PFAS IN STORMWATER CONTROL MEASURES: REMOVAL, DISTRIBUTION, AND LONG-TERM FATE

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Background/Objectives:

Per- and polyfluoroalkyl substances (PFAS) are highly stable environmental contaminants that persist in soil, water, and sediment due to their resistance to degradation. Stormwater is increasingly recognized as a significant non-point source of PFAS, mobilizing these compounds from urban and industrial surfaces into receiving water bodies. As a result, effective stormwater treatment is critical to limiting PFAS release into the environment. Stormwater control measures (SCMs), including biofilters, media filters, hydrodynamic separators, and retention ponds, are commonly used to manage runoff. However, their effectiveness in treating PFAS under real-world conditions remains largely unexplored, and few studies have compared SCM types or evaluated long-term performance. To address these gaps, this study evaluated PFAS fate, transport, and removal across seven SCMs during multiple storm events. The analysis included phase-specific partitioning, influent-effluent comparisons, and year-long monitoring of a retention pond impacted by legacy AFFF contamination to assess persistence and potential remobilization.

Approach/Activities:

PFAS concentrations were characterized in stormwater runoff, surface water, and sediment across seven SCMs: three biofilters (one with a media filter), three hydrodynamic separators (two with media filters), and one retention pond. Composite samples were collected at influent and effluent points using automated samplers during 21 storm events, with additional grab sampling at the retention pond. PFAS partitioning between filtered water (<0.7 µm) and particulate (>0.7 µm) phases was assessed. Chemical analysis was performed using LC-QTOF-MS in MRMHR mode, targeting 26 PFAS compounds, of which 16 were consistently detected (including PFOS and PFOA) and included in the analysis. A mass balance model was developed for the retention pond using stormwater runoff and surface water concentrations, and hydrologic inputs to evaluate PFAS behavior over time, accounting for evaporation and irrigation losses.

Results/Lessons Learned:

PFAS partitioning to solids increased with carbon chain length, with long-chain compounds (C > 8) exhibiting stronger affinity for particulates. While SCMs are generally effective at removing particulate-bound contaminants, the majority of PFAS in stormwater were present in the filtered-water phase (<0.7 µm), which was not effectively captured by particle-based treatment. Removal of particulate-phase PFAS was also inconsistent, influenced by low solids concentrations and resuspension during storm events. Speciation analysis showed sulfonates mainly accumulated in sediments, whereas carboxylates remained in the filtered phase. Long-term monitoring of the retention pond revealed precursor depletion alongside elevated concentrations of terminal PFAS, indicating in situ transformation and potential for persistent contamination and remobilization. PFAS concentrations exceeded regulatory thresholds even at sites without known AFFF use, highlighting stormwater as a diffuse source of PFAS. As PFAS formulations shift toward more mobile compounds like GenX, SCMs must evolve to include targeted treatment mechanisms and long-term monitoring strategies.

About The Author

Cesar Gomez-Avila, Ph.D., is an environmental engineer specializing in contaminant fate and transport, stormwater management, and PFAS treatment optimization. He has extensive experience working with a range of contaminants, including PFAS, hydrophobic organic compounds (e.g., PAHs, PCBs), heavy metals, and microplastics, across stormwater, sediment, and surface water systems. His work focuses on understanding contaminant fate and transport and long-term behavior to inform environmental remediation strategies. Cesar holds a Ph.D. in Chemical Engineering from Texas Tech University, where his research addressed sediment recontamination via stormwater pathways and contaminant transport in aquatic systems.