Stormwater Action Monitoring

Project Title

Bioretention Media Blends to Improve Stormwater Treatment: Final Phase of Study to Develop New Specifications

Effectiveness Study

Lead Entity

King County

Partners

Herrera Environmental Consultants

Washington State University

Western Washington University (Institute for Watershed Studies and Environmental Toxicology)

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? Send an email to SAMinfo@ecy.wa.gov

Study goals

This project developed a new bioretention soil media (BSM) specification that achieves the following treatment objectives, in order of priority:

1) Meets basic treatment objectives (80% removal for total suspended solids)
2) Meets enhanced treatment objectives (30% removal for dissolved copper and 60% for zinc)
3) Meets the phosphorus treatment objectives (50% phosphorus removal)
4) Is affordable and available
5) Reduces stormwater toxicity for aquatic organisms

Healthy plant growth was also important so that bioretention installations, which are often placed in urban street settings, are an attractive landscape amenity.

Stormwater management problem

Bioretention is a widely applicable and flexible best management practice (BMP) in the suite of stormwater treatment practices. The current Stormwater Management Manual for Western Washington specification for BSM is a mixture of 60% sand and 40% compost (60:40). Nitrogen, phosphorus, and copper are often exported from the current 60:40 BSM mixture. This can increase concentrations of these pollutants in the BMP outflow, which is a concern for sensitive surface waters.

Project findings

This column-scale study tested eight experimental BSM treatments using stormwater from a regional highway. Influent stormwater was compared to effluent from each BSM blend for total suspended solids (TSS), total and dissolved copper (Cu), lead (Pb), and zinc (Zn), total phosphorus (TP), orthophosphorus (ortho-P), nitrate + nitrite, fecal coliform bacteria, polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH).

Only one experimental blend, an 18-inch layer of sand, coir, and biochar placed on top of a 12-inch polishing layer of sand, activated alumina, and iron aggregate (Treatment 4 in the study), provided adequate pollutant capture to meet the study objectives. This blend provides the basis of the study's final recommendation. The other experimental blends had the following results:

- **Treatment 1:** An 18-inch layer of 60:40 placed on top of a 12-inch drainage layer of pure sand exported TP, ortho-P, nitrate + nitrite, and total and dissolved Cu.
- **Treatment 2:** An 18-inch layer of 60:40 placed on top of a 12-inch polishing layer of sand, activated alumina, and iron aggregate performed better than 60:40 on pure sand due to the polishing layer capturing contaminants flushing from the compost-based media. However, the polishing layer could not fully mitigate the TP, ortho-P, and nitrate + nitrite from the 18 inches of 60:40.
- **Treatments 5 and 6:** Both sand, coir, and biochar placed on top of a pure sand drainage layer met basic treatment (80% TSS reduction) and enhanced treatment (30% reduction of dissolved Cu and 60% dissolved Zn reductions objectives). They did not meet study objectives for ortho-P or TP removal.
- The other four treatments did not achieve study objectives.

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In the toxicological evaluations, most of the treatments prevented the anticipated toxic impacts to *C. dubia* and *D. rerio* to a similar degree in four dosing experiments. However, for yet unknown reasons, the treatments lost some of the preventative benefit during the final dosing event.

Recommendations

An alternative BSM specification is recommended which includes a cost-effective combination of media blends or layers to meet water quality treatment objectives. Combined, the primary and polishing layers meet Ecology's basic, enhanced, and phosphorus treatment objectives. The primary layer alone (sand–coir–biochar) meets basic and enhanced treatment objectives. The polishing layer should be used if reducing phosphorus by 50% is required or desired. The compost mulch overlay ensures robust plant growth. Specifications for the components of the recommended blend layers are provided in the final report.

Table 1: Application of New Bioretention Soil Media (BSM) Layers

	Basic Treatment	Enhanced Treatment	Phosphorus Treatment	Expanded Plant Palette & Growth
Primary layer of 70% sand/20% coir/ 10% high-carbon wood ash (biochar)	X	X		
Primary layer plus polishing layer of 90% sand/7.5% activated alumina/ 2.5% iron aggregate	X	X	X	
Primary plus polishing layer plus compost mulch[1]	X	X	X	X

[1]For surface-draining bioretention facilities, do not use the primary layer alone with compost mulch, without the polishing layer, because the BSM will export phosphorus and nitrogen. For compost specifications, see SWMMWW BMP T7.13 Bioretention which refines the Washington State compost specifications (WAC 173-350-220)

Why does this study matter?

The export of nutrients and copper from bioretention with the current BSM specification is an increasing concern for facilities with underdrains or those in proximity to sensitive receiving waters. A new BSM specification that meets Ecology's basic, enhanced, and phosphorus treatment objectives greatly expands the settings where designers and jurisdictions can confidently apply bioretention systems to manage stormwater runoff. In addition, the study provides treatment information for copper, zinc, nitrate + nitrite, fecal coliform, PAHs, and TPH.



What should we do with this information?

Stormwater managers should share this information with their project engineers and review staff as well as with local designers. The 60:40 BSM is still appropriate for use in most areas when surface discharges from bioretention are not needed. The new BSM specification is intended for projects in areas that are sensitive to phosphorus or nitrogen, or where bioretention facilities with underdrains are likely to be installed.

What will Ecology do with this information?

Given this new information, Ecology will update the Focus Sheet on BSM specifications (Ecology Publication #13-10-017, last revised in May 2016) to include final specifications for this new BSM in addition to the current 60:40 BSM.

Want more information?

Visit the SAM website at ecology.wa.gov/SAM and search for "Bioretention Alternative Blend"

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