Treatment of DNAPL Source Zone in an Active Manufacturing Facility with Alkaline Activated Persulfate

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In-Situ Chemical Oxidation (ISCO) using alkaline activate persulfate (AAP) was selected to treat 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethene (PCE), and 1,4-dioxane contamination existing below the floor of an active, high security, Department of Defense contractor, manufacturing facility. The remedial goal was to reduce groundwater concentrations to below 1 mg/L within the contaminant source area, where initial groundwater concentrations exceeded 100 mg/L. Dense non-aqueous phase liquid (DNAPL) phase contamination was suggested by the elevated concentrations and was also observed in certain soil cores.

There was intense pressure on our Client to achieve the project remedial goals, within a specific timeframe. The business unit of the facility needed to resume operations within the target area. XDD had a limited window of opportunity, after which, access to the target area would have been impossible. XDD completed the entire response within the span of 8 months – from proposal, design and work plan phase (requiring regulatory approval), bench testing, full-scale implementation, and performance verification – on time to meet the tight timeline requirements of the Client.

AAP technology involves adjustment of the aquifer pH to alkaline conditions (typically greater than pH 10.5). Reaction of the oxidant (FMC Klozur^{TM} sodium persulfate) at high pH conditions promotes formation of aggressive oxidant radical species capable of breaking down the target contaminants. AAP also has several safety advantages when used under a building. Subsurface gas evolution is minimal, which greatly reduces the potential for gas intrusion into the indoor air space. This was particularly important for this application, since this allowed the facility to maintain it's 24-hour manufacturing schedule without significant disruption.

Bench Test

XDD initially completed a bench scale evaluation to identify the base buffering capacity and soil oxidant demand of the soils. The compounds 1,1,1-TCA and 1,4-Dioxane can be particularly recalcitrant to oxidation technology if the process is not optimized for site-specific conditions. Through a systematic optimization strategy, XDD engineered the AAP formulation to account for an unusually high soil buffering capacity, and relatively high background interference sensitivity. Finally, the degradation of the site contaminants was confirmed on the bench test prior to a field application. The bench optimization step was a key component of this successful treatment approach.

Field Application

Approximately 55,000 gallons of oxidant solution was injected into the target area during two separate field events. The target source area was approximately 30 feet wide by 60 feet long, with a targeted saturated zone

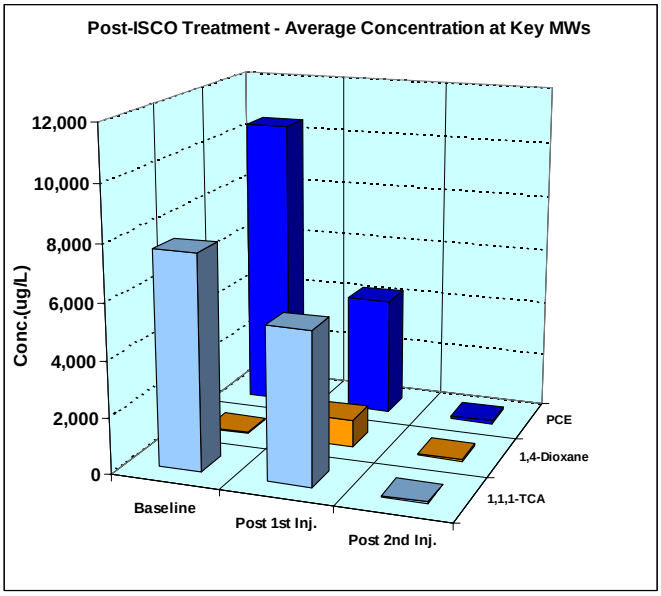
thickness of approximately 15 feet (total of 1,000 cubic yards). The injection depth interval spanned two distinct geological units consisting of a shallow sandy silt zone overlying a lower permeability glacial till zone. Separate injection well systems were installed at two discrete depths to ensure optimal oxidant distribution into each distinct soil layer. A total of 68,500 pounds of FMC Klozur™ was injected at field concentrations of 100 to 200 g/L. The injection solution also contained approximately 33,800 pounds of sodium hydroxide to adjust pH to required alkaline activation range.

Field Application Results

At over one year after the AAP treatment was completed, monitoring results have confirmed that the remedial goal has been achieved, and that there has been no significant rebound of the contaminants. Concentrations were reduced in many of the performance monitoring locations to near MCL levels. Elevated pH and increased metals concentrations within the immediate target area have been persistent since the treatment was completed, but this has not impacted downgradient water quality. During the initial bench testing for this application, the soil buffering capacity at this site was determined to be relatively high. Considering the high buffering capacity of this aquifer, high pH conditions were not expected to expand substantially beyond the extents of the targeted source area. Groundwater monitoring data will be presented to show the actual residual effects of the AAP treatment on the target area and downgradient aquifer system. Consideration of these treatment residuals and the potential for long-term effects on the aquifer is an integral part of the ISCO design process, and this should be considered prior to application of any ISCO technology.

Post-ISCO Treatment			
Average Concentration - Key Monitoring Wells (ug/L)			
Compound	Baseline	Post 1st Inj.	Post 2nd Inj.
PCE	10,492 *	4,234	113
1,1,1-TCA	7,645 *	5,435	64
1,4-Dioxane	35 *	988	79

*Max. PCE, TCA, and 1,4-dioxane was 48,600, 18,200 and 3,100 ug/L



Key XDD Personnel

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