

Enhanced In-Situ Bioremediation Field-Scale Study Comparing Different Carbon Sources

Steven T. Downey (steven.downey@shawgrp.com) and
Lingke Zeng (Lingke.zeng@shawgrp.com) (Shaw E&I, Inc., Knoxville, TN)
Doug Mullendore (Douglas.L.Mullendore@usace.army.mil) (USACE, Nashville, TN)

The former West Virginia Ordnance Works (WVOW) near Pt. Pleasant, WV was used to manufacture TNT from 1942 to 1945. In May 1981, seepage of red water was observed adjacent to Pond 13 (area designated as OU-2). Investigations found the shallow groundwater to be contaminated with nitroaromatics. Based on these and other studies, the WVOW site was placed on the National Priorities List (NPL) in 1984 under CERCLA. The primary chemicals of concern in ground water are 2,4,6-trinitrotoluene (TNT), 1,3-Dinitrobenzene (DNB), 1,3,5-Trinitrobenzene (TNB), 2,4-dinitrotoluene (DNT), and 2,6-DNT. The OU-2 ROD was signed in 1988 requiring the Army to design and construct a groundwater extraction and treatment system. Operation of this pump and treat system was initiated in 1997 to contain and treat two groundwater plumes in this area; in 2005 a third plume was added to the system.

Field-scale treatability studies will be performed at each of these three plumes to determine Enhanced In-Situ Bioremediation (EISB) effectiveness at achieving OU-2 ROD cleanup goals and to estimate full-scale remediation costs for the most effective carbon source. The ROD goals for 2,4,6-TNT; 1,3-DNB; 1,3,5-TNB; 2,4-DNT; and 2,6-DNT are 50, 14, 200, 0.11, and 0.022 µg/l respectively. The three plumes are the Pond 13 Wet Well Area (P13WWA), Yellow Water Reservoir (YWR), and Red Water Reservoir (RWR). At the P13WWA plume, an emulsified oil substrate mixed with a microbial nutrient (yeast extract) will be injected into the intermediate aquifer in an elliptical pattern around the two extraction wells. Approximately 40 injection points will be utilized. This same carbon and nutrient source will be injected into the aquifer at ten points within the YWR plume. At the RWR plume Hydrogen Release Compound® (HRC®) will be injected into the aquifer at eighteen points.

At all three sites baseline sampling will be performed prior to injection of the carbon source. For P13WWA performance sampling will be performed monthly for 3 months followed by quarterly for three additional quarters. At the YWR and RWR performance sampling will be quarterly for one year. Samples will be analyzed for nitroaromatics, metabolic acids, TOC, ferrous iron, nitrite/nitrate, and sulfate/sulfite.

Enhanced anaerobic biodegradation of nitroaromatic contaminants with amendment of a carbon source has been successfully demonstrated in the laboratory and under limited field conditions. During the biotic or abiotic reduction of TNT under anaerobic conditions, nitro groups are reduced to amino groups, creating 2-amino-4,6-DNT and 4-amino-2,6-DNT. The amino-DNTs are subsequently reduced to diaminonitrotoluene under more reducing conditions. The final product of TNT reduction is triaminotoluene (TAT). The anaerobic reduction rates decrease with the number of nitro groups being converted to amino groups. Consequently, the complete anaerobic reduction of TNT to TAT requires reducing condition less than -200 millivolts (mV). Once TAT is formed, it absorbs to soil irreversibly and is not detected during groundwater analysis.