In Situ Treatment of MtBE and BTEX at a Bulk Petroleum Storage Facility Using the VTX Catalytic Treatment System

Introduction

This project involved the cleanup of a perched aquifer beneath a petroleum bulk storage facility for a confidential client. A series of MtBE and gasoline spills had resulted in the contamination of a shallow perched aquifer that posed a significant threat to a local drinking water source. The spills had contaminated approximately 5 acres of groundwater within a perched aquifer in the immediate vicinity of the bulk storage facility.

Geology/Hydrogeology

The prominent geologic unit at the surface of the site is the Tazewell Outwash Formation. The Tazewell is a Pleistocene-aged glacial outwash up to 170 feet thick. The unit is composed of sand, gravel, silt and clay typically occurring as a fining upward sequence. Shale and limestone bedrock of Pennsylvania age underlie the sediments. The Ohio River has cut a trough in the Tazewell and deposited sand, silt and clay floodplain sediments.

Two hydrogeologic units have been identified at the site: 1. a thin sandy stratum perched on a silty clay layer (perched unit) and 2. an underlying regional san and gravel aquifer. The first unit consists of surficial silty clay soil underlain by a fine sand layer. The thickness of this unit varies from five feet near the river to 25 feet think near the southern edge of the property. The saturated protion of this unit varies from three to five feet in thickness. Groundwater flow in the perched unit is north- northeast.

Beneath the perched saturated unit is a silty clay aquatard. The aquatard, which begins approximately 15 feet below grade, ranges in thickness from three to nine feet and pinches out at the northeast corner of the site.

Remedial Action

The majority of petroleum hydrocarbon contamination is thought to remain in the fine sand located between four and 15 feet below grade in the northern portion of the site. Two technologies are applied to this groundwater mass in order to reduce dissolved contaminants in the perched water. The two technologies are: 1) chemical oxidation (VTX) and 2) enhanced intrinsic bioremediaton (AnoX).

The site dewatering systems consists of 151 vacuum dewatering points. These are distributed beneath and northeast of the truck padding rack and adjacent truck staging area (see site map). The dewatering points are arranged in rows and distributed across the identified area of the perched groundwater plume. Each point consists of a vertical, 1.5 inch diameter PVC riser inserted to the bottom of a four-foot length, two-inch diameter, 0.010 inch-slot PVC well screen. A solid PVC hose is attached to a 90-degree elbow attached to the upper end of the riser at a depth of approximately three feet below

grade. Usually, the solid PVC hoses for two dewatering points are united and attached to one of 78 horizontal sub-mains. The sub-mains are routed below grade in trenched to the Dewatering/VTX Chemical Oxidation building. There they are attached to dedicated flow control valves, mounted on a manifold.

A vacuum blower is attached to the manifold. It is operated periodically to recover perched groundwater. During operations, the valves far one to 20 sub-mains are opened. The number of valves open at any time is determined by the area of the plume targeted, the depth of the perched aquifer in that location and the water yield. Recovered water is separated from the recovered air and transferred to an oil/water separator. After phase separation, water is transferred to one of the three 30,000 gallon treatment tanks. VTX is added to the treatment tanks along with hydrogen peroxide and mixed. The VTX and peroxide oxidize the dissolved petroleum hydrocarbons within three hours to carbon dioxide and water.

A minimum of one day after oxidation treatment, liquid AnoX nutrients are added to the treated water along with a mixture of petroleum degrading bacteria. After the bacteria are well distributed in the water, the contents of the tank are allowed to flow into one of three infiltration galleries via gravity. The galleries are strategically placed above spill zones within the site. Galleries contain four, five or twelve infiltration lines. To date, each batch of treated and inoculated water has re-entered the subsoil in approximately 45 minutes, regardless of the number of re-infiltration lines utilized.

The rate of groundwater collection is most influenced by the depth of the perched aquifer as well as ambient temperature. Freezing temperatures signal a halt to the process. One tank of water can be recovered and treated in 7 to 10 days. Raw and treated water samples are collected and analyzed in accordance with the Federal Underground Injection Control permit.

Results to Date

Following are groundwater concentration contour maps for the subject site for benzene and MtBE. It is believed that the site will achieve regulatory goals and come to closure during the summer or fall of 2002.

View Contour Map 1
View Contour Map 2

Table 1. Percent Reduction per Quarter of Benzene within the Perched Aquifer

Quarter	Impacted Ground Water for Benzene (Gallons)	Average Concentration per Contour Range (ug/L)	Amount of Benzene (lbs)	Total Pounds of Benzene per Quarter (lbs)	Percent Reduction per Quarter

Table 2. Percent Reduction per Quarter of MtBE within the Perched Aquifer

Quarter	Impacted Ground Water for MtBE (Gallons)	Average Concentration per Contour Range (ug/L)	Amount of MtBE (lbs)	Total Pounds of MtBE per Quarter (lbs)	Percent Reduction per Quarter
1st	912,109	75	0.57	22.55	
	835,986	300	2.09		
	619,864	750	3.87		
	470,431	3000	11.76		
	89,998	5950	4.26		
2nd	1,040,886	75	0.65	15.85	30%
	936,215	300	2.34		
	586,454	750	3.66		
	360,365	3000	9.01		
	4,311	5300	0.19		
3rd	1,117,524	75	0.70	10.40	34%
	928,033	300	2.32		
	372,923	750	2.33		
	216,486	2800	5.05		
4th	964,725	75	0.60	9.17	12%
	794,889	300	1.99		
	400,320	750	2.50		
	217,459	2250	4.08		
5th	512,303	75	0.32	2.48	73%
	370,370	300	0.93		
	107,888	750	0.67		
	45,108	1500	0.56		