

Environmental Bio-Systems, Inc.

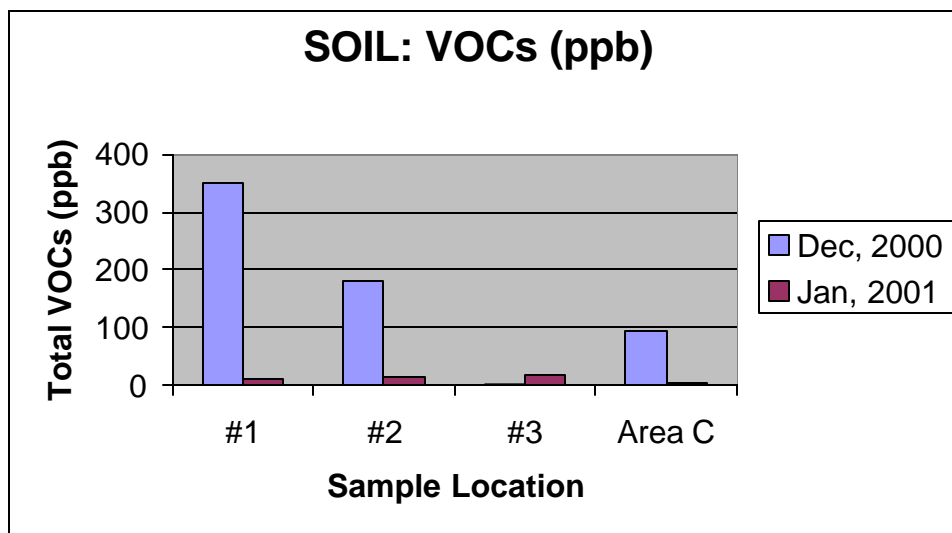
TECH MEMO #103: CHEMICAL OXIDATION OF TCE AND PCE IN SOIL & GROUNDWATER

By Jim Jacobs, CHG, 415-381-5195

THE VOC PROBLEM: Chlorinated solvents, including tetrachlorethylene (PCE), trichloroethylene (TCE) and dichloroethylene (DCE), are among the more challenging synthetic volatile organic compounds (VOCs) to assess and remediate, due to their high specific gravity and generally slow natural degradation. Pump and treat technologies have been used in groundwater remediation of VOCs. Soil remediation of VOCs using vapor extraction methods work best in high permeability soil. In both treatment methods, significant costs and time must be allocated for operations and maintenance while site closure may be a distant goal.

NEW REMEDIATION APPROACH: Hydrogen peroxide can chemically oxidize VOCs forming carbon dioxide and water as end products in a reaction that usually lasts seconds to minutes, with the longest reactions lasting hours. ENVIRONMENTAL BIO-SYSTEMS uses both a direct push method as well as a specialized lance system for the delivery of treatment chemicals. In-situ oxidation uses contact chemistry of the oxidizing agent to react with volatile organic compounds. A common oxidizer used in soil and groundwater remediation is hydrogen peroxide and the hydroxyl radical. Hydrogen peroxide when in contact with a metal catalyst such as iron (II), which is commonly known as Fenton's reagent, forms the more powerful oxidizer, the hydroxyl radical. The metal catalyst can be usually provided by iron oxides within the soil or fill, or added separately as iron sulfate. Fenton's reagent has been well documented for over 100 years and has been in use in water treatment plants for well over 50 years.

RESEARCH AND CASE STUDY: NEWARK, CALIFORNIA; INDUSTRIAL COMPLEX: ENVIRONMENTAL BIO-SYSTEMS provided the delivery system for chemical oxidation of VOCs. Prior to the treatment, a bench test was performed. Soil concentrations of total VOCs in soil were as high as



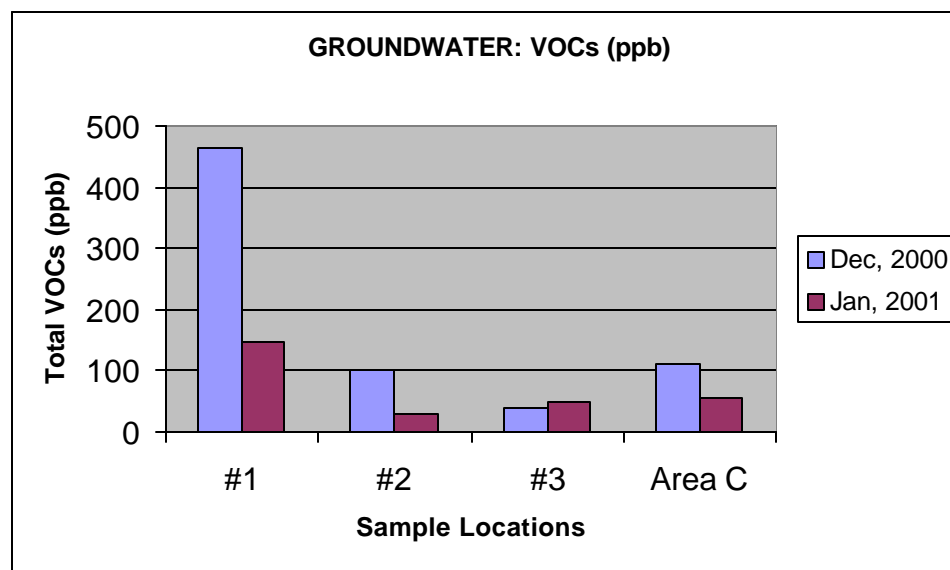
Environmental Bio-Systems, Inc.

TECH MEMO #103: CHEMICAL OXIDATION OF TCE AND PCE IN SOIL & GROUNDWATER

By Jim Jacobs, CHG, 415-381-5195

350 mg/kg. Water was as high as 450 mg/kg. . Approximately 450 m³ of soil were treated in the pilot test. The depth of contamination was 0 to 3 m. ENVIRONMENTAL BIO-SYSTEMS treated the soil with 18% hydrogen peroxide. The natural iron content in the soil was sufficient for Fenton's Reagent and creating the hydroxyl radical. The pH of the groundwater was 8.4, and 7 to 10 percent concentration of sulfuric acid was used to lower the subsurface pH.

ENVIRONMENTAL BIO-SYSTEMS injected 74 ports on 2-foot spacing with approximately 50 to 100 gallons of 20% to 25% hydrogen peroxide per port. A significant amount of VOCs were oxidized in both the soil and groundwater during the first treatment event. Significant reductions in both soil and groundwater are documented in the charts and reflect only one ENVIRONMENTAL BIO-SYSTEMS treatment event. Client reference: Parsons.



ITEM	DESCRIPTION
Contaminants	TCE, PCE, 1,2-DCE
Medium	Soil and Groundwater
Volume	450 m ³
Depth	0 to 6 meters
Treatment Solutions	Hydrogen Peroxide (25%) and Sulfuric Acid (10%)
Cost of Remediation	US \$35,000
Location	Newark, California
Client	Parsons (2001)

SUMMARY: A bench test followed by a rigorous pilot scale test ensured field success.