Summary of Four Applications of Colloidal Activated Carbon for the In-Situ Treatment of PFAS in Groundwater

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There is considerable interest in developing an in situ remediation approach to target per- and polyfluoroalkyl substances (PFAS) compounds in groundwater. Currently most PFAS plumes are contained using hydraulic methods such as pump and treat which while effective for containment are generally ineffective for remediation. Potential in situ remedial techniques such as sorptive materials, solidification, stabilization, foam fractionization, and other approaches have been tested at laboratory scale but most have not undergone testing in the field. The one in situ approach that has undergone numerous field tests and applications is the application of colloidal activated carbon. This presentation discusses the results of four applications of colloidal activated carbon for the treatment of PFAS in groundwater at four geologically differing sites including at sites with comingled benzene, toluene, ethylbenzene, xylenes, petroleum hydrocarbons and chlorinated ethenes. Concentrations of total PFAS at the four sites ranged up 18,000 ng/L with carbon chain lengths varying from C4 to C12 PFAS being present.

The colloidal activated carbon was injected at the four sites using direct push technology. The sites' geology varied from a sand aquifer to a silty sand till to fractured bedrock. The colloidal activate carbon was applied using a dense lateral and vertical grid system under low pressures. High resolution monitoring of the aquifer was completed pre- and post-injection using a combination of continuous cores and multilevel monitoring wells systems coupled with detailed geochemical, microbiological and hydrogeological monitoring.

Detailed testing of the four aquifers indicated that heterogeneities within the aquifers influenced the delivery and distribution of the colloidal activated carbon, however, overall treatment of the PFAS and comingled compounds was not impacted within the unconsolidated aquifers. Total organic carbon content of the aquifers increased by up to four orders of magnitude compared to pre-injection background levels resulting in significantly higher foc aquifer content. Analyses of the distribution of the colloidal activated carbon post injection determined that the colloidal activated carbon was effectively delivered to the target injection zones with greater than 95 percent of the colloidal activated carbon being detected within the target zone.

The results of the performance sampling, conducted for up to five years, indicated that colloidal activated carbon was effective at attenuating the PFAS and comingled compounds of concern to below regulatory limits in the unconsolidated aquifers suggesting that geology, groundwater geochemistry, and hydrogeology had minimal effects on the performance of the colloidal activated carbon. However, treatment of the PFAS within the fractured rock showed a different treatment profile with low carbon chained carboxylic PFAS breaking through the fractures within 1 year of application. The preliminary conclusions of the four studies suggest that colloidal activated carbon is an effective alternative to ex situ methods such as pump and treat and potentially allow stakeholders less expensive options while increasing the flexibility of treatment.

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Rick McGregor is the President of InSitu Remediation Services Ltd and has over 26 years' experience in groundwater and soil assessment and remediation. Rick has worked in over 30 countries and has authored numerous papers on groundwater assessment and remediation. Rick holds a M.Sc. from the University of Waterloo in hydrogeology and geochemistry and is a Certified Ground Water Professional in Canada and the United States.