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Bioremediation Treatability Study for Nitrobenzene, Aniline, and Diphenylamine at a Former Explosives Manufacturing Facility, Southern New Jersey, USA

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Background/Objectives. In support of a large full-scale impacted soil and sediment bioremediation land treatment project, the comprehensive treatability study investigated the land treatment of nitrobenzene (NB), aniline, and diphenylamine (DPA) in soil. The performance criteria for the contaminated soils are the New Jersey Non-Residential Direct Contact Soil Remediation Standards (NRDCSRS) and site specific Impact to Groundwater Soil Remediation Standard (IGWSRS). The performance criteria for the sediment are site specific Ecological Risk Based Remediation Standards (ERBRS). The presence of lower permeability (highly plastic) soils was evaluated and proved to be a significant challenge in the evaluation. The objectives of the treatability study were to evaluate the feasibility of the biological land treatment application, develop contingent remedial approaches to mitigate the technical obstacles posed for land treatment and to develop data to support the remedial design basis. A full scale pilot test was implemented to evaluate site specific conditions and confirm design and operational protocols.

Approach/Activities. The laboratory treatability study consisted of four tasks: (1) soil sampling – collected representative soil samples for the treatability study; (2) bulking simulation – identified the type and dosages of bulking agents to improve soil properties (i.e., permeability) for land treatment; (3) pre-treatment – evaluated technologies capable of reducing chemical toxicity to allow for land treatment implementation; and (4) land treatment simulation – conducted an extended laboratory land treatment test to simulate the field conditions and refine pilot test/full scale design criteria. The pilot test consisted of four different test cells with varying contaminant constituents, soil texture (plastic clays, cohesive silts, sands) and bulking agents. This presentation will focus on the treatability study results and path forward design of the pilot test.

Results/Lessons Learned. An improved understanding of the three major contaminants was achieved through the treatability study. Mainly, that NB could not be degraded effectively through reactive chemical oxidation methods or at elevated levels of more than 2,500 milligrams per kilogram (mg/kg) through biodegradation. However, NB and aniline are readily dissipated through abiotic processes, and can be readily degraded under moderate concentrations of less than 1,500 mg/kg. Elevated aniline at more than 2,500 mg/kg may pose toxicity to microbes. DPA was confirmed to pose no toxicity at elevated levels, and can be readily degraded. DPA cannot be lost through abiotic processes under ambient temperatures, so DPA reduction would solely rely on biodegradation
As a means to enhance the potential for success in the face of elevated contaminant concentrations, four alternative remedial enhancements were tested where arsenic stabilization (due to soil to groundwater leachability standards) was not necessary as arsenic was shown to be not leachable, chemical oxidation was deemed to be ineffective, GAC enhancement was effective but reduced the abiotic loss rate of NB and aniline, and bioaugmentation slightly increased the degradation kinetics for NB source soil. A result of the low permeability soil tests displayed that bulking steps will effectively increase soil permeability to allow for abiotic losses.