Lessons Learned during Ex Situ Bioremediation at a Large Hydrocarbon Contaminated Site

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Background/Objectives. This project was undertaken to support a sale of industrial property along the St. Lawrence River. The property was noted to have three (3) large, isolated areas of contaminated silty clay soil and corresponding groundwater plumes. The three (3) contaminated areas totaled over 2.7 acres at depths of up to 16 ft below ground surface (bgs). Contaminants of concern included petroleum hydrocarbons (PHCs) fractions 1-4, benzene, toluene, ethylbenzene, and xylene (BTEX), and polycyclic aromatic hydrocarbons (PAHs). Non-aqueous phase liquid (NAPL) was present in some areas, typically within higher permeability seams within the native silty clay soil. The objective was to support a sale of property agreement which stipulated the vendor clean the site of the latter contaminants to the applicable generic criteria.

Approach/Activities. In order to facilitate remediation for such a large volume of contaminated soil, AEL decided to use an ex situ bioremediation strategy, where soils were excavated and treated on site. Soil excavation extents were determined in real time using an ultraviolet fluorescence (UVF) site laboratory and verified via laboratory samples. Soil treatment was carried out in bermed treatment cells which were lined with the native clay soil and plastic. Contaminated soil was placed into the cells to a predetermined height to maximize oxygenation of the soil in the cells. The cells were then sprayed with a bioaugmentation mixture composed of hydrocarbon degrading bacteria, nutrients, and enzymes to aid in the bacterial metabolism of the hydrocarbon contamination. In addition, a biosurfactant was added to the mixture to release the hydrocarbon contaminants from the soil into solution.

Currently, two (2) rounds of post remediation soil sampling have been carried out from a subset of the soil treatment cells. Completion of ex situ soil bioremediation is anticipated to be completed by the end of 2023, but significant progress has been made to date.

Groundwater contamination is anticipated to be largely removed during excavation of the clay dominant soils. However, calcium peroxide powder was spread at the base of each excavation prior to backfill to provide an oxygen source for bacteria, thus facilitating in situ bioremediation of residual groundwater contamination. Additionally, infiltration galleries were installed in strategic locations of the excavations to support future in situ remedial injection programs, if deemed necessary.

Results/Lessons Learned. Overall, ex situ soil treatment is a cost-effective method to treat hydrocarbon contaminated soils, which would otherwise require more expensive approaches of landfilling, surfactant extraction, or thermal remediation. However, the process can take a longer time to completion. As with any large remedial endeavor, ex situ soil remediation at scales of this size requires careful attention during planning and implementation phases. Design flaws will quickly manifest themselves in the field and must be modified to avoid replication across the entirety of the project. Specific to this bioremediation technology is the importance to optimize between available land area and the treatment cell design, as optimal cell aeration configurations often require more land area. In this project, nearly the entirety of the usable property was configured for use of treatment cells. Additionally, low permeability soils such as those at this property may require additional aeration via soil mixing in order to achieve complete biodegradation at the base of the treatment cell.