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Nitrate Enhanced Bioremediation Restores Fuel Contaminated Groundwater to Drinking Water Standard

Jet fuel
Bioremediation
Groundwater

by John Wilson, Robert S. Kerr Environmental Research Laboratory

Nitrate enhanced bioremediation restored a jet fuel contaminated aquifer to drinking water standard levels within 165 days. This field demonstration, at the U.S. Coast Guard Facility at Traverse City, MI, repeated and validated a remediation conducted in the Upper Rhine Valley in Germany more than ten years ago. To the author's knowledge, nitrate enhanced bioremediation has been used at only one other fuel contaminated site in the United States, One factor constraining the use of nitrate bioremediation is that nitrate in groundwater is subject to a drinking water standard. Yet, nitrate presents a viable treatment alternative to, oxygen enhanced bioremediation. Although oxygen has been effective for many fuel spills, success is sometimes limited due to the low solubility of oxygen. Nitrate is more soluble than oxygen and is less expensive. The significance of the nitrate bioremediation at Traverse City is that the concentration of nitrate used in the bioremediation was below Federal drinking water standards.

At Traverse City, jet fuel containing benzene, toluene, ethylbenzene and xylene compounds had leaked from underground storage facilities. The fuel contaminated both the unsaturated soils and the aquifer. For this reason, it was necessary to install an infiltration gallery system as the first stage of bioremediation prior to the addition of the nitrate. The infiltration gallery system, using pumped aquifer groundwater, saturated the unsaturated zone so that when nitrate and nutrients were added, they could be evenly distributed In order to determine the effects of dilution of the contaminants in the recirculated groundwater and the effects of natural bioremediation, nitrate and nutrients were not added for six weeks. Prior to the addition of the nitrate, the area was sampled to evaluate what biorestoration had occurred without nitrate enhancement. This analysis found that indigenous ambient concentrations of oxygen and nitrate had removed benzene to below 0.1 µg/L, from initial concentrations of 760 µg/L. The other contaminants required artificially induced nitrate additions to achieve acceptable levels.

(see Jet Fuel, page 2)

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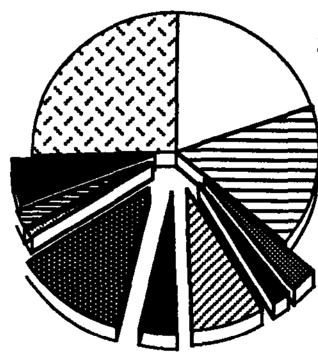
We at *Tech Trends* are glad to tell you what we know to be available in the field of innovative cleanup technologies. We would also like to hear from you about innovative technologies that have been pilot tested or applied at your sites so that we can spread the good word.

If you have something you feel we should know about, contact the Editor of *Tech Trends* at 703-525-0485.

Technologies for Source Control at Superfund Sites

Innovative Technologies (37%)

- Soil Washing
- Chemical Extraction
- Bioremediation
- *In Situ* Soil Flushing
- Vacuum/Vapor Extraction
- *In Situ* Vitrification
- Chemical Treatment
- Thermal Desorption



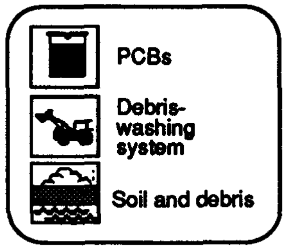
Available Technologies (63%)

- Solidification/Stabilization
- On-Site Incineration
- Off-Site Incineration

Data are derived from 1982-1989 Records of Decision

Debris Washing System Removes PCBs, Herbicides

by Naomi P. Barkley,
Risk Reduction Engineering Laboratory



A rugged, transportable debris washing system (DWS) has successfully removed polychlorinated biphenyls (PCBs) from transformers at the Gray Superfund Site in Hopkinsville, KY, and herbicides and benzonitrile from drums at the Shaver's Farm Site in Chickamauga, GA. The DWS, an EPA-developed technology, was demonstrated as part of EEA's Superfund Innovative Technology Evaluation (SITE) program. The DWS may have broad applicability for other sites that contain toxic organic and inorganic chemical residues intermingled with remnants of razed structures (wood steel, concrete blocks, bricks) as well as contaminated soil, gravel, concrete and metallic debris (e.g., machinery and equipment, transformer casings and miscellaneous scrap metal). The DWS was developed to decontaminate material so that it can be considered "clean" fill for disposal (either on site or off site) as a nonhazardous waste rather than a hazardous waste. Metallic debris can be sold to a metal smelter.

The DWS entails the application of an aqueous solution during a high pressure spray cycle, followed by turbulent wash and rinse cycles. An aqueous rather than organic cleaning solution was used because organic solvents tend to be more costly and am more difficult to handle than aqueous cleaning solutions. The pilot-scale system consists of a 300 gallon spray tank, a 300 gallon wash tank, a surfactant holding tank, a rinse water holding tank, an oil/water separator and a solution treatment system with a diatomaceous earth filter, an activated carbon column and an ion exchange column. Ancillary equipment includes a spray tank heater, pumps, particutate filters, a metal basket and a stirrer motor.

At the Gray Superfund Site, soil was contaminated with lead and PCBs from a metal reclaiming operation that involved open burning of electrical transformers. Before the DWS cleaning process began, 75 transformer casings were cut in half with a partner saw and the pieces were wiped to provide samples of pretreatment PCB concentrations. The transformer halves were placed in the wash basket and lowered into the spray tank that was equipped with multiple water jets that blast loosely adhered contaminants and dirt from the debris. After the spray cycle, the basket was removed and transferred to the wash tank, where the debris was washed with a high turbulence wash. Each batch of debris was cleaned for one hour in the spray tank and one hour in the wash tank. During both the spray and wash cycles, a portion of the cleaning solution was cycled through a closed looped system where the oil/water separator removed the oil/PCB contaminants. The remaining cleaned solution was then recycled. After the wash cycle, the debris basket was retuned to the spray tank, where it was rinsed with water.

After completion of the cleaning process, post treatment wipe samples were obtained from each of the transformer pieces to compare with the before treatment samples. Concentrations before treatment ranged from 0.1 to 98 µg/100 cm^2. After treatment all but seven of the 75 transformers showed concentrations less than the minimum allowable level of 10 µg/100 cm^2. The seven transformers that did not meet acceptable levels were rewashed, after which all seven had PCB concentrations below the detection limit of 0.1 µg/100 cm^2. All of the transformers could be sold to a scrap metal dealer or to a smelter for muse.

The surfactant solution and rinse water were neutralized to a pH of 8, using concentrated sulfuric acid, and then passed through a series of particulate filters on an activated carbon drum. Finally, they were passed through an ion exchange column. After the treatment, the PCB concentration was reduced to below the detection limit of 0.1 µg/L.

The DWS was also demonstrated at Shaver's Farm with drums containing the herbicide Dicamba and benzonitrile, a precursor in the manufacture of Dicamba. Be fore treatment, some concentrations of benzonitrile ranged as high as

(see Debris Washing, page 4)

Jet Fuel

(from page 1)

The nitrate and nutrients were batch mixed in separate polyethylene tanks and fed into the infiltration gallery and a groundwater recirculation system through automatically controlled chemical feed pumps. The pump flow rates were adjusted weekly to compensate for changes in nitrate and nutrient composition in the recirculated water. The recirculated water was sampled weekly from cluster wells that had pipe lines routed below land surface to the building that also housed the nitrate feed tanks. The sampling revealed that, after the addition of nitrates, toluene levels dropped rapidly in the fuel spill, but took a much longer time in the recirculated water. Ethylbenzene and m+p-xylene were also removed after the addition of the nitrates; however, o-xylene was not found to biodegrade until toward the end of the demonstration. Overall, toluene levels dropped from 4500 to less than 1 µg/L, ethylbenzene levels from 840 to 6 µg/L and *o+p+m* -xylene levels from 4,000 to 60 µg/L.

For more information, call John Wilson of EEA's Robert S. Kerr Environmental Research Laboratory at FTS-743-8800 or 405-332-8800.

Air Emissions from Soil Excavation Controlled by Tent Enclosure with Exhaust System

VOCs, SO_2
Enclosure with exhaust system
Air

by Jack Hubbard, Superfund Innovative Technology Evaluation Program

The McCall Superfund Site in Fullerton, CA has aviation fuel refinery wastes—mud, tar and char—from oil refinery and drilling operations. Pre-remedial investigations concluded that excavation of the waste potentially could release significant air emissions of volatile organic compounds(VOCs) and sulfur dioxide (SO_2) to the surrounding community. To safeguard against such a problem, a trial excavation was conducted within a temporary tent enclosure with air from the enclosure vented through an exhaust treatment system. The exhaust system consisted of a sodium hydroxide-based wet scrubber and an activated carbon bed adsorber, the purpose of which was to reduce emissions of sulfur dioxide and organic compounds. The air emission objectives of the demonstration were to measure the extent of emissions that might occur during excavation, to assess emission control provided by the enclosure and its exhaust treatment system and to monitor emissions at the site bonndaly. The demonstration was conducted as part of the Superfund Innovative Technology Evaluation (SITE) Program at EPA's Risk Reduction Engineering Laboratory.

During the excavation, unexpected high levels of SO_2 and total hydrocarbons (THC) were encountered. For example, during tar excavation five-minute average values for SO, reached 1,000 parts per million (ppm) and THC levels reached 492 ppm. However, the enclosure's exhaust treatment system removed up to 99.9% of the SO, and up to 90.7% of the THC. The demonstration indicated that excavation is feasible under an enclosure and that the emissions from the enclosed site could be effectively treated with no adverse impacts noted at the site boundary. Excavation and waste handling activities would not be feasible without an enclosure and an air treatment system.

This SITE demonstration also sought to: (l) better determine the nature of the waste and the treatment needed to improve its handling characteristics; (2) study the effect of vapor-suppressing foam during excavation activities; and (3) determine problems that might occur during excavation for full-scale remediation. The results indicated that the waste could be easily treated for further processing in a thermal destruction unit. Because the waste failed the Toxicity Characteristic Leaching Procedure, it would not be possible to simply excavate it for redisposal without treatment. Vapor suppressing foams did not perform as anticipated.

For more information, call Jack Hubbard of EPA's SITE Program at FTS-684-7507 or 513-569-7507.

Chemical Reagent at Lee Farm Reduces both Lead Levels and Soil/Ash Volume

Lead
Chemical fixation
Soil

by Steven Faryan, On-Scene Coordinator, Region V

A new process used at the Lee Farm Site, an abandoned battery dump in Woodville, WI, not only reduced leachable lead levels in soil from 200-300 to 1-2 mg/L but also decreased soil volume by 22% The leachable lead level in the black ash from satellite sites was similarly reduced from 348 to 1 mg/L and the black ash volume was decreased by 50%. Lead levels after treatment comply with the new land disposal restrictions for lead and are below the regulatory standard for the Toxic Characteristic Leaching Procedure (TCLP). The treatment, a trademarked chemical fixation process, adds chemicals (reagents) to the contaminated soil that change the form of the contaminant so that it is no longer soluble in water. The process is known as the MAECTITE process and was developed by MAECORP of Chicago, IL..

The treatment has several steps. First, the brown soil material is screened so that oversized pieces larger than three to five inches in diameter are removed from the rest of the material which is mixed with a trademarked powder as it proceeds on a conveyor through a shredder/grinder. The material is then conveyed into a pug-mill mixer where a trademarked liquid solution with the reagents is added. This mixture is agitated and then conveyed onto a clay pad where it has a curing time of six to 24 hours. Curing time is the time it takes for the chemicals to react with the contaminated materials to reduce the leachable lead levels. After results from an off-site laboratory confirm that TCLP results of less than 5 mg/L is met, the friable material is placed at one end of the site where eventually a clay cap will be compacted over the area.

The treatment of the black ash is slightly different in that a second trademarked pozzalime powder is added as well. This additional powder is necessary because of the extremely high levels of lead (up to 22%) and the low pH of the

(see Lead, page 4)

The Third Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International, sponsored by EPA, will be held at the Fairmont Hotel, Dallas, Texas on June 11-13, 1991. International and domestic vendors of innovative hazardous waste treatment technologies will present over 25 technical papers and 60 displays. Case studies of applied technologies in real-life situations will be presented. For registration information, contact: JACA Corp., 550 Pinetown Road, Fort Washington, PA 19034 Telephone: 215-643-5466.

Lead

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untreated soil. This Spring a rotary drum screen will be used to treat the oversized material.

The oversized material is batch-treated in a seven-cubic yard capacity rotary mixer where the reagents are added directly to the mixer and agitated. TCLP levels after treatment are below 5 mg/L. About five batches are treated a day.

Before the on-site activities began at Lee Farm, EPA's Technical Assistance Team collected soil samples and MAECORP performed a series of treatability studies and bench scale test runs. Prior mineralogy studies indicate that the lead is transformed into apatite and anglesite minerals which are extremely immobile and stable. Actual treatment at Lee Farm has successfully chemically fixed over 12,000 tons of lead contaminated soils, battery casings and debris, averaging 275 tons per day. EPA plans to demonstrate the process at another site as part of its SITE program.

For more information, call Steve Faryan, the Region 5 On-Scene Coordinator for the Lee Farm Site, at FTS-353-9351 or 312-353-9351.

Debris Washing

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47,000 μg/100 cm^2 (averaging 4,556 μg/100 cm^2. Post treatment samples averaged 10 μg/100 cm^2, with a range from below the detection limit to 117 μg/100 cm^2. Before treatment, some Dicamba values ranged as high as 180 μg/100 cm^2 (averaging 23 μg/100 cm^2). Post treatment concentrations tanged from below detection limits to 5.2 μg/100 cm^2 and averaged 1 μg/100 cm^2. The water treatment system was effective in reducing contaminant concentrations, with the exception of arsenic and Dicamba, to below the detection limit.

The system has been successfully used to remove PCBs and certain pesticides, dioxins and furan residues. While the system has not been tested for removal of all types of organic contaminants from surfaces of debris, results are promising. A full scale system is being developed for further demonstration. IT Environmental Programs, Inc. (formerly PEI Associates, Inc.) will commercialize the technology.

For more information, call Naomi Barkley at EPA's Risk Reduction Engineering Laboratory at FTS-684-7854 or 513-569-7854.

Tech Trends welcomes readers' comments, suggestions for future articles and contributions. Address correspondence to: Managing Editor, Tech Trends (OS-110W), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460.

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