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Combined ISCO/Bioremediation at an Operating Gas Station

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Background/Objectives. An operating facility in the midwestern US consists of a convenience store building, two fuel dispensing islands, three underground storage tanks (USTs) containing gasoline, and one kerosene UST. The site is located in a Well Head Protection Area (WHPA). Releases from the UST area resulted in soil and shallow groundwater contamination by BTEX/MTBE. Active facility operations mandated that an in situ remedial strategy rapidly reduced contaminant of interest (COI) concentrations in a safe and effective manner (i.e., materials easy to handle on site; no extreme activation chemistries such as heat or grossly elevated pH). Moreover, a single, one-time application event was highly desirable.

Approach/Activities. Provect-OX® is a dry powder containing sodium persulfate and ferric oxide that can be easily applied into a subsurface environment via direct mixing, hydraulic fracturing, pneumatic fracturing, and direct push injection of slurries or liquids. Ferric iron can safely activate persulfate which quickly yields sulfate and ferrate radicals to effectively oxidize chlorinated solvents, petroleum hydrocarbons and other organic compounds such as pesticides in soil, sediment and groundwater. Importantly, the process also enhances subsequent utilization of sulfate and iron as terminal electron acceptors for facultative redox reactions for improved biodegradation of any residual COIs. This combination of chemical and biological treatment mechanisms allows for more cost-efficient dosing of the product while supporting long-term, sustained, secondary bioremediation processes to manage residuals and prevent contaminant rebound (COI rebound is a common problem encountered with conventional in situ chemical oxidation [ISCO] technologies). Compared to other methods of stimulating secondary biodegradation processes using oxygen release compounds (such as calcium or magnesium oxyhydroxide), iron materials remains in place and active for many years. Additional benefits include: i) does not generate excessive heat/off-gases, and ii) does not mobilize heavy metals or lead to the generation of secondary impact issues such as elevated arsenic, chromium resulting from grossly elevated pH.

Results/Lessons Learned. During the Fall of 2015 a total of 1,350 lb of reagent was applied via 15 direct push injection points throughout an area measuring ca. 200 ft2 adjacent the USTs targeting MW-2 proximal to the UST area. Reagents were injected from ca. 5 to 8 ft bgs. Each point received 65 USG water containing 60 to 110 lbs reagent applied as an aqueous slurry (10% to 20% reagent). Within 180 days of treatment, benzene concentrations had been reduced to levels that support an Exposure Risk-Based evaluation and No Further Action. Post-remedial monitoring will continue through Fourth Quarter 2016. This presentation will outline field application (issues associated with field equipment and surfacing), summarize the data below, and review total project costs.

Monitor Well	**Benzene (ug/L)**				**TEX (ug/L)**				**MTBE (ug/L)**			
	0 days	60 days	90 days	180 days	0 days	60 days	90 days	180 days	0 days	60 days	90 days	180 days
2	**132**	**46.5**	**62.4**	<5	<5	<5	<5	<5	**45**	<4	<4	<4
3	**579**	**10.5**	**182**	<5	<5	<5	<5	<5	**15.2**	<4	<4	<4
6	**114**	**13.8**	**73.7**	**23.5**	**88.2**	<5	<5	<5	<4	<4	<4	<4
RAO	5				700				40			