge of the VOC plume. There is likely an additional VOC source area near the leading edge. Enhanced in situ bioremediation (EISB) technology was implemented in 2012 by direct push injection (DPI) of emulsified vegetable oil (EVO) for microbial reduction of Cr(VI) to Cr(III) and to support reductive dechlorination of VOCs in the portions of the plume with Cr(VI) over 5 mg/L and VOCs over 20 mg/L. EVO had been tested (along with other donors) on bench scale prior to field scale injections. Commercially available microbial cultures were also injected. To prevent re-contamination of the injection area by the upgradient plume, a 700 foot biobarrier was installed. Subsequent investigations indicated a much larger contamination footprint in the vicinity of the 2012 DPI area. A second biobarrier consisting of over 400 multiscreened injection wells spanning 2,400 feet was installed in 2015 approximately 100 to 200 feet upgradient of the Bay. DPIs were planned downgradient of the second biobarrier to address another hot spot, but due to excessive utilities, the design was modified to a biobarrier spanning 260 feet. In all, the biobarriers span over 3,300 feet, with all wells receiving EVO. In one portion of the second biobarrier, lactate was also injected in 2015 due to presence of elevated Cr(VI). Also, in 2015 a small portion with recalcitrantly high levels of VOCs received EVO combined with zerovalent iron (ZVI).

Approach/Activities. Activities included injection of electron donors and microbial cultures at 377 DPI locations and 78 injection wells in 2012; and at 52 DPI locations and over 400 injection wells in 2015. Several rounds of groundwater monitoring have been completed since 2012 to evaluate EISB progress.

Results/Lessons Learned. EISB is capable of addressing elevated levels (in some cases over 100 mg/L) of both VOCs and Cr(VI). Elevated sulfate (given proximity to Bay) did not appear to be detrimental to EISB. Bench testing had indicated that Cr(VI) would need to decrease to < 10 mg/L before reductive dechlorination could occur, but this was not the case at a number of locations. The microbial culture was also found to be quite robust, despite elevated levels of contaminants and presence of brackish water. EISB coupled with ZVI was found to be effective at decreasing elevated TCE levels. Injection of lactate in the portion of the second biobarrier resulted in substantial decrease in Cr(VI) within a few months.

Elevated levels of methane were observed in a number of EVO injection wells. Future injections into the biobarriers will include a comparison of traditional EVO and EVO mixed with an anti-methanogenic reagent. At one of the injection areas, a groundwater monitoring well is located 60 feet downgradient of the 2012 injections. While the first 3 years of monitoring indicated no change in Cr(VI) or VOCs, data from the fourth year indicate a decrease in Cr(VI) and TCE coupled with increase in cis-1,2-dichlorethene at this location (prior to 2015 injections). This suggests that the minimum longevity of EVO in the saturated zone is at least 3 years.