Linebach Funkhouser, Inc.
environmental compliance & consulting

Chemical Oxidation – Aerobic Bioremediation
Bulk Fuel Oil Facility – New Albany, IN

Site Location:	**New Albany, IN**
Contaminants:	**Benzene, Toluene, Ethylbenzene, Xylene (BTEX)**
Impacted Matrix:	**Unsaturated & Saturated Soils and Groundwater**
Remediation Remedy:	**Soil Blending with Klozur CR® - Chemical Oxidation & Aerobic Bioremediation**

Since the 1900s, this site was a bulk fuel oil facility. The site operated both large AST (aboveground storage tank) systems off-loading to railcars as well as a retail distributor of gasoline and diesel fuel via 4 UST (underground storage tank) systems. Remediation at the site consisted of over-excavating 107 tons of contaminant soil along with the mixing of 1,395 lbs of Klozur CR prior to backfilling. Linebach Funkhouser, Inc. (LFI) used soil mixing as the application technology to apply the Klozur CR product.

Chemical oxidation, with activated persulfate, for the treatment of organic contaminants in soil and ground water has been successfully applied in the field over the past several years. In general, persulfate chemical oxidation is a very effective technology for many recalcitrant compounds. However, contaminants may reside in low permeability zones or in down-gradient portions of plumes, where soil heterogeneity may make it difficult for any *in situ* technology to effectively and economically remediate these problematic areas. In addition, slow re-partitioning of contaminant from soils or bedrock and non-aqueous phases may induce groundwater concentration

re-bounding after the oxidant has been expended. As a result, multiple application of the oxidant or soil blending may be required to improve contact with the contaminant. Alternatively, aerobic bioremediation, enhanced through the slow release of oxygen is effective for the treatment of BTEX, PAH, TPH, and other aerobically biodegradable contaminant. However, bioremediation of source zones and hot spots may be difficult. The high contaminant concentrations in these areas may be toxic to microbial populations. Moreover, treatment times are often lengthy due to the slow kinetics of mass transfer, making bioremediation unattractive for time sensitive remediation applications.

Klozur CR is a combination of chemical oxidation and aerobic remediation. Chemical oxidation is ideal for targeting hot spot and source zones, where the ratio of contaminant to soil oxidant demand is high, driving contaminant destruction kinetics so that these zones can be treated in several weeks to months. In addition Klozur CR can increase levels of natural organic matter by the partial oxidization of soil components and solubilization due to temporary elevation of the soil and ground water pH in excess of 10. This increase in natural organic matter is beneficial to the nascent microbial population, increasing microbial density which can impact the rate of contaminant destruction. At sites with high groundwater flow rates, the groundwater will transport both the dissolved organic matter and oxygen into the down-gradient plume, supporting contaminant reduction beyond the initial target zone. Klozur CR combines the speed and power of high-pH activated persulfate with the long-term efficiency of enhanced aerobic bioremediation. It has been designed for emplacement at the bottom of excavations to address residual contamination, which is how it was utilized at this site.

Following soil excavation of the contaminated soil at the former bulk oil facility, LFI mixed the 1,395 pounds of Klozur CR® (Calcium Peroxide and Sodium Persulfate) product provided by FMC Corporation into the open excavation prior to backfilling on March 25, 2010. The trackhoe was used to mix the dry product in with the groundwater and saturated soils (i.e. the smear zone) prior to backfilling the excavation. A 4-inch diameter replacement well was installed to a depth of 12 ft following the removal of the 2-inch diameter monitoring well that exhibited the BTEX contamination. The replacement well was constructed of 10 ft of 4-inch inside diameter (ID) Schedule 40 PVC well screen flush-threaded to 4-inch ID Schedule 40 PVC riser material. The purpose of these intrusive efforts was to expedite the remediation of the dissolved fraction benzene in groundwater concurrently with removing contaminated soil in the vicinity of the original MW-13 (data below) that may be continuing to leach into the groundwater. Following well installation activities, the excavated area was backfilled utilizing up to 1-inch diameter recycled concrete slag via the trackhoe.

Below are pre and post monitoring data for MW-13, which is the site's downgradient well. Klozur CR soil blending application occurred on March 25, 2010. The monitoring wells were sampled 56 days after the date of mixing. As shown below, all of the BTEX concentrations were reduced to below detection limits; specifically, dissolved benzene was reduced by three orders of magnitude in concentration which was the target constituent for this project.

Sample		BTEX and MTBE by 8260B				
Location	Date	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
Default Residential Closure Levels (ug/L)		**5**	**1,000**	**700**	**10,000**	**40**
Default Industrial Closure Levels (ug/L)		**52**	**8,200**	**10,000**	**20,000**	**870,000**
MW-13						
	10/18/05	**45.6**	5.6	1.2	23.7	<5
	01/30/07	**172**	28.3	10.5	97.8	<1(L1)
	05/01/07	**155**	21.0	9.89	73.2	<1
	08/03/07	**160**	21.9	3.34	110	<1
	11/08/07	**86.5**	16.0	9.29	75.7	<1
	02/07/08	**199**	22.0	7.67	83.2	<1
	05/06/08	**106**	23.6	7.33	102	<1
	08/06/08	**72.1**	16	10.5	75.2	<1
	11/11/08	**86.4**	14.9	2.49	74.7	<1
	02/19/09	**58.8**	4.9	4.28	18.1	<1
	05/28/09	**277**	14.1	9.75	55.3	<1
	08/27/09	**174**	15.1	10.5	65.2	<1
	11/23/09	**300**	22.2	7.4	100	<1
	02/25/10	**284**	13.5	<5	48.8	<5
	05/20/10	<1	<1	<1	<2	<1

Future quarterly sampling efforts will continue to monitor for the potential rebound of contaminants. If rebound does not occur, LFI will request a Notice of Completion for the site from IDEM's State Cleanup Section.