



Page Content

- 1 Overview of typical O&M issues
- 2 Design phase O&M considerations
- 3 Construction phase O&M considerations
- 4 Post-construction phase O&M
- 5 Maintenance costs
- 6 Useful resources
 - 6.1 Additional detailed O&M information
 - 6.2 Case studies
 - 6.3 Maintenance training documents and videos
 - 6.4 O&M resource catalog
- 7 References

Operation and maintenance (O&M) of filter strips

Green Infrastructure: Filter strips, when vegetated, provide water quality benefits, may provide some stormwater volume reduction, and may provide typical benefits of vegetation, such as habitat, depending on the vegetation type.



This page provides guidance for operation and maintenance (O&M) of filter strips. **Filter strips** (https://stormwater.pca.state.mn.us/index.php?title=Overview_for_pretreatment_vegetated_filter_strips) are designed to filter **suspended solids** ([https://stormwater.pca.state.mn.us/index.php?title=Total_Suspended_Solids_\(TSS\)_in_stormwater](https://stormwater.pca.state.mn.us/index.php?title=Total_Suspended_Solids_(TSS)_in_stormwater)) from runoff as water passes over the filter strip. Most filter strips are vegetated, with grass and **perennial native vegetation** most widely used.

Supplemental information can be found on the page called Operation and maintenance of filter strips - supplemental information. Supplemental information includes the following.

- Removing sediment and debris buildup
- Preventing or minimizing **washout** and erosion of the **pretreatment** (<https://stormwater.pca.state.mn.us/index.php?title=Pretreatment>) vegetated filter strip
- Vegetation establishment
- Maintaining vegetation



Image of a vegetated filter strip

- Snow storage
- Maintenance agreements
- Additional references

Contents

- 1 Overview of typical O&M issues
- 2 Design phase O&M considerations
- 3 Construction phase O&M considerations
- 4 Post-construction phase O&M
- 5 Maintenance costs
- 6 Useful resources
 - 6.1 Additional detailed O&M information
 - 6.2 Case studies
 - 6.3 Maintenance training documents and videos
 - 6.4 O&M resource catalog
- 7 References

Overview of typical O&M issues

Vegetated filter strip (https://stormwater.pca.state.mn.us/index.php?title=Overview_for_pretreatment_vegetated_filter_strips), also known as buffer strips or buffers, are vegetated land areas between a pollutant source and a surface water body (also called a **receiving water**). They can be stand-alone practices or used as **pretreatment** (<https://stormwater.pca.state.mn.us/index.php?title=Pretreatment>) to other practices like **bioretention practices** or **wet ponds** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_ponds). They reduce the flow velocity of water and filter and **infiltrate** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_infiltration_Best_Management_Practices) pollutants such as sediment from stormwater. Vegetated filter strips may be subject to high public visibility, trash loads, **sedimentation** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_sedimentation_Best_Management_Practices), pedestrian traffic, and even vehicular traffic or loads. Vegetated filter strips can provide **ecosystem services** such as **nutrient cycling** and storage, carbon **sequestration**, **climate adaptation**, and habitat for bees, butterflies, and other insects and small animals that pollinate.

Vegetated filter strips require dedicated and regular maintenance to ensure proper and long-lasting operation, and in most cases a vegetated filter strip should be designed to be effective for at least 10 years (NRCS (<https://efotg.sc.egov.usda.gov/references/public/MN/393mn.pdf>), 2010). The most frequently cited O&M concerns for vegetated filter strips include

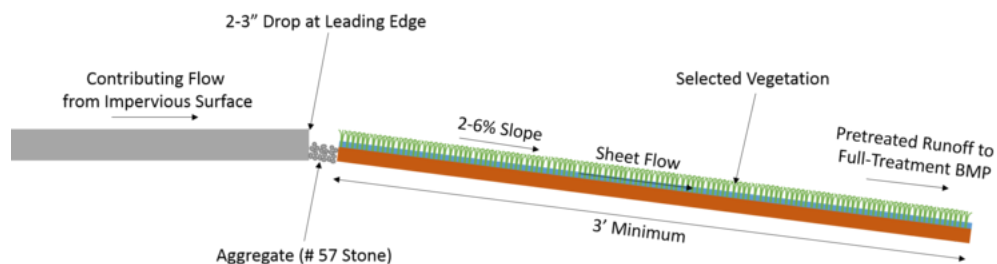
- flow channelization and erosion,
- insufficient/inadequate vegetative cover, and
- sediment and debris accumulation leading to practice clogging.

The sections below describe best practices to prevent or minimize these common problems.

Design phase O&M considerations

Designers should design these practices in ways that prevent or minimize O&M issues. Examples include the following.

- Using a maximum **contributing drainage area** (https://stormwater.pca.state.mn.us/index.php?title=Contributing_drainage_area_to_stormwater_BMPs) to filter strip area ratio of 6:1
- Limiting the lateral slope from contributing impervious surfaces to less than or equal to 1%
- Checking that the maximum groundwater level is 2 to 4 ft below the filter strip
- Providing a vegetation design plan, emphasizing erosion resistant and native plantings (see Plants for Stormwater Design (<https://www.pca.state.mn.us/water/plants-stormwater-design>)) to enhance pollinator and wildlife habitat, improve **infiltration** (https://stormwater.pca.state.mn.us/index.php?title=Stormwater_infiltration_Best_Management_Practices) and **evapotranspiration**, reduce urban **heat island** effect, provide optimized **carbon sequestration**, and provide **climate adaptation**. Site-specific plant selections should take into account sun exposure, shade, proximity to traffic corners (visibility issues), interior vs exterior plantings, salt-tolerant plants, etc. The selection of plantings suitable to their immediate surroundings will minimize long-term care and replacement frequency.
- Designing the filter strip length based on the **hydrologic soil group** (https://stormwater.pca.state.mn.us/index.php?title=Design_infiltration_rates), slope, and vegetation (PADEP (<http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4673>), 2006).
- Providing pretreatment (<https://stormwater.pca.state.mn.us/index.php?title=Pretreatment>) (e.g. gravel trench spreader) if necessary. Pretreatment can be used to dampen the effects of high or rapid inflow, dissipate energy, provide additional storage, and prevent the BMP from becoming overloaded by sediment. Pretreatment is a required part of infiltration and filtration practices covered under the Minnesota Construction Stormwater General Permit. Vegetated filter strips are often used as a pretreatment practice (https://stormwater.pca.state.mn.us/index.php/Overview_for_pretreatment_vegetated_filter_strips) to meet the intent of the stormwater permit, as identified in sections 16 and 17 (https://stormwater.pca.state.mn.us/index.php?title=2018_Minnesota_Construction_Stormwater_Permit), but are designed with a different set of standards when they are a standalone structural practice.
- Installing **berms** where necessary to direct the flow and prevent **bypassing**.
- Prohibiting any kind of traffic through the installation of a visible barrier or signage.
- Providing educational signage to increase public awareness.



Schematic illustrating design features for a pretreatment vegetated filter strip.

Designers should consult and include any local requirements regarding **green infrastructure**. O&M considerations often depend on whether the practice is located on public land, private land, or in the public right of way. For example, plantings in the public right of way that conflict with any traffic safety considerations could require increased O&M, such as pruning or complete removal.

Designers should also recognize the need to perform frequent maintenance to remove trash or excess sediment, check for clogging, and if necessary perform practice cleaning. Designers can incorporate design solutions to facilitate maintenance activities. Examples include

- incorporating multiple and easy site access points, and
- providing recommendations of vegetation appropriate to the location.

The designer should also provide a site-specific O&M plan that includes the following.

- Construction inspection schedule and checklists
- Post-construction routine maintenance schedule and checklists
- Operating instructions for the practice (if applicable)

For more design information on vegetated filter strips, link here (https://stormwater.pca.state.mn.us/index.php?title=Design,_construction,_operation_and_maintenance_specifications_for_pretreatment_vegetated_filter_strips).

Construction phase O&M considerations

Proper construction methods and sequencing play a significant role in reducing O&M problems. Some key items during the construction phase include the following.

- **Before construction begins**
 - Check the grading where the practice will be placed to enable **sheet flow** from the **level spreader** and throughout the filter strip. Grading must be uniformly perpendicular to the direction of flow to prevent **channelized flow**.
 - Protect the proposed filter strip from the surrounding area by using upstream **sediment traps** (https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices_-_Sediment_traps_and_basins) or barriers and diversions to direct stormwater flows from the contributing drainage area away from the practice.
 - Install any needed **erosion** (https://stormwater.pca.state.mn.us/index.php?title=Erosion_prevention_practices) and **sediment controls** (https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices) in your construction site and prepare a storm water pollution prevention plan (SWPPP) (https://stormwater.pca.state.mn.us/index.php?title=SWPPP_Template_for_Small_Construction_Sites).
 - Designate a stormwater supervisor to make sure someone is responsible for erosion and sediment control.
 - Hold a pre-construction meeting with the designer and the installer to review the construction plans and the sequencing of construction.
- **During construction**
 - Construct any pretreatment devices first.
 - Implement soil stabilization measures until permanent vegetation is established.
 - Use as much of the existing topsoil on the site as possible to enhance plant growth.
 - Prevent **soil compaction** by marking boundaries of the practice to ensure no construction traffic occurs on the practice. Foot traffic should be minimized if possible.
 - Ensure that the plant and vegetation mix conforms to the vegetation design plan.
 - Inspect the practice during construction to ensure that the vegetated filter strip practice is built in accordance with the approved design and standards and specifications.
- **After construction**
 - Verify that the vegetated filter strip practice was built in accordance with the approved design and standards and specifications.
 - Verify that the filter strip area is fully stabilized with vegetation prior to removing any barriers, diversions, or erosion and sediment control measures.
 - Verify that the practice directs flow as intended over the entirety of the practice. This serves as a verification that the practice is functional at the time of construction.
 - Use a detailed inspection checklists that include sign-offs by qualified individuals at the completion of construction, to ensure that the contractor's interpretation of the plan is acceptable to the professional designer. An example construction phase inspection checklist is provided below ([https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_\(O%26M\)_of_filter_strips#Useful_resources](https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_(O%26M)_of_filter_strips#Useful_resources)).
 - Review and discuss the plant warranty/establishment period with the plant provider to understand the conditions under which failing plants will be replaced.
 - Determine if stormwater should be kept **offline** from the practice until the seedlings are established.
 - The design/construction team should provide the O&M team with the following information to be included in the O&M plan.
 - The plant warranty.
 - The **as-built** plans of the practice
 - A list of conditions that might cause failure of the practice if not properly maintained.

Post-construction phase O&M

Effective short and long-term operation of vegetated filter strips requires a dedicated and routine maintenance plan with clear guidelines, expectations, and schedules. Proper maintenance will not only increase the expected lifespan of the facility but will improve aesthetics and property value. A maintenance plan clarifying maintenance responsibilities should be required for all practices.

Some important post-construction considerations are provided below along with recommended maintenance standards.

- A site-specific **Operations and Maintenance Plan** should be prepared by the designer prior to putting the practice into operation. This plan should provide any operating procedures related to the practices. The plan should also provide clear maintenance expectations, activities, and schedules. Include photos if possible. Be clear about who is responsible for the maintenance and the type of expertise that will be needed for distinct O&M activities. The O&M plan should include an anticipated budget for O&M activities. The O&M plan should also include an example O&M inspection checklist and an example maintenance report. Example O&M plans and checklists are provided in the Useful Resources section ([https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_\(O%26M\)_of_filter_strips#Useful_resources](https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_(O%26M)_of_filter_strips#Useful_resources)).
- A legally binding and enforceable maintenance agreement should be executed between the practice owner and the local review authority that provides adequate access for the inspection, maintenance, and necessary equipment. Example maintenance agreements are provided in the Useful Resources section ([https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_\(O%26M\)_of_filter_strips#Useful_resources](https://stormwater.pca.state.mn.us/index.php?title=Operation_and_maintenance_(O%26M)_of_filter_strips#Useful_resources)).
- Inspection and maintenance activities are distinct and can be done as separate activities or together. Inspection will typically assess the practice for any O&M issues, whereas maintenance will address the O&M issues identified by the inspection. A dedicated inspection effort on a large number of BMPs can help prioritize maintenance activities.
- While maintenance is being conducted, ensure that no heavy vehicle traffic occurs on the vegetated filter strip and foot traffic is limited to avoid compaction.
- Minimize use of any fertilizer.
- Avoid mowing when the ground is wet. Doing so can create rutting from the wheels.
- Vegetated filter strips should not be used for permanent snow storage because this will extend the duration of ineffective treatment caused by increased snowpack. Other snow and salting considerations can be found on the Vegetated filter strip detailed maintenance activity description page.

Overview and schedule of general maintenance activities for vegetated filter strips

Link to this table

Activity	First Year of Operation			O&M benefit ^a
	Frequency	Time period	Level of effort	
Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health.	At least twice after storm events 0.5 inches	Within the first 6 months	1-2 hours	1,5
Check for evidence of clogging or failing of the inlet, outlet, and bypass pipes.	At least twice after storm events 0.5 inches	Within the first 6 months	<1 hour	1
Remove any stormwater diversion or barriers once seedlings are established.	Once	When plants are sufficiently established	1-2 hours	1,2,3,4,5
Supplemental watering during drier periods,	1/week	During first 2 months	1-2 hours	2,3,4,5,6

particularly if keeping stormwater offline until plant seedlings are established.	initially As needed	First growing season	1-2 hours	2,3,4,5,6
Mow grass in surrounding area to 3-4 inches	As needed	During growing season	1 hour	1,2,3,4,5,6
Removal of sediment and debris from the toe of slope or level spreader.	Biannually	In spring and fall	1-2 hours	1,5
Reseed bare spots as needed.	As needed	First growing season	2-4 hours	1,2,3,4,5,6

After First Year of Operation

Activity	Frequency	Time Period	Level of Effort per Visit	O&M Benefit ^a
Inspect the level spreader for sediment buildup and the vegetation for signs of erosion, bare spots, and overall health.	Annually and after storm events larger than the 10-year return period	After winter and after storm events larger than the 10-year return period	1-2 hours	1,5
Mow the grass or vegetation only if needed. Avoid mowing when the ground is wet.	As needed	During growing season	1-2 hours	1,2,3,4,5,6
Inspect for and remove excess sediment in the pre-treatment device and/or in the main treatment area.	Monthly	All year long	4 hours if removal is needed	1
Remove sediment and debris from the toe of slope or level spreader.	Biannually	In spring and fall	1-2 hours	1,5
Remove trash and debris from the pre-treatment device and/or in the main treatment area.	Monthly during rainy season	All year long. Cleaning may need to be done more frequently during the summer storm season and less during the drier winter season	1-2 hours	1,5
Mow grass in surrounding area to 3-4 inches	As needed	During growing season	1 hour	1,2,3,4,5,6
Weed and remove invasive plants	Twice during growing season	During growing season	1-2 hours	2,3,4,5
Inspect plant composition and health and replace as needed	Annually	In fall or spring	4 hours if plant replacement is needed	2,3,4,5,6
Reseed bare spots as needed.	Biannually	In spring and fall	1-2 hours	1,2,3,4,5,6
Supplemental watering during drier periods, particularly if keeping stormwater offline until plant seedlings are established.	As needed during extended dry periods	Dry periods	1-2 hours	2,3,4,5,6
Spring cleanup (cut back and remove last year's material)	Annually	In spring	2-4 hours	2,3,4,5
Fall cleanup (removed excessive leaf litter, particularly in areas with lots of trees)	Annually	In fall	2-4 hours	2,3,4,5

After 5+ Years of Operation (non-routine maintenance)

Activity	Frequency	Time Period	Level of Effort per Visit	O&M Benefit ^a
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After long term operation of the practice, some occasional and infrequent maintenance activities might be required, such as bigger repairs, soil regeneration, regrading, or redesign of key elements of the practice. As needed As needed Could be significant depending on the activity 1,2,3,4,5,6

Key to Maintenance Benefits:

1. Proper stormwater flow and infiltration
2. Creation and maintenance of wildlife habitat
3. Creation and maintenance of pollinator habitat
4. Nutrient cycling and storage
5. Aesthetics and public enjoyment
6. Carbon sequestration

Common problems and how to troubleshoot them for vegetated filter strips

Link to this table

Consult with a landscaper or horticulturist. Check that plants are suited to the local conditions. Replace soils and plants

Symptom	Possible Causes	Solution
Channelization of flow	Improper grading	Install infiltration trench or level gravel spreader trench upstream of practice
Erosion	Improper (too steep) grading and/or plant loss	Correct for drainage and flow path issues to make sure flows are evenly distributed. Make sure the flow paths are unobstructed
Vegetation is not able to establish	Plant selection is inappropriate for the site	Consult with a landscaper or horticulturist. Check that plants are suited to the local conditions. Make sure BMP is protected from snow storage or salt application.

Maintenance costs

Maintenance costs will vary on a number of factors, including but not limited to the following.

- Size of the practice and its **contributing drainage area** (https://stormwater.pca.state.mn.us/index.php?title=Contributing_drainage_area_to_stormwater_BMPs)
- Type of plantings used
- Site visit frequency
- Level of maintenance needed
- Local weather conditions
- Staffing needs (number of staff, external vs. internal staff, etc)
- Travel time between sites
- Efficiencies of scale (single GI vs. a cluster of GI)
- Equipment needed

Preventative maintenance is key to minimizing major costs associated with repairs. The annual cost of maintaining filter strips (mowing, weeding, inspection, litter removal, etc.) is generally between \$100 and \$1,400 per acre (based on 2006 cost estimate, PADEP 2006 (<http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4673>)). Maintenance may be higher the first few years, while plants are being established.

Useful resources

Additional detailed O&M information

Supplemental information can be found on the page called Operation and maintenance of filter strips - supplemental information. Supplemental information includes the following.

- Removing sediment and debris buildup
- Preventing or minimizing **washout** and erosion of the **pretreatment** (<https://stormwater.pca.state.mn.us/index.php?title=Pretreatment>) vegetated filter strip
- Vegetation establishment
- Maintaining vegetation
- Snow storage
- Maintenance agreements
- Additional references

Case studies

- Case studies for pretreatment (https://stormwater.pca.state.mn.us/index.php?title=Case_studies_for_pretreatment)

Maintenance training documents and videos

- Chesapeake Stormwater Network: Filter Strips and Grass Channels Webcast Slides (<https://chesapeakestormwater.net/events/webcast-visual-indicators-filter-strips-grass-channels/#resources>)
- UMass Amherst: Vegetative Filter Strips May Deter Pesticide Runoff (<https://www.youtube.com/watch?v=Sw-Aj7ADfWw>) - YouTube video

O&M resource catalog

MPCA has compiled publicly available O&M resources (https://stormwater.pca.state.mn.us/index.php?title=Green_infrastructure_operation_and_maintenance_catalog_wiki_table) (Excel format (https://stormwater.pca.state.mn.us/index.php?title=File:Green_Infrastructure_Operation_and_Maintenance_Resource_Catalogue.xlsx)) related to green infrastructure. This non-exhaustive catalog is intended as a resource to practitioners.

Example O&M plans, checklists, reports, and maintenance agreements for vegetated filter strips

Link to this table

Document	Link
Operation & Maintenance Plan	Clean Water Services, Oregon (https://www.cleanwaterservices.org/media/2184/vegetated-filter-strip.pdf)
Construction phase inspection checklist	Fairfax County, VA (https://www.fairfaxcounty.gov/landdevelopment/sites/landdevelopment/files/default/files/deq-spec-2-sheet-flow-final.pdf)
O&M inspection checklist	Virginia DEQ BMP Clearinghouse (https://www.mwaa.com/sites/default/files/vdeq_bmp_clearinghouse_construction_inspection_certification_form.docx)
	MPCA Checklist (https://stormwater.pca.state.mn.us/index.php/Vegetative_filter_system_-_operation_and_maintenance_checklist)
	University of Kentucky (https://www.uky.edu/cpmd/download/file/fid/731)

City of Richmond, VA (http://www.richmondgov.com/PublicUtilities/documents/BMPQuantity_Vegetated_Filter_Strips_Inspection_Checklist.pdf)

City of Roseville, CA (https://www.roseville.ca.us/UserFiles/Servers/Server_7964838/File/Government/Departments/Development%20Services/Engineering/Applications%20Forms%20and%20Handouts/SW%20Quality%20Maintenance%20Program/Vegetated%20Filter%20Strip%20Maintenance%20Check%20List.pdf)

City of Durham, NC (<https://durhamnc.gov/DocumentCenter/View/2235/Level-Spreader---Vegetative-Filter-Strip-Checklist-Non-Fillable-PDF>)

O&M
example
report

Milwaukee Metropolitan Sewerage District (MMSD) (https://www.mmsd.com/download_file/view/1016/602)

Metropolitan St. Louis Sewer District (MSD) (<https://portal.laserfiche.com/Portal/DocView.aspx?id=3361965&repo=r-a96260ce>)

Example Maintenance Agreement 1 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_1)

Maintenance Agreements Example Maintenance Agreement 2 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_2)

Example Maintenance Agreement 3 (https://stormwater.pca.state.mn.us/index.php?title=Example_Maintenance_Agreement_3)

References

- PADEP. 2006. Pennsylvania Stormwater Best Management Practices Manual (<http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4673>). Volume 34.
- NRCS, 2010. Conservation Practice Standard (<https://efotg.sc.egov.usda.gov/references/public/MN/393mn.pdf>).

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