# Case Study for the Injection of BOS 200+ to Remediate Saturated Zone LNAPL at the Former Marshall Iron & Metal Site, Marshall, Michigan

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**Background/Objectives.** The Marshall Iron & Metal Site is located on South Industrial Road in the City of Marshall, Michigan. The Site was part of a railroad maintenance yard, including a coal house and lumber yard, from 1899 to 1931. From 1938 to 1960, a foundry operated adjacent to the Site. The Site operated as an auto salvage and metal scrap yard from 1961 to 1996, after which the owner discontinued operations and removed all of the remaining scrap metal.

Historical remedial activities consisting of excavation and disposal of soil and debris was completed in October and November 2015. During well abandonment activities light non-aqueous phase liquid (LNAPL) was observed in an offsite monitoring well on an adjacent municipal property. In 2016, remedial investigation (RI) activities were conducted to delineate the LNAPL. These RI activities included installation of three soil borings and three groundwater monitoring wells and performance of a laser induced fluorescence (LIF) survey. Subsequently, in the spring of 2021, a quantitative remediation characterization (qRDC) was performed consisting of installation of 23 soil boring and temporary wells.

The primary objectives of the remedial effort using BOS 200®+ (a Trap and Treat® Product) are: 1) reduce the mobility of the LNAPL to prevent further migration toward the Kalamazoo River, and 2) enhance natural source zone depletion via biological degradation processes on the BOS 200+ activated carbon platform ultimately reducing saturated TPH concentrations to levels that eliminate the potential for mobile LNAPL.

**Approach/Activities.** The remedial activities included a) implementation of a quantitative Remedial Design Characterization (qRDC) from which the qCSM for the LNAPL plume was developed. The qRDC included installing 23 soil borings/23 temporary wells and six additional monitoring wells, including the collection of over 125 soil samples and 35 groundwater samples for TPH analyses, b) bench testing to determine specific LNAPL characteristics including density, solubility, carbon range (C14 to C40), and adsorption capacity onto the BOS 200®, c) performing a field pilot test to determine injection point spacing and fluid volumes needed to effectively distribute the BOS 200+ in the subsurface, d) development of a full-scale BOS 200+ design using the data from the historical RI work and items a, b & c, e) full-scale implementation consisting of injection of >120,000 lbs of amendments and 130 gallons of bacteria concentrate making up the BOS 200+ in ~279 direct push injection points, and f) post-injection performance monitoring. The presentation will provide a project overview with specific focus on components of the field effort including the qRDC, BOS 200+ injections and results from the 1.5 years of post-injection performance monitoring including development of preliminary degradation rates/model.

**Results/Lessons Learned.** The qRDC demonstrated that saturated TPH sorbed mass varied with depth and lithology. Much of the TPH mass was found in the saturated regime. TPH concentrations in the saturated soil were >20,000 mg/Kg. Post-injection metagenomic sequencing demonstrated that a rich and diverse microbial population has been established that can remediate the site LNAPL. This population in combination with the activated carbon platform and nutrients/terminal electrons acceptors provide in the BOS 200+ provides for

LNAPL plume control in the short term, while providing for long-term treatment utilizing the BOS 200+ biological processes to degrade the saturated zone petroleum hydrocarbon mass.