The Effects of Mulch on Stormwater Treatment and Maintenance Effort in Bioretention Systems

Stormwater Action Monitoring

Effectiveness Study

Lead Entities

Partners

Highlights:

- Mulches preserve bioretention soil moisture to aid plant survival in the summer. Arborist chips and nugget mulches help retain the most water.
- Mulches cut weeding time by half and limit nitrogen export from soil.

Stormwater issues related to the study

Weeding, summer watering, and replacement of plants in bioretention systems can be costly. By design, stormwater that flows into bioretention facilities will contact a mulch layer first, before other biological components. Stormwater managers want to understand the role that mulch plays in reducing operation and maintenance (O&M) costs and limiting pollutant export, and how benefits differ among common mulch choices.

Study Objectives

The study used 16 experimental bioretention cells located at Washington State University's Puyallup Extension campus. The cells were refurbished and four replicates each were topped with: three different types of mulch (arborist chips, medium bark mulch, and nugget mulch, see Figure 1) and no-mulch, for study control. The study objectives were to quantify, by mulch presence and type:

- difference in the necessary weeding time and effort;
- water retention in the bioretention cells;
- soil moisture content in the bioretention cells; and
- pollutant reduction across the mulch types.

Project findings

All three mulches suppressed weed growth significantly over controls, and no single mulch type was significantly better over the two years of this study.

All bioretention cells reduced by half the water outflow *rates*. The cells topped with nugget mulch had significantly lower outflow *volumes* than the other mulches and no-mulch controls.



Figure 1: Three types of mulch were tested in bioretention systems

All three mulches preserved more soil moisture than the no-mulch controls. The cells with arborist chips maintained the highest soil moisture readings during the study, experiencing dry conditions (defined for this study as having soil moisture less than 25% water content by volume) only 22% of the study period, while no-mulch control cells

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 by measuring stormwater impacts on the environment and evaluating the effectiveness of stormwater management actions.

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experienced dry conditions nearly 83% of the time. Bioretention cells with medium bark and nugget mulch experienced dry conditions 38% and 33% of the time, respectively.

The arborist chips - but not the other mulches - were depleted, presumably due to soil microbe consumption, and were replenished during the study.

While all of the bioretention cells exported nitrogen and phosphorus, the nitrogen concentrations in bioretention effluent were significantly lower in the presence of mulch compared to the no-mulch controls.

While not an intentional component of the study design, sun exposure and shade had a significant impact in plant stress and survival. The plants in the cells that were partially shaded by a nearby building were more robust than the plants in full sun.



Figure 2: Mulch plays a critical role in maintaining soil moisture, and limiting weeds

Recommendations

Add and maintain mulch at the recommended depth of 2 to 3 inches to help retain water and suppress weeds. The nugget mulch and medium bark mulch lasted for the duration of the study, and may need to be replenished after 2 or 3 years. Arborist chips needed annual replenishment in this study, increasing costs.

Use the plant “ninebark” sparingly in Washington bioretention cells and rain gardens because it spreads rapidly by putting out runners under the mulch, likely requiring added maintenance to prevent it from taking over the bioretention facility.

Why does this study matter?

This study quantifies the benefits provided by a 2-3 inch layer of mulch in a bioretention facility for weed suppression, water retention, plant survival, and pollutant reduction.

What should stormwater managers do with this information?

Add and maintain a mulch layer to help retain water and reduce plant loss in bioretention cells, particularly in full sun, and to limit the establishment of weeds. Stormwater maintenance programs utilizing mulches may see reduced O&M costs overall due to reducing watering needs in the summer, improved plant survival, and reduced weeding or the need for herbicides. Bioretention designers, landscape designers, horticulturists and others should limit use of water loving and easily spreading plants such as ‘ninebark’ to minimize maintenance needs in bioretention facilities and rain gardens.

What will Ecology do with this information?

Ecology will update the guidance for bioretention facility best management practices (BMPs) in the stormwater management manuals to recommend covering bioretention soil mix with a mulch covering. Ecology continues to support bioretention BMP projects and to prioritize these approaches and other low impact development (LID) or ‘green infrastructure’ treatment options for stormwater runoff management.

For more information see the completed project at ecology.wa.gov/SAM Effectiveness Studies or contact Dr. Jayakaran anand.jayakaran@wsu.edu, the lead of this study.

This was written by the SAM program for the Department of Ecology. It was originally hosted on EZview and was transferred to Biblio for records purposes as a publication in 2026.

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