

Provect-OX™ - Self-Activating *In Situ* Chemical Oxidation (ISCO) and Enhanced Bioremediation for Dissolved Plume Destruction

Former Gasoline Station – St. Albans, West Virginia

Constituents of Interest: BTEX, MTBE and TBA

Lead Contractor: Innovative Environmental Technologies, Inc. (IET)

Project Summary

The site is a former gas station located in St. Albans, West Virginia. The site was contaminated with benzene, toluene, ethylbenzene, xylene (BTEX), methyl tert-butyl ether (MTBE), and tert-butyl alcohol (TBA). The area of concern was approximately 3,775 sq ft with a target vertical interval from ca. 6 to 12 feet below ground surface (ft bgs). The geology at the site is primarily clay with depth to groundwater at ca. 5 ft bgs. Two monitoring wells were addressed during the injection program, MW-5R and MW-9. The in situ injection program targeted the BTEX, MTBE and TBA with Provect-OX™ (US Patent 9,126,245), which is an advanced chemical oxidation and accelerated bioremediation technology.

Remediation Plan

Innovative Environmental Technologies, Inc. (IET) applied Provect-OX to the subsurface via a patented injection process and apparatus (US Patent 7,044,152) such that the activation processes occur in a controlled manner. A total of 19 injection points and 7,300 lbs of Provect-OX were utilized to treat the area of concern (**Figure 1**).

The Provect-OX rapidly oxidizes the organic contaminants present in soil and groundwater and provides long-term, sustained secondary bioremediation to manage residuals and prevent contaminant rebound. This is accomplished by using ferric iron (Fe III) as a safe and effective means of activating persulfate, which quickly yields sulfate and ferrate radicals for chemical oxidation treatment. The process also enhances subsequent utilization of sulfate and iron as terminal electron acceptors for facultative redox reactions to support secondary biodegradation of any residual contaminant mass.

Treatment Program Results

Field, geochemical and volatile organic compound data for the two target monitoring wells are presented below in **Table 1** and **Table 2**. Chemical oxidative conditions are evident during the first MW-5R post-treatment sampling event with an ORP of +171.7 mV and increases in dissolved oxygen and conductivity. Sulfate and iron measurements confirmed that Provect-OX was

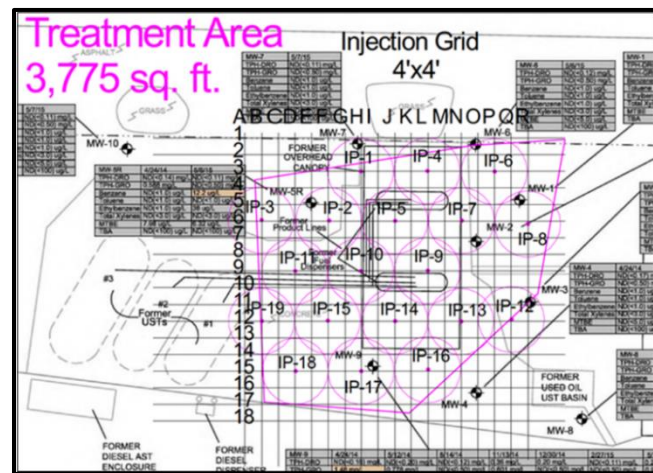


Figure 1: Injection Point Site Map

successfully applied with the targeted area. During the June 2016 sampling event, the field parameters transition towards a reducing environment with ORP of -124.5 mV and the dissolved oxygen concentration decreasing to 0.40 mg/L. However, the presence of elevated sulfate and iron concentrations suggest that the environment is still transitioning, and it has not yet established conditions that would fully favor biological attenuation of the targeted compounds.

Due to the absence of any MW-9 field parameter data during the March 2016 sampling event, it is not possible to assess how the geochemistry was initially affected by the remedial injection; however, the highly elevated sulfate and iron concentrations confirm that Provect-OX was successfully applied with the targeted area. During the June 2016 sampling event, the field parameters indicate a reducing environment with an ORP value of -147.6 mV and significantly reduced sulfate and iron concentrations.

Table 1. Field and Geochemical Data for MW-5R and MW-9

Sampling Date	MW-5R			MW-9		
	05/06/15	3/31/16	06/21/16	05/06/15	3/31/16	06/21/16
Depth to Groundwater (ft)	6.26	5.68	6.05	11.33	7.14	5.54
pH	6.48	8.97	8.96	6.28	NM	9.47
ORP (mV)	NM	+171.7	-124.5	NM	NM	-147.6
D.O. (mg/L)	0.16	1.23	0.40	0.21	NM	6.04
Conductivity (mS/cm)	0.804	3.53	2.59	0.657	NM	1,974
Temperature (°C)	16.12	13.93	18.75	17.07	NM	19.04
Sulfate (mg/L)	NM	1,260	1,230	NM	2,000	600
Iron (mg/L)	NM	1.12	8.23	NM	174	0.425

NM: Not Measured

Due to the oxidative and bioattenuation conditions, the petroleum hydrocarbon groundwater concentrations in both monitoring wells decreased, with MW-9 exhibiting non-detect concentrations for all contaminants of concern (**Table 2**). Additional BTEX and MTBE decreases in MW-5R are expected due to the iron and sulfate enhanced bioremediation processes.

Table 2. VOC Data for MW-5R and MW-9

Sampling Date	MW-5R		MW-9	
	05/07/2015	06/24/2016	05/07/2015	06/24/2016
Benzene (µg/L)	12.2	7.48	77.0	ND
Toluene (µg/L)	ND	ND	2.89	ND
Ethylbenzene (µg/L)	36.0	25.3	66.5	ND
Total Xylenes (µg/L)	ND	ND	6.64	ND
MTBE (µg/L)	6.32	5.98	72.8	ND
Tert-Butyl Alcohol (µg/L)	ND	ND	1,480	ND

ND: Non-Detect

Please contact our office at (815) 650-2230 or via email at info@provectusenv.com for additional information regarding this project or our technologies.