

Stormwater Action Monitoring 2023 Annual Report



Stormwater Action Monitoring (SAM) is the regional cooperative stormwater monitoring option in the municipal stormwater permits.

SAM is the alternative to outfall monitoring in the permits.

The SAM program funds projects to improve stormwater management, reduce pollution, improve water quality, and reduce flooding. The projects do this by measuring stormwater impacts on the environment, evaluating the effectiveness of stormwater management techniques, and suggesting changes to the stormwater manuals, local practices, and permit requirements. SAM projects also build tools, techniques, and resources for permittees.

All jurisdictions, large and small, can benefit from SAM projects by using findings to protect local lakes, rivers, streams, wetlands, and Puget Sound.

<https://ecology.wa.gov/SAM>

This is the ninth annual report from the Washington State Department of Ecology (Ecology) on implementation of Stormwater Action Monitoring (SAM), a collaborative program funded by more than 90 Western Washington cities and counties, the ports of Seattle and Tacoma, and the Washington State Department of Transportation (WSDOT). Ecology manages SAM's revenues, expenditures, agreements, and communication of findings.

Highlights for 2023

The Stormwater Work Group (SWG) and SAM organized the fourth solicitation round for new projects in 2023. Proposed studies were presented to an audience of stormwater managers, permittees, and interested stakeholders at a workshop in August. Permittee were polled on their preferences in September. In November, SWG considered the permittee voting and made the decision to fund five new projects. These projects will begin in 2024-25. We anticipate starting the planning process for new projects again in 2025, as Round 5.

Program Management

Stormwater Work Group

SWG meets four times per year to implement, improve, and expand the regional stormwater monitoring program. The group strives for consensus around a cooperative program that leverages existing programs, scientific expertise, and other capacity to improve our understanding of stormwater impacts and evaluate the effectiveness of stormwater management actions.



The SWG welcomes participation on the group's subcommittees and caucuses. All meetings are open to the public. See the [SWG website](#).

What is the connection between SAM and the SWG?

The SWG sets priorities and oversees the budget for SAM. All SAM projects are selected and approved by the SWG. The SWG makes recommendations to support SAM implementation and other stormwater-related monitoring.

Permittees fund SAM. Permittees, state and federal agencies, and universities all provide leadership on SAM projects. Ecology serves as the administrative entity that manages expenditures of funds to implement SAM.

The Pooled Resources Oversight Committee (PRO-C) is a subgroup of SWG and oversees SAM project scopes, schedules, budgets, and SAM contracting decisions. PRO-C also provides review and recommendations to the SWG on Ecology's administration of the SAM. Both the SWG and PRO-C are formal committees whose members represent stakeholder groups.

Who makes up SAM?

SAM receives annual revenue from Cities, Counties, Ports, WSDOT and the US Navy via an option in the NPDES Municipal stormwater permits.

Cities: Aberdeen, Algona, Anacortes, Arlington, Auburn, Bainbridge Island, Battle Ground, Bellevue, Bellingham, Black Diamond, Bonney Lake, Bothell, Bremerton, Brier, Buckley, Burien, Burlington, Camas, Centralia, Clyde Hill, Covington, Des Moines, DuPont, Duvall, Edgewood, Edmonds, Enumclaw, Everett, Federal Way, Ferndale, Fife, Fircrest, Gig Harbor, Granite Falls, Issaquah, Kelso, Kenmore, Kent, Kirkland, Lacey, Lake Forest Park, Lake Stevens, Lakewood, Longview, Lynden, Lynnwood, Maple Valley, Marysville, Medina, Mercer Island, Mill Creek, Milton, Monroe, Mount Vernon, Mountlake Terrace, Mukilteo, Newcastle, Normandy Park, Oak Harbor, Olympia, Orting, Pacific, Port Angeles, Port Orchard, Poulsbo, Puyallup, Redmond, Renton, Sammamish, SeaTac, Seattle, Sedro-Woolley, Shoreline, Snohomish, Snoqualmie, Steilacoom, Sumner, Tacoma, Tukwila, Tumwater, University Place, Vancouver, Washougal, Woodinville.

Counties: Clark, Cowlitz, King, Kitsap, Pierce, Skagit, Snohomish, Thurston, Whatcom.

Ports: Tacoma and Seattle.

Agencies: Washington Department of Transportation and the United States Navy.

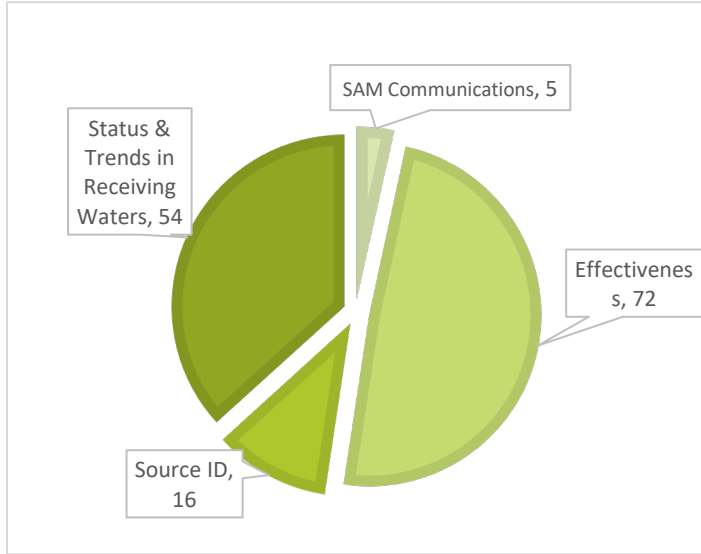
In-kind funds have been received from Washington Departments of Ecology, Agriculture, and Fish and Wildlife, the United States Geological Survey, Penn Cove Shellfish, and Cedar Grove Composting.



Administration

Contracts and Agreements

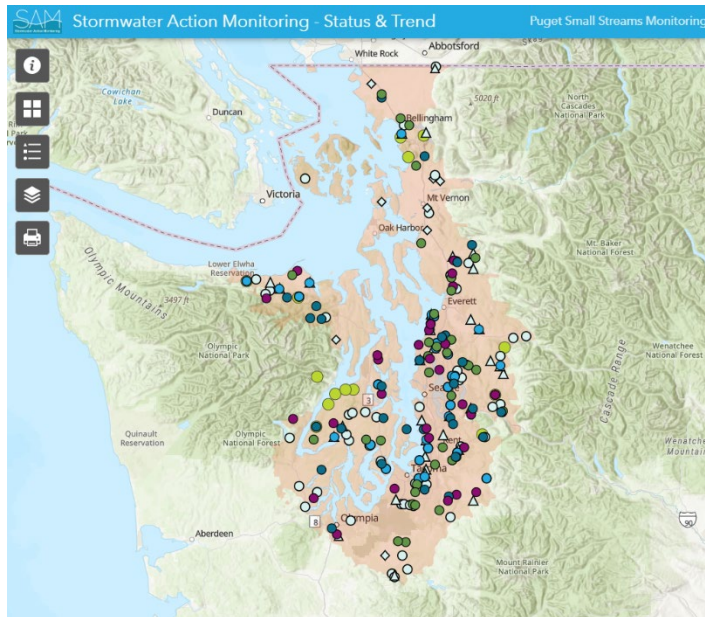
Since 2014, SAM staff with assistance from Ecology's fiscal, management, and contracts sections have processed about 150 contracting actions. Actions include initiating new contracts, making amendments, and closing completed contracts. In 2023, four contracts were completed and closed out and five were amended. We continue to build in contingencies, time to hire subcontractors, and time to incorporate review processes that are expected by technical committees and Ecology's SAM staff to minimize the high rate of amendments.



Status & Trend Studies of Receiving Waters

Are conditions in receiving waters getting better or worse?

SAM is assessing the impacts of stormwater runoff in urban and urbanizing areas in the Puget Sound and Lower Columbia River watersheds. These studies are long-term and active each year. Reports completed in 2023 are showcased in the blue boxes.



Puget Sound Basin Studies

Stormwater managers know that effective and lasting improvements to infrastructure, best management practices, and changing behaviors of Puget Sound residents takes time. Long-term monitoring of key environments help us determine if conditions are getting better in the areas adjacent to urban areas. Two receiving waters studies cover the Puget Sound watershed. Each study monitors 33 randomly selected sites from across four levels of impervious cover and two reference sites.

- **Puget Small Streams (PSS):** U.S. Geological Survey (USGS) leads the small urban streams assessment for SAM. Monitoring includes water, sediment, macroinvertebrate sampling and physical habitat

assessment. Water level and temperature using sensors are monitored continuously throughout the year. Restrictions related to the pandemic continue to impact field work, chemical analysis, and

reporting. The annual reports for water year 2020 was publishing in early 2024. The 2021 and 2022 report will now likely be published in winter 2024.

- **Puget Sound Nearshore Mussels:** Washington Department of Fish and Wildlife (WDFW) leads the biannual nearshore assessment for SAM. WDFW wrapped up their laboratory analysis from the 2020/2021 survey. They are expected to publish these findings in summer 2024. They also began their next round of monitoring in fall of 2023. The findings from 2023/2024 are expected to be published in summer 2025.

Lower Columbia River Study

The Lower Columbia Urban Streams (LCUS) study monitors small urban streams in Clark and Cowlitz counties. The LCUS study design includes trend sites that will be monitored yearly and status sites that will be sampled at five-year intervals. Trend analyses will be conducted every five years.

Clark County leads this streams assessment for SAM. Monitoring includes water, sediment, macroinvertebrate sampling and physical habitat assessment. Water level and temperature using sensors are monitored continuously throughout the year. Clark County completed the third round of sampling in 2023. They also produced a report of their findings from water year 2022.

2022 Lower Columbia Urban Streams Findings

Annual Report, October 2023

Monitoring began in late 2021 and continued through summer 2022. Stream health conditions in this study are measured by multiple indicators. Some findings from water year 2022 include:

- Most stream flow measurements met criteria for supporting salmonoid use, while no site met the temperature criteria.
- Benthic Index of Biotic Integrity (BIBI) scores generally declined in subwatersheds with increasing impervious surface and traffic. All but two sites had “Poor or Very Poor” BIBI scores with human disturbance index percentages greater than 14. All but one site with greater than 54% riparian cover had “Fair” BIBI scores. Sites with less than 54% riparian cover typically had “Poor or Very Poor” BIBI scores.
- Metal concentrations in stream sediments were below the cleanup standards.

Over time, this study will provide enough data to categorize LCUS streams in good, fair, or poor condition. Trend analyses and risk assessments will be conducted every five years to identify the key stressors causing poor stream conditions in the region. Read the [full report](#).

Source Identification Projects

What are the common sources of illicit discharges and best ways to reduce them?

SAM Source Identification projects identify common problems and propose regional actions on source control to prevent transport of pollutants in stormwater. Two projects were active at the beginning of 2023 with one finishing in fall 2023. The completed study is shown in the blue box:



- **Mobile Business:** King County and consultants have worked with the WA Department of Revenue to pull business listing information to help jurisdictions identify mobile business types from business licensing data. A pilot outreach effort in southern King County wrapped up in 2023. The pilot program recommend ways to identify mobile businesses and methods to conduct inspections and outreach for



the purposes of stormwater source control and pollution prevention. Three new outreach brochures were developed during the Pilot Program on mobile automobile repair, commercial landscaping, and pressure/power washing. The engagement with the Pilot Program participants to select the topics and outreach brochure content helped create more relevant materials for permittee use across the region.

Business Source Control & Inspection Program Guidance

SAM Fact Sheet #31, August 2023

Ecology's 2019 Phase II Municipal Separate Storm Sewer (MS4) National Pollutant Discharge Elimination System permit required permittees for the first time to develop and implement a source control business/site inspection program. A few Phase I and Phase II jurisdictions with existing business inspection programs offered to share lessons learned. Washington Stormwater Center (WSC) and consultants updated a 2020 guidance manual with new chapters, an online training program, outreach materials in several languages, and many other tools, videos, and examples. Municipal stormwater permittees who are developing or refining their business source control and inspection programs will be able to access this guidance and resources to help meet their permit requirements. The 2023 manual provides resources, templates, and strategies developed based on research, input, and experiences of jurisdictions that have developed similar programs.

This SAM project funded development of a free online training program based on the popular in-person trainings held in 2023. The training which highlights critical items related to developing an inspection program, conducting inspections, and identifying potential issues. The course consists of four modules:

1. Overviews of the manual, source control BMPs, and the permit
2. Setting up an Inspection Program
3. Implementing an Inspection Program
4. Additional Resources

Effectiveness Studies

How well are required or innovative stormwater management practices working?

SAM is measuring the effectiveness of BMPs and stormwater management actions to reduce negative hydrologic impacts and the discharge of pollutants to receiving waters. Bulleted studies were active in 2023, and completed SAM projects are shown in the blue boxes.



- **Paired watershed retrofit and restoration:** The City of Redmond paired watershed study is in year 8 of 10. Annual Reports for Water Years 2021 and 2022 were published this year. The 2016-2022 Trend Analysis Report originally planned as a standalone document was incorporated into the 2021 Annual Report.
- **Hydrologic performance of the oldest bioretention:** The City of Olympia tested the infiltration rate of 50 older bioretention facilities to evaluate influential factors on the best designs and maintenance lessons learned. The findings are expected to be published in a report in early 2024.
- **Evaluation of BMP Maintenance:** The City of Bellevue evaluated the maintenance thresholds or conditions for ponds, vaults, trenches, and tanks through a permittee survey and a literature data review. Preliminary findings were published in two memos in 2023. A white paper in 2024 will

incorporate these findings to recommend how BMP maintenance efforts can be adjusted to maximize overall environmental outcomes to meet permit requirements.

- **Ditch Maintenance for water quality study:** WSU’s study to evaluate different ditch shapes and grass mixtures for roadside ditch reseeding completed data collection in 2023. Their final report and a presentation of the findings is expected in 2024.
- **Longevity of bioretention soil mix for toxicity reduction:** WSU continues to evaluate coho toxicity reduction by the 60:40 default bioretention soil mix. Ecology leveraged this existing SAM study to add 3 additional water years for coho toxicity and quantification of the emergent 6PPD-quinone compound using legislative proviso funds. The findings are expected to be published in late 2024.
- **Hydrologic benefit of smaller street trees:** WSU and the Evergreen State College began data collection in a project quantifying the effectiveness of young, small trees to mitigate stormwater runoff in Western Washington. This study builds off a previous SAM study of the hydrologic benefits of mature trees.

Guidance for evaluating the effectiveness of public education and outreach programs

SAM Fact Sheet #28, February 2023

In this project, Washington State University and Evergreen StormH2O used surveys and literature to evaluate which types of stormwater problems are amenable to, and best addressed by, behavior-change efforts. Washington municipal-stormwater permittees now have an online decision-support tool, templates, guidance, and training available to guide their work on prioritizing stormwater-education efforts and evaluating effectiveness of their programs.

Cities and counties cannot fully control all the stormwater draining from the urban environment. Aspects of their stormwater management programs which aim to change behaviors of households, businesses, and others are critical tools in improving stormwater quality and protecting our natural resources. Managers can use information from the website, literature review, and evaluation guidance manual to help select suitable behavior change campaigns and then evaluate those efforts using valid approaches. Those evaluations can inform their decisions on management needs and future campaigns. The Evaluation Guidance Manual includes information about social marketing and community-based social marketing resources, sample size selection, common evaluation instruments, data types, and analysis methods. Permittees may also use the report template to meet their permit reporting requirements.

Particle size importance for stormwater characterization and BMP effectiveness

SAM Fact Sheet #29, August 2023

Washington State Department of Natural Resources and Evergreen StormH2O completed a literature review of the size of particles in stormwater, bound contaminants, and the effectiveness of a range of treatment approaches for those particle sizes.

Sources of particles to stormwater include automotive, local soil erosion products, and atmospheric deposition. The most transported sizes appear to be clay and silt sizes.

Literature reviewed focused on heavy metals, nutrients, and PAHs attached to particles, which suggests pollutant concentrations are generally higher for clay and silt-sized particles. Targeting clay and silt-sized particles may remove the highest amounts of metals, nutrients, and bacteria.

Studies with particle size data for BMP influent and effluent were located for 19 structural and one operational BMP. Most BMPs were highly effective at removing silt and fine sand sized particles. Proceed with caution, though-- these findings are based on only a few data points or a single study and there are many BMPs for which data were not located.



Mesocosom testing facility at WSU-Puyallup used in the outlet control study

Outlet control performance for bioretention facilities

SAM Fact Sheet #30, August 2023

Washington Stormwater Center and Aspect Consulting evaluated performance of flow controlling outlet for bioretention facilities. Both water quality and water quantity performance results were compared to bioretention facilities operated with the typical media filter hydraulic controls to find advantages for sites trying to optimize bioretention facility performance.

Bioretention systems can be designed to rely on the permeability of the bioretention soil media (BSM) to restrict flow rates (i.e., “media control”) or incorporate flow-restricting devices (valves or orifices) on the underdrain outlets to throttle flow rates through the system (i.e., “outlet control”). This research compared discharges from both outlet-controlled and media-controlled designs.

When effluent stormwater pollutant concentration is of primary concern, an outlet control approach provides limited benefit. This approach moderately improved treatment performance for some pollutants but may increase the risk of leaching pollutants from BSM, particularly for compost-based media that already have the potential to leach. An outlet control approach could be beneficial for applications where (1) more predictable and longer residence times are desired to target specific analytes, or (2) there is concern about short-circuiting through a portion of the media bed and exhausting the treatment capacity along the short-circulate pathway, and (3) the selected bioretention media has limited risks for nutrient and dissolved copper leaching. Outlet control effectively slows the water down, increases residence time, and saturates the full media bed more often. This study shows no impact on O&M or plant health associated with this outlet control bioretention designs.

SAM's 2023 Communications

In 2023, SAM-funded projects garnered significant attention with presentations at regional environmental and municipal conferences. This year SAM projects were featured at the Green Stormwater Infrastructure Summit and [MuniCon](#). Project leads also presented at several local American Public Works Association (APWA) stormwater managers' meetings. These conferences and meetings are an important opportunity to disseminate research findings and foster a broader understanding of effective stormwater management.

The SAM program's website serves as a central hub for project information and program administration. Each active study is granted its own project page, ensuring that detailed and up-to-date information is readily accessible. When completed, projects are concisely summarized in the website's accordion sections—find them under Effectiveness Studies, Source Identification, and Status and Trends. The SAM webpages are filled with stormwater resources, including factsheets, comprehensive final reports, educational presentations, and informative videos.

Additionally, the website hosts our regular newsletters and a compilation booklet of studies conducted between 2013-2019. We're working on the second compilation booklet for studies conducted between 2019-2024 and are excited to unveil it in 2024!

Fond Farewell to Brandi

While SAM rounded out 2023 under her leadership, in February 2024 Brandi Lubliner left Ecology to take a role in stormwater and watershed planning at the City of Tacoma. Brandi was SAM's first coordinator and was instrumental in getting the program off the ground. She laid a solid foundation for the program's continued success. We are grateful for her work and are also very glad she didn't go far!



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