Designing for SCM Maintenance

A guidance document for including maintenance in the planning and design of post-construction stormwater control measures.

Tennessee Stormwater Association
January 2023

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1 Background and Purpose

The mission of the Tennessee Stormwater Association (TNSA) is to assist members with their local efforts to comply with State and Federal clean water laws; including stormwater regulations promulgated by the Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC). TNSA's goal is to protect and improve the quality of the waters of Tennessee through the exchange of information and knowledge regarding design, construction, maintenance, administration and operation of stormwater facilities.

TNSA membership is composed of designated Municipal Separate Storm Sewer Systems (MS4s) including local governments (city and county), universities, military installations, and other entities such as the Tennessee Department of Transportation (TDOT). Associate members include environmental advocacy groups, non-profits, the academic community, as well as substate or federal government entities. Private sector membership is available to for-profit engineering, environmental, scientific and management firms or other organizations with an interest in stormwater.

The TNSA Stormwater Control Measure (SCM) Committee's mission is, in part, to provide standardized SCM guidance to membership. The SCM Committee is comprised of stormwater management professionals working in both the public and private sector across Tennessee who are vested in seeing local water quality protected to the maximum extent practicable.

The 2022 TDEC National Pollutant Discharge and Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System (MS4) Permit, herein "Permit", contains new SCM utilization, verification, and maintenance requirements. The Permit is also expected to be the baseline for establishing the future NPDES Phase I MS4 requirements.

This guidance document is intended to assist stormwater design professionals with SCM design and TNSA member permittees who are developing or enhancing program elements for SCMs.[1] It does not replace state or local stormwater management rules. However, designing for maintenance is necessary for proper SCM performance. The SCM Committee strongly recommends incorporating SCM maintenance needs early in the design stage to better enable these practices in helping Tennessee communities meet state and local water quality goals.

2 Introduction

Post-construction stormwater control measures (SCMs) are key infrastructure assets within our communities. It is critical we acknowledge every SCM requires maintenance. When properly maintained, these facilities can be high value amenities for the public and the property owner. On the other hand, SCMs can negatively impact local resources and become aesthetic eyesores when maintenance is deferred or not completed.

[1] Disclaimer: This document was prepared by members of the Tennessee Stormwater Association and intended as a guidance and educational tool. The SCM Committee does not establish policy. Please refer to local MS4 programs for specific SCM design and maintenance requirements.

Post-construction SCM maintenance programs must ensure inspection and maintenance activities are performed (Honningford & Benty, 2013). Designing with that first step in mind will create maintenance ready SCMs that function as intended and are more resilient to the impacts of climate change.

Design professionals should consider 3 primary SCM maintenance intervals when planning for SCM maintenance:

- Routine - General upkeep of the practice that occurs regularly or on a defined schedule such as managing vegetation or removing trash and debris.
- Proactive - Occurs less frequently but assists in preventing more costly tasks like repairing bank erosion.
- Restorative - Tasks that return a SCM's functionality, such as repairing an outlet structure (Hunt, Waickowski, & Lord, 2021).

Table 1. Examples of routine, proactive, and restorative maintenance activities (Hunt, Waickowski, & Lord, 2021)

MAINTENANCE	DESCRIPTION
ROUTINE	• Inspections • Trash removal • Sediment removal • Pruning of woody vegetation • Thinning of vegetation • Side slope stabilization • Mowing • Mulching • Testing pavement surface infiltration rate
PROACTIVE	• Controlling weeds and other undesired plants • Cleaning/scraping filter media • Soil testing • Soil aeration • Vegetation replacement • Fertilization • Irrigation • Hose and pipe connections inspected for leaks • Disinfection
RESTORATIVE	• Media/soil replacement • Inlet/outlet structure repair • Conveyance system repair • Disease control for vegetation • Denuding overgrown practices by unwanted species • Embankment, dam, and channel repair due to erosion or rodents • Wound dressing for vegetation • Vacuum sweeping of permeable pavement

In Tennessee, NPDES permitted MS4 programs must follow specific rules regarding SCM inspection and maintenance. All SCMs require maintenance and permitted MS4s are required to ensure inspection and maintenance activities are performed. It is the role of MS4s to ensure all new SCMs with their associated inspection and maintenance requirements comply with the permit, which is initially completed through the plan review process and then subsequently through post-construction documentation.

If a local MS4's SCM development guide or design manual does not include individual SCM maintenance information, the Tennessee Permanent Stormwater and Design Guidance Manual can be used as a reference (Tennessee Department of Environment and Conservation, 2014). Other state and local programs may also be referenced.

3 Conceptual Design Guidance

The SCM Committee recommends the engineering and design community improve design standards by planning for maintenance activities early in the conceptual design phase as this is critical to ensuring the long-term functionality of the selected practice. The following guidance recommendations are applicable to both MS4 programs and design professionals. This is not intended to be an exhaustive list, but rather a starting point for good designs.

3.1 Plan Submittal

MS4s should establish policies regarding plan submittal, plan review, and post construction SCM inspection, and maintenance processes. These policies should reference specific state and/or local code requirements, be publicly available and accessible, and, ideally, be developed with affected stakeholder input. The engineering community should reference these policies when designing projects and submitting plans for review and approval.

Recommendation for MS4 Programs

1. Require a pre-submittal design consultation meeting between the stormwater program plan reviewer, designer, and property owner to establish maintenance priorities and communicate post-construction responsibilities based upon the concept drawings.

3.2 Site Placement

Site placement of an SCM on a particular property is an important consideration when planning for anticipated maintenance activities.

A single, centralized SCM allows all maintenance activity to take place in one location, which lessens maintenance crew mobilization. However, if these systems are located in the rear of the property, such as behind a building, or underground, there is a greater chance the SCM can be neglected because it is not highly visible.

Decentralized SCMs distributed across a site often utilize smaller footprints and can be integrated into the landscape. These systems can require more frequent inspection and maintenance due to their smaller treatment surface areas and higher visibility.

Evaluating SCM placement should also account for maintenance activities associated with a pretreatment component, such as a forebay, that captures solids and trash/floatables. Pretreatment components must be cleaned out periodically.

Recommendations for Designers

1. Determine whether the owner desires high visible SCMs that can be a landscaping amenity.
2. Locate SCMs where future maintenance activity will be feasible and safely completed.

3.3 Maintenance Needs

Each type of SCM requires its own maintenance plan with its own maintenance needs and access. A centralized SCM, like a detention pond, may have a fence for safety purposes with access provided to maintenance personnel via gate, key, or touchpad. For sites with SCMs distributed throughout the project, such as bioretention, the need for routine maintenance must be communicated to the site owner and access for landscape teams evaluated when siting the facility or designing the landscaping plan.

For SCMs reliant on infiltration to reduce pollutants, avoid placing them in areas where in-situ soils are poor (as determined by infiltration testing) or subject to frequent and/or recurring inundation, such as a floodplain.

Maintenance of proprietary SCMs should follow guidance provided by the manufacturer. Underground SCMs should have manholes, trench covers, or hatches for easy access to internal system components, such as bulk trash cages or biofiltration media. If the SCM needs to be maintained by a vacuum truck, a support area, e.g. space for truck parking, should be located within maximum boom length distance for the most efficient clean out.

Recommendations for Designers

1. Anticipate the maintenance needs of each potential SCM in the site plan.
2. Plan for sufficient access to each SCM to allow future maintenance activities to take place without significant impact or disturbance to the surrounding property.
3. Reference SCM maintenance requirements on the construction drawings and note that future maintenance activities be completed by a qualified professional per the NPDES permit.

3.4 Life Cycle Cost Accounting

The cost of construction is almost always considered during the site design process. However, full life cycle costs are not considered as frequently by the owner/operator. Life cycle costs refers to all costs that occur over the economic life of a project. These costs include design and permitting, construction, land acquisition, operation and maintenance, and major rehabilitation or replacement costs (Colorado Department of Transportation, 2019).

Fully evaluating both short-term and long-term costs associated with SCM installation and maintenance is necessary as most problems with SCMs are less costly to correct when they are caught early.

> "An ounce of prevention is worth a pound of cure" to design practices with maintenance in mind.

Every SCM has an expected life span and maintenance can extend the life cycle. Properly accounting for that time period when conceptually designing an SCM is helpful.

Decentralized SCMs, like bioretention, initially have more frequent inspection and maintenance intervals, i.e. after every major storm for the first few months after installation is complete (University of New Hampshire, 2017). Meanwhile an underground proprietary cartridge filter associated with a manufactured treatment device (MTD) may only have to be inspected annually. Vegetative maintenance of the bioretention is often performed by typical landscaping companies every 6-12 months, whereas an underground system requires more specialized maintenance, but at a less frequent interval (every 2-3 years).

Landscaping costs for the initial installation and future replacement must be considered for vegetated SCMs. Mobilization costs for routine, proactive, and restorative maintenance activities should be included during the conceptual design phase. Similarly, costs of new media or mulch, specialized equipment, training, or certifications, such as confined space entry, and local material disposal fees should also be considered when designing the SCM.

Recommendations for Designers

1. Consult maintenance vendors for the cost of recurring maintenance and full replacement cost estimates when evaluating which SCMs to use on site.
    a. Include mobilization costs for SCMs that require frequent maintenance as well as material and labor costs. Factor in any specific, additional local maintenance requirements, e.g. 2-year maintenance contract requirement in Chattanooga.
2. Select source materials and components for SCM construction, such as bioretention media, that have been subjected to rigorous quality assurance and quality control standards to ensure they meet specifications.
3. Update bond estimate cost inputs to utilize up-to-date figures to provide more accurate sureties in place should an SCM require complete rehabilitation.

3.5 Post-Installation

Designing for maintenance does not end with project submittal or initial design. The site designer of record can amend the design during construction if site conditions warrant change orders. Making site changes based on underlying soil conditions should be noted because that affects future maintenance of SCMs reliant on infiltration.

If SCM locations are adjusted or if the intended purpose of the SCM changes, recorded maintenance documents and/or exhibits should be adjusted and re-recorded. Similarly, if an approved underground proprietary SCM is replaced with another, the change needs to be documented for the permittee, MS4 stormwater program, and the owner because maintenance requirements will likely differ from the previous design.

Recommendation for MS4 Programs

1. Require owners to submit a new Operation and Maintenance (O&M) Plan if the intended function of the SCM changes (e.g. a dry detention basin changes to a wet pond with a permanent pool of water) or if a proprietary SCM is replaced.

4 Site Design Guidance

Design and installation of SCMs can account for a significant portion of the overall cost of new land development or redevelopment projects. SCMs are an investment and maintenance will help ensure SCMs continue to perform correctly. The following recommendations will help safeguard SCM designs by enabling them to be adequately maintained and perform over time as expected.

4.1 Plan for Maintenance Activities

Project stakeholders should recognize that maintenance-free SCMs do not exist. The design professional and owner/operator must conscientiously consider the life span of each SCM in the design phase and plan for required maintenance.

> Not considering maintenance early in site design will result in SCMs falling into disrepair, creating a burden on the communities where we live, work, and play.

Recommendations for MS4 Programs

1. MS4s and permitting agencies should publish recommended maintenance activities and intervals for each type of SCM in manuals and/or local policy for easy reference.
    a. Identify visual maintenance indicators for systems with high visibility and underground systems to quickly determine need and urgency without fully entering system.
    b. Define inspection versus maintenance activities. Not all inspections result in a required maintenance activity.
2. Review SCM maintenance needs during the plan approval process and again prior to construction.
    a. SCMs landscaped with vegetation require more frequent inspections.
    b. Encourage placement of signage to identify SCM locations throughout the property or larger development.
    c. Understand the effects of more frequently occurring, higher intensity storms on SCMs and adjust inspection and/or maintenance intervals as necessary.
3. Require site plan submittals include a note on the construction drawings that post-construction inspection and maintenance activities should be completed by a qualified professional.
4. Require an O&M Agreement and O&M Plan be submitted with the site plan.
5. Ensure the O&M Plan specifies that inspection and maintenance activities should be completed by a qualified professional.
    a. A qualified professional should be a licensed professional engineer, a licensed landscape architect, or other qualified professional, such as one holding an active certification with SCM Inspection and Maintenance from the University of Tennessee.

Recommendations for Designers

1. Integrate pretreatment features to extend maintenance cycles by reducing large sediment, trash, and floatables/debris from entering the treatment surface area or internal components.
2. Choose vegetation that release minimal organic content while also providing enough growth/coverage at maturity.

3. Include standard SCM maintenance agreement (or other legal instrument) language addressing post-construction maintenance requirements. A copy of the approved site plan with clearly delineated SCMs should be recorded with the SCM agreement.
4. Utilize proprietary SCMs that have been tested in accordance with nationally recognized protocols.

4.2 Design for Maintenance Access

Ensuring SCMs can be safely accessed for maintenance is a critical element of the overall site design for land development and redevelopment projects. Regular maintenance to ensure proper function of an SCM is a legally binding stormwater management requirement in Tennessee as found in Sec. 4.2.5.7 of the NPDES Small MS4 General Permit.

Recommendations for MS4 Programs

1. Require a minimum path width for maintenance access for approved SCMs.
2. Require access paths be made of a specific material providing it remains functional when used by heavy equipment such as a track hoe.
3. Require access for maintenance be incorporated into safety fencing enclosing SCMs.

Recommendations for Designers

1. Locate SCMs within the site plan to accommodate the frequency and convenience of maintenance activities. SCMs integrated into highly visible locations will likely receive more frequent maintenance than those located behind buildings, underground, or in hard to access areas.
2. Evaluate the onsite logistics necessary to complete maintenance activity on various SCMs. For example, a rain garden or engineered biofilter may be possible to maintain with minimal crew and equipment and underground systems will require a vacuum truck, support vehicles, and a staging area for parts and other equipment.
3. Design the length and width of the maintenance access or easement to sufficiently support necessary maintenance activities.
    a. For proprietary SCMs, follow recommendations provided by manufacturers.
    b. Where heavy equipment is needed, provide an access path or road of an appropriate load-bearing material and width to accommodate its use. Account for the height and weight for mobilization of vacuum trucks and other heavy equipment.
4. SCMs not located within public easements should include a provision to allow inspection and maintenance access.
5. Incorporate maintenance access into safety fencing around the perimeter of stormwater ponds. Safety fencing protects human safety but must also allow maintenance activity to occur.
6. Utilize underground SCMs that have correctly sized manholes, trench covers, or hatches to allow easy access to internal treatment components. Avoid locating these access openings where they could be a tripping hazard or impede vehicular traffic flow during maintenance activities.

5 Summary

All permanent, post-construction SCMs require maintenance. SCMs will neither function correctly nor maintain aesthetic value unless they are properly operated and maintained (North Carolina Department of Environmental Quality, 2018). In Tennessee, ensuring SCM maintenance is completed is a requirement of the NPDES permit. There are three types of maintenance to consider when designing for future maintenance activities: recurring, proactive, and restorative.

As stormwater professionals, our common goal is to create practices that are resilient and meet performance expectations while considering short and long-term maintenance frequency and costs. The site designer should perform proper due diligence in selecting the SCM that best meets their site-specific needs. The better we prepare sites and practices for maintenance activity, the more likely maintenance will be performed.

This has the direct effect of improving the quality of our local waterways. Designers who seek to lower the long-term maintenance cost of SCMs for site owners need to examine the maintenance guidelines of various devices and ask maintenance-related questions during the evaluation process to ensure the system they specify will indeed provide the lowest total cost of ownership (Laird, Wolfe, & Allen). Ultimately, we can improve water quality across Tennessee by designing with maintenance in mind.

6 Helpful Links

- Tennessee Permanent Stormwater and Design Guidance Manual
- Tennessee Water Resources Research Center
- North Carolina Stormwater Design Manual
- Virginia Stormwater BMP Clearinghouse
- Stormwater Equipment Manufacturers Association

7 References

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