Jet Fuel Remediation at Paulínia Refinery (REPLAN), São Paulo, Brazil.

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Introduction

Accidental release of light non-aqueous phase liquids (LNAPLS), such as petroleum based fuels, is common throughout the world and it is the principal cause of groundwater contamination by chemical compounds. LNAPLS are less dense than water and, if present in subsurface, these contaminants often persist as a separate phase due to their generally low solubility. If free phase is present in an aquifer, it can be detected in observation wells screened according the range of water table fluctuation. The complete removal of LNALPS in free phase or residual is not possible due to the geological heterogeneities and water table fluctuation. Monitored natural attenuation is a passive remediation system for residual LNAPL that depends on natural processes and has been the most important advancement in the field of remediation during the last years.

Site Description

During a site investigation performed in Paulinia refinery, the largest in Brazil, located at São Paulo State, in 2003, monitoring wells intercepted aquifer contaminated with jet fuel, which leaked from an underground pipeline

Detailed studies were conducted to furnish 3D configurations of free and dissolved phases, as well as local geology, in order to design a remediation system to remove the contaminants. The free phase jet fuel plume was found to be lying on the water table within an area of approximately 200 x 130 m (Figure 1), and nearby underground pipeline free phase was 1.60 m in thickness in a monitoring

well. A total of 500 m^3 of oil, according to initial estimates, is thought to have spilled from pipeline.

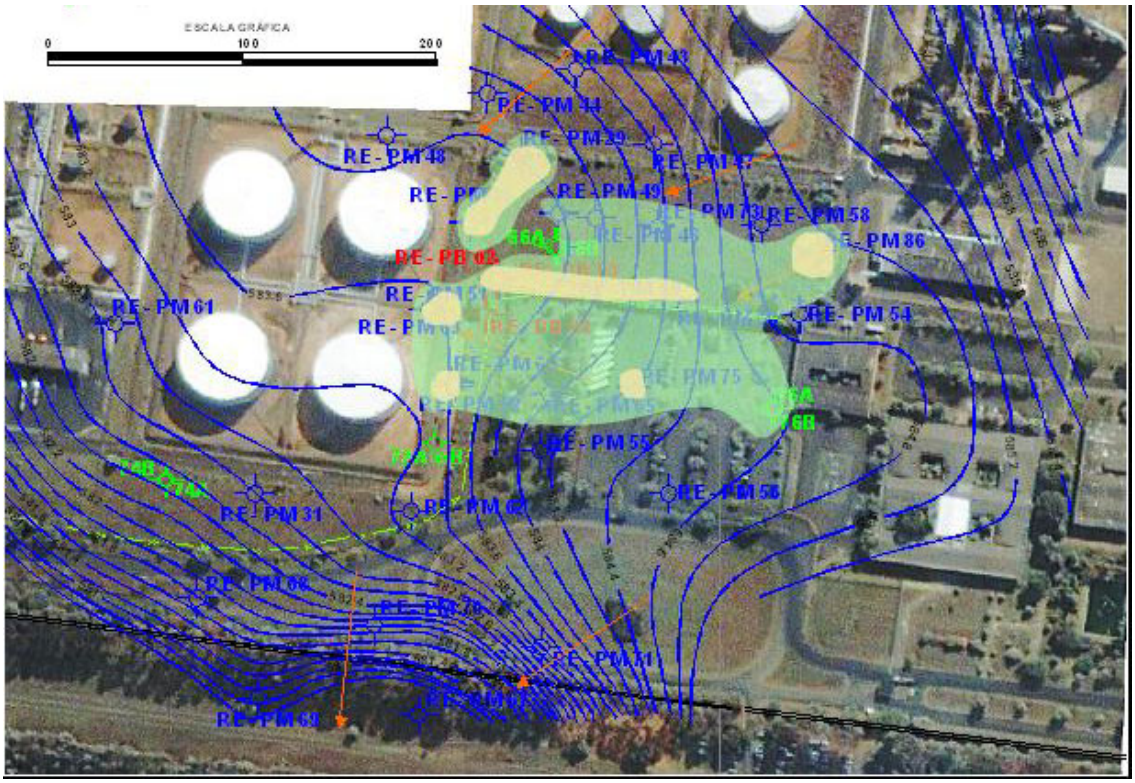

Figure 1: Free-phase jet fuel area (July- 2006)

Remediation

The remediation system in operation since June of 2005 is composed of 4 pumping wells and 41 monitoring wells. Oil/water emulsion is pumped and sent to oil separators, after which oil is sent to the refining processes and water phase to water treatment plant. After fifteen months of active remediation 5920 liters of jet fuel were recovered.

Water table level and oil thickness variations (Figure 2) are monitored by use of interface meter and pressure transducers, which provides an estimate of oil volume infiltrated into the ground, through the entire remediation process, as well as spatial change of LNAPL plume configuration.

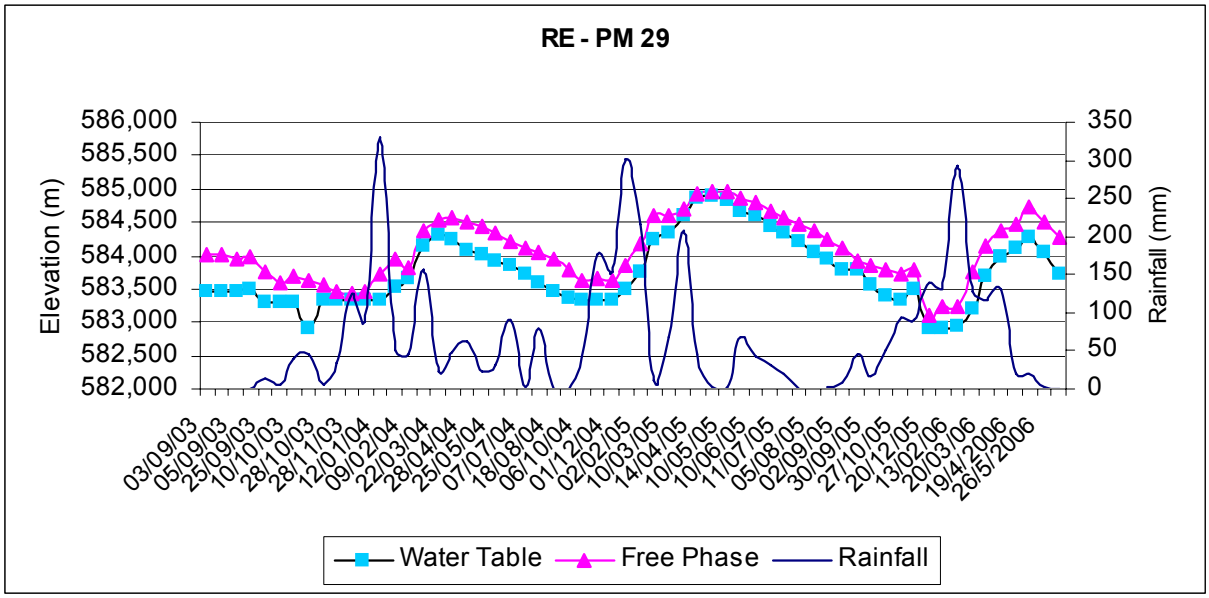

Figure 2: Water table and oil free phase levels

Free phase plume configuration varies with water level change, which is intrinsically related to intensity of rainfall. During dry season, the plume expands, while in the rainy season it reduces to the point where, in many wells, the free phase becomes extinct.

Although pumping was initiated in June, oil production only occurred 3 months later, after October. Peak production occurred in January and ceased in March, and thereafter only dissolved phase was produced.

The biodegradation of benzene, toluene, ethyl benzene and xylene isomers (BTEX) dissolved in groundwater through aerobic respiration and manganese and iron reduction were observed from changes in groundwater chemistry along the flow path. The highest concentration of ferrous iron was 36 mg/L and that of manganese amounted to 35 mg/L in a monitoring well.

Conclusions

Rainfall, volume of recovered oil, free phase thickness, water level fluctuation and plume dispersal were examined, which led to the conclusion that seasonal water table level variation is the main factor controlling mobility, stability and oil volume recovery in the contaminated site. Monitored natural attenuation is the main remediation process for dissolved phase.