LOI # 17

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Organization: Seattle Public Utilities

Study Title: Green Stormwater Infrastructure and Bioretention Monitoring for Maintenance

Which topics from the SWG's priority list (Appendix A) do you propose to address?

19, 8

What type of project is being proposed?

Environmental sampling study

Short description of the proposed project

Seattle Public Utilities (SPU) will monitor stormwater contaminants including the emerging contaminants tire wear particles (TWP), 6PPD, and 6PPDQ at well-established green stormwater infrastructure (GSI) sites including vegetated bioretention cells throughout Seattle. Contaminant concentrations will be measured in stormwater at GSI inflow and outflow points, in sediments collected from associated catch basins and sedimentation structures, and from set depth intervals in bioretention soil mix (BSM) soil cores collected from bioretention cells. These data points will be visualized and compared against applicable numerical water quality and soil criteria to help SPU and Permittees better understand the transport and fate (capture) of stormwater contaminants and evaluate treatment effectiveness of the GSI over time.

This work will inform adaptive management strategies and help refine operations and maintenance (O&M) best practices for bioretention and GSI. For example, the monitoring study results may help inform how often upstream catch basins or sedimentation structures should be cleaned or identify specific areas and depths within bioretention cells where BSM replacement is needed. In addition, results may provide important information about the presence of TWP, 6PPD, and 6PPDQ in bioretention cells and associated structures as potential continuing sources of 6PPDQ to stormwater. Ultimately, this monitoring will enhance our understanding of contaminant sources and capture, enabling more targeted maintenance and

improved designs. As new GSI are built statewide, our goal is to help guide O&M best practices—either monitoring or in place of it where monitoring is impractical or cost-prohibitive—to ensure continued effectiveness of this stormwater BMP.

What type of information will be collected or analyzed for this proposed study?

Stormwater and sediment monitoring data will be collected from GSI and bioretention systems consisting of sedimentation structures including catch basins and series of lined or unlined vegetated bioretention cells filled with a 70 percent sand/30 percent compost bioretention soil mix (BSM). The focus will be on well-established systems, having been in place receiving urban stormwater for several years, but varying in infrastructure, for example using infiltration and ponding or infiltration with an underdrain to underground injection control (UIC) wells for stormwater treatment.

Stormwater samples will be collected during storm events from bioretention cell and sedimentation structure inflow and outflow points at several sample locations along the length of the GSI systems and monitored for total suspended solids (TSS), hardness, metals (Cd, Cu, Pb, Zn), total phosphorus, ortho-phosphate, nitrate + nitrite, total Kjeldahl nitrogen, NWTPH-Dx, PCB Aroclors, and 6PPDQ. The stormwater monitoring data will be compared between different combinations of inflow and outflow points at both individual bioretention cells and along the length of the GSI system to evaluate treatment effectiveness; also, stormwater monitoring data will be analyzed alongside sediment data collected from the systems to better understand contaminant transport and capture throughout the system.

Sediment samples will be collected from catch basins and other sedimentation structures located upstream and downstream of bioretention cells and from sediment cores extracted from the BSM from the series of bioretention cells and monitored for total solids, total organic carbon (TOC), grain size parameters, pH, metals (Cd, Cu, Pb, Zn), NWTPH-Dx, PCB Aroclors, and the emerging contaminants tire wear particles (TWP), 6PPD, and 6PPDQ. Within each bioretention cell, two sediment cores will be collected from the BSM: one at the upstream end, where direct stormwater inflow and sediment accumulation are expected; and one at the downstream end, near the cell's discharge point, where sediment accumulation is also likely. After removal of the sediment from the borings, each sediment core will be segmented into the following depth intervals: 0–2 inches, 2–10 inches, and 10–18 inches, or to the bottom of the bioretention cell, whichever is shallower. The sediment data will be visualized both with depth and along the length of the GSI systems to better understand contaminant transport and capture and focus maintenance efforts.

These data will supplement water quality, sediment (sedimentation structure and BSM soil core), and stormwater contaminant data previously collected by SPU at Venema, Pinehurst, and Carkeek Cascade GSI systems.

What are the anticipated measurable outcomes and key deliverables that will be produced by the proposed study and how will they be used by Permittees and the Washington State Department of Ecology?

Key measurable outcomes and deliverables that are anticipated to be produced for and used by Permittees and the Washington State Department of Ecology (Ecology) are data describing stormwater contaminants in both stormwater and sediment from well-established bioretention GSI sites that create a more complete picture of contaminant transport and capture and refinements to programmatic operations and maintenance (O&M) documentation that supports continued effectiveness of both long established and newly implemented bioretention and GSI as a stormwater best management practice (BMP).

To evaluate the stormwater, sediment, and BSM data, we will visualize and analyze measured stormwater contaminant concentrations in stormwater at inflow and outflow points and in sediments with depth and longitudinally in the BSM in the bioretention cells and associated sedimentation structures for each GSI site to better understand pollutant transport capture. Also, published water quality criteria (Ecology acute freshwater criteria for protection of aquatic life, appropriate for characterizing short-term storm events large enough to cause flows through the GSI and for consistency with the acute freshwater criterion for 6PPDQ) and sediment criteria (Ecology Model Toxics Control Act (MTCA) Method A soil cleanup, Ecology Ecological Indicator Soil Concentrations (EISCs), EPA Ecological Soil Screening Levels (Eco-SSLs), and EPA Regional Screening Levels (RSLs) for residential soil where available) may be used as comparison points for the measured concentrations to guide further sampling efforts and maintenance. Exceedances of these criteria will be evaluated alongside depth and longitudinal profiles to determine appropriate maintenance actions, such as sediment or BSM removal or replacement. Non-exceedances will also be assessed to determine whether the sedimentation structures and/or BSM are effectively removing stormwater contaminants.

The data collected from the monitoring conducted for the proposed study will be analyzed at both individual bioretention and GSI sites and Citywide across the GSI program. This dual-level analysis will help Permittees better understand how its GSI functions as stormwater BMPs and inform improvements to current O&M strategies. Site-specific data may support adaptive management for individual GSI locations. However, broader insights can be gained by comparing data across multiple sites with varying characteristics—such as bioretention cell

configurations (e.g., number, depth, type, and connections to sedimentation structures) and stormwater inputs (e.g., land use, contributing drainage area, and chemical composition). By analyzing these variables, we can develop maintenance strategies that are both effective and scalable. This includes establishing clear benchmarks or triggers for maintenance that ensure treatment performance while promoting operational efficiency. Collecting more data also enhances our understanding of pollutant transport and fate—both within the GSI and throughout the stormwater system, including receiving waters.

The results from this study will help Permittees inform GSI design enhancements, including improved treatment trains or by offering guidance on using a lower-cost sacrificial media. Moreover, sediment data for a given GSI site will be considered along with available stormwater monitoring data to inform current transport and fate and future monitoring efforts and ultimately, inform programmatic O&M for bioretention and GSI to concerned Permittees.

List the permittees or agencies you are proposing to coordinate with.

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and UW Tacoma Center for Urban Waters (potentially)