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Sustainable Bioremediation of a Legacy Hydrocarbon Plume Using Biostimulation: Microbiology and Biogeochemistry

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Background/Objectives. The study area is a petroleum hydrocarbon (PHC)-contaminated site downgradient from historical underground storage fuel tanks that were active from the late 1950s to early 1980s in Saskatoon, Saskatchewan, Canada. The site has been in continuous use as a retail gas station from the 1950s. The PHC plume extends beneath an adjacent apartment building, and has been the subject of considerable in situ remediation efforts over the past four years to remove the bulk of the PHCs and reduce the risk of vapor inhalation by the apartment residents. The previous remediation efforts included the physical removal of PHCs by multiphase extraction and bioventing to promote aerobic biodegradation. These strategies have proven effective for removing the bulk of PHCs from the site; however, the remaining PHC-contamination remains relatively recalcitrant to removal. To address this challenge, we have biostimulated the indigenous microbial communities at the site to degrade the residual PHCs by amending site groundwater with a solution of sodium tripolyphosphate, nitrate, and ferric ammonium citrate. The objectives of this study are to: 1) track changes in groundwater geochemistry, mineralogy, and microbiology arising from biostimulation of the indigenous microbial community; 2) add to our growing knowledge of the biogeochemistry of in situ remediation at PHC-contaminated sites; and 3) improve our strategies for in situ remediation of PHC in the region of study. This research is part of Federated Co-operatives Limited's commitment to the Sustainable In-Situ Remediation Co-operative Alliance (SIRCA).

Approach/Activities. Groundwater monitoring wells (including an uncontaminated control well) were installed at the field site in October 2015, and we performed sampling for baseline characterization of sediment mineralogy (October 2015), and groundwater microbiology and geochemistry (October 2015, June 2016). Biostimulation began in July 2016, and extracted groundwater amended with the biostimulation solution was circulated and re-amended at the site until early November 2016. Groundwater samples were collected in August 2016 and October 2016 to characterize the depletion of the amendments and their impacts on the groundwater microbiology and geochemistry. Groundwater geochemistry was characterized by analysis for ion concentrations, pH, ORP, TOC, TIC, and organic constituents. Sediment mineralogy was characterized using synchrotron powder x-ray diffraction. Groundwater microbiology was characterized by high-throughput 16S rRNA gene sequencing of extracted DNA, and sequencing data were processed using the mothur software package. These results will allow us to examine the spatial and temporal biogeochemical response to biostimulation, relative to the baseline biogeochemistry.

Results/Lessons Learned. We will present our baseline and initial results from the mineralogical, geochemical, and microbiological characterization from this study. Our goal is to develop a conceptual model of the biogeochemical response to biostimulation to aid in the

development of a remediation strategy that can be used to address PHC impacts at similar sites in the region.