Linking Proven Technologies to Bioremediate TNT and Metabolites and Facilitate On-Site Reuse of Soil

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Background/Objectives. Despite advances in soil contaminant treatment technologies, more than 80 percent of approved remedies involve the encapsulation or relocation of contaminant mass. Energetics represent a unique contaminant class in that remedial strategies for soil often require treatment before encapsulation or relocation. Under this paradigm, the economics of contaminant treatment to remediation standards can be comparable to or more favorable than those of pre-treatment and encapsulation or relocation. Remedial planning at a former explosives and energetics manufacturing facility identified bioremediation as a means to cost-effectively address TNT in soil as a source to groundwater, establish soil conditions suitable for industrial redevelopment, and avoid relocation (landfilling) of TNT-impacted materials offsite. Crystalline TNT particles entrained in a poorly-sorted glacial till soil matrix presented challenges addressed via an ex-situ approach developed through bench and pilot studies that demonstrated implementability and effectiveness. An estimated 100,000T of soil require treatment across 11 excavation areas spanning 9 acres. This presentation will present the development and implementation of an ex situ bioremediation remedy that links physical, chemical, and biological processes to 1) improve bioaccessibility of TNT mass, 2) establish near-optimal conditions for enhanced bioremediation, and 3) achieve remediation standards to facilitate the reuse of treated soil onsite.

Approach/Activities. Sequentially, soil containing crystalline TNT first undergoes physical processing to 1) segregate native aggregate, 2) reduce TNT particle size and increase surface area to volume ratio, and 3) decrease soil volumes requiring bioremediation by concentrating the TNT in the fine soil fraction. Physical processing leverages the developed understanding of site geology and properties of crystalline TNT using a custom soil processing plant relying on proven technologies common to the mining industry. Material streams emerging from the plant include: oversize material (native rock aggregate free of TNT particles) and a fines soil slurry containing TNT at reduced particle sizes amenable to biodegradation. Next, a commercial soil amendment (micro-scale ZVI + comminuted plant fiber capable of enhancing reducing conditions and microbial activity) is blended with the soil slurry. After amendment addition and mixing, the slurry is pumped to geotextile tubes (geotubes) arranged in treatment cells for gravity dewatering. Enroute, the slurry receives coagulant and polymer to ensure that the amended solids settle and dewater as a homogeneous mixture. The soil moisture and temperature within the geotubes are near optimal for the amendment to enhance reducing conditions and stimulate microbial activity to degrade TNT and its metabolites.

Results/Lessons Learned. Following a treatment period of ~120 days in the geotubes, based on results from a pilot-scale demonstration, we expect TNT concentration reductions of more than 99%, rendering treated material suitable for use as backfill in the excavation areas. Residual TNT in treated, backfilled material will continue to undergo in-situ degradation given the durability of the reducing conditions attributable to the amendment. TNT mass removal from soil facilitates a monitored natural attenuation remedy for groundwater and redevelopment for industrial uses. Design and performance data on the degradation of TNT and associated metabolites will be presented. Observations related to design optimization, operational considerations, regulatory approvals, sustainability, and lessons learned will be shared.