



**NGWA 2006 Petroleum Hydrocarbons and Organic Chemicals in Ground Water®: Prevention, Assessment, and Remediation Conference**

**Tuesday, November 7, 2006 : 9:40 a.m.**

**A Case Study of Indirect Geochemical Indicators:**

**James A. Jacobs**, Environmental Bio-Systems Inc and **Donald G. McEdwards, Ph.D., PE**, CHG, The McEdwards Group

Enhanced bioremediation is a useful groundwater technology for sites containing residual petroleum hydrocarbons where source removal has occurred. Although enhanced aerobic bioremediation is a slow process, it can reduce site closure schedules from decades for natural attenuation in an anaerobic environment to a few years with the addition of dissolved oxygen. Several passive and semi-passive oxygen delivery systems have been developed over the past decade. The iSOC gas infusion system works in wells as small as 2-inch diameter and has been used on over 250 sites. The gas diffusion system allows oxygen to dissolve slowly at about 15 cc/min or 0.77 cubic feet per day per monitoring well.

For in-situ enhanced bioremediation of petroleum hydrocarbons, direct contaminant concentrations are useful to monitor the success of the project. However, as water levels rise and fall over the complete hydrologic cycle, other indirect indicators provide confirmatory data for microbial activity and changes in geochemical conditions. Indirect indicators include dissolved oxygen, heterotrophic plate count, specific aerobic degraders, macronutrients ammonia nitrogen and ortho-phosphate, total inorganic carbon, total organic carbon, total dissolved solids, speciated alkalinity, pH, oxygen reduction potential, chemical oxygen demand, biological oxygen demand, ferrous iron, sulfate and nitrate. A gas infusion case study using the iSOC technology from Mapleshade, New Jersey was evaluated for indirect indicators, which verify that enhanced bioremediation was responsible for the hydrocarbon degradation (benzene > 96%, MTBE = 89% and TBA = 54%) that occurred over a 6-month period. In this case, an average of 221.6% increase in total inorganic carbon between pre-treatment and post-treatment samples in 9 wells shows the degradation was related to the iSOC treatment, and not related to seasonal changes in the hydrologic contaminant cycle.

**James A. Jacobs, P.G., C.H.G., Environmental Bio-Systems, Inc.**, Jim Jacobs has 25 years of experience in remediation and consulting. He is interested in in-situ remediation methods and is a two-time Fulbright award winner in environmental engineering. 707 View Point Road, Mill Valley, CA 94491; Tel: 415-381-5195; [jimjacobs@ebsinfo.com](mailto:jimjacobs@ebsinfo.com); [www.ebsinfo.com](http://www.ebsinfo.com)

**Donald G. McEdwards, Ph.D., PE, CHG, The McEdwards Group** Don McEdwards has 30+ years of experience in remediation and consulting. He has developed various environmental products, including the Rota-Pump for groundwater sampling and testing. In-situ remediation is an area of interest for Dr. McEdwards.

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