

Large Scale BTEX Plume Remediation Using Controlled-Release Oxygen Compounds

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PROJECT BACKGROUND

Leaking underground storage tanks (LUSTs) at a re-fueling station produced a one-acre benzene, toluene, ethylbenzene, and xylene (BTEX) plume in the underlying sand/gravel aquifer. The 1,000-gallon and 300-gallon gasoline LUSTs were used for truck and equipment operations. The LUSTs had created a contaminant plume extending 390 feet downgradient from the source area with total BTEX in groundwater exceeding 24,000 micrograms per liter (ug/L). In an effort to mitigate the source, excavation activities removed 795 yd³ of contaminated soil. As further site monitoring progressed, it was observed that groundwater BTEX concentrations continued to exceed the Illinois EPA cleanup levels and a remediation plan was needed to ensure adequate and cost-effective cleanup.

Contaminant	Pre-Remedial Concentrations	Cleanup Goals
Benzene	352	5
Toluene	17.1	1,000
Ethylbenzene	383	700
Xylenes	704	10,000

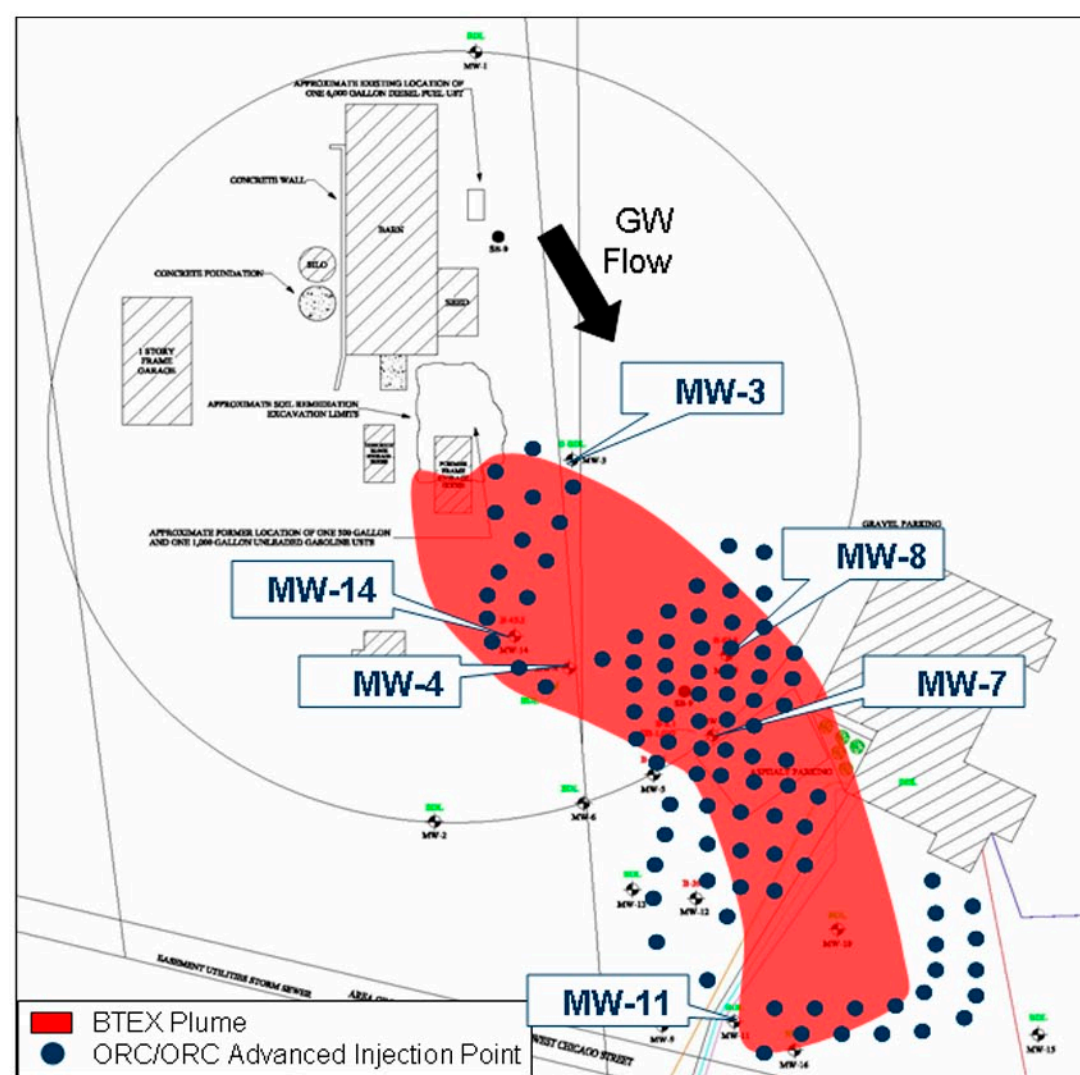


Figure 1. ORC/ORC Advanced Injection Design over the BTEX Plume

REMEDIAL TECHNOLOGY & DESIGN

In-Situ Enhanced Aerobic Bioremediation

A pilot test was designed to determine the feasibility of using enhanced aerobic bioremediation to reduce BTEX concentrations in groundwater. In September 2000, a total of 300 pounds of Oxygen Release Compound (ORC[®]) was applied upgradient of well MW-4. Within 4 months, BTEX concentrations declined from 1,456 to 124 ug/L, a reduction of more than 90%.

Baseline	Oct 2000	Nov 2000	Jan 2001	Reduction
1,456	673	149	124	91%

The success of the pilot test led to a full-scale application in January 2002. The application was heavily focused on the upper part of the plume (MW-4) and the mid-plume area (near MW-7). A re-application was performed in December 2002 to focus on continued reduction within the mid-plume area. In July 2004, an application using ORC Advanced[®] was applied to the mid-plume area as well as a barrier at the foot of the plume to prevent any off-site migration.

	Upper Plume (MW-4)	Mid-Plume (MW-7)	Lower Plume (MW-11)
Sept 2000	ORC [®]		
Jan 2002	ORC [®]	ORC [®]	
Dec 2002		ORC [®]	
July 2004		ORC Advanced [®]	ORC Advanced [®]

Oxygen Release Compound (ORC[®])

ORC[®] is a magnesium-based peroxygen that delivers pure oxygen into the subsurface for the purpose of stimulating the aerobic degradation of petroleum hydrocarbons. ORC[®] contains a minimum of 10% oxygen by weight and typically delivers oxygen to the subsurface for periods of up to 12 months.

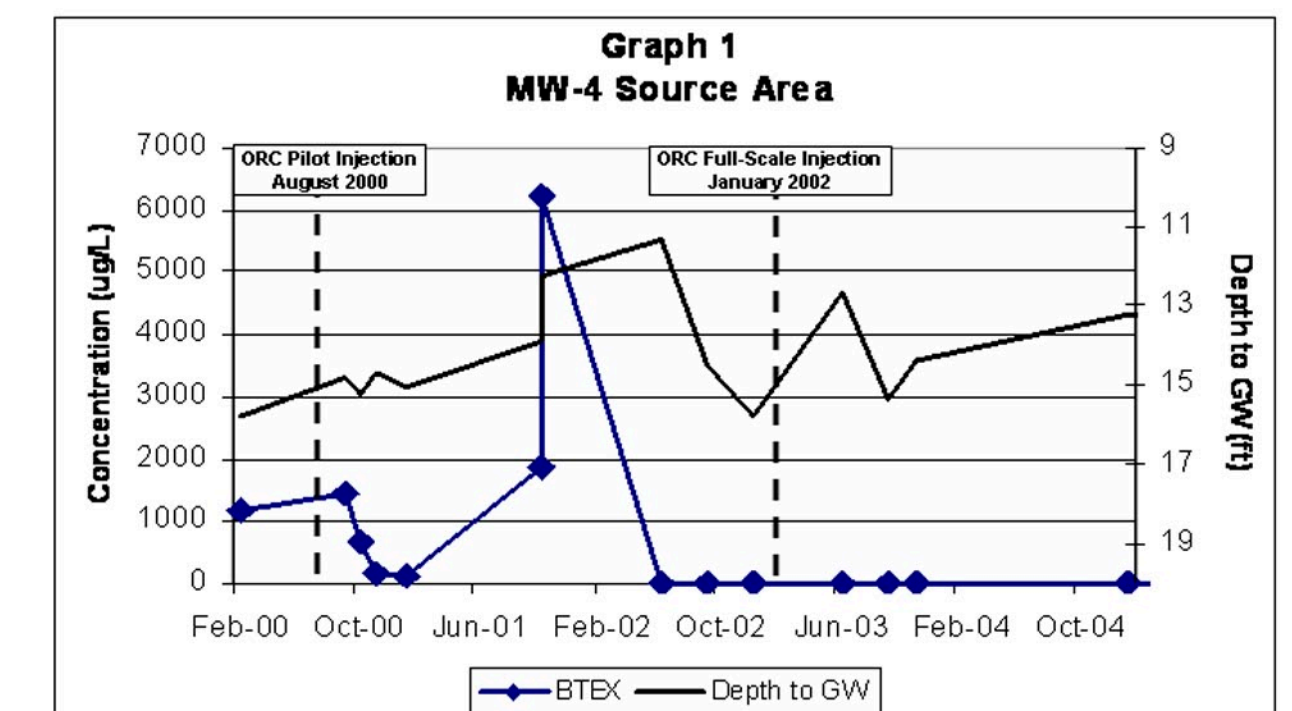
ORC Advanced[®]

Similar to ORC[®], ORC Advanced[®] is a calcium oxyhydroxide product containing 17% oxygen by weight. When hydrated, ORC Advanced[®] releases oxygen and forms calcium hydroxide and water. This controlled-release of oxygen can last up to 12 months with a single application.

RESULTS

Source Area - MW-4, MW-14

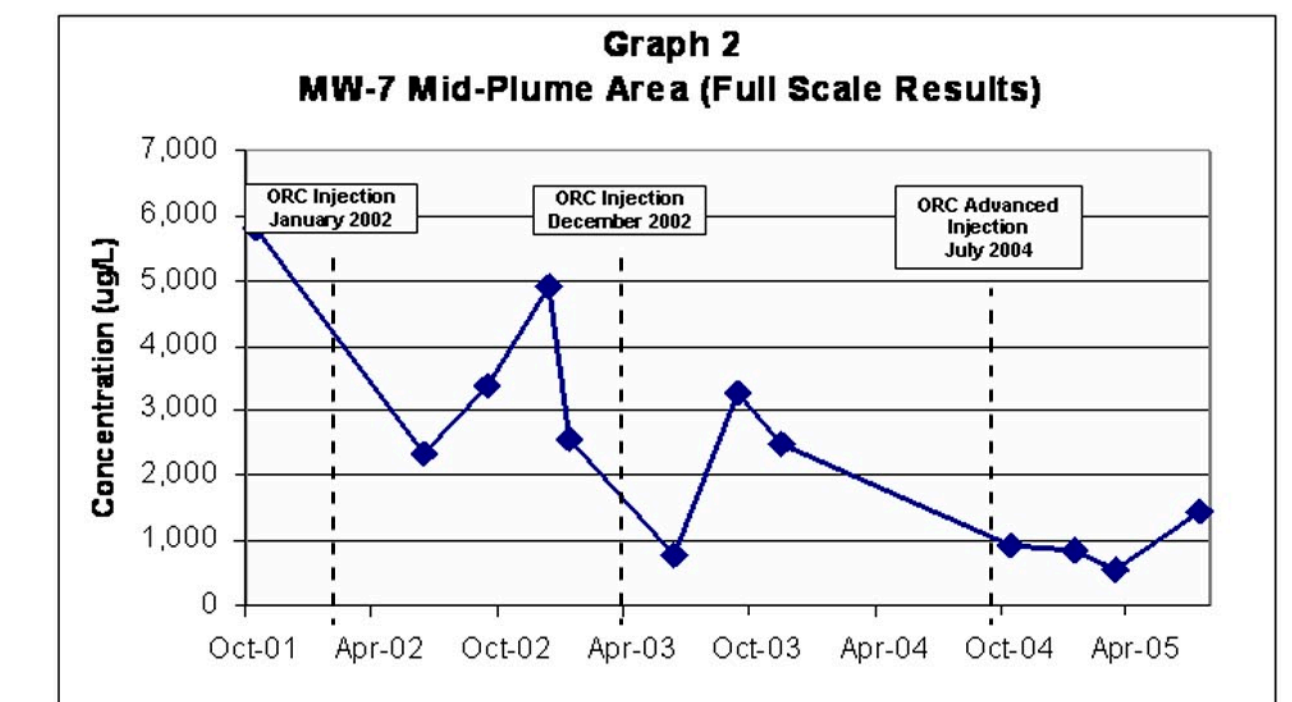
Pilot results at MW-4 indicated a reducing trend immediately following the application. However, a rise in BTEX was observed following the initial decline in concentrations. This rise can be explained by the change in groundwater elevation which is outlined in Graph 1. A high groundwater event in October 2001 resulted in a BTEX concentration of over 6,000 ug/L but was quickly reduced to non-detect. BTEX levels remained below the cleanup goals for the remainder of the pilot and full-scale monitoring. Well MW-14, also monitored during the pilot test, showed a similar trend. BTEX concentrations were initially reduced, then rose in response to the rise in groundwater. Non-detect levels were reached 11 months later.



Mid-Plume Area - MW-7, MW-8

A continuous decrease in BTEX resulted in an overall contaminant mass reduction of 85% in MW-7 (Graph 2). An initial concentration of 5,798 ug/L was reduced to 1,456 ug/L over the 11 month monitoring period.

BTEX concentrations in well MW-8 fluctuated after the ORC injections. A decrease of 99% was observed within 5 months of the initial application. Fluctuations followed with two spikes of more than 6,000 ug/L. A decreasing trend was then observed and levels were reduced to approximately 2,000 ug/L.



Lower Plume Area - MW-11

The barrier application at the lower portion of the plume treated elevated benzene levels as well as prevented any off-site migration. Concentrations remained at non-detect levels in most wells (MW-9, MW-11, MW-16). Well MW-12 was last sampled with a benzene concentration of 40 ug/L.

CONCLUSION

The multiple ORC applications were successful at sustaining an aerobic environment to facilitate bioremediation. The lower plume area continues to measure non-detect in all contaminants. Concentrations in the mid-plume area have reduced significantly and it is expected that the remaining benzene and ethylbenzene will reach cleanup goals as monitoring continues. The source area has reached cleanup goals in all contaminants except benzene which is on a decreasing trend towards the remedial goal of 5ug/L.

