



## A CASE STUDY FOR THE APPLICATION OF BASE CATALYZED SODIUM PERSULFATE TO TREAT GROUNDWATER CONTAMINATED WITH BTEX

### **Project Location** North Florida

### **Contaminants** BTEX

### **Product Used** Base Catalyzed Sodium Persulfate

### **Scope and Media** Chemical Oxidation of Impacted Groundwater

### **Results** Successfully Reached FDEP Secondary and GCTL Cleanup Standards for BTEX in All Monitoring Wells

In June of 2006, base catalyzed sodium persulfate was applied into the saturated zone at a site in Florida, north of Tallahassee, where elevated concentrations of BTEX have been reported in groundwater. Chemical oxidation using base catalyzed persulfate was selected as the remedial strategy due to its proven ability to treat BTEX compounds. Fenton's chemistry has also been proven effective to treat these compounds but sodium persulfate was selected since it is safer to handle than hydrogen peroxide at higher concentrations and is effective over a wide range of pH conditions. It is also less affected by background groundwater chemistry than Fenton's chemistry. When catalyzed with a base, sodium persulfate has an oxidation potential comparable to Fenton's chemistry.

### **SITE BACKGROUND**

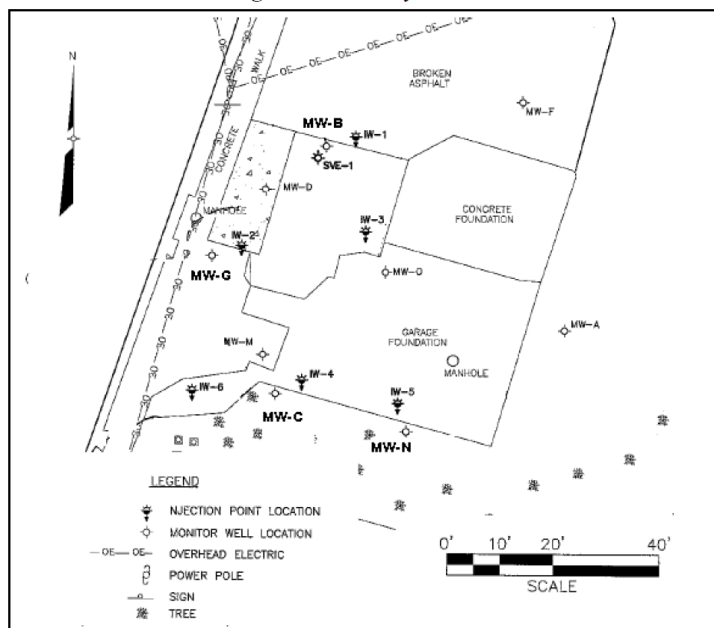
In order to determine the appropriate quantity of persulfate required, soil and groundwater samples were collected during injection well installation and sent to Redox Tech for total oxidant demand (TOD) analysis following procedures outlined in Haselow et al. 2003. This analysis is designed to allow for proper oxidant loading calculations by accounting for all the oxidant sinks that are present in site-specific soils and groundwater, in addition to the target contaminants. The results from this analysis reported TOD values ranging from 0.67 to 0.95 grams of oxidant per kilogram of saturated aquifer material. For design purposes, a TOD of 0.95 g/kg was applied.

### **APPLICATION METHODS**

Approximately 4,600 pounds of sodium persulfate was mixed with water to form a twenty (20) percent by weight solution. A predetermined quantity of twenty five (25) percent by weight solution of sodium hydroxide was mixed into the sodium persulfate batches prior to injection to catalyze the persulfate. Injections were conducted at six (6) injection locations constructed of 1-inch diameter PVC screens and risers. The injection wells were screened from approximately 40 to 50 feet below ground surface (bgs) and spaced approximately 20 to 30 feet apart to address an area of approximately 4,800 square feet (**Figure 1**). Two additional injections were also performed using direct push drilling techniques in areas where permanent injection points could not be installed (south of monitoring well MW-B and north of monitoring well MW-C).

A follow up injection was conducted in February 2007 to address remaining contamination. Approximately 500 gallons of a 6% by weight solution of base catalyzed sodium persulfate was injected at each of the six injection points described earlier (275 pounds of sodium persulfate per injection location). Post injection groundwater samples were collected in late March and mid June of 2007 and results are presented in **Figure 2** and **Figure 3**.

Figure 1. Site Layout

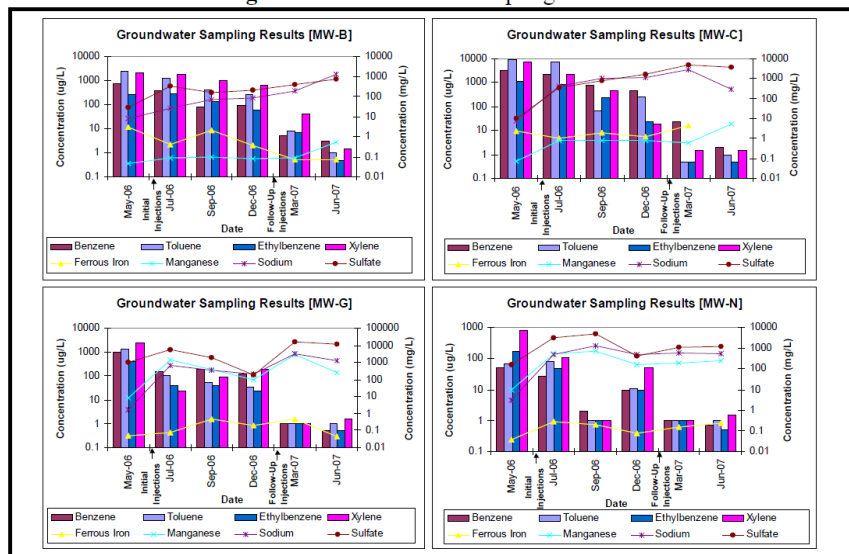


## RESULTS

Groundwater samples from monitoring wells were collected one (1), three (3), and six (6) months after injections were completed. **Figure 2** presents a graphical representation of the results from monitoring wells MW-B, MW-C, MW-G, and MW-N. A consistent downward trend of all contaminants of concern was evident. Benzene concentrations in all wells had dropped an order of magnitude from pre-injection levels with an average reduction of 86%. The benzene concentration in monitoring well MW-N had

reached the FDEP secondary cleanup standard (10 $\mu$ g/L). In addition, toluene, ethylbenzene, and xylene had reached secondary cleanup standards in all reported monitoring wells with the exception of xylene in MW-B. Average reduction in these monitoring wells for toluene, ethylbenzene, and xylene was 92%, 90%, and 90% respectively.

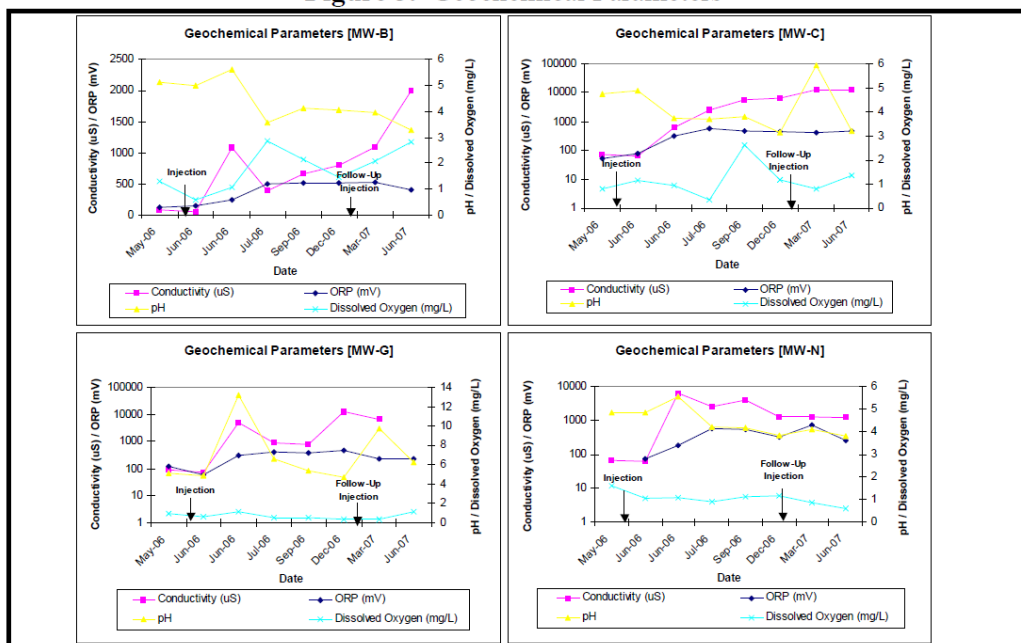
Figure 2. Groundwater Sampling Results



**Figure 2** also presents concentrations of ferrous iron, manganese, sodium, and sulfate from groundwater samples. As expected, the sodium and sulfate concentrations are shown to increase significantly after the injection. The sodium increase is a result of sodium in the persulfate solution. The sulfate is generated during the persulfate reaction. The injection of sodium persulfate and sodium hydroxide also results in a significant increase in conductivity as shown in **Figure 3**. Higher conductivity measurements provides an approximation

of the volume of influence of the oxidant injection. **Figure 3** also presents pH and oxidation reduction potential (ORP) measurements collected during sampling. ORP, in practical terms, is a measurement of the potential to oxidize contaminants in a solution. As a result of the persulfate injections, the oxidation potential, or the measurement of the ability to oxidize contaminants, has increased significantly in all areas.

**Figure 3. Geochemical Parameters**



Analytical results indicate that the FDEP secondary and GCTL cleanup standards for all monitoring wells (MW-B, MW-C, MW-G, and MW-N) have been reached.

Sulfate concentrations, which are a result of the oxidation of persulfate, remain elevated in the monitoring wells MW-B, MW-C, MW-G and MW-N suggesting that biological oxidation will likely continue. Sulfate acts as an electron acceptor and will help promote additional destruction of residual BTEX, if present.

