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DEPARTMENT OF TRANSPORTATION

OFFICE OF RESEARCH & INNOVATION

TECHNICAL SUMMARY

Stormwater Bioslope Site Monitoring Continues Using Local Filter Media

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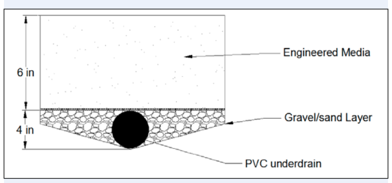
PROJECT COST:
$33,250



This drawing shows the design of one set of test filtration sites. Filtration samples were obtained from the underdrain pipes.

Researchers continued monitoring the performance of a large stormwater control bioslope installation and a set of test plots for two years. The test plots were constructed with local recycled media instead of traditional filter materials. The salvaged peat and compost are effective and economical, and prevent unnecessary waste.

What Was the Need?

To meet state regulations that prevent excess rain and road contaminants from entering the watershed, MnDOT and other agencies construct various kinds of stormwater management devices, including low-impact development installations such as bioslopes and bioswales (shallow ditches at the bottom of bioslopes) that mimic the natural landscape.

Engineered bioslopes and bioswales are built along some roadways during highway construction. They contain amended filter materials—typically mixtures of compost and sand—that enhance the slope's capacity to contain and filter rainwater, as well as support plant growth. In a previous project, MnDOT investigated the use of local filter media in bioslopes in northeastern Minnesota to replace traditional compost and washed sand normally hauled in for these installations. The study examined the use of compost, peat and muck excavated locally from highway projects as filter media. Taconite tailings, a local mining byproduct that could replace sand, were also studied.

The project's results were promising. With some adjustments, Phase II of the project monitored one bioslope and a set of test plots for capture of water, pH levels, and retention/release of phosphorus and metals (copper, lead and zinc) for an additional two years.

MnDOT wanted to learn how well the installations have continued to capture and filter contaminants, as well as estimate when they would need to be refreshed or replaced. This project continued the lab and field investigations of the bioslope sites in northeastern Minnesota for two more years (2019–2020).

What Was Our Goal?

The goal of this project was to continue monitoring the biofiltration of the test plots at the Natural Resources Research Institute (NRRI) and the biofilter installed along 5.7 miles of Highway 169 at Eagles Nest, which were subjects of the previous projects. A further objective was to determine the effects of aging on alternative filter media and estimate effective life span.

What Did We Do?

To capture runoff, researchers monitored seven outflow pipes at the NRRI site plots and two outflow pipes at the Eagles Nest site. The outflow pipes were connected to drain tiles that had been installed under the modified soil media when the sites were constructed. As a result, the researchers did not have to add any new construction to continue with the monitoring. Six suction lysimeters were used to collect water samples from the Eagles Nest bioslope. These devices sample water from the soil through movement via vacuum. The six were installed after spring snow and removed after the first fall snow in 2019. Stainless steel pan lysimeters replaced the suction lysimeters in 2020 after they were all damaged by grass mowing and animal activities in late 2019. Other damage to equipment occurred throughout the project period; however, devices were replaced as necessary and researchers continued collecting data.

continued

"The reuse of local sourced filtration media generated within project limits that would otherwise be discarded as waste as an alternative to shipped-in new materials in engineered bioslope installations has been a success—functionally, sustainably and economically."

—Dwayne Stenlund,
Erosion Control Specialist, MnDOT Office of Environmental Stewardship

"This project's extended monitoring provides more data for stormwater application design and management using salvage materials. It will support and promote smarter and more economical material reuse strategies."

—Meijun Cai,
Environmental Engineer, University of Minnesota Natural Resources Research Institute

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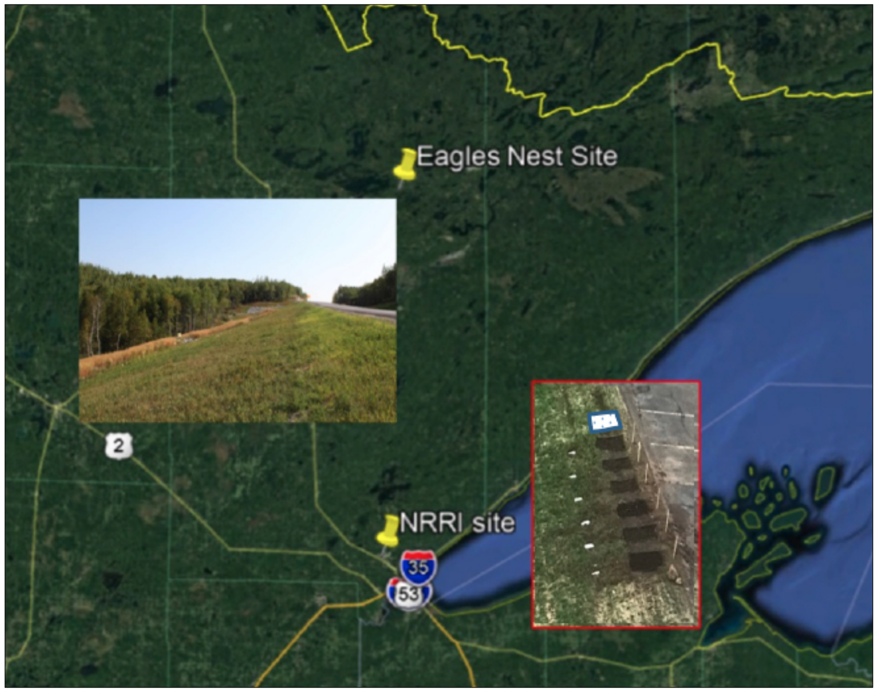

The location of the project's two sites: a 5.7-mile installation along Highway 169 at Eagles Nest and a set of test plots installed at NRRI.

After rain events, researchers collected water samples from the field and then filtered them through a membrane. Filtered samples for metals analysis were acidified to a pH of less than 2 and stored at room temperature. Samples for phosphorus were preserved in a 4 degree Centigrade cooling room immediately after filtration.

Concentrations of metals (copper, lead and zinc) in water samples were measured by graphite atomic absorption spectrometry; phosphorus was measured by the colorimetric method. The detection sensitivity limit for metals and phosphorus was measured in parts per billion (1 microgram per liter).

What Was The Result?

Results indicated that there were definite changes in biofilter leachate over time. Phosphorus drainage concentrations from compost and peat soils decreased over time from both sites due to plant uptake and depletion of phosphorus from the filter materials. The mixture of compost and taconite tailings also released less phosphorus than the mixture of compost and natural soil. The compost released more copper over the last two years than previously, while zinc levels remained stable.

The lowest phosphorus concentrations were achieved when the soil mixture contained 10% compost and 10% salvaged peat, indicating that the best stormwater control practice may be to limit the organic filter media ratio to 20% of the total bioslope-engineered filter media. Overall, the performance of the bioslopes containing peat and compost indicated that this use of recovered filter media in this type of stormwater control installation is valid and can aid in future design.

What's Next?

Researchers recommended continued monitoring of both the NRRI test plots and the Eagles Nest bioslope installation to determine if performance changes over time. Further, they noted that examination of the soil materials after five years will aid in determining the effective life span of the installation.

This Technical Summary pertains to Report 2021-15, "Continued Monitoring of Stormwater Effluents From Filter Media in Two Bioslope Sites," published June 2021. The full report can be accessed at mndot.gov/research/reports/2021/202115.pdf.