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Sustainable Remediation of Dissolved-Phase Hydrocarbons at an Active Fuel Service Station Using an Integrated In Situ Remedial System

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Background/Objectives. In 2012, petroleum hydrocarbons were identified in the potable water supply for a kiosk at a retail fuel service station, which prompted a comprehensive soil and groundwater investigation to immediately address and control the risk to human health and the environment. The soil and groundwater investigation identified a widespread hydrocarbon plume across the site, which extended beneath the kiosk and fuel service infrastructure. The subsoils were classified as a fine-grained clay, which contained some sand and gravel. Hydrocarbon contamination was generally reported in the soils at an average depth of 2.3 meters below grade (mbg), which was at the approximate groundwater interface. Groundwater modelling indicated that groundwater was flowing from east to west with an average hydraulic gradient of 0.02 m/m.

Approach. The remedial action plan was designed to provide a sustainable and non-intrusive approach, thereby limiting costly disposal fees and operational downtime of the retail fuel service station. A collaborative effort was initiated resulting in the design and implementation of an integrated in situ remedial system. The concept behind the design was to allow for several tried and true in situ methods to be integrated into one remedial system. The system was designed to allow for independent or simultaneous implementation of vapor extraction, groundwater recovery, and on-site treatment, air sparging, nutrient amendment to promote bioremediation, and oxidant amendment to promote chemical decomposition.

Results. The remedial system was initially operated for 300 frost-free days during 2015 and 2016 and recovered approximately 138,000 L of contaminated groundwater, which were discharged to the municipal sewer system, following on-site treatment using a carbon filtration system. Mass balance calculations indicated that approximately 3,000 kg of hydrocarbons were removed through vapor and groundwater recovery over this time frame. Groundwater sampling completed in August 2016 indicated that the dissolved-phase hydrocarbon concentrations were reduced by 84% across the site since the May 2015 baseline groundwater sampling event. In situ biodegradation of dissolved hydrocarbons was also evident as nitrate and nitrite had become limited through denitrification which indicated that anaerobic reduction was occurring. This was further supported by the presence of elevated CO_2 monitored in the vadose zone, and a negative oxygen reduction potential (ORP) measured throughout the dissolved-phase plume.

Moving forward, we are evaluating the use of recovered and treated groundwater to be utilized for amendment preparation and delivery for the final in situ polishing of the site. There is a distinct advantage to re-using the recovered and treated water, as we would be consistent with the site groundwater chemistry as well as allowing for the re-introduction and distribution of indigenous bacteria to the site, while minimizing waste generation. Based on the groundwater chemistry of the site, we feel a tailor-made in situ amendment combined with the indigenous bacteria population will promote optimal conditions to complete the site remediation.