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Current Research on Phytoremediation of PFASs

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Background/Objectives. Poly- and perfluorinated alkyl substances (collectively known as PFASs) are a ubiquitous, environmentally persistent and broad group of problematic synthetic chemicals. Remedial treatment options are limited due to the inherently stable carbon-fluorine bond, identified as one of the strongest chemical bonds in nature. Identified scalable treatment options include granular activated carbon (GAC) and possibly other sorbent media scrubbing. Experimental treatment options include mechanical ball milling using alkaline reagents and Laccase-catalyzed humification reactions.

The role of plant-assisted remediation of PFAS is poorly understood, with the majority of established research geared toward evaluation of uptake and translocation of PFAS into agricultural targets. Here we document the first comprehensive review of literature on phytoremediation of PFAS. Work was funded through AECOM's innovation fund initiative. Project research was justified through the need for alternative and cost-friendly PFAS treatment options and understanding the role that plants play in potentially serving as vector vehicle for PFAS transfer to higher ecological trophic levels and human consumption. The intent of the scope was well-defined in looking for novel plant-assisted remediation approaches and not exploration of bioaccumulation of PFAS into plants.

Approach/Activities. Research was initiated in three phases, starting with a literature search and deposition of over 1,300 published literature citations derived from pertinent key word searches. The initial literature fetch was performed using JabRef v. 3.6, a flexible and stable public-domain open source bibliography reference manager. The native file format used by JabRef is BibTeX, a standard bibliography format widely used in academic journals. The second phase of work entailed sorting through the citations and identifying pertinent research, thought-centers, research trends, and promising plant-based remedial technologies. A third phase will be the development of a white paper "Current Research on Phytoremediation of PFASs".

Results/Lessons Learned. A total of 1,300 citations were reviewed from the late 1960s to present day, with relevant topics identified being plant uptake (103 papers), use of laccase enzymes (58 papers), presence of PFASs in bio-solids (32 papers), vegetable uptake (30 papers), phytoremediation (15 papers), and constructed wetlands (9 papers). The majority of research to date has centered on understanding of plant uptake of PFASs resulting from the application of bio-solids waste. Early research suggests that PFASs within the perfluorocarboxylic acid (PFCA) group have greater proclivity to be translocated into plants than perfluoroalkyl sulfonic acids (PFSA). Promising phytoremediation mechanisms include enhanced rhizodegradation and inoculation of the root zone with laccase-producing fungi and bacteria. AECOM is also exploring the use of carboxylate-rich plants as targets for translocation of PFCAs.