Stormwater Action Monitoring

Bioretention Hydrologic Performance Study – Focus on Current Designs

Effectiveness Study

Lead Entity

City of Olympia Public Works – Water Resources

Partners

City of Bellingham

City of Marysville

City of Renton

Monroe School District

Tacoma School District

Tumwater School District

Clear Creek Solutions

Taylor Aquatic Science

Associated Earth Sciences

Aspect Consulting, LLC

Raedeke Associates, Inc.

Collectively improving stormwater management

Stormwater Action Monitoring (SAM) is a collaborative, regional stormwater monitoring program that is funded by more than 90 Western Washington cities and counties, the ports of Seattle and Tacoma, and the Washington State Department of Transportation. SAM's goal is to improve stormwater management to reduce pollution, improve water quality, and reduce flooding. We do this by measuring stormwater impacts on the environment and evaluating the effectiveness of stormwater management actions.

Questions about SAM?
See ecology.wa.gov/SAM

Study goals

This is the second phase of the Bioretention Hydrologic Performance (BHP) Study. Both study phases evaluated the hydrologic effectiveness of bioretention facilities—specifically, how well modeled expectations for stormwater flow control match observed and measured performance at actual installations across Western Washington.

This study phase focused on bioretention facilities that were designed using the current software version of *Western Washington Hydrology Model* (WWHM 2012), which includes the bioretention design model as opposed to other models. For more background, see SAM Fact Sheet #12: Bioretention Hydrologic Performance Study, Phase 1.

Stormwater management problem

Many bioretention facilities are built in the region to control stormwater flows and provide water quality treatment. They are also increasingly installed as retrofits, built to fit into an already developed landscape, to add more stormwater control than previously existed.

Local governments seek evidence that bioretention facilities are efficient and effective in treating stormwater and can help protect receiving waters from erosive flows. A multidisciplinary assessment verifies that facilities function as intended and supports more bioretention infrastructure.

Project findings

All ten bioretention sites were recently constructed (within two years). Conclusions from the first BHP study were reaffirmed in this second phase, and some new findings are specific to the retrofit facilities (five of ten sites) monitored in this phase.

Geotechnical and soil conditions: Bioretention soil texture was again coarser than Ecology's guidance, resulting in greater infiltration rates than designed. Evidence of foot traffic compaction was seen, especially near edges of smaller linear facilities. More infiltration appears to occur near inflow locations, potentially affecting vegetation survival and water quality treatment performance in underdrain facilities.

Site design and hydrology modelling: The WWHM 2012 model built from field measurements of each site adequately represented observations, verifying accuracy of the model's ability to predict performance. However, the design models were often not set up correctly for infiltration rates and safety factors. Top areas (at overflow elevation) for three constructed bioretention facilities (two of which were retrofits) were substantially smaller than indicated in the design report, resulting in less flow control than intended. Low-set overflow elevations in other cases allowed frequent overflows to occur. Field-measured infiltration rates were substantially higher in the field at five facilities, resulting in a greater degree of infiltration than predicted by the model.

Vegetation survival: Plantings reflected the original planting plans, but unfortunately the many water-loving plants were a mismatch with the well-drained soil conditions of bioretention facilities. Shrubs generally survive better than herbaceous plants.

Recommendations

There are still areas for improvement in design, review, and construction stages. Some newer facilities showed inconsistencies in constructed conditions compared to their designs, which affected their performance.

For jurisdictional designers/engineers/landscape architects:

- Maintain a ratio of 5% bioretention top area to drainage area for underdrained facilities.
- Maintain a minimum 6-inch riser height above the bioretention mulch surface.
- Confirm the observed and model infiltration rates, safety factors, and associated parameters in the model using the technical information report and site plan.
- For jurisdictions that encourage infiltration with low native soil rates, consider encouraging a capped underdrain to allow variable drainage after installation.
- Sample bioretention soil mix prior to installation to ensure appropriate particle size distribution and use depths specified in the stormwater manual.
- Select plant species tolerant of a wide range of moisture conditions both vertically and laterally, recognizing greater moisture availability near the inflow, to increase plant survival and reseeding over time.

For jurisdictions and Ecology:

- Develop a checklist for engineers and permit reviewers to verify correct entry of model parameters.
- Consider the use of a variable evapotranspiration rate in the model, rather than the existing default for all conditions.

Why does this study matter?

The BHP studies provide proof of performance from 20 existing facilities and guidance for future installations. The findings show that bioretention facilities work as intended for stormwater runoff flow control, providing stormwater managers with confidence in requiring their use. Trainings reached over 260 individuals, and a recorded training is available on the Washington Stormwater Center YouTube channel.

What will Ecology do with this information?

Ecology will reconsider the evapotranspiration rates in WWHM 2012. At this time, Ecology is not considering allowing flexibility for designer use site by site unless multiple local government reviewers request such flexibility.

Ecology intentionally does not require retrofit facilities to meet the same design criteria as new and redeveloped facilities. Designers should use best professional judgment to maximize improvements in stormwater management with the available space.

Ecology will continue to encourage local reviewers to develop a simplified checklist and will consider guidance for construction phase inspections to ensure that facilities are installed to function as designed.

What should we do with this information?

Stormwater managers should be confident in the use of WWHM 2012 for bioretention installations. Performance expectation and predictable basin-wide stormwater management depend on accurate design, model, and construction of the bioretention facilities. Stormwater managers should discuss these findings with their staff to ensure appropriate designs, review, hydrologic performance, and maintenance.

Local staff conducting reviews are encouraged to develop a simple review checklist to verify future bioretention facilities and evaluate models, technical reports, and plan conditions for consistency. Planting plans should anticipate a wide range of dry and wet conditions and use a variety of plants likely to survive site-specific conditions.

For more information

Visit the SAM website at www.ecology.wa.gov/SAM and search for "bioretention hydrologic performance."