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Remediation and Management of Deep Petroleum Hydrocarbon Impacts Using PersulfOx® at a Former Agricultural Site

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Background/Objectives. Environmental subsurface investigations related to the mixed (commercial and residential) urban redevelopment of the former farming facility in Calgary, Alberta, revealed deep contamination in the soil and groundwater beneath the site with petroleum hydrocarbons (PHCs) due to release(s) of gasoline and diesel from the former aboveground storage tanks. During a remedial excavation, PHC impacts above the applicable vapor inhalation guidelines were identified within the fractured shale and sandstone bedrock identified between 4.5 and 6.5 meters below ground surface (mbgs). Given the nature and the depth of the bedrock, additional remedial excavations were no longer feasible below 6.5 mbgs. Activated persulphate in the form of PersulfOx was used on a large scale within the main excavation to remediate residual impacts and was followed by post-remediation monitoring to determine changes in sub-surface concentrations of contaminants and the groundwater chemistry. Remediation using PersulfOx was conducted in cold sub-surface conditions. The paper discusses the conceptual site model, distribution of petroleum hydrocarbon constituents in the media, the challenging conditions due to the presence of bedrock and free phase product, subsequent remedial efforts using PersulfOx and management of petroleum hydrocarbon impacts.

Approach/Activities. Detailed investigations were conducted at this large former agricultural site to establish the boundaries of contamination due to farm gasoline and diesel. An advanced oxidation technology (i.e., PersulfOx®), normally associated with unconsolidated soils, were utilized for in situ treatment of soil and groundwater within the excavation to determine its effectiveness in treating impacts within fractured bedrock. The oxidant was introduced into an open excavation at low ambient temperatures (during an Alberta winter). Approximately 5,000 m^3 of groundwater within the final excavation extents (100 m x 50 m) and in the fractured bedrock was treated with 18,700 kg (41,215 lbs) of PersulfOx. Post-treatment with PersulfOx, additional groundwater sampling was completed from the treated groundwater within the open excavation and from a number of groundwater monitoring wells that were installed in the bedrock within the excavation area and in the vicinity to confirm post-remediation soil and groundwater PHC concentrations.

Results/Lessons Learned. All post-remediation soil and groundwater PHC concentrations were below the vapour inhalation pathway guidelines for commercial use. Introduction of PersulfOx resulted in the absence or reduction of PHC impacts within the fractured bedrock in an open excavation, within a short period of time and under the low groundwater temperatures. However, high sulphate concentrations were identified as a result of this chemical application which over the long term would assist in the natural attenuation of any residual PHCs which could potentially rebound.