Soils in cold regions experience low rates of natural attenuation due to decreased microbial activity at lower temperatures. For sites where engineered remediation activities are not implemented due to the remote nature of the site or other technical challenges, this reduced degradation rate ultimately increases the time required for a site to reach regulatory closure guidelines. Therefore, modifications to typical remediation strategies are required to increase the effectiveness of biodegradation in cold-region soils. Building upon previous work performed in Saskatchewan, a bench-scale microcosm study was conducted to support the development of a potential in situ bioremediation plan at a site with petroleum hydrocarbon contamination within a remote community in the Yukon Territory. Three different bench tests were carried out to evaluate the efficacy of different biostimulatory solutions. The biostimulatory solutions included additions of varying amounts of nitrogen and phosphorus, depending on key characteristics of the soil, preventing nutrient-limited conditions. Key soil characteristics that drove formulation of the various biostimulatory solutions included buffering capacity, calcite content, and iron content. An oligotrophic biostimulatory solution was also used to assess performance of petroleum hydrocarbon degrading microorganisms with the addition of a lesser nutrient dose. Sulphate and iron-based components were added to act as terminal electron acceptors for use by the microorganisms. Ammonium iron citrate, was added to chelate calcium or magnesium ions, reducing phosphorous mineralization and competition for phosphorous adsorption sites. All three bench test studies, including a novel microcosm setup, showed that the biostimulatory solutions stimulated petroleum hydrocarbon (specifically the F2 fraction) degradation over a 28-day period. Nitrate and sulphate acted as electron acceptors, with phosphate concentrations decreasing over time, indicating nutrients were bioavailable and degradation was occurring. Results from the microcosm study indicated that a treatability study using a biostimulatory solution may identify an alternate viable remedial option for the cold-region soils and confirmed the benefits of optimizing biostimulatory solutions based on evaluating and understanding different soil properties.

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Amy Jimmo recently started her Ph.D. in soil science at the University of Saskatchewan evaluating the performance of biostimulatory solutions in enhancing natural attenuation. She has previously completed a Bachelor of Science in biology at the University of New Brunswick and Master of Science in toxicology from the University of Saskatchewan. Since 2010 Amy has been employed by Jacobs (previously CH2M) as an environmental scientist working on various projects including environmental site assessments, bioremediation, monitored natural attenuation and screening level risk assessments. When working on this remote site, Amy connected Jacobs’ technical team with researchers at the University of Saskatchewan, to implement cutting edge science to increase the available options for hydrocarbon remediation in arctic conditions.