Treatment of Urban Toxic Contaminants in Stormwater

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Background/Objectives. Urban stormwater runoff is a major non-point source of contaminants of concern (COC) release and recontamination of sediment in receiving waters at or close to Department of Defense (DoD) sites. Many COCs, including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) as well as metals, will strongly bind to stormwater particulate matter (PM) and eventually sediments and result in dispersed contamination and costly remediation and cleanup challenges. PCBs and many PAHs are highly toxic persistent organic pollutants (POPs) that accumulate in the food chain due to their hydrophobic characteristics, whereas copper is one of the more challenging heavy metals in stormwater due to its toxicity to aquatic life and strong affinity to organic matter. The goal of the project is to develop new and innovative treatment media or mixes of media to provide optimal removal of PCBs, PAHs and copper from stormwater runoff originating from DoD sites with particular focus on those COCs that are associated with PM as well as remaining dissolved fractions. Current stormwater management practices or best management practices (BMPs) such as rain gardens, sand filters and bioretention facilities are designed to dispose of the runoff as fast as possible, not to treat the contaminants. Therefore, removal by microbial degradation of the adsorbed POPs and immobilization of copper organized in a “treatment train” BMP will be examined.

Approach/Activities. The research and data collection will initially take place using research-level stormwater monitoring. The collected data will guide subsequent project tasks toward development of technologies for removal of COC affiliated with PM, which can be coupled with established PM removal technologies. As a first step, PCB, PAH, and copper concentrations will be measured at UMD Campus (College Park, MD) and multiple DoD sites to reveal the relationship between contaminant loads and the sizes of PM in stormwater. Various types of geomedia will be developed for capture of dissolved-phase COCs. Several types of geomedia or amended geomedia may result, each with defined characteristics for capture of specific COCs (PCBs, PAHs and copper). Possible sources of geomedia include locally-sourced “standard” bioretention media and amendments such as compost (yard waste), wood chips, activated carbon (AC), biochar, aluminum and/or iron oxide. The criteria for selection of media will include high sorption capacity, rapid rates of uptake, no leaching of captured COC or other undesired substances, promotion of biodegradation of organic COC and/or long-term immobilization of copper. In situ biodegradation will be examined via biomolecular tools for PCB and PAH degrading microorganism and detection of degradation products; strength of affiliations of copper in the geomedia will be determined. A passive sampling approach will be employed for monitoring breakthrough of the geomedia.

Results/Lessons Learned. Addressing and removing COCs such as PCBs, PAHs and copper near their sources, where concentrations are higher and they are less dispersed, will keep these pollutants isolated near their source, where they can be managed more effectively and in a more sustainable manner. A “treatment train” approach is envisioned, with layers or modules that specifically target PM and affiliated COCs, followed by layers that may separately or collectively target dissolved COC. Ease of maintenance and long-term COC management will drive these approaches, where passive sampling will be employed for testing of geomedia breakthrough. Layers or modules can be easily replaced when needed. The results from this project will assist in the development of the next generation of stormwater management tools, to effectively prevent release of COCs into local water bodies and (re)contaminating sediments. An overall DoD benefit is a more efficient reduction of environmental risk at lower costs.