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# Remediation of Per- and Polyfluoroalkyl Substance (PFAS) Contaminated Soil with Colloidal Activated Carbon: Lessons Learned from a Swedish Case Study

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Per- and polyfluoroalkyl substances (PFAS) are fluorinated organic chemicals that have extensively been used for more than five decades worldwide, resulting in their ubiquitous spreading . In the light of their toxicity, recalcitrance and bioaccumulation potential, their use and disposal are increasingly being limited. Groundwater is one of the environmental pathways critical for PFAS dispersal and subsequent human exposure. Case studies on PFAS groundwater contamination are lacking and remediation efforts applied in full-scale are limited. In this context, the main objective of this study was to quantify the extent of PFAS contamination in the subsurface and evaluate the effectiveness of a trap-and-treat *in-situ* soil remediation method with the use of colloidal activated carbon. A PFAS-contaminated site was selected for investigation in Sweden, that has previously been used for fire-fighting training with PFAS-containing aqueous fire-fighting foam (AFFF).

PFAS concentrations and hydrological properties of the contaminated site were investigated. Groundwater was sampled through five monitoring wells, while surface water samples were collected at four different locations in a stream adjacent to the site monthly-bimonthly. PFAS concentrations were quantified for 11 individual PFASs. Colloidal activated carbon was injected in the subsurface, aiming for a good distribution of the sorbents in the treatment zone. Monitoring wells were drilled upstream and downstream to the injection well, identifying variations in concentrations through time. Total oxidizable precursor concentrations were also quantified in two observation wells. Other parameters that were monitored in the wells included pH, conductivity and metals concentrations. Groundwater levels were measured by manual sounding as well as by automated logging with barometric compensation. Aquifer characteristics were defined by slug tests and the site's geological characteristics were investigated.

Prior treatment, groundwater concentrations of ∑PFASs were up to 24 μg $L^{-1}$, while two significant hotspots were identified. ∑PFASs concentrations decreased by ~74% based on the original concentration within and directly downstream of the treatment zone approximately three months after applying the colloidal activated carbon. Differences in the PFAS composition profile after injection, indicated a stronger reduction for PFOS in comparison to, for example, PFOA. However, long-term monitoring is needed to assess the treatment's efficiency over time.