

## DIRECT OXYGEN INJECTION SUCCESSFUL IN BIOREMEDIATING PAHS IN GROUNDWATER – NAS PENSACOLA

### Site/Location:

Naval Air Station Pensacola,  
Florida

### Site Description:

Contamination Assessment Reports were completed in 1997 and 1998. Monitored Natural Attenuation was implemented until it was found that groundwater exceeded FDEP action levels. A bioremediation treatability study was then implemented.

### Technology:

Bioremediation Treatability Study, MNA to NFA

### Contaminant:

PAHs

### Action Levels:

FDEP Groundwater  
Cleanup Target Levels

### Legal Driver:

FDEP Chapter 62-777,  
F.A.C.

### Project Summary

At Site 1140MW (Figure 1), located at NAS Pensacola's Outlying Landing Field (OLF) Bronson, a Contamination Assessment Report (CAR) and a CAR Addendum were completed in 1997 and 1998, respectively. A Monitored Natural Attenuation Plan (MNAP) was implemented until it was found that groundwater exceeded Florida Department of Environmental Protection (FDEP) site-specific action levels requiring the discontinuation of the MNAP. However, despite the elevated concentrations, it was evident that natural attenuation processes, including natural biodegradation, were occurring. Tetra Tech NUS (TtNUS) hypothesized that the aquifer was oxygen deficient and the microbes were likely starved for oxygen (an essential ingredient for aerobic biological degradation). Therefore, TtNUS proposed that the best remedial option to reduce these concentrations would be to stimulate and accelerate this natural process by injecting oxygen into the subsurface. Because of the difficulty in treating PAHs via bioremediation, TtNUS recommended that an Enhanced Natural Attenuation Treatability Study be implemented.

As an alternative to the injection of "conventional" chemicals that release oxygen into the subsurface when hydrated, a novel concept consisting of direct oxygen injection was proposed. Continuous injection of oxygen would enhance the biostimulation process of the recalcitrant contaminants of concern (COC) present at the site. The iSOCTM system was selected as the product to use in this treatability study. iSOCTM is a specially designed microporous mass transfer device invented for use in groundwater remediation. The iSOCTM technology dissolves oxygen gas into the groundwater without bubbles through a diffuser. This proprietary device, invented and manufactured by inVentures Technologies, Inc. (iT<sub>i</sub>), was shown to increase dissolved oxygen (DO) concentrations in the groundwater more than 30 parts per million or more than four times the solubility limit of oxygen. The continuous source of elevated DO concentrations in the aquifer creates strong aerobic conditions that can stimulate in-situ bioremediation of the petroleum hydrocarbon plume for a long period of time. The elevated and continuous DO concentrations in the aquifer also foster advective and diffusive movement and hence favorable distribution in the aquifer.

The treatability study focused on reducing the contaminant concentrations within the source area. A total of five iSOCTM diffusers were installed in new injection wells in this source area (Figure 2). A baseline-sampling event was completed prior to installation and numerous sample rounds of performance groundwater sampling were conducted. During the quarterly groundwater sampling events, groundwater



**Figure 1:** Site 1140MW at OLF Bronson, NAS Pensacola, FL.



**Figure 2:** Installation of the iSOC™ and oxygen tank in well vault.

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samples were collected from the five monitoring wells selected in the MNAP and analyzed for the COCs and natural attenuation parameters.

### Regulatory Requirements/Community Involvement

Throughout the site assessment and treatability study, extensive coordination was maintained between the state regulators, the Navy, and contractor personnel. This close communication allowed open discussion and rapid regulatory approval in the planning and implementation of this innovative approach.

### Construction Challenges

One of the more significant challenges in successfully implementing in-situ remediation is achieving homogeneous distribution of the amendment in typically a non-homogeneous subsurface geologic environment. The continuous release of elevated DO concentrations via the iSOCs™ was an important aspect of the project as it is believed that the novel injection method allowed for consistent permeation of oxygen into the tighter pore space, which is often challenging to remediate.

### Cost Avoidance Measures

By using this innovative approach, the cost associated with remedial design and full-scale remedial action and perhaps more importantly long-term monitoring was avoided. The successful implementation of this treatability study reduced the contamination across the entire site, thus reducing these costs between an estimated \$50,000 and \$110,000.

### Project Successes

Based on the results of the groundwater sampling and analysis activities conducted in March 2005, no PAH compounds were found at concentrations that exceeded the Groundwater Cleanup Target Levels (GCTLs). 1-Methylnaphthalene remains present in groundwater from monitoring wells MW-03 and MW-09 (Figures 3 and 4). The concentrations of 1-methylnaphthalene have continued to decrease even following removal of the iSOCs™ system. 2-Methylnaphthalene was not detected in any of the wells sampled in this latest round. The remaining PAHs were found in small or undetectable concentrations in all of the wells. The concentrations of petroleum constituents detected in site groundwater have significantly decreased since the baseline sampling event, which is indicative of the ongoing progress of natural attenuation during this post treatability study monitoring period.

Operation of the iSOCs™ has been terminated as the treatability study objectives have been achieved. The State of Florida requires periodic monitoring following operation of an active remediation system. Therefore, continued quarterly monitoring is planned. If concentrations remain below Florida GCTLs, the site will qualify as a No Further Action site.

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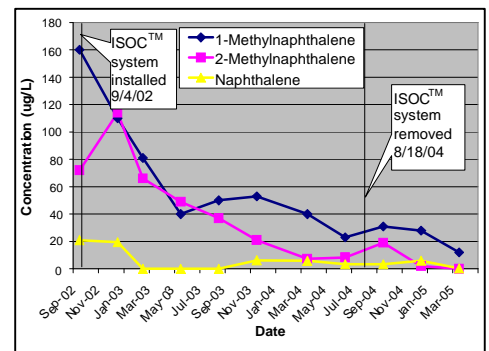


Figure 3: Results from MW-03.

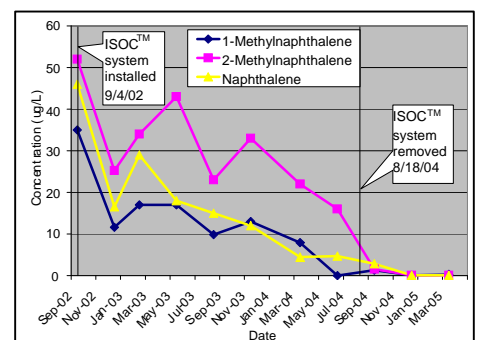


Figure 4: Results from MW-09.