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Contaminant Transport and Fate in Engineered Charcoal Remediation Systems

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Site soils contaminated with mixed pollutants (e.g. hydrocarbons and heavy metals) pose a risk both to near-surface receptors and groundwater systems. Remediation of these sites often involves excavation and on-site treatment. However, for various reasons, it may be preferable to treat the contaminants *in situ*. Permeable Reactive Barriers (PRBs), which are well-known in the treatment of groundwater contaminant plumes, but equivalent barriers for contaminants migrating vertically through the vadose zone have not been explored. A recent innovation involves the application of microbially seeded charcoal, where micro-organisms shown to degrade site contaminants are encouraged to colonise the charcoal, which is then placed in the ground either beneath contaminated soil or mixed with it. As rain infiltrates and washes contaminant toward the water table, it sorbs to the char and/or is microbially transformed by the organisms.

The charcoal used is the result of incomplete combustion of biomass and is noted for being an exceptional sorbent. Unlike ordinary porous media, charcoal particles are plate-like in nature, resulting in the potential for more complex flow. As for all PRBs, residence time is a key design and performance parameter, and better understanding of sorption isotherms and flow behaviour is needed for application design.

We evaluate sorption behaviour of a number of different heavy metals and organics on select types of charcoal, both seeded and non-seeded. Initial heavy metal sorption data suggests that wood chars derived from different plants are diverse in their sorption capacities, and will readily adsorb certain metal species over others, which has implications for PRB design. Similarly, sorption of organic compounds is dependent on the presence of differing surface functional groups, cellulose/resin content, and specific surface area. Preliminary data from column studies operated under variably saturated conditions suggests that water flow within the charcoal is highly heterogeneous in nature (varying at the cm scale). Consequently the unique particle structure of charcoal, combined with the variably saturated conditions, results in preferential flow paths within the system. Thus, there is a range of residence time, which has implications for treatment performance and the monitoring thereof.