VERSION: MARCH 2025

NORTHEAST TENNESSEE

SCM Inspection & Maintenance Manual

The City of Johnson City, TN
The City of Kingsport, TN
The City of Bristol, TN
The City of Elizabethton, TN

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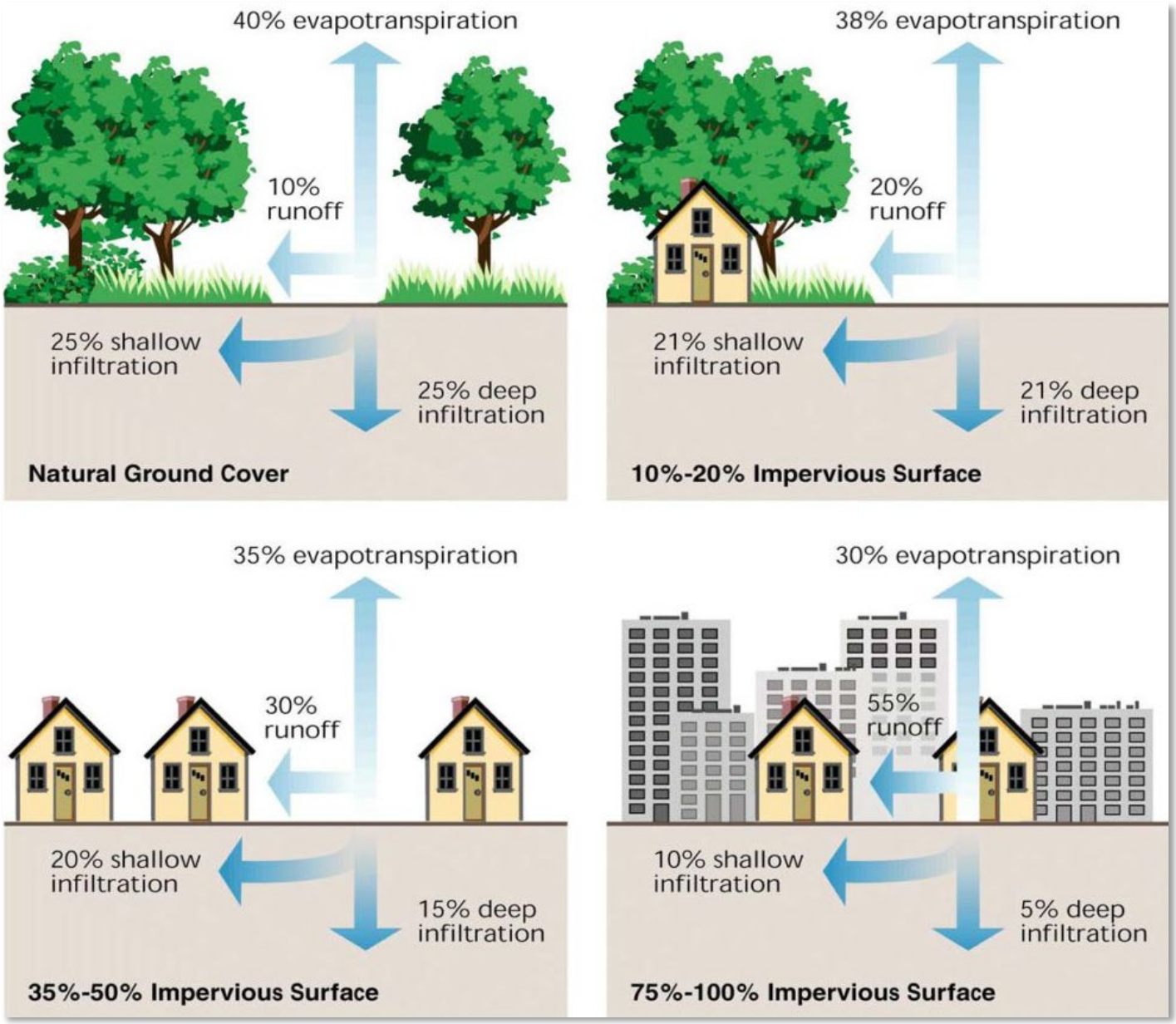
SCM Inspection & Maintenance Manual

1.1 Introduction to Stormwater

Stormwater, also known as stormwater runoff, forms when rainwater does not soak into the soil. Instead, it flows over the land, ponding in low-lying areas or draining into nearby storm drains and ditches. The amount of stormwater that runs off after it rains or snows depends on many factors, including the amount of rain or snow, how quickly it falls, and the type of ground it falls on. Hard surfaces, like rooftops and pavement, do not let rain soak into the ground. In fact, hard surfaces produce more stormwater than land covered by plants and soil. As more property is developed, hard surfaces cover more land, and more stormwater is produced (see Figure 1). This change from natural land cover to rooftops and pavement is why growing cities and towns experience stormwater problems, such as flooding, erosion, and water pollution.

Figure 1. Effect of Impervious Surfaces on Stormwater. *(Source: USEPA)*



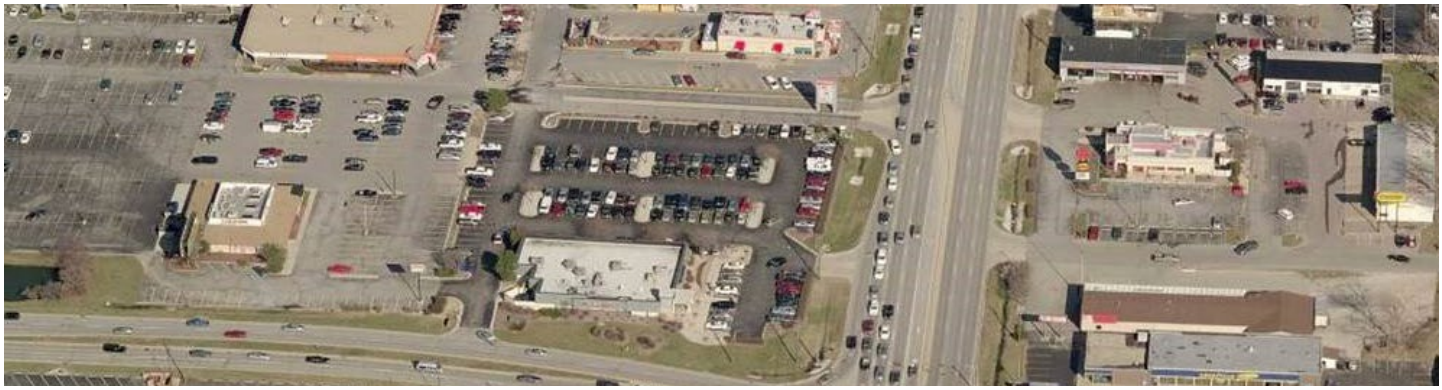
Stormwater carries a variety of pollutants (see Figure 2). As stormwater runs off rooftops. driveways, parking lots, yards, and roads, it picks up dirt (sediment), litter, animal waste, pesticides, herbicides used on lawns and landscaping, oils and greases from cars and industries, dusts, and other substances.

Figure 2. Sources of stormwater pollution

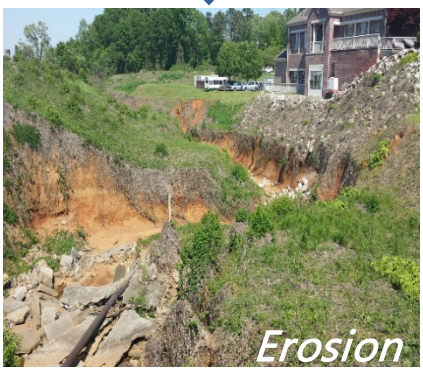
(Source: City of Urbana, IL)

Unfortunately, stormwater does not flow to water treatment plants for cleaning. Instead, it flows into ditches and pipes that drain the water to our local streams, rivers, and lakes. These natural waterways are critically important to the quality of life in our cities. Not only do they receive stormwater drainage, but they also supply drinking water and support many recreational opportunities. Local governments continually combat stormwater issues, like property flooding, stream erosion, and pollution (Figure 3).

Figure 3. Effect of Impervious Surfaces on Stormwater. *(Source: USEPA)*



Without proper management, stormwater from developed land can cause:



1.2 Stormwater Control Measures

Stormwater control measures (hereafter called SCMs) are devices designed and constructed to manage stormwater on a developed property. They are a necessary part of a property's infrastructure because they can prevent the flooding, erosion, and pollution caused by the stormwater generated by the property. This protection extends not only to the property with the SCMs, but also to the storm drainage system, properties, and local waterways that are located downstream of the SCM. Thus, SCMs are critically important to a community's health, safety, welfare, as well as the economic vitality of local businesses and industries.

There are many types of SCMs. Nearly all are designed to remove pollutants by temporarily storing (detaining) the stormwater produced by the first portion of a rain or snow storm. Typically, this "first flush" is the most polluted stormwater because it picks up and carries the dirt, trash, and other pollutants that have accumulated on the ground since the last storm. While the dirty water is temporarily stored, pollutants are removed from the water by settling, filtering, or in other ways, depending on the SCM's design. Ultimately, cleaner water is released from the SCM to local storm drains, ditches, streams, rivers, and lakes.

A special set of SCMs, called green infrastructure SCMs, use loose soil and plants to mimic a natural landscape (see Figure 4). They are designed to let the dirty stormwater soak into the ground where pollutants are removed through natural processes, such as plant uptake and biological filtration. These SCMs not only remove pollutants but can also be designed to reduce the amount of stormwater that discharges from the property. From a stormwater perspective, these SCMs are designed to mimic the stormwater control provided by a more natural, undeveloped landscape.

Figure 4. Bioretention SCM. *Bioretention SCMs use soil and plants to remove pollutants from stormwater. They are not designed prevent flooding during large storms. (Source: Knox County TN)*

Some SCMs, such as detention basins and stormwater wetlands, can detain large amounts of stormwater, protecting nearby properties from flooding. After a storm, they slowly release the stormwater over several days, rather than in a big rush. These SCMs are critical to public safety.

Federal, State, and local governments in the United States are beginning to recognize the importance of SCM maintenance to the public welfare. In Tennessee, the Tennessee Department of Environment and Conservation (TDEC) Rule 0400-40-10-.04 and a corresponding municipal stormwater permit requires many cities and counties, including Johnson City, Kingsport, Bristol, and Elizabethton, to ensure SCMs that address stormwater pollution are properly designed, constructed, and maintained. Thus, these cities have rules governing how SCMs are selected, designed, constructed, and maintained for a developed property. Land developers are also required to document how each SCM on a property is constructed. These rules are in place to safeguard local streams and regional waterways from the impacts of stormwater pollution. The rules also ensure that the local government and private property owners have a good record of how the SCM was built.

1.3 Property Owner Responsibilities for SCMs

SCMs must be maintained to operate properly whenever it rains or snows. Unmaintained SCMs do not prevent stormwater problems. In fact, unmaintained SCMs can make flooding, erosion, and pollution worse. There can be enormous costs incurred for the repair of properties, roadways, or waterways that are damaged or polluted because SCMs have been neglected. However, when SCMs are properly maintained, their maintenance costs are relatively low. Often, well-maintained SCMs can function for many years, needing only minor repairs.

Each city ensures SCMs are maintained through requirements and enforcement provisions of one or more local ordinances (laws) that require the inspection and maintenance of SCMs. The intention of these requirements is to ensure SCMs are fully functional at all times. So, **if you own property in the City of Johnson City, Kingsport, Bristol, or Elizabethton that has one or more SCMs, then you are responsible for maintaining them in a fully functional condition**. More information on SCM rules, inspections, and maintenance requirements is provided in Chapters 2 and 3.

1.4 Using This Manual

This manual was created to support property owners in meeting their responsibilities for SCMs. It establishes the local rules pertaining to SCMs, which are enforceable through ordinances in Johnson City, Kingsport, Bristol, and Elizabethton (see Section 1.5). Moreover, the manual provides basic information on SCM maintenance and inspection in a way that does not require specialized or technical knowledge of SCM design and construction. It is a good resource for SCM owners and maintainers to understand what the city requires, how to perform routine maintenance, how to inspect an SCM and gauge whether it is functioning properly, and how to submit inspection reports to the city. The contents of each chapter are summarized below.

- Chapter 1 (this Chapter) introduces the concepts of stormwater and SCMs and explains the content and use of this manual.
- Chapter 2 explains SCM owner responsibilities and other rules pertaining to SCMs.
- Chapter 3 provides general information on SCM maintenance, protection, and required inspections.
- Chapter 4 presents a detailed *SCM Inspection & Maintenance Guide* for most SCM types used in northeast Tennessee. For each specific type of SCM, the guide:
  - provides an understanding of the function and primary components;
  - provides basic guidance on routine maintenance activities, the solutions to the most common SCM problems, and who to contact for help with SCM repairs;
  - establishes the local government's operation and maintenance standards via an Operation & Maintenance *Standards Checklist*. The checklist guides inspections of an SCM's primary components. Each standard must be achieved for each component or the SCM is considered "non-compliant" with local government requirements. This checklist MUST be used for the Five-Year Professional SCM Inspection required by local governments. Property owners and SCM maintainers are strongly encouraged to use this inspection regularly to guide routine maintenance and repairs of their SCMs.

This manual does not delve into the repair of poorly functioning or badly neglected SCMs. For significant repairs and problems, SCM owners are strongly encouraged to contact a professional civil engineer, landscape architect, or SCM vendor (for manufactured SCMs) to determine an appropriate repair approach.

1.5 Manual Relationship to Local Government Regulations

The requirements of this manual are enforceable through local government ordinances in Johnson City, Kingsport, Bristol, and Elizabethton. The ordinances in each city that authorize the use and enforcement of the requirements established in this manual are listed below.

Table 1 – Relevant Local Governments and Ordinances

City of Johnson City, TN Stormwater Management 209 Water Street Johnson City, TN 37601 Phone: (423) 975-2700 Email: stormwater.scm@johnsoncitytn.org Website: https://www.johnsoncitytn.org/	City of Johnson City Code of Ordinances Title 14, Chapter 3 *Stormwater Ordinance*
City of Kingsport, TN Stormwater Services Division, Water Services Operations Center 1113 Konnarock Road Kingsport, TN 37664 Phone: (423) 229-9454 Email: WSEngineers@KingsportTN.gov Website: https://www.kingsporttn.gov/	Code of Ordinances of the City of Kingsport TN Part II, Chapter 38, Article III *Stormwater Management*
City of Bristol TN Engineering Division Phone: 423-989-5585 Email: engineering@bristoltn.org Website: https://www.bristoltn.gov/ *Physical Address* 212 Blackley Road Bristol, TN 37620 *Mailing Address* P.O. Box 1189 Bristol, TN 37621	City of Bristol TN Code of Ordinances Chapter 74, Article VII *Post-Construction Water Quality Management*
City of Elizabethton, TN Utilities Department Phone: 423-547-6240 Email: stormwater@cityofelizabethton.org Website: https://www.elizabethton.org/ *Physical Address:* Engineering Dept 217 Sycamore Shoals Dr. Elizabethton, TN 37646 *Mailing Address:* Engineering Dept 136 S. Sycamore St. Elizabethton, TN 37642	City of Elizabethton Municipal Code Title 18 Chapter 6 *Stormwater and Water Quality Issues*

2.1 Introduction

This chapter establishes and explains city rules and requirements for long-term operation and maintenance of privately and publicly owned SCMs located in Johnson City, Kingsport, Bristol (TN), and Elizabethton. These rules are necessary to support each city's compliance with the requirements of the Tennessee Department of Environment and Conservation (TDEC) *Rule 0400-40-.10* and associated municipal stormwater permits, and to protect public and private properties from flooding, erosion, and stormwater pollution. The box on the right provides an overview of the responsibilities of SCM owners and cities that result from the rules.

Responsibilities of SCM Owners

Inspect the SCM regularly to determine its maintenance and repair needs.

Maintain the SCM so it remains fully functional, and in keeping with its Record Drawing.

Protect the SCM to prevent damage.

Have a qualified professional **inspect and document** the condition of the SCM once every 5 years, and provide the inspection report to the city.

Responsibilities of Cities

Inspect, document, and maintain SCMs located on city-owned properties.

Review inspection reports provided by private property owners.

Enforce the city ordinance requirements for SCM inspection and maintenance.

Report on the effectiveness of the ordinance to TDEC annually.

2.2 SCM Inspections

Two types of SCM inspections are addressed in this manual. First, routine SCM inspections performed at least monthly are important to alert property owners and SCM maintainers to the maintenance and repair needs of an SCM. Second, stormwater ordinances in Johnson City, Kingsport, Bristol (TN), and Elizabethton require property owners to have **an inspection of every SCM on their property performed and documented by a qualified professional at least once every five years.** These inspections must be done using inspection checklists provided in this manual. Failure to obtain the Five-Year Professional Inspection is a violation of the city ordinance.

More detailed information on SCM inspections is provided in Chapter 3.

2.3 SCM Maintenance

City stormwater ordinances also establish that **property owners are responsible for operating and maintaining stormwater control measures (SCMs) located on their properties, in keeping with its original design and construction.** An SCM's original design and construction is documented in the Record Drawing associated with the property. More detailed information on SCM maintenance and SCM Record Drawings are provided in Chapter 3.

Although the property owner is ultimately responsible for ensuring their SCMs are maintained, informal maintenance inspections and maintenance activities can be carried out by others, such as tenants, property managers, or lawn/landscape contractors, working on behalf of the owner.

Failure to maintain an SCM violates the city's stormwater ordinance where the SCM is located and can result in enforcement actions against the property owner. Enforcement actions can include requirements for corrective actions, fines, civil penalties, and/or property liens.

2.4 SCM Repair and Modification

All private and public infrastructure ages and eventually requires repair. SCMs are no different. They withstand all types of weather, so wear and tear is unavoidable even for SCMs that are well-maintained. Occasional repairs are expected to keep SCMs operating properly. Rules for SCM repairs are as follows.

1. **SCM repairs must be performed as soon as possible after the need for repair is noticed**. Ideally, repairs will occur prior to the next rainfall. Attending to repairs quickly can prevent further damage to the SCM, failure of the SCM, and enforcement actions by the city.
2. With the exception of vegetation, **an SCM cannot be modified from its original design and construction, as depicted in the Record Drawing, without prior approval from the city.** Permanently removing SCM components, repairing or replacing them with different sizes, shapes, or materials, or changing the water flow by adding, blocking, or redirecting inlets or outlets are examples of SCM modifications that are not allowed (see the Case Study on the next page). These modifications can impact the functionality of the SCM, potentially leading to further damage, flooding, or erosion in or around the SCM, or on nearby properties. Modifications can also reduce an SCM's ability to filter pollutants from stormwater, degrading the water quality of nearby streams and lakes. However, in some cases, modifications are necessary to prevent stormwater issues. In such instances, approval from the city is required. Contact details for each city's stormwater department are provided at the bottom of this page.
3. **SCM vegetation can be changed from what is depicted in the Record Drawing if the changes are in keeping with the plant coverage and type requirements for the SCM.** If plants are required as part of an SCM, property owners CAN remove and replace the vegetation to achieve a desired look. New plants must comply with the vegetation requirements of the SCM. These requirements are described in the *Operation & Maintenance Checklists* for SCMs presented in Chapter 4.

Figure 5. SCM Vegetation *The property owner is allowed to replace the plants in this bioretention SCM provided the new planting scheme meets the plant coverage and type requirements described in the checklist in Section 4.3 of this manual. (Source: University of Tennessee, Knoxville TN)*

Case Study: Repairing a SCM The outlet of a SCM is an 8-inch diameter corrugated metal pipe (see picture on the left below). It's material and dimensions are shown on Record Drawing. The pipe is accidentally crushed, causing a blockage. How should it be repaired?

- ✗ Replacing the pipe with a larger or smaller diameter pipe is not allowed. A smaller pipe could cause flooding or erosion near the SCM, while a larger pipe could cause erosion or flooding on other properties.
- ✗ Using a different pipe material or changing its size or placement could change the integrity and function of the pipe, the outlet structure, and the SCM. This can result in outlet failure, damage to the SCM, or flooding, erosion, and property damage nearby. Changes from the original design are prohibited.
- ✓ The damaged pipe must be replaced with the same diameter and type of pipe (8-inch diameter, corrugated metal) for the SCM to meet its operation and maintenance standards.

The pictures below depict a repair that is in violation of city requirements. The repaired pipe is very different from the original construction. For a repair of this nature and magnitude, it is best to consult a civil engineer or landscape architect before undertaking the work. *(Pictures Source: Forester Network)*

Pipe Condition BEFORE Damage
(as designed pipe condition)

Pipe Condition AFTER Repair*
(different diameter, material, installation)

2.5 SCM Removal and Relocation

SCMs cannot be removed or relocated without prior approval from the city. SCMs are critical to preventing flooding, erosion, and/or pollution, so changing the location of an SCM or removing it entirely eliminates these protections and can cause negative impacts. Removal or relocation of an SCM without prior city approval is a violation of the city ordinance that regulates SCMs (see Chapter 1). At a minimum, the property owner responsible for a removed or relocated SCM will be required to rebuild the SCM or provide an engineering study of the replaced or relocated SCM at their own cost (see Figure 6). They may also

Figure 6. SCM Reconstruction *SCMs that have been removed or relocated without city approval will likely need to be reconstructed. Reconstruction can be a significant and expensive. Consult your city stormwater department before making an expensive mistake. (Photo source: City of Lincoln NE)*

be responsible paying civil penalties and for repairing damage to other properties that may have resulted from SCM relocation/removal.

Each city has procedures to allow the approval of the removal or replacement of SCMs in certain circumstances. For example, an SCM can be removed when a property is redeveloped (i.e., buildings and pavement on a property are removed, replaced, or added). Redevelopment requires various municipal permits and approvals which alert the city's stormwater department of any requests for changes to an SCM. Typically, a new SCM better suited to the redeveloped property will be required.

2.6 Prohibited Uses of SCMs

The activities and uses listed in Table 2 are prohibited within SCMs. These activities and uses do not meet SCM operation and maintenance standards and can damage it, causing improper operation. Repairs could be costly to the property owner. Moreover, a damaged SCM can result in water pollution, flooding, and erosion on nearby properties and local waterways. Property owners must take care not to allow the following uses or activities within the SCM. Allowing these activities is a violation of the city ordinance that regulates SCMs (see Chapter 1).

Table 2 - Prohibited Uses and Activities for SCMs

X Storage (even if temporary) or dumping of landscape materials, (e.g., mulch or grass clippings) equipment, and waste	X Storage (even if temporary) or dumping of industrial, commercial, or household materials, equipment, or wastes
X Application of herbicides, pesticides, or fertilizers not suitable for use near waterways	X Storage, transfer, application, and dumping of sewage, even if treated
X Repair, storage, or parking (even if temporary) of vehicles or equipment under repair or in disrepair *(e.g., a junk yard)*	X Regular entry by anyone not performing inspection or maintenance activities *(unless the SCM is designed to allow such entry)*
X Picnic areas, concert venues, and other gathering areas *(unless the SCM is designed and constructed for such use)*	X Recreational areas, playgrounds, sports fields, *(unless the SCM was designed and constructed for such use)*
X Pet relief or play areas *(e.g., dog parks)* or dog kennels	X Livestock pens, corrals, or feeding areas
X Installation of rooftops, pavement, or other hard surfaces unrelated to the SCM *(unless shown in the Record Drawing)*	X Vehicle or equipment traffic or parking *(unless the SCM was designed and constructed for such use)*
X Swimming or fishing	X Home or commercial gardens *(however, plant maintenance for vegetated SCMs is allowed)*

SCMs that have plants as part of their design (e.g., bioretention areas and dry extended detention basins) are both an SCM and a part of the property's landscape. Vegetated SCMs are often not recognized by passersby as SCMs at all because they blend so well with the landscape. Often, extra measures must be taken to protect vegetated SCMs from litter, pet waste, dumping of landscape waste, and unwanted entry by cars or people. Simple measures such as nearby trash cans, pet waste disposal stations, "No Entry" or "No Parking" signs, or decorative fencing can be helpful in protecting an SCM.

2.7 City Responsibilities

TDEC rules and permits also require permitted cities to develop and enforce a permanent stormwater program that includes the following elements.

- Maintenance of publicly owned SCMs
- SCMs inspections at least once every five years by a qualified professional
- Procedures to verify that SCMs are being inspected and maintained
- Local authority, legal agreement, or other means to ensure SCM maintenance
- Local authority to access SCMs and implement enforcement actions for failure to comply with local SCM inspection and maintenance requirements

For more information on any of these city responsibilities, please contact your city's stormwater department. Contact information is located at the bottom of this page.

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3.1 Introduction

This chapter provides general information for stormwater control measures (SCMs), as follows.

- Understanding the types of SCMs and how to find and identify them on a property
- Performing an informal inspection of an SCM to determine its maintenance and repair needs
- Performing and documenting a Five-Year Professional Inspection of an SCM
- Maintaining an SCM to keep it in functioning properly and what to do if major repairs are needed
- What additional resources are available if help is needed inspecting, maintaining, or repairing an SCM

3.2 SCM Types

There are many different types of SCMs, each of which operates and is maintained differently. Thus, it is important for property owners and SCM maintainers to understand which type of SCM is located on a property. Different types of SCMs have different names to help engineers, City staff, and SCM owners and maintainers locate and identify which SCMs are on a property. Standard SCM types are listed by name in Table 3.

Table 3 – SCM Names

Standard Name	Possible Alternative Names for the Same SCM
Bioretention Area	Bioretention Area, Rain Garden
Cistern	Rain Tank, Rain Barrell, Rain Storage Tank
Dry Detention Basin	Detention Basin, Dry Detention Pond, Detention Pond
Dry Extended Detention Basin	Dry ED Basin, Dry ED Pond
Dry or Wet Enhanced Swales	Dry Swale, Wetland Swale, Wet Swale
Grass Channel	--
Green Roof	Vegetated Roof, Planted Roof
Infiltration Practice	Infiltration Trench, Infiltration Pond, Infiltration Basin
Manufactured Treatment Device	MTD, Proprietary BMP or SCM, or the MTD manufacturer's model name
Permeable Pavement System	Pervious Concrete, Pervious Asphalt, Permeable Pavers, Green Parking Lot
Sand Filter	Perimeter Sand Filter
Stormwater Wetland	Engineered Wetland, Wetland Detention Basin
Underground Detention Basin	Underground Detention Pond
Urban Bioretention Area	Stormwater Island, Rain Garden, Bioretention Area
Water Quality Basin	Wet Detention Pond, Wet Pond, Wet ED Pond

It is important to note that SCM names, and even the acronym 'SCM', have changed over the years as stormwater regulations have evolved. Between 2008 and 2024, SCMs were called either 'Water Quality Facilities' or 'Best Management Practices' (BMPs). As well, their individual names may differ from the standard names listed in Table 3. Thus, the possible alternative SCM names that could be used on city or property owner documents are also listed in the table.

3.3 Finding Your SCM

3.3.1 SCM Appearance

Not every SCM is easily seen and identified, especially for people who don't work in land development and landscape management. This is because there are many types of SCMs constructed in a wide variety of sizes, shapes, and appearances (see Figure 7). A fenced wet detention basin is easy to see, while a manufactured treatment device is not because it is located underground. Even SCMs located in plain site can be unrecognizable often because they serve multiple purposes. SCMs can look like part of the property's landscaping, or can also function as a parking lot, sidewalk, or a roadway. In fact, many private property owners are not aware they have an SCM until the city advises them.

Figure 7. Examples of Different SCMs. *Clockwise from top left: Bioretention area (rain garden) at the University of Tennessee; Filterra® Manufactured Treatment Devices in Huntersville NC (source: Contech ES); ADSORB-it Catch Basin Filter (source: Stormwater BMP Products); Dry Detention Basin in White House TN; Permeable paver parking areas in Auburn AL*

If you have been advised by your city that you have one or more SCMs on your property, use the information provided in the following sections to find them. If you are unable to find them, call the city stormwater department using the contact information located at the bottom of this page and at the end of Chapter 1.

3.3.2 Locating SCMs on Properties Constructed After 2008

Most SCMs constructed after 2008 are documented. Table 4 lists the legal instruments or property documents that can identify the SCMs on a property. Ideally, at least one of these documents will provide enough information for a property owner to understand the number, types, and locations of the SCMs on their property. Property owners who do not have of any of the documents listed in the table may be able to find them by performing a title search for their property or by contacting the local Register of Deeds.

Table 4 – Property Document or Instruments That May Identify SCMs	
Property Plat	A **plat** is a map that shows the divisions of a piece of land, property shapes and sizes, nearby streets, boundary locations, easements, and possibly flood zones. Easements associated with SCMs may be shown on the plat. Property plats are available from the local Register of Deeds. Regardless of the date of property construction, plats are not always dependable for the identification of SCMs. However, they may show easements for SCMs (see next row) or identify SCMs in notes included on the plat.
Easement	**Easements** will be shown on the property plat. For SCMs, easements are held by the city where the property is located. It grants access to city staff for the purpose of ordinance enforcement. The easements do not provide the city with ownership of SCMs located on private property, nor do they give them responsibility for the operation and maintenance of SCMs. SCMs constructed in 2008 or later will probably be shown in a drainage, storm (or stormwater), or water quality easement and are of particular interest. They should also have an access easement to the SCM from a public roadway.
Covenant	Maintenance for some SCMs is addressed by a property covenant. **Covenants** for SCMs will likely be titled "*Covenants for Permanent Maintenance of Water Quality Facilities and Best Management Practices*" (the terms "Water Quality Facilities" and "Best Management Practices" refer to SCMs). These legal documents require the property owner to ensure perpetual and proper maintenance of SCMs on the property. Covenants executed by the property's developer are recorded with the local Register of Deeds. When property transfers occur, the covenants are transferred to the new owner, who is subject to their terms.
Record Drawing	A **Record Drawing** is a set of maps and narratives prepared at the end of construction that describe the SCMs on a property exactly as they were constructed. These drawings are typically prepared by a land surveyor and the site design professional (e.g., civil engineer) who assisted the land developer with the design and construction of the SCM. They may be recorded with the property's deed or be attached to SCM covenants (if available). The city may have a copy in their archived files. Some covenants will have an SCM Location Map showing the types and locations of the SCMs. Record drawings should exist for SCMs constructed after 2008. Record drawings were not created for older SCMs.

Operation & Maintenance Plan (O&M Plan)	An **Operations & Maintenance (O&M) Plan** is a set of documents that locate the SCMs on a property and describe how they should be maintained. The Plan should include an SCM Location Map showing the types and locations of the SCMs. The O&M Plan may be recorded with the property's deed or plat or attached to the covenants. Usually, the city will have a copy of the O&M Plan in their archived files.

Some of the documents listed in Table 4 may include a SCM Location Map. An example map is presented in Figure 8. It shows the property boundary, building and pavement footprints, and the location and proper name of any SCMs located on the property. Five SCMs are shown in the figure. Can you find them?

3.3.3 Locating SCMs on Properties Constructed Before 2008

The documents listed in Table 4 may not be helpful for older properties. SCMs constructed before 2008 may be identified only by an easement or not at all. If you cannot find an SCM or are unsure about which SCMs are on your property, contact the city's stormwater department where the property is located. Contact information is at the bottom of this page and in Chapter 1.

3.4 Understanding Your SCM

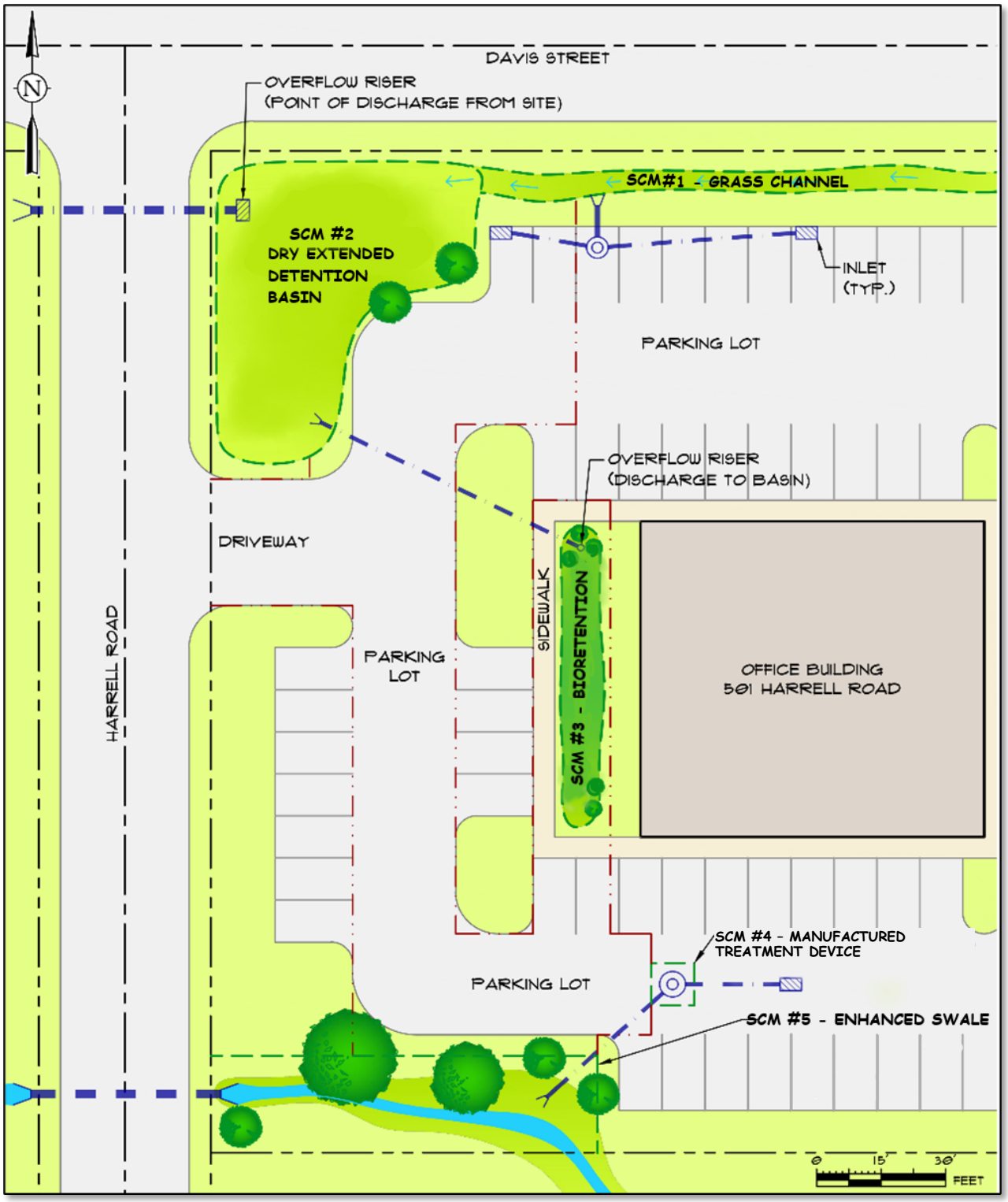
Like their widely varying looks, different SCMs function in different ways. Even two SCMs that operate for the same purpose, such as flood control, may not function the same way. For example, a retention basin SCM prevents flooding by collecting stormwater and allowing it to evaporate. In contrast, a detention basin SCM prevents flooding by allowing collected stormwater to drain from the basin at a very slow rate. It is important to know how your SCM is supposed to function so you can understand if it is operating properly.

The *SCM Inspection & Maintenance Guides* provided in Chapter 4 of this manual are intended to help property owners and SCM maintainers understand, inspect, and maintain their SCMs. One guide is provided for each type of SCM listed in Table 3. Simply use the SCM name to match the SCM located on your property with the correct guide. Each guide presents the following SCM specific information.

- The SCM purpose and how it works
- The primary components of the SCM
- Routine maintenance activities
- Common problems and resolutions
- When to call an expert
- The *Operation & Maintenance Standards Checklist*

Different types of SCMs have different inspection and maintenance needs. For this reason, it is important that persons responsible for SCM inspection and maintenance review the SCM's Record Drawing, if it is available, and the appropriate *SCM Inspection & Maintenance Guide* (found in Chapter 4) as often as needed to understand their SCM. Together, these documents are the best resources for understanding the SCM being inspected and maintained.

Figure 8. Example SCM Location Map. *Can you find the five SCMs on the map?*



3.5 SCM Inspections

This chapter describes the two types of inspections that are important for SCM longevity and compliance with city requirements and State of Tennessee rules.

3.5.1 Routine Inspections

A routine inspection is a frequent, informal examination of an SCM's primary components and the area draining to the SCM to determine what maintenance and repair activities are needed to keep the SCM functioning properly. Table 5 provides basic information on routine SCM inspections.

Table 5. Routine Inspections

Purposes	Round inspections are performed to evaluate whether the SCM is functioning properly and determine what maintenance or repair activities are needed
Frequency	Routine inspections should be performed at least monthly and a few days after a heavy rain or snow. For many SCMs, they are most easily done as part of landscape maintenance activities.
Inspector Qualifications	Any person who is knowledgeable of SCM operation and maintenance can perform a routine inspection. However, a (Tennessee) Certified SCM Inspection and Maintenance Professional[2] is preferred. See below this table for more information.
Inspection Guidance	Use the *Operation & Maintenance Standards Checklist* provided in Chapter 4 to guide routine inspections. Use of the checklist is not required but is strongly recommended. It describes the city's standards for proper operation and maintenance of an SCM in the form of questions to be answered during an inspection. This helps the inspector understand which components need maintenance or repair. SCM maintainers should use the checklist as often as needed until they are familiar with the SCM. Checklists completed for routine inspections do not need to be submitted to the city.

The Tennessee Department of Environment and Conservation (TDEC) and the University of Tennessee Knoxville collaborate on a SCM Inspection and Maintenance Professional training course and certification. The course is intended for design professionals, engineers and landscape architects, landscape and other green industry professionals, and SCM inspection personnel. It aims to build a solid working knowledge of proper operation and maintenance of permanent stormwater measures. As SCMs become more commonplace, it is anticipated that landscape businesses and property management companies will seek this certification for their employees. Property owners are encouraged to look for these individuals to perform routine inspections of their SCMs. This will ensure that their SCMs are managed by a knowledgeable individual. More information on the course and certification can be found at www.tnstormwatertraining.org.

Typically, cities will not enforce the performance of routine inspections unless they determine an owner has been negligent in the required maintenance of an SCM. However, frequent routine inspections are strongly encouraged simply because they support proactive, on-going maintenance to keep an SCM in good working condition. Frequent routine inspections and associated maintenance can prevent costly repairs.

An example of how a routine inspection can prompt SCM maintenance is presented in the case study below.

Case Study: A Routine Inspection Leads to SCM Maintenance

An office park has a bioretention SCM that manages stormwater from the parking lot. A landscape company working for the property owner performs routine inspections and maintenance of the SCM each time they tend the landscape. They used the *Bioretention SCM Operation & Maintenance Standards Checklist* provided with the *Bioretention SCM Inspection & Maintenance Guide* in Chapter 4 to guide their work.

While inspecting item #2 on the checklist, they see a deep buildup of soil in the SCM's pretreatment area. This is not typical. Looking around the parking lot that drains to the SCM, they realize the source of the problem is a soil stockpile placed temporarily on the parking lot by a plumber who is currently fixing an onsite broken water line in a grassy area adjacent to the parking lot. The stockpile is not covered, so some of the soil washed into the pretreatment area of the SCM during a storm the previous night. They also see that the soil did not wash further into the main treatment area. So, the pretreatment component of the SCM worked as it should, preventing the dirt from reaching the rest of the SCM. But it needs to be cleaned out.

The landscape company removes the dirt from the pretreatment area, returning it to the temporary soil stockpile. They also talk with the plumber and find he will finish his work that day. He plans to remove the temporary stockpile on the parking lot, returning the soil to its original location covering the water line. He will also sweep the area of the parking lot where the stockpile was located with a broom to get as much soil off the area as possible.

However, SCM maintenance is not complete. The grassy area disturbed by the plumber is now exposed soil that can wash into the parking lot (and therefore to the SCM) if it rains. Storms are expected late the next day. So, the landscape company decides to return to the office park late in the afternoon or first thing in the morning (after the plumber is finished) to seed and straw (or sod) the disturbed soil over the water line to prevent soil erosion. This will reduce the possibility that excess soil will wash into the SCM again.

In this example, the routine inspection led to two minor maintenance activities: 1) removal of the excess soil from the pretreatment area; and 2) covering the disturbed soil over the water line to prevent more dirt from washing into the SCM. Had the landscape company not taken these steps, additional soil buildup in the SCM would eventually wash into the main treatment area of the SCM, eventually killing the plants and clogging the SCM It was important to find the source of sediment or other pollutants that appear in the SCM and quickly correct the problem.

3.5.2 Five-Year Professional Inspections

Stormwater ordinances in Johnson City, Kingsport, Bristol (TN), and Elizabethton require SCM owners to obtain a documented inspections of their SCMs from a qualified professional at least once every five years. This inspection is mandated by TDEC Rule 0400-40-10-.04 and corresponding municipal stormwater permits for each city. Table 6 provides city requirements for Five-Year Professional Inspections.

Table 6. Five-Year Professional SCM Inspection Requirements

Purpose	Five-year inspections are performed primarily to document whether the SCM is functioning properly and being maintained in compliance with city requirements.
Frequency	Five-year inspections must be performed once every five years, between May 1st and Sept 30th.
Owner Responsibilities	The property owner must ensure the five-year inspection is performed, documented, and provided to the city as required.
Inspector Qualifications	Five-year inspections must be performed by one of the following qualified professionals: ✓ A Landscape Architect or Professional (Civil) Engineer with an active license in the State of Tennessee ✓ A Tennessee Certified SCM Inspection and Maintenance Professional (see the paragraph below Table 5 on the previous page)
Inspection Requirements	Inspections must be performed and documented using the *Operation & Maintenance Standards Checklist* provided in Chapter 4 of this manual. Use the correct checklist for the SCM being inspected. The completed checklist must be provided to the city's stormwater department within 45 days of completion of an inspection. Consult the city website or contact the city where the SCM is located for information on submitting completed checklists. City contact information is at the bottom of this page and at the end of Chapter 1. Failure to perform the inspection in keeping with these policies and failure to provide inspection documentation to the city are violations of the city ordinance and may result in enforcement actions.

3.6 Maintaining Your SCM

3.6.1 Routine Maintenance

If an SCM were an automobile, routine maintenance would equate to an oil change. **Routine maintenance is defined as the regular cleaning and light repair activities that are performed on a repetitive and frequent basis to ensure the long-term operation of the SCM.** Routine maintenance should be done at least

monthly. For many SCMs, it is performed most easily whenever general property and landscape maintenance occurs or when issues are noticed during an inspection. Examples of routine maintenance include the following.

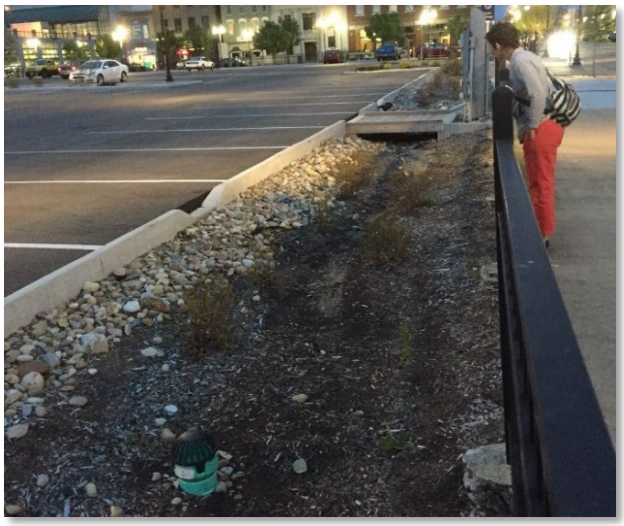
- Trash, debris, leaf litter, and minor sediment removal (sweeping or light shoveling) within the SCM and in the area that drains to it
- Debris removal from the inlets and outlets
- Plant or grass care, weeding, and mulching
- Repair and cover eroding soil in the SCM or in the area that drains to the SCM
- General cleaning and light repairs to SCM signs and other physical protection measures (fences, rocks, curbs/gutters, etc.)

Figure 9. SCM Cleaning *Removing trash, leaves, and debris is a routine maintenance activity for all SCMs.*

Routine maintenance activities may vary depending on the type of SCM, the season (e.g., mulching in the spring, leaf removal in the fall), and the land use and activities within or the condition of the area draining to the SCM. For example, an SCM that receives drainage from a fast-food restaurant parking lot where disposable food and drink containers are commonplace will likely require more frequent trash removal than an SCM that receives drainage from an office building parking lot. **Consult the *SCM Inspection & Maintenance Guide* in Chapter 4 for specific and detailed information on the routine maintenance necessary for each type of SCM.**

For most SCMs, the majority of routine maintenance activities can be done by anyone generally knowledgeable in landscape and property maintenance. However, there are activities that may require an expert. For example, hiring a professional landscaping company or consulting a horticulturist knowledgeable in plants suitable for an SCM may be a good idea. Vegetated SCMs, such as bioretention areas, are designed to be safely inundated with water when it rains. Thus, the plants within the bioretention area must be able to withstand occasional water inundation followed by periods of drought.

Figure 10. The Importance of Plant Care *Poor plant care in this bioretention SCM led to a large repair to remove and replace unhealthy soil and plans.*



Ultimately, safety, cost, and effectiveness are key factors in determining who will carry out certain maintenance activities. **Don't hesitate to call an expert when needed.** Trained professionals can identify problems early on that might prevent more costly repairs later.

3.6.2 Significant Repairs or Rehabilitation

SCM repairs should be expected since most SCMs are exposed to weather, traffic, and people. Even well-maintained SCMs occasionally need repairs after a heavy storm or large snowmelt, or as the result of an unexpected disturbance to the SCM. In any case, **problems must be corrected as soon as possible** to prevent further damage to the SCM, your property, the properties around yours, and the drainage system and local streams or lakes that receive drainage from the SCM. Significant repairs may require the services of a licensed contractor, professional engineer, landscape architect, or soil scientist. Because repairs can sometimes be costly, creating a long-term fund for large maintenance items is highly recommended. Examples of large maintenance tasks include the following.

- Repairs to or replacement of structural components (e.g., curbing, outlets, underdrain, observation wells, etc.)
- Removal of large amounts of sediment or mature trees
- Loosening or replacement of compacted soil in SCMs that require loose soil for stormwater management
- Structural repair or replacement of manufactured treatment device SCMs or their components
- Large-scale removal and replacement of dead, damaged, or unhealthy soil and vegetation

3.6.3 Removal and Disposal of Sediment from SCM

For SCMs, "sediment" refers to the loose sand, clay, silt, and other soil particles that accumulate within SCMs. It can come from soil erosion and the decomposition of plants and animals. It is also mixed with mulch from the surrounding landscape, grit dislodged from shingles and pavement, pet and animal waste, and small particles of a variety of materials located in the area draining to an SCM. The United States Environmental Protection Agency considers sediment the most common pollutant in rivers, streams, lakes, and reservoirs.

Figure 13. Sediment Disposal *The accumulated sediment in this office park bioretention SCM can be put in the trash or used somewhere else on the property. (Source: ces.org)*

Most SCMs are designed to remove much of the sediment that is present in stormwater. Some SCMs, like an extended dry detention basin, let sediment settle to the bottom of the basin before discharging cleaner stormwater. Other SCMs, like manufactured treatment device SCMs use filters or swirling actions to remove sediment from stormwater. Regardless of how sediment gets into the SCM, it will accumulate over time and need to be cleaned out. For SCMs that allow sediment to settle to the bottom, digging out the accumulated soil will be needed. For SCMs that filter stormwater, the filter media and/or filter cartridges may require periodic cleaning or replacement in accordance with the manufacturer's recommendations.

In most cases, sediment removed from an SCM can be disposed of as trash or used elsewhere on the property as fill or landscape dirt. However, in some cases, the disposal of these materials can be a concern because more worrisome

pollutants may be present. This really depends on the land use of the area draining to the SCM. For example, accumulated sediment in an SCM that manages stormwater from a commercial truck fueling/parking area may have significant amounts of petroleum (e.g., gasoline, oils, and greases) or metals. If the SCM receives runoff from a commercial or industrial setting, the sediment removed by the SCM may be hazardous. Before disposing of potentially contaminated or hazardous sediment, contact a professional (civil) engineer or the Tennessee Department of Environment & Conservation (TDEC) for guidance.

3.7 Additional Resources

Sometimes, SCM management requires technical or specialized expertise or equipment, or help is needed determining the cause of SCM problems despite regular maintenance. This section provides information on additional resources that can evaluate SCM problems and help with maintenance and repairs. Tips for hiring help with SCMs is presented in the box below.

Tips for Hiring Help to Manage or Repair Your SCM

- Hire individuals or companies with experience in the maintenance and repair of SCMs, especially the types of SCMs located on your property. Inform them that your city has specific standards for SCM operation if they are not already aware.
- Provide them with any documentation you have on the SCMs on your property.
- Make sure they use this manual, especially the appropriate *SCM Inspection & Maintenance Guide* for the SCMs on your property. SCM guides and their corresponding inspection checklists are located in Chapter 4.

3.7.1 Engineers and Landscape Architects

Local ordinances require SCMs to be designed by a professional (civil) engineer or landscape architect licensed in the State of Tennessee. They understand the design specifications and calculations required for proper design. As well, they are qualified to perform the required Five-Year Professional SCM inspection. Consider hiring a professional engineer or landscape architect when an SCM is not functioning properly, when the cause cannot be determined, and when significant repairs to SCM components are needed. These professionals can ensure repairs are done properly and made in compliance with city standards. The following websites can provide additional information on finding an appropriate professional.

- Tennessee Society of Professional Engineers: https://www.tnspe.org/
- Tennessee Chapter of the American Society of Landscape Architects: http://www.tnasla.org/

3.7.2 Landscape Management Companies and Plant Specialists

Plants in an SCM are important to its function as they help with pollutant removal and prevent erosion. For the SCM to function properly, its plants must be healthy and must cover all (or the majority of) the SCM's surface area[1]. Plant and soil care and the replacement of dead or dying plants are critical maintenance activities for vegetated SCMs. First, plant types in the SCM (e.g., grasses, shrubs, small trees) and coverage must conform with the standards established in Chapter 4. Second, plants selected for SCMs must be able to withstand periods of inundation. Finally, native plants suitable for SCMs are encouraged over non-native plants because they typically require less maintenance. For these reasons, property owners may want to hire help to maintain vegetated SCMs.

Landscape management companies and plant specialists can help with plant and soil maintenance and repair, in addition to plant selection. Table 7 provides more guidance on the types of resources available to help with vegetated SCMs. Additional information on several different types of landscape resources is presented below the table.

Table 7. Additional Resources for SCM Plant and Soil Management

Resource	SCM(s) Best Used for:		Activities
Professional Landscape Company	Bioretention Area Enhanced Swale Infiltration Basin Urban Bioretention	Stormwater Wetland Vegetated MTDs Water Quality Basin	Routine inspections Five-Year Professional SCM Inspections* Plant care and management Soil care and management Minor component repairs
Grass Mowing Company	Grassed permeable pavement systems Dry Detention and Extended Detention Basins		Routine inspections Five-Year Professional SCM Inspections* Grass care and erosion prevention Minor component repairs
Tree Service or Arborist	All SCMs with large mature trees within an SCM or located in close proximity to SCM components		Safe removal of mature trees Tree health issues Tree selection and replacement
Master Gardener	Bioretention Area Enhanced Swale Urban Bioretention	Stormwater Wetland Vegetated MTDs Water Quality Basin	Plant care and management Soil care and management Plant selection and replacement
Plant Nursery	Bioretention Area Enhanced Swale Urban Bioretention	Stormwater Wetland Vegetated MTDs Water Quality Basin	Plant selection and soil care Native plant selection

** – See Section 3.5.2 above for more information on SCM inspector qualifications for the Five-Year Professional SCM Inspection. Some landscape and grass mowing companies may employ qualified inspectors.*

1 Consult the appropriate *SCM Inspection & Maintenance Guide* in Chapter 4 to determine the plant coverage requirement for your vegetated SCMs.

Master Gardeners

Master gardeners are gardeners who have been specially trained and sponsored by the University of Tennessee Extension system. They volunteer their expertise and services to the community, providing reliable, gardening information and education opportunities. The University of Tennessee and the Northeast Tennessee Master Gardener Association have related master gardener groups that may have resources and gardeners available to answer questions and help with the vegetation, soil, and media in your SCM. They can be reached through the following websites:

- University of Tennessee Master Gardener Program: https://mastergardener.tennessee.edu/
- Northeast Tennessee Master Gardener Association: http://www.netmga.net/

Plant Nurseries

Plant nurseries should have staff knowledgeable on plant species that can withstand the conditions within an SCM. However, not all commercial nurseries may have the knowledge and inventory of native species. More time may be needed to find native species. If you contact a nursery, make sure they are familiar with your type of SCM.

City Stormwater Department

Your city can provide additional guidance on how to locate, inspect, and maintain SCMs, and can answer questions on a variety of other stormwater related topics. Contact information is at the bottom of the page.

Additional Online Resources

Across the country, cities and private property owners are working to reduce stormwater's negative impacts through SCMs. Table 8 lists some recommended websites that may be able to provide additional information on SCMs. These are not the only web-resources available. As you conduct your own research, remember that some SCMs and recommendations you find may not apply to local conditions or your specific SCM.

Table 8. Recommended SCM Resource Websites

Tennessee Department of Environment & Conservation – Division of Water Resources https://www.tn.gov/environment/program-areas/wr-water-resources-home.html
Tennessee Stormwater Association https://www.tnstormwater.org/
Tennessee Water Resources Research Center https://tnwrrc.tennessee.edu/training/trainingprograms.html
Tennessee Native Plant Society https://www.tnps.org/
University of Tennessee Extension https://utextension.tennessee.edu/
Environmental Protection Agency Stormwater Pollution https://www.epa.gov/npdes/npdes-stormwater-program

4.1 Bioretention Area

SCM Inspection & Maintenance Guide

Bioretention areas are stormwater control measures (SCMs) that clean pollution from stormwater. Bioretention areas are built as shallow, sunken areas that catch stormwater from surrounding property. The water soaks into the soil of the bioretention area. Most bioretention areas in northeast Tennessee are designed to manage up to 1½ inches of rainfall, draining completely within 48 hours after the rain. Bioretention areas blend well with a property's managed landscape and can be used as vegetated borders for parking lots, driveways, sidewalks, and buildings (see Figure 1).

Benefits of Bioretention

- Removes pollutants from stormwater
- May reduce erosion in nearby streams
- May decrease flooding
- Provides habitat for butterflies & birds
- Creates an interesting landscape

Property Owner Responsibilities

The city regulates bioretention areas located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's bioretention area(s) are maintained in proper operating condition**. See Chapter 2 of this manual for more information on city rules for SCMs and property owner responsibilities.

Figure 1. Bioretention Area *(Source: WSP)*

SCM Inspection Checklist

The *Operation & Maintenance Standards Checklist* provided at the end of this guide was designed to help property owners, SCM maintainers, and cities determine if a bioretention area is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of bioretention area components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a bioretention area's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a bioretention area must meet ALL applicable operation and maintenance standards. Non-compliant bioretention areas are subject to city enforcement.

Primary Components

To inspect a bioretention area using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. Owners should obtain a copy of the property's Record Drawing to better understand bioretention areas on their property and their components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Bioretention Area Components

1. **Inlets** let water flow into the SCM. There can be multiple inlets in a bioretention area.
2. **Pretreatment areas** slow water entering the SCM and remove trash, debris, and heavy sediment. They are typically lined with concrete, rock, or dense grass.
3. The **main basin** is designed to allow stormwater to soak into an **engineered soil media**, which filters out fine pollutants. **Plants** also remove pollutants and keep the soil healthy and loose. **Underdrains** drain treated water that does not percolate into the surrounding soil. **Cleanouts** allow inspection and cleaning of the underdrain.
4. **Outlet(s)** let water exit the SCM and drain to the property's stormwater system. There may be multiple outlets.
5. **Emergency overflows** allow water in excess of the SCM's design capacity to drain out of the main basin safely. This prevents flooding of the SCM and surrounding area.
6. The **drainage area** (not shown) is the area of land that drains to the bioretention area when it rains.
7. The **access easement** (not shown) extends from a public road to the bioretention area. It allows access to the SCM by the city when necessary.

Figure 2. Bioretention Area Components *All components are shown except the drainage area (#6) and access easement (#7). In many cases, the drainage area is a parking lot , driveway, or rooftop adjacent to the bioretention area. Note: some bioretention areas do not have underdrains. (Graphic source: WSP)*

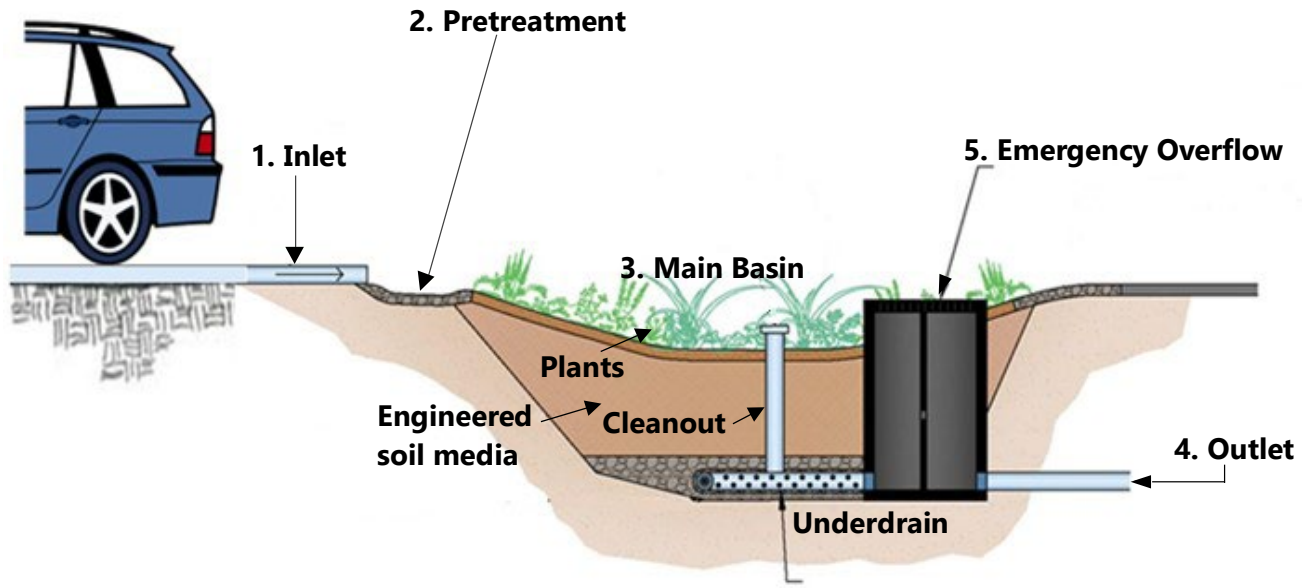


Figure 3. Bioretention Component Examples

Left: The pretreatment area shown at the top right of the photo is lined with stone to slow water and catch trash, debris, and sediment as it flows into the main basin. Right: The underdrain cleanout can be seen in the main basin. Notice the pretreatment area is grassed and allows for sheet flow from the parking lot. The SCMs in both pictures receive drainage from the parking lot. (Source: WSP)

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the bioretention area's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Weed and prune** to remove weeds and invasive plants and keep appropriate vegetation healthy and maintained. Cut and remove dead stems of herbaceous plants.
- ☑ **Cover areas of bare soil and repair eroded areas** with plants or mulch as soon as they are noticed. Do this in the main basin, pretreatment area, and drainage area.
- ☑ **Refresh mulched areas** by loosening compacted mulch with a rake. Replenish mulch when needed to a total depth of 3 to 4 inches in the main basin.
- ☑ **Water plants** as needed to maintain their health, especially during initial establishment of plant growth (first 18 months). Skip the fertilizers and pesticides and opt for natural alternatives as much as possible.

Cleaning

- ☑ **Remove trash, fallen leaves, debris, and accumulated sediment** from all bioretention area components. Do not store anything in the SCM, including grass clippings, leaf piles, and temporary stockpiles of landscape material (e.g., mulch). Dispose of removed material properly.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly. Repair areas of bare soil and erosion.

Other Activities

- ☑ **Remove or cover pollutants in the drainage area** that can be washed into the bioretention area during a storm. Store them inside a building or cover them with a tarp if they are outside. Store vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans before they overfill using appropriate fluid disposal methods.
- ☑ **Verify that required SCM signs are in place**. SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable, damaged or lost.
- ☑ **Inspect the bioretention area's components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Bioretention areas are designed to function in tough conditions, from gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems, should they arise. Table 2 describes the most common problems for bioretention areas and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Standing water in the bioretention area after 3 days with no rain.	If the SCM has an underdrain, it may be clogged. Use the cleanout to remove any clogs. The main basin may be clogged with surface sediment that has washed into the bioretention area over time. See Table 3.
Trash, debris, and sediment frequently accumulate in the main basin.	Clean the pretreatment area more often to ensure it works properly. Determine the source of trash (e.g., litter, frequently overflowing trash cans, etc.) and take steps to reduce the problem (e.g., add trash cans, pick up litter, and empty trash cans more frequently, etc.). For landscape debris, clean the SCM and drainage area more frequently. Ensure landscape debris is disposed of in the trash or remove it from the premises so it cannot wash into the SCM. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Dead or dying plants	Determine and correct the problem if possible (too much water, not enough water, too much or too little sun, pests, disease, fertilizer, etc.). Replace dead and dying plants with healthy plants that are appropriate for use in an SCM. Species diversity can help with plant survival.
Erosion or bare soil in the main basin	Erosion may indicate that runoff is moving too fast into the main basin. Make sure the pretreatment area is maintained and working properly, and the plants are healthy and cover most of the basin (see checklist).

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a landscape company if: ▸ Sediment frequently clogs the main basin ▸ Plants are often unhealthy or die quickly ▸ Erosion occurs frequently in the main basin	For significant component repairs or for a solution to an unsolved problem, consult a licensed professional (civil) engineer or landscape architect to ensure repairs are in keeping with the SCM's approved design.

Operation & Maintenance Standards Checklist
Bioretention Area

This checklist guides an evaluation of the operation and maintenance standards for bioretention areas, organized by primary component. It can be used for bioretention areas with or without underdrains. **For its design to be considered compliant by the city, a bioretention areas must meet ALL applicable standards. Non-compliant bioretention areas are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The bioretention area name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Bioretention Area 1" or "SCM A." Otherwise, describe the location of the bioretention area on the property (e.g., Bioretention area behind main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):		
	Phone #:	Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other			
	License or Certification #	License or Certification Expiration Date:		
Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number	Name of Staff Approving This Inspection Report
Has the City Entered and Approved This Inspection? Yes / No	Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one: Yes / No

Reason for Follow-Up?

Questions? Please contact your local stormwater department!

Operation & Maintenance Standards Checklist
Bioretention Area

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the bioretention area needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact the city's stormwater department for corrective actions that will take longer than 30 days. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel, or an area lined with dense grass or stone.*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are inlets free of erosion and areas of bare soil?				
	c. Are the inlets free of damage or modifications that may impair their intended operation?				
2	*The* **Pretreatment Area** *removes trash, debris, and dirt from stormwater flowing in. This helps to prevent clogging of the main basin. Pretreatment areas are usually lined with dense grass or stone or may be a small stilling basin.*				
	a. Is the area free of trash, landscape debris, weeds, pet waste, and significant deposits of sediment?				
	b. Is the area fully lined with concrete, rocks, or dense grass, and free of damage, erosion, and areas of bare soil?				
	c. Are the areas where stormwater enters and exits the pretreatment area free from obstructions, modifications, and damage, allowing water to easily flow through it?				
3	*The* **Main Basin** *is where stormwater is collected and soaks into the soil. Engineered soil media, plants, underdrains, and cleanouts are all part of the main basin.*				
	a. Do plants cover at least 70% of the surface area of the main basin? Are the remaining areas covered by mulch or landscape stone? (Areas of bare soil are not allowed.)				
	b. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and fire ant mounds?				
	c. Are most plants healthy, with minimal signs of disease, distress, or poor care? (Signs of distress include wilted, scorched, discolored, or pest-damaged leaves; foul odor; slimy, consistently wet, brittle, or discolored roots, bark, trunks, or stems.				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	d. Is the main basin free of weeds and entirely free of cattails? (Cattails are evidence that the SCM is not draining properly after a storm and that wetland conditions are forming.)				
	e. Are trees (if specified and allowed) limited to about one per 50 square feet?				
	f. Are check dams (if present) free of damage and free of weeds and accumulated debris and sediment? (Check dams usually look like rock dams designed to slow down water)				
	g. Is the area free of significant deposits of sediment, trash, pet waste, and debris from inflowing stormwater and no outlet openings are buried or covered by accumulated sediment/mulch?				
	h. Does the area appear to function properly given recent rainfall conditions? • Standing water is not present on the surface of the main basin and not visible in the underdrain (viewed via the cleanout, if a cleanout is included) *(if inspection is performed at least 72 hours after a storm)*; or, • Standing water or wet conditions are present but discharging as expected through the underdrain (viewed via the cleanout) or outlet (if visible) *(if inspection is performed within 72 hours after a storm or within prolonged period of wet weather)*				
	i. Is the main basin free of damage, evidence of soil compaction (e.g., compressed mulch, tire tracks) and sinkhole/throats or drop-outs (i.e., depressions or openings in the ground surface that form on their own, especially after rainfall)?				
	j. Is the cleanout free from damage? (the cap is on and can be removed without issue, and the pipe is not cracked or broken)				
	k. Is the inside of the cleanout pipe free of sediment and debris?				
	l. When observed through the cleanout, is the underdrain free of damage and significant accumulations of sediment?				
	The **Outlet Structure and Emergency Overflow** *let stormwater exit the SCM and bypass the SCM during intense or long storms without flooding the surrounding area. Some bioretention areas have underdrains as part of the outlet structure.*				
4	**a.** Are the outlet structures (if visible) and emergency overflow free of damage and modifications that may impair their function as originally designed?				
	b. Is the emergency overflow buried (partially or fully) by accumulated sediment or mulch?				
	c. Are the outlet structures (if visible) and emergency overflow free of trash, landscape debris, sediment deposits, and other materials that may impede flow out of the main basin?				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	d. Is the area downstream of the outlet(s) free from erosion caused by water flowing from the outlet(s)?				
5	*The* **Drainage Area** *is the land that drains stormwater to the bioretention area during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lead to lower maintenance and repair needs for the bioretention area.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the bioretention area during a storm?				
6	*The* **Access Easement** *extends from a public roadway to the bioretention, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the bioretention area be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the bioretention by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.
Access

4.2 Cistern

SCM Inspection & Maintenance Guide

Cisterns are stormwater control measures (SCMs) that catch and temporarily store rain that falls onto rooftops (see Figure 1). The water is collected in a tank located above or below the ground. Once filled, the water in the cistern must be used or drained so the cistern is ready to capture more rainfall. Common uses for the stored non-potable water include landscape irrigation, toilet flushing, exterior washing, cooling water towers, and laundry. Cisterns are commonly paired with vegetated SCMs like bioretention areas, permeable pavement, grass channels, and enhanced swales.

Benefits of Cisterns

- Allow reuse of rainwater, reducing stormwater runoff
- Provide a water source for non-potable uses
- Relatively easy to maintain as compared to other SCMs

Property Owner Responsibilities

The city regulates cisterns located on private properties to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's cistern(s) are maintained in proper operating condition**. See Chapter 2 of this manual for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Cistern *(Source: Philadelphia Water Department)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this cistern *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city to determine if a cistern is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of cistern components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a cistern's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Thus, using the checklist for routine inspections is the best way to keep a cistern functioning properly as required by local ordinance. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a cistern must meet ALL applicable operation and maintenance standards. Non-compliant cisterns are subject to city enforcement.

Primary Components

To inspect a cistern using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the cisterns on their property and its components.

The components are explained in Table 1, and most of them are shown in Figure 2. More detailed examples of some components are shown in Figure 3.

Table 1. Cistern Components

1. **Inlets** let water flow into the SCM. In cisterns, inlets consist of gutters, downspouts, and pipes.
2. **Pretreatment device** (if present) removes debris and dust that washes off the roof from the water before it flows into the cistern.
3. The **main storage tank** is where stormwater is collected and held for later use or release.
4. The **emergency overflow** safely releases excess water when the main tank gets too full.
5. The **outlet(s)** let water exit the cistern. The primary outlet may be operated manually, automatically, or via a computer link.
6. The **drainage area** (not shown) is the area that drains to the cistern when it rains. The drainage area for most cisterns is a rooftop.
7. The **access easement** (not shown) extends from a public road to the cistern. It allows access to the SCM by the city when necessary.

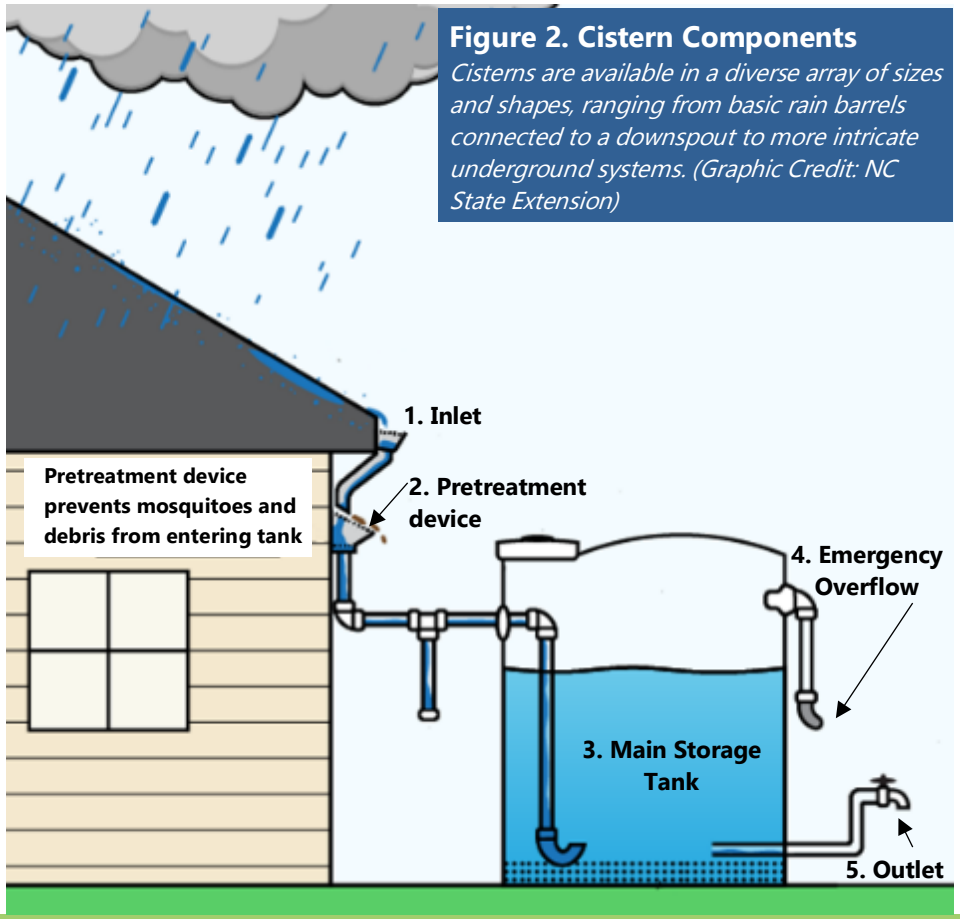
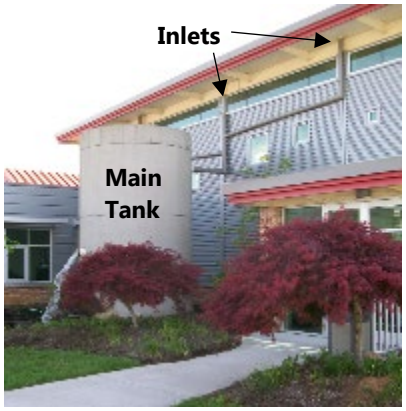


Figure 2. Cistern Components
Cisterns are available in a diverse array of sizes and shapes, ranging from basic rain barrels connected to a downspout to more intricate underground systems. (Graphic Credit: NC State Extension)



Left: The water from this cistern is used in a decorative pond on the property. (Source: Knox County, TN)

Figure 3. Cistern Component Examples *Right: The outlet of the cistern releases water to a nearby field, where it soaks into the ground. Thus, pollutants present on the rooftop (such as bird droppings, dust, and shingle grit) do not drain into the onsite stormwater system and local streams (Source: Knox County, TN)*

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the cistern's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Cisterns can be large enough for a person to enter. Cistern tanks can meet the definition of a confined space under 29 CFR 1926.1202, and therefore present a safety hazard. **DO NOT ENTER THE CISTERN TANK! ONLY PERSONS WITH OSHA CONFINED SPACE TRAINING CAN ENTER THE TANK. A SAFETY CREW MUST BE PRESENT.**

Cleaning

- ☑ **Keep the drainage area clean.** Remove leaves from gutters draining to the cistern. Consider installing a screen on gutters to prevent leaves, twigs, and larger debris from entering the inlets.
- ☑ **Remove leaves and debris from the pretreatment device** on a regular basis. Clean more frequently in the spring and fall, when pollen, dust, leaves, and debris are more prevalent. Dispose in the trash.
- ☑ **Check for erosion at the cistern outlet.** Repair immediately with sod or a rock apron and, if possible, reduce the outlet flow velocity to avoid erosion. Regardless, the cistern must drain within 48 hours after a rainfall.

Other Activities

- ☑ **Check the water level and water usage regularly.** The cistern should be drained sufficiently within 48 hours after a rainfall to allow for the capture of stormwater from the next rainfall.
- ☑ **Check for blockages throughout the system.** Sediment and debris inside the components can block flow through this system and potentially damage the components.
- ☑ **Check the system connections** between gutters, downspouts, buildings, hoses, and spigots. Repair sediment buildup, damage, cracks, or leaks promptly to protect the SCM, roof, and foundation.
- ☑ **Verify that required SCM signs are in place**. SCM signs required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Prevent damage to the cistern** by informing landscapers, contractors, and others who may be working on the landscape or building of the location and purpose of the SCM.
- ☑ **Inspect the cistern components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Cistern Troubleshooting

Cisterns are designed to function in tough outdoor conditions. Although they are designed to withstand these conditions, problems can occur. Regularly performing the routine maintenance activities described previously should eliminate or reduce the severity of problems. Table 2 describes the most common problems for Cisterns and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Cistern often overflows, or the high flow activator (if present) engages.	Stored water is being released too slowly or not at all. If there are no blockages present and the system seems to work as expected, it will increase water usage and/or empty storage before large storms.
Excessive debris/sediment build-up inside the main tank.	The pretreatment device is not working. It may be damaged or not well maintained. If the device is full of sediment and debris, sediment will bypass it and build up in the main tank. Clean the pretreatment device and its inflow and outflow pipes/hoses and check/repair damage. The main tank may also need to be cleaned. Construction activities may temporarily contribute to excessive sediment buildup on nearby rooftops. If construction is occurring nearby, clean the pretreatment device more frequently until construction ends.
Water in the tank has a foul odor.	Microbes or algae in the cistern (in the main tank) have overgrown. Follow the manufacturer's instructions to drain and clean the tank and replace or clean filters.
The area around the storage tank is wet or humid.	There may be a leak in the pretreatment device, or in the pipes, hoses, or connections surrounding the tanks, or the outlet is clogged. Check for leaks and clogs, and repair as quickly as possible following the manufacturer's instructions.
Erosion or scouring at the outlet and along the flow path.	Stabilize the eroded area and vegetate any bare spots. Add erosion control measures as needed (typically rock or rip rap aprons). Make sure the flow path away from the outlet is unobstructed.
Excessive mosquitos in or around the cistern.	Gutters and open top tanks are not draining fully. Check pretreatment devices and outlets and repair them as necessary.

When to Call an Expert

Sometimes problems occur that require an expert to figure out or correct, either because they present a safety issue (such as entering the main tank, which is a confined space), are too complex or difficult to manage alone, or replacement parts are required. When components are damaged, they must be repaired or replaced in keeping with the original cistern design. Failure to do so may result in city enforcement. **For significant component repairs, consult the cistern manufacturer or installer or a professional (civil) engineer**. Always ensure properly trained people are performing cistern maintenance.

Operation & Maintenance Standards Checklist
Cistern

This checklist guides an evaluation of the operation and maintenance standards for cisterns, organized by primary component. **For its design to be considered compliant by the city, a cistern must meet ALL applicable standards. Non-compliant cisterns are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The cistern name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Cistern 1" or "SCM A." Otherwise, describe the location of the cistern on the property (e.g., Cistern behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):		
	Phone #:	Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other			
	License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number	Has the City Entered and Approved This Inspection?	Name of Staff Approving This Inspection Report	Is a Follow-Up Inspection by Staff Required? Circle one	Reason for Follow-Up?
	Yes / No	Date of Inspection Approval:	Yes / No	

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Cistern

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the cistern needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the cistern.*				
	a. Are the gutters, downspouts, and other inlet features free of leaves, sediment, and other obstructions?				
	b. Are the downspouts and gutters securely attached to the building and the tank?				
	c. Are the downspouts, gutters, and the connections between them free of damage, modification, and signs of leakage?				
2	**Pretreatment devices** *remove trash, debris, and dirt from stormwater flowing into the main tank of the cistern.*				
	a. Has the pretreatment device been cleaned recently?				
	b. Area the pretreatment device and connections to and from it free of damage, modifications, and signs of leakage?				
3	*The* **Main Tank** *is where stormwater is collected and held for later use or release.*				
	a. Does the tank have available capacity for the next rainfall?				
	b. Is less than 5% of the tank's storage volume occupied by sediment or debris deposits?				
	c. Is the tank free of cracks, leaks, warps, bulges, modification, or any other forms of damage?				
	d. Is the water in the tank free of odors?				
	e. Is the area around the tank dry and free of signs of long-standing water?				
	f. Are pipes, hoses, valves, spigots, and pumps working properly?				
	g. Are cistern operation personnel properly trained in cistern operation?				
4	*The* ***Outlet*** *lets water exit the cistern. The* **Emergency Overflow** *allows water to flow directly to the outlet when water levels in the cistern get too high.*				
	a. Are the outlet and emergency overflow free of leaves, sediment, and other obstructions?				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	b. Are the outlet and emergency overflow securely attached to the main tank or other structure?				
	c. Do the outlet and emergency overflow and the connections between them and the tank free of damage, modification, and signs of leakage?				
	d. In small storms, does the emergency overflow remain dry if the previous rain event occurred four or more days prior?				
5	*The* **Access Easement** *allows access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the cistern be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the cistern by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.3 Dry Detention Basin

SCM Inspection & Maintenance Guide

Dry detention basins are Stormwater Control Measures (SCMs) that store stormwater and release it slowly, over 1 to 3 days after a storm (see Figure 1). There are two types of dry detention basins.

Benefits of Dry Detention Basins

- Prevent flooding
- Reduce downstream channel erosion and stormwater pollution (extended detention basins only)

1. A **standard dry detention basin** is designed to prevent flooding of the surrounding area.
2. An **extended dry detention basin** prevents flooding of the surrounding area, slows stormwater releases so they do not erode downstream channels and streams, and treats polluted stormwater by allowing pollutants, like sediment, to settle to be bottom of the basin before the water drains out.

Both types of basins are designed to discharge all stormwater within 48 hours after a storm and return to a completely dry condition. They may take longer to drain after prolonged or heavy rain.

Property Owner Responsibilities

The city regulates dry detention basins located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's dry detention basin(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Dry Detention Basin *(City of White House TN)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this guide can be used by property owners and persons maintaining SCMs to determine if a dry detention basin is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of dry detention basin components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a dry detention basin's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to ensure compliance with operation and maintenance standards.** Routine inspections are the best way to keep a dry detention basin functioning properly as required by local ordinance. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a dry detention basin must meet ALL applicable operation and maintenance standards. Non-compliant dry detention basins are subject to city enforcement.

Primary Components

To inspect a dry detention basin using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the basin(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Detention Basin Components

1. **Inlets** let water flow into the forebays (#2). A single basin may have multiple inlets.
2. **Forebays** are shallow concrete, grass, or rock depressions below each inlet. They prevent substantial amounts of trash, debris, and sediment from washing into the main basin.
3. The **outlet structure** allows water to exit the basin in a controlled way to prevent flooding or treat stormwater pollution. Most will have multiple openings that discharge water at specific flow rates per city rules.
4. The **emergency spillway** lets stormwater safely exit the basin before it floods.
5. The **main basin** is the large area of dense grass and (sometimes) rock where stormwater is held. It is surrounded by embankments.
6. The **embankments** are the berms (usually grassed, earthen berms) that keep water in the main basin. The dam is the embankment nearest the outlet structure.
7. The **drainage area** is the area of land that drains to the basin when it rains.
8. The **access easement** (not shown) extends from a public road to the basin. It allows the city access to the basin when necessary.

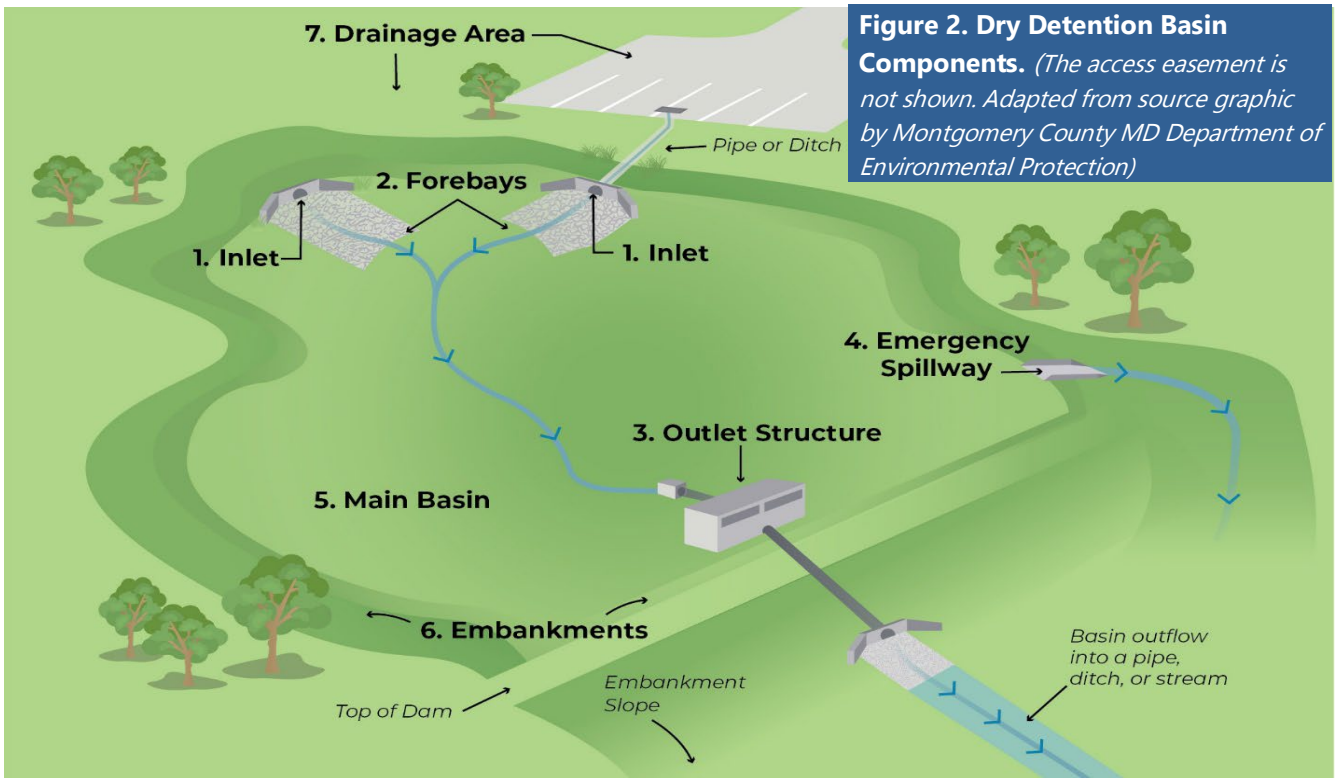
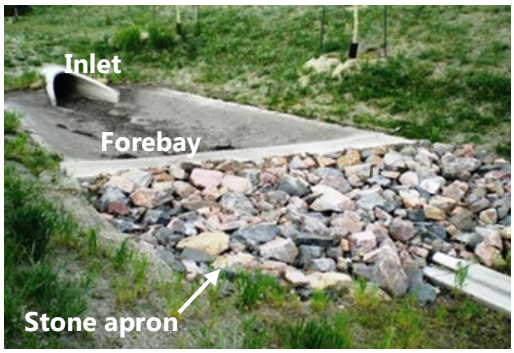


Figure 2. Dry Detention Basin Components. *(The access easement is not shown. Adapted from source graphic by Montgomery County MD Department of Environmental Protection)*



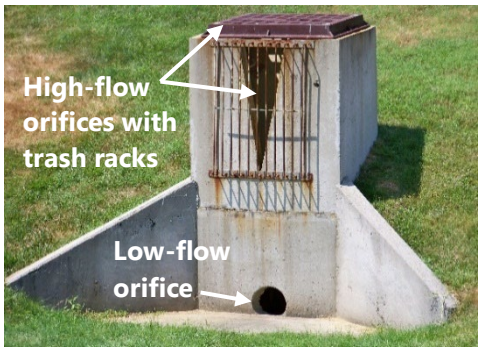


Figure 3. Examples of Basin Components. *Left: This forebay has a stone apron to slow water as it flows into the main basin. (Source: Colorado DOT Report No. CDOT-2016-05); Right: This outlet structure has a low-flow orifice and two high-flow orifices with rebar trash racks. (Source: Josh Wyrick)*

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the dry detention basin's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Mow** all grassed areas at least twice a year; turf grasses should be mowed more frequently.
- ☑ **Remove trees and woody shrubs** on the dam and slopes, in the main basin, and in the access easement at least twice a year.
- ☑ **Seed, sod, or cover areas of bare soil and repair eroded areas** with grass or other appropriate ground cover as soon as they are noticed. Do this in the basin and its drainage area.
- ☑ **Apply organic, eco-friendly fertilizers only when necessary** (at most, once or twice a year) to maintain dense, healthy grass within the drainage area and on the outside of embankments. Avoid using fertilizers (and herbicides) altogether in the main basin and on the basin-side of embankments. Better yet, kick the fertilizer habit entirely by creating a healthy soil environment using natural methods (consult an expert).

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment** from the inlets, forebay, main basin, and outlet structure as often as possible. Do not store anything, in the basin, including temporary stockpiles of landscape material (e.g., mulch). Dispose of landscape debris (e.g., bagged clippings, fall leaves, brush) in the trash.
- ☑ **Keep the drainage area clean, too.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Control burrowing animals, beavers, and fire ants**, especially on the embankments and around the outlet structure. A licensed Animal Control Operator (ACO) can help with animals, especially beavers.
- ☑ **Cover potential pollutants in the drainage area** that can be washed into the basin during a storm. Use a tarp and berm if they are outside or store them inside a building. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Verify that required basin signs are in place**. Safety and educational signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the basin components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Dry detention basins are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for dry detention basins and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
The main basin frequently does not return to a dry condition within 48 hours of a storm.	The outlet structure or the receiving pipe/ditch may be clogged. Wait until it is safe to check these components and remove the clog. This condition is likely not a concern if it is observed during or after a prolonged series of storms.
Trash, debris, and sediment frequently accumulate in the forebay.	Clean the forebay frequently. If it is full of trash, debris, and sediment, it cannot prevent these materials from getting washed into the main basin. Over time, this problem can lead to more costly repairs to basin components. So, it must be addressed as soon as it is noticed.
Trash, debris, and sediment frequently accumulate in the main basin.	For trash, identify the source (e.g., litter, overflowing bins) and take steps to reduce it (e.g., add bins, pick up litter, empty bins more often). Regularly maintain landscaping in and around the drainage area. Require landscapers to cover stockpiles and properly dispose of debris. For sediment, locate the source (e.g., bare soil, stockpiles) and cover or repair it as needed.
Burrowing animals or fire ants are present in the main basin or embankments.	Safely remove pests using methods that do not contaminate water (e.g., no pesticides). Call an expert if needed. Over time, both of these pests can degrade the structural ability of the embankments. Address these issues as soon as they are noticed.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** for: • Grass, landscape, and erosion repair • Removal of large accumulations of sediment A **tree service company** can remove large trees. A **licensed Animal Control Officer** can remove beavers and other pests	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist

Dry Detention Basin

This checklist guides an evaluation of the operation and maintenance standards for dry detention basins and is organized by primary component. It can be used for both standard and extended dry detention basins. **For its design to be considered compliant by the city, a basin must meet ALL applicable standards. Non-compliant basins are subject to city enforcement.**

SCM Name and Location		Today's Date:
	The detention basin name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Dry Detention Basin 1" or "SCM A." Otherwise, describe the location of the dry detention basin on the property (e.g., Dry detention basin behind main office building).	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other	
	License or Certification #	License or Certification Expiration Date:

SCM Owner Information	Name (Person(s) or Company):		Contact Name (If Different):	
	Street Address:	City:	State:	Zip:
	Phone #:		Email:	

This Section is for Stormwater Staff Use Only

Identification Number		Has the City Entered and Approved This Inspection? Yes / No	
Name of Staff Approving This Inspection Report		Date of Inspection Approval:	
Is a Follow-Up Inspection by Staff Required? Circle one	Yes / No		
Reason for Follow-Up?			

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Dry Detention Basin

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the basin needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete.

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel lined with dense grass or stone. There may be multiple inlets to a detention basin.*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are the inlet pipes and headwalls undamaged and not modified?				
	c. Are ditch inlets fully lined with dense grass or stone (mulch is prohibited)? There must be no erosion and large areas with bare soil *(channel inlets only)*.				
	d. Are the areas just upstream and downstream of the inlets free of soil erosion and standing water?				
2	*The* **Forebay** *slows down stormwater before it enters the main basin. A forebay can be made of concrete, riprap stone, or (less often) dense grass. There should be a forebay downstream of every inlet to the basin.*				
	a. Is the forebay kept clean (no buildup of trash, landscape debris, sediment, and standing water)?				
	b. Are grassed areas densely vegetated and free of soil erosion?				
	c. Are the entrances and exits to the forebay free of obstructions and modifications?				
3	*The* **Main Basin** *is where stormwater is stored in the basin. It is surrounded by the embankments.*				
	a. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and fire ant mounds?				
	b. Is the area free of trash, debris, and significant accumulations of sediment?				
	c. Is the area free of dumped, stored, or stockpiled materials, (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	d. Is the area free of any intentionally built structures (e.g., sheds, storage pads, fences, etc.) that were not included in the original property design?				
	e. Does healthy, dense grass or another grassy ground cover at least 90% of the surface area of the main basin? Is the area free of large bare spots and areas of dead/dying grass? Is the area free of trees and plants with woody stems?				

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	f. For inspections more than 2 to 3 days after a storm, can you confirm that no standing/stagnant water and wetland plants (e.g., cattails) are present?				
	g. Standing water may be present during inspections within 2 to 3 days of a storm or during a prolonged period of wet weather. Can you confirm that water is flowing into the outlet structure as expected ?				
4	*The* **Embankments** *surround the main treatment area and hold the water in the basin. Most embankments are earthen and lined with dense grass or riprap stone. If included in the original design, more decorative embankments incorporating boulders, retaining walls, and other hardscaping may also be incorporated .*				
	a. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and fire ant mounds?				
	b. Are the embankments free of trash and debris, structures (e.g., sheds, storage pads, walls, etc.) and fences that were not included in the original property design?				
	c. Do the embankments appear undamaged and stable? (no erosion, sloughing, sliding, bulging, cracking, leaking, fire ant mounds, evidence of burrowing animals, wet areas, etc.)				
	d. Is the area entirely free of trees and plants with woody stems?				
	e. Are vegetated areas on embankments entirely (100%) with healthy, dense grass or another grassy ground cover? Are they free of large bare spots or areas of dead/dying grass? Are they mostly covered by grass/ground cover without trees and plants with woody stems? Are the non-vegetated areas fully covered by riprap stone or concrete?				
5	*The* **Emergency Spillway** *is typically located on top of an embankment and covered with concrete or dense grass. There is usually only one emergency spillway; however, large basins may have multiple spillways.*				
	a. Is the emergency spillway undamaged and not modified in any way that changes its proper function (i.e., blocked by a fence, excavated lower than it should be, etc.)?				
	b. Is the area just below the spillway free of soil erosion or scour holes?				
	c. Is the spillway fully lined with dense grass (mulch is prohibited) or concrete?				
6	*The* **Outlet Structure**, *typically a concrete pipe or box (or corrugated metal pipe), sits at the basin's bottom near the toe of an embankment. It connects to an outlet pipe allows water to exit the basin in a controlled way. Outlet structures have multiple openings. Most outlets have a small low-flow orifice near structure's bottom. The orifices above the low-flow outlet will gradually get larger (and may even have different shapes) as they near the top of the structure.*				
	a. Is the low-flow orifice (i.e., the small hole at the base of the structure) free of blockages and clogs allowing water to easily drain through it?				

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	b. Are the other orifices (or the trash racks or filter boxes that may cover them) free of trash, debris, sediment, or other material that would cause the water to back up and not drain properly?				
	c. Are skimmers (if present) unclogged, show evidence of regular cleaning, and fully operational?				
	d. Does the outlet structure appear undamaged and has not been modified in any way that would change its function?				
	e. Is the area around the outlet structure or below the outlet pipe free of erosion or scour holes?				
7	*The* **Drainage Area** *is the land that drains stormwater to the detention basin during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the basin's maintenance and repair needs .*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil, or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				
8	*The* **Access Easement** *extends from a public roadway to the basin, allowing maintainers and the city to access the basin for inspection and maintenance enforcement purposes.*				
	a. Can the basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the basin by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.4 Enhanced Swale (Wet or Dry)

SCM Inspection & Maintenance Guide

Enhanced swales are stormwater control measures (SCMs) designed to capture and treat stormwater from small storms using low check dams to slow or contain runoff (see Figure 1). They are usually shallow, wide, and vegetated to help filter stormwater runoff. There are two types of enhanced swales.

Benefits of Enhanced Swales

- Stormwater soaks into the ground or evaporates, reducing runoff and erosion
- Easier to maintain than underground pipes

1. **Dry enhanced swales** are broad, shallow, and covered with thick grass. They typically include an underdrain to filter stormwater through the bottom of the swale and are common in residential settings.
2. **Wet enhanced swales** retain water, creating marshy conditions that support wetland vegetation. Used in high water table or poorly draining areas, they allow sediment and pollutants to settle for easy removal.

Property Owner Responsibilities

The city regulates enhanced swales located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring the enhanced swale(s) on their property are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Dry Enhanced Swale *The low concrete check dams slow stormwater, allowing runoff from small storms to soak into the soil. During large storms, runoff flows safely over the dams and continues downstream. (Source: MD Dept of Environment)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this guide should be used to determine if an enhanced swale is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of enhanced swale components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand an enhanced swale's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Routine inspections keep an enhanced swale functioning properly per local ordinances. See Chapter 3 of this manual for general information on SCM inspections.

The *Operation & Maintenance Standards Checklist* describes the required operation and maintenance standards for enhanced swales in a question format. A "Yes" answer means the standard in question has been met. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, an enhanced swale must meet ALL applicable operation and maintenance standards. Non-compliant enhanced swales are subject to city enforcement.

Enhanced Swale Primary Components

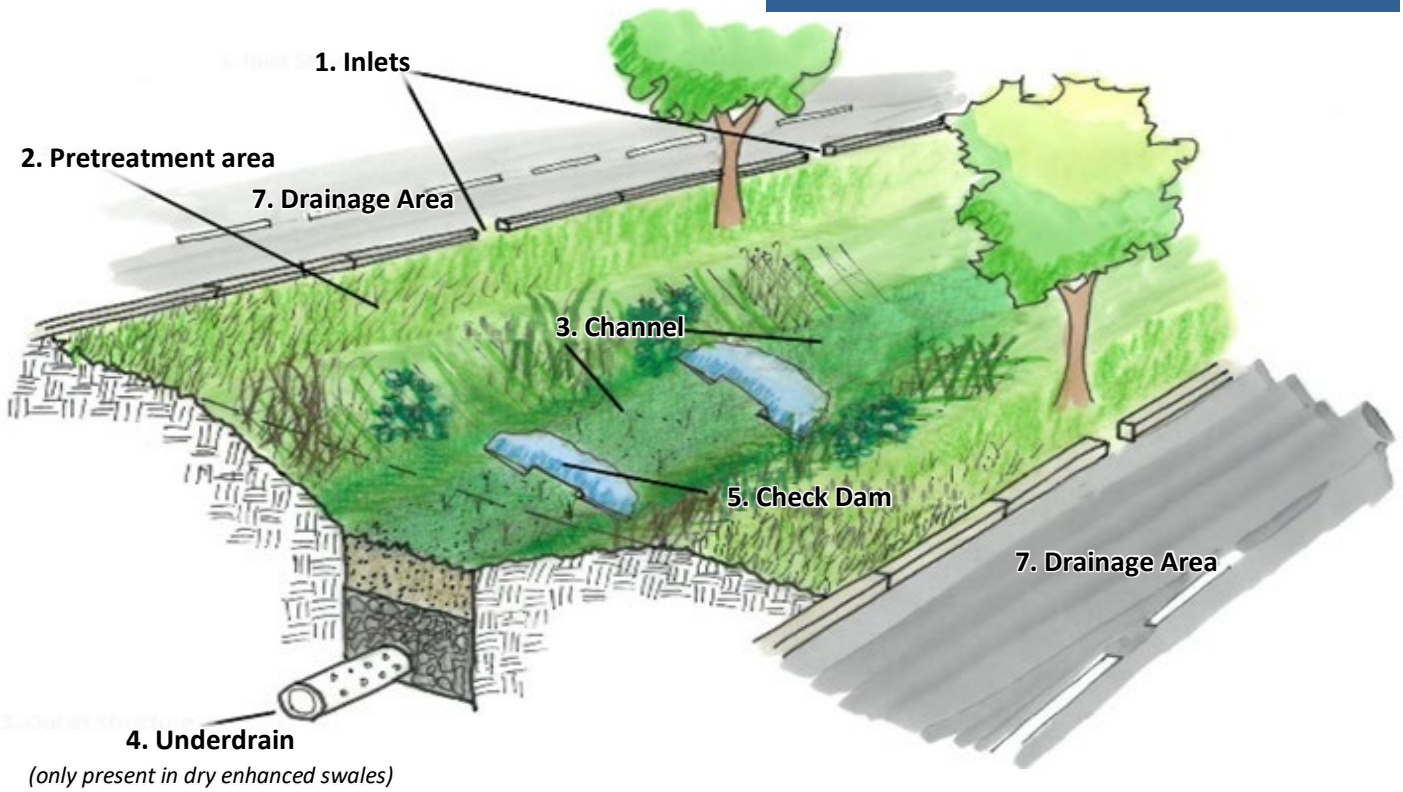
To inspect an enhanced swale using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the enhanced swale(s) on their property and the components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Enhanced Swale Components

1. **Inlets** let water flow into the SCM.
2. **Pretreatment areas** are rock or vegetated areas that runoff flows over (or through) before reaching the channel. These areas can remove trash and debris before water enters the channel.
3. The **channel** is where stormwater is collected. Channels in dry swales do not hold water for more than about 2 days after storms. Wet swales are designed to remain wet at all times, although they may dry during a drought.
4. Dry swales have an **underdrain** that lets water that has soaked into the soil exit the SCM. Wet swales do not have underdrains.
5. **Check dams** slow water in the swale, providing time for treatment of polluted stormwater. During intense or long storms, water will flow over the dams. Wet swales may not include check dams.
6. The **outlet structure** (not shown) allows water to exit the swale in a controlled way.
7. The **drainage area** is the area of land that drains to the swale when it rains.
8. The **access easement** (not shown) extends from a public road to the swale. It allows the city access to the swale when necessary.

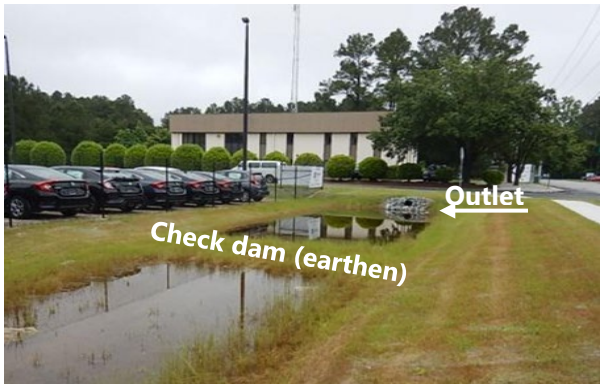
Figure 2. Enhanced Swale Components



4.4 Enhanced Swale (Wet or Dry)

SCM Inspection & Maintenance Guide

Figure 3. Examples of Swale Components. *Left: Wet enhanced swale with earthen check dams. (Source: MD Dept of Environment); Right: Underdrain of a dry enhanced swale (Source: NC State Extension Publications).*



Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the enhanced swale's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Mow** all grassed areas at least twice a year; turf grasses should be mowed more frequently.
- ☑ **Maintain the plants.** Enhanced swales must be fully covered by healthy plants. Dry enhanced swales must have dense grass. Wet enhanced swales must have dense grass or non-woody, emergent wetland plants that can endure frequent, long-term inundation. Native grasses or plants are preferred because they are better suited to East Tennessee's climate. Areas of bare soil and mulch are not allowed. Avoid using fertilizers or pesticides.

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment** from the swale as often as possible. Do not use the swale to dump or store anything, including temporary stockpiles of landscape material (e.g., mulch). Dispose of landscape debris (e.g., bagged clippings, fall leaves, brush) in the trash.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.
- ☑ **Remove or compost leaves in the fall.** Leaves can kill the grass and other plants and clog the swale.

Other Activities

- ☑ **Cover potential pollutants in the drainage area** that can be washed into the swale during a storm. Use a tarp and berm if they are outside or store them inside a building. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Verify that required signs are in place**. Signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the swale components after every major storm** for debris and damage. Clean and repair components as needed. Ensure there is no erosion in the main treatment area or around inlets and outlets. Contact the city's stormwater department if you have concerns.
- ☑ **Ensure pedestrians, vehicles, and heavy equipment are not entering the swale.**
- ☑ **Control burrowing animals, beavers, and fire ants** as they can damage components and cause improper swale operation. A licensed Animal Control Operator (ACO) can help with animals, especially beavers.

Enhanced Swale Troubleshooting

Enhanced swales are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems can occur. Regularly performing the routine maintenance activities described previously should prevent or reduce the severity of problems. Table 2 describes the most common problems for enhanced swales and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
A dry swale frequently does not return to a dry condition within 48 hours of a storm.	The outlet or underdrain structure may be clogged. Wait until it is safe to check these components and remove the clog. If no clog is found, the soil in the channel may be compacted due to heavy foot traffic or machinery in the swale. Consult a civil engineer for repair.
Trash, debris, and sediment frequently accumulate in the swale.	Clean inlets, channels, check dams, and outlets regularly to prevent clogging. Determine the source of trash (e.g., litter, frequently overflowing trash cans, etc.) and take steps to reduce the problem (e.g., add trash cans, pick up litter, and empty trash cans more frequently, etc.). Maintain the landscape in the drainage area and around the swale regularly. Require landscapers to cover stockpiles and dispose of debris in the trash or remove it from the premises. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Plants are unhealthy or dying	Irrigate swale vegetation during dry periods. Wet swales often include wetland plants. If they are unhealthy, the swale may not be holding water to sustain them. Salt and sand used on roadways/parking lots during the winter can damage a swale's plants. Revegetation may be necessary to restore healthy, dense growth.
Areas of erosion	Erosion indicates that runoff is moving too fast or is too concentrated in the area of erosion. Slow and/or spread runoff using plants or rock aprons.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** if you notice: • Sediment is clogging the swale • Vegetation needs to be replaced • Erosion in the swale	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Enhanced Swale

This checklist guides an evaluation of the operation and maintenance standards for enhanced swales, organized by primary component. **An enhanced swale must meet ALL applicable standards for its design to be considered compliant by the city. Non-compliant swales are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The enhanced swale name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Enhanced Swale 1" or "SCM A." Otherwise, describe the location of the enhanced swale on the property (e.g., Enhanced swale behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):		
	Phone #:	Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other			
	License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number	Name of Staff Approving This Inspection Report	Has the City Entered and Approved This Inspection?	Date of Inspection Approval:	Is a Follow-Up Inspection by Staff Required? Circle one	Reason for Follow-Up?
		Yes / No		Yes / No	

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Enhanced Swale

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the swale needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe, curb opening, or just an area where water is allowed to flow into the swale. An enhanced swale may have multiple inlets .*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are the inlets undamaged and not modified?				
	c. Are the inlet structures free of erosion, bare spots, and scour?				
2	**Pretreatment areas**, *which may be vegetated or rock-lined, remove trash, debris, and dirt from stormwater flowing into the enhanced swale. The* **channel** *is where stormwater is collected and soaked into the soil.*				
	a. Are pretreatment areas and the channel free of trash, debris, and accumulations of sediment?				
	b. Are pretreatment areas and the channel free of signs of pedestrian, vehicle, animal, or heavy equipment damage? (There is no evidence of compacted soil, pet waste, or damaged plants).				
	c. Are pretreatment areas and the channel free of dumped, stored, or stockpiled materials (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	d. Are pretreatment areas and the channel free from evidence of oil or other pollutants?				
	e. Are pretreatment areas covered with healthy, dense grass or rock? Is the area free of large bare spots and erosion?				
	f. Dry Enhanced Swales Only: Is the channel entirely (100%) covered with healthy, dense grass or another grassy ground cover? Is the area free of large bare spots or areas of dead/dying grass?				
	g. Dry Enhanced Swales Only: For inspections more than 2 to 3 days after a storm, can you confirm that no standing/stagnant water and wetland plants (e.g., cattails) are present?				
	Standing water may be present during inspections within 2 to 3 days of a storm or during a prolonged period of wet weather. Can you confirm that water is flowing into the outlet structure as expected?				

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	h. Wet Enhanced Swales Only: Is the channel entirely (100%) covered with a mix of healthy wetland and upland vegetation? Is the area free of large bare spots or areas of dead/dying plants?				
	i. Wet Enhanced Swales Only: Does the swale appear to be holding water such that wetland plants are established and thriving?				
3	*The* **check dams** *let runoff from large storms safely pass through the enhanced swale without flooding the surrounding area. They could be constructed of rock, concrete, densely vegetated soil, or other stable material. Check dams should be undamaged, level, and free of erosion or soil accumulations on all sides .*				
	a. Are the check dams reasonably level and undamaged? (The top of the dam should be fairly level, so water flows evenly over it, rather than flowing over just one or more low spots on the dam.)				
	b. Are earthen check dams densely vegetated and free of areas of bare soil and animal burrows?				
	c. Are the areas around the check dams free of erosion or scour?				
4	Dry Enhanced Swales Only: *The* **UNDERDRAIN** *allows water that has soaked into the soil to exit flow out of the swale. Most underdrains will have an observation port to allow inspection. If there are no observation ports, mark these as NA.*				
	a. For inspections more than 2 to 3 days after a storm, can you confirm that no standing/stagnant water is present in the underdrain?				
	b. Slow-flowing water may be present during inspections within 2 to 3 days of a storm or during a prolonged period of wet weather. Can you confirm that water is flowing through the underdrain as expected?				
5	*The* **Outlet Structure** *lets water exit the swale. In some cases, the outlet structure consists of an underdrain. In other cases, it may be a catch basin or pipe that connects to the stormwater conveyance system.*				
	a. is the outlet structure visible and free of damage and modifications that may impair its function as originally designed?				
	b. Is the outlet structure free of trash, landscape debris, sediment deposits, and other materials that may impede flow out of the main basin?				
	c. Is the area downstream of the outlet(s) free from erosion caused by water flowing from the outlet(s)?				
6	*The* **Access Easement** *extends from a public roadway to the swale, maintainers and the city access for inspection and maintenance enforcement purposes.*				
	a. Can the enhanced swale be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the swale by large maintenance equipment?				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	The **Drainage Area** *is the land that drains stormwater to the swale during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the swale's maintenance and repair needs .*				
7	**a.** Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil, or sparse vegetation that could be a source of sediment washing into the enhanced swale during a storm?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to person(s) performing maintenance or repairs.

4.5 Grass Channel

SCM Inspection & Maintenance Guide

Grass channels are vegetated stormwater control measures (SCMs) that slow and filter storm water before further treatment by another SCM (see Figure 1). The grass slows down stormwater and aids filtration. Stone or concrete dams help slow water in steep areas. During heavy storms, grass channels direct excess runoff to another SCM or storm drain. A properly functioning grass channel drains returns to a dry condition after a storm.

Benefits of Grass Channels

- Removes pollutants from storm water
- Slows stormwater, which can reduce erosion in nearby streams
- Eliminates nuisance flooding
- Easier to maintain than underground pipes

Property Owner Responsibilities

The city regulates grass channels located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring the SCMs on their property are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Grass Channel *(Source: Nashville LID Manual)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this grass channel *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city determine if a grass channel is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of a channel's components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a grass channel's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Thus, using the checklist for routine inspections is the best way to keep a grass channel functioning properly as required by local ordinance. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a grass channel must meet ALL applicable operation and maintenance standards. Non-compliant grass channels are subject to city enforcement.

Primary Components

To inspect a grass channel using the *Operation & Maintenance Standards Checklist*, it is important to know the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the grass channel(s) on their property and the components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Grass Channel Components

1. **Inlets** (not shown) let water flow into the SCM. A grass channel can have multiple inlets.
2. **Pretreatment areas** remove trash, debris, and dirt from stormwater flowing in. Inlets are often lined with rock or dense grass.
3. The **channel** is where stormwater flows and filters. The channel may have **check dams** to slow water.
4. Channels are usually designed to carry large flows. However, some channels include **emergency overflows** (not shown) to safely exit excess water.
5. The **outlet** (not shown) allows water to exit the channel. It usually discharges to another grass channel, a different SCM, or to the property's stormwater conveyance system.
6. The **drainage area** (not shown) is the area of land that drains to the grass channel when it rains. Typically, this is a paved area or rooftop.
7. The **access easement** (not shown) extends from a public road to the channel. It allows the city access to the channel when necessary.

Figure 2. Grass Channel Components. *(Graphic adapted from: Fairfax County VA Stormwater Facility Fact Sheets)*

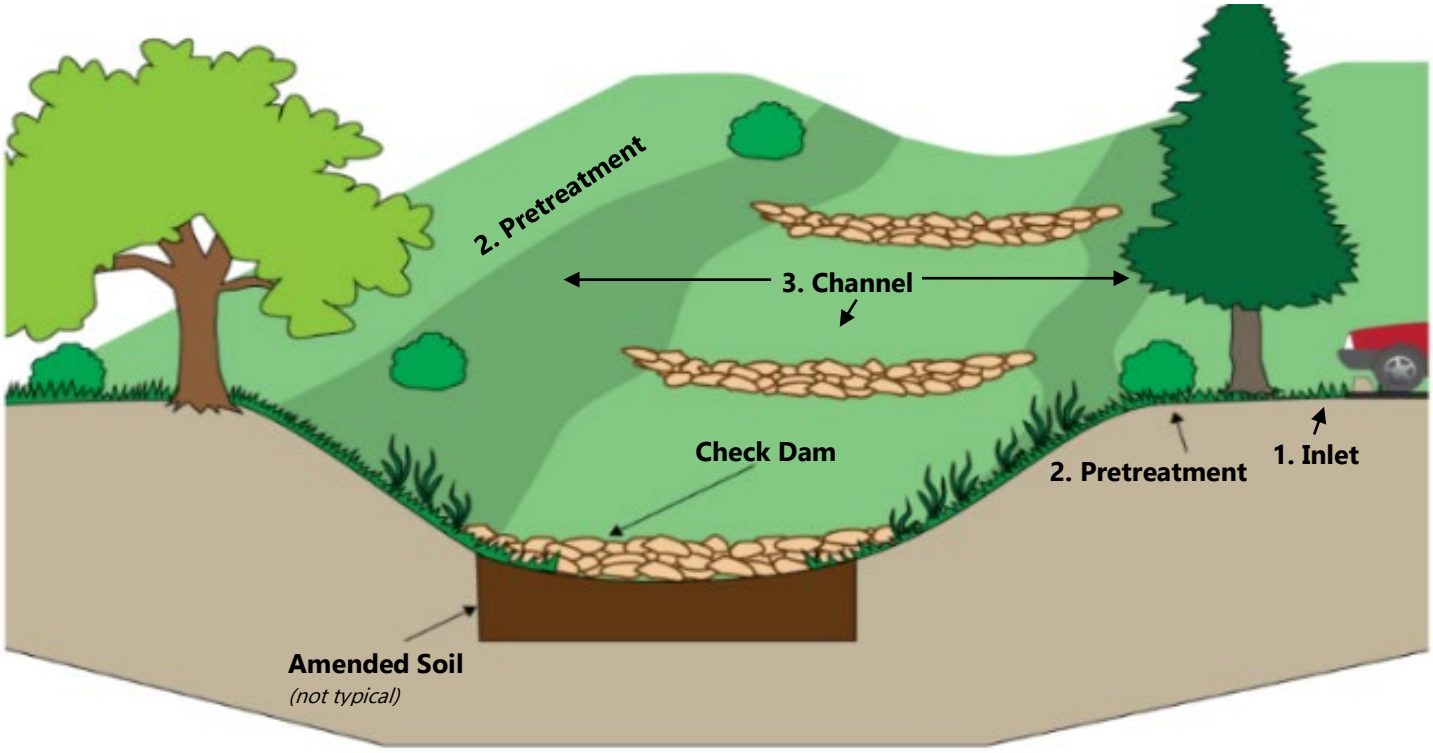


Figure 3. Grass Channel Components

Left: Downspouts (not shown) drain stormwater on the roof to the grass channel. (Source: City of Norfolk VA) Right: This grass channel accepts receives water from the parking lot and drains into a grated outlet. The outlet leads to the property's underground stormwater system. (Source: Nashville LID Manual)

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the grass channel's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Mow** the channel at least twice a year; turf grasses should be mowed more frequently.
- ☑ **Control erosion, weeds, and animals.** Grass channels must be fully covered by dense grass to provide stormwater filtration. Keep weeds under control so they do not overtake the grass. Avoid using fertilizers or pesticides as much as possible. Areas of bare soil and mulch are not allowed. Remove any woody shrubs and trees that have taken root. Remove/relocate burrowing animals.

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment** as often as possible. Do not store anything, including temporary stockpiles of landscape material (e.g., mulch and soil), in the channel. Dispose of landscape debris (e.g., bagged clippings, fall leaves, brush) in the trash.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.
- ☑ **Remove or compost leaves in the Fall.** Leaves left on the channel can kill the grass and clog outlets.

Other Activities

- ☑ **Cover potential pollutants in the drainage area** that can be washed into the grass channel during a storm. Use a tarp and berm if they are outside or store them inside a building. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Verify that the required signs are in place**. SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the grass channel components after every major storm** for debris and damage. Clean and repair components as needed. Ensure there is no erosion in the main treatment area or around inlets and outlets. Contact the city's stormwater department if you have concerns.
- ☑ **Ensure pedestrians, vehicles, and heavy equipment are not entering the grass channel.**

Troubleshooting

Grass channels are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for grass channels and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Standing water routinely remains in the grass channel after 2 days with no rain.	The outlet may be clogged or buried. Wait until it is safe to check the outlet and correct the problem. If this problem occurs frequently at check dams, the bottom of the channel may be too compact to allow water percolation. Amend the soil and re-sod.
Trash, debris, and sediment frequently accumulate in the grass channel.	Clean inlets and swales regularly to prevent clogging and ensure proper infiltration. Identify the source of trash (e.g., litter, overflowing bins) and reduce it by adding bins, picking up litter, and emptying bins more often. Maintain the landscape in the drainage area and around the channel regularly. Require landscapers to cover stockpiles and dispose of debris in the trash or remove it from the premises. Find the source of accumulated sediment (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Grass is unhealthy or dying	Excessive amounts of salt and sand used on driveways and parking lots can damage the grass. Inform property managers. Water the grass during dry periods. Fertilize if necessary, using fertilizers that are appropriate for use near waterways.
Erosion or bare soil in the channel.	Consider installing check dams. Check dams (if present) may not be level, so water concentrates and erodes the channel. Repair check dams so water flows over them evenly.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** if: • Erosion occurs frequently • Check dams require repair	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Grass Channel

This checklist guides an evaluation of the operation and maintenance standards for grass channels, organized by primary component. **A grass channel must meet ALL applicable standards for its design to be considered compliant by the city. Non-compliant grass channels are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The grass channel name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Grass Channel 1" or "SCM A." Otherwise, describe the location of the grass channel on the property (e.g., Grass channel behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company): Phone #:	Contact Name (If Different): Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address: Phone #:	City: Email:	State:	Zip:

This Section is for Stormwater Staff Use Only

Identification Number	Has the City Entered and Approved This Inspection?	Name of Staff Approving This Inspection Report	Is a Follow-Up Inspection by Staff Required? Circle one	Reason for Follow-Up?
	Yes / No	Date of Inspection Approval:	Yes / No	

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Grass Channel

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the grass channel needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe, culvert, curb cut, or area lined with dense grass or stone. A grass channel may have multiple inlets .*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are inlets free of erosion and areas of bare soil?				
	c. Are the inlets free of damage or modifications that may impair their intended operation?				
2	*The* **Pretreatment** *area removes trash, debris, and dirt from stormwater flowing into the grass channel. Pretreatment areas are typically rock-lined or dense grass aprons.*				
	a. Is the area free of trash, landscape debris, weeds, and significant deposits of sediment?				
	b. Is the area fully lined with rocks or dense grass and free of damage, erosion, and areas of bare soil?				
	c. Are the areas where stormwater enters and exits the pretreatment area free from obstructions and damage, allowing water to easily flow through it?				
3	*The* **channel** *is where stormwater flows.*				
	a. Does dense grass cover at least 95% of the surface area of the channel? Is the area free of large bare spots or areas of dead/dying grass? Is it free of cattails or evidence that wetland conditions are forming?				
	b. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and fire ant mounds?				
	c. Is the channel free of damage and sinkholes/throats or drop-outs (i.e., depressions or openings in the ground surface that form on their own, especially after rainfall)?				
	d. Is the channel free of dumped, stored, or stockpiled materials (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	e. Is the channel free of evidence of pollutant dumping (e.g., oil sheen, paint stains, foam/froth, etc.)				

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	f. Are check dams (if present) free of damage and largely free of weeds and accumulated debris and sediment? (Check dams usually look like rock dams designed to slow down water)				
	g. Does the channel appear to function properly given recent rainfall conditions? • Standing water is not present in the channel *(if inspection is performed at least 72 hours after a storm)*; or, • Flowing water or wet conditions are present, but the channel is draining as expected *(if inspection is performed within 72 hours after a storm or within prolonged period of wet weather)*				
	h. Are trees (if present) limited to about one per 50 square feet?				
4	*The* **Emergency Overflows** *(if present) let stormwater flow out of the channel if it is not designed to handle large flows.*				
	a. Is the emergency overflow free of damage or modifications that may impair its intended operation?				
	b. Is the area around the overflow structure free of erosion or scour?				
5	*The* **Outlet** *lets water exit the channel. The outlet may be a culvert, grated drain leading to an underground pipe, or even the transition of the channel from one property to the next, or transition to another SCM.*				
	a. Is the emergency overflow free of damage or modifications that may impair its intended operation?				
	b. Is the outlet free of sediment, trash, and debris that could cause clogging?				
	c. Is the outlet and the location just beyond (downstream) of it free of erosion and scour?				
6	*The* **Drainage Area** *is the land that drains stormwater to the channel. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the maintenance and repair needs for the grass channel.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the grass channel during a storm?				

7	*The* **Access Easement** *extends from a public roadway to the channel, allowing maintainers and the city access for inspection and maintenance enforcement.*				
	a. Can the grass channel be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the grass channel by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.6 Green Roof

SCM Inspection & Maintenance Guide

A **green roof** (also called vegetated or living roof) is a stormwater control measure (SCM) where plants grow in a thin layer of planting media (Figure 1). Rainwater soaks into the media, reducing runoff in small storms (up to 1 inch). During larger storms, excess water drains via outlets after flowing along a waterproof layer.

Benefits of Green Roofs

- Reduce stormwater from rooftops
- My decrease localized flooding
- Insulate the roof
- Provide an amenity (in some cases)

Extensive green roofs have a thin growing medium and hardy, low-water plants like succulents and grasses. Intensive green roofs use a thicker medium and support a wider variety of plants.

Property Owner Responsibilities

The city regulates green roofs located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring the green roof(s) on their property are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

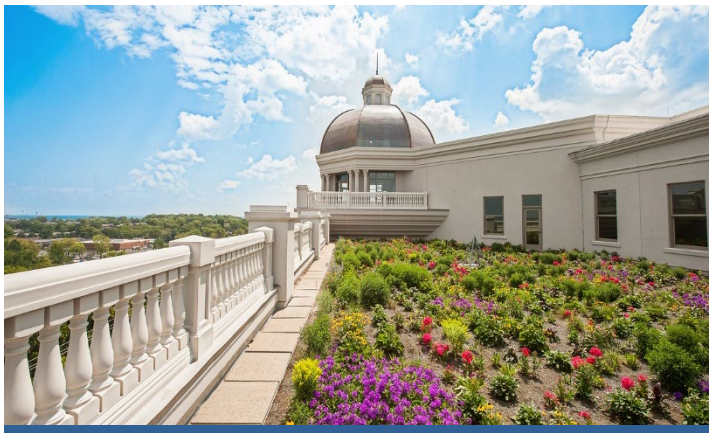


Figure 1. Green Roof at Belmont University in Nashville *(Source: Belmont University)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this green roof *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city to determine if a green roof is operating properly.

- **The checklist guides an evaluation of green roof components, describing the city's standards for proper operation and maintenance of each.** When used along with any maintenance guidance provided by the manufacturer/installer of the roof, these documents allow inspectors and maintainers to understand a green roof's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Thus, using the checklist and maintenance guidance provided by the roof manufacturer/installer for routine inspections is the best way to keep a green roof functioning properly as required by the local ordinance. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a green roof must meet ALL applicable operation and maintenance standards. Non-compliant green roofs are subject to city enforcement.

Primary Components

To inspect a green roof using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing and maintenance guidance provided by the green roof manufacturer/installer to better understand their green roof and its components as they may differ from that shown below.

Typical primary components of a green roof are explained in Table 1, and most of them are shown in Figure 2. More examples of green roofs in Tennessee are shown in Figure 3.

Table 1. Green Roof Components

1. Visually, the **plant area** is the entire area covered by plants. It is designed with multiple underlying layers, each providing a different purpose. Typical green roof layers are described generally herein and shown in Figure 2; however, roof design varies by manufacturer. Thus, the number, name, and placement of layers may vary from what is shown in the figure. It is best to consult the Record Drawing and maintenance guidance provided by the roof manufacturer.
   - The **plant layer** is where the vegetation grows.
   - The **growing media layer** is comprised of the soil in which the plants grow.
   - **Drainage and filtration layers** allow the movement and filtration of excess water that will exit the roof via the outlet.
   - **Protection and storage layers** provide additional water storage and a root barrier to prevent damage to the roof. Depending on the roof design, several protection layers may be necessary.
   - **Waterproofing and insulation layers** prevent roof water from entering the building and provide insulation from outdoor temperatures.
2. The **outlet** lets excess water exit the roof. Outlets often consist of gutters, pipes, and downspouts. There is often more than one outlet for a single green roof.

Figure 2. Green Roof Components. *The plant area acts like a sponge to retain rainwater, allowing it to evaporate, be used by plants, or slowly drain through the outlet. (Graphic adapted from Dan Swenson of Nola.com)*

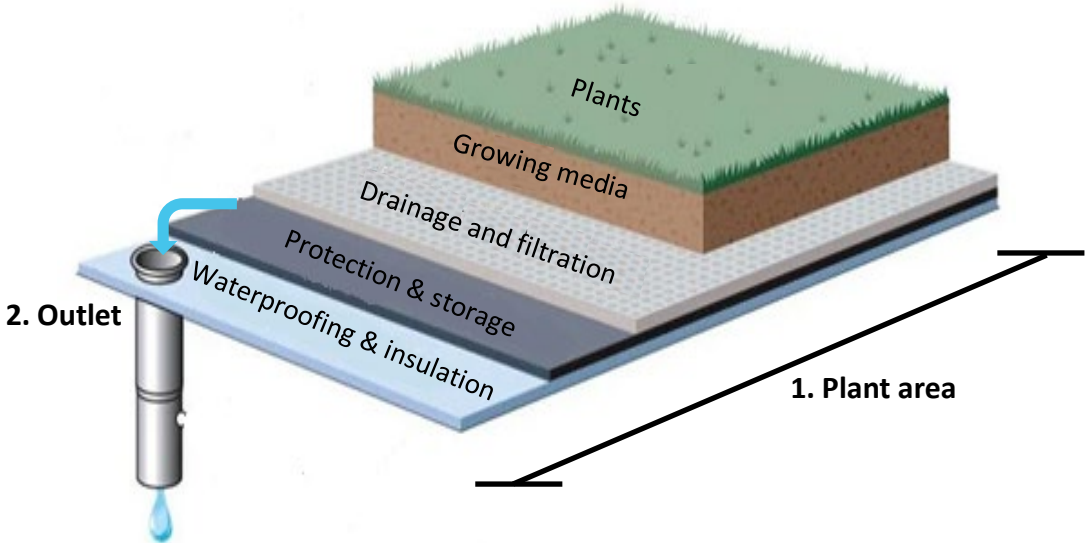


Figure 3. Green roof examples in Tennessee *Left: A green roof provides an amenity at The Pinnacle at Symphony Place, an office and retail building in Nashville (Source: cleanwaternashville.org). Right: The green roof at Nashville Music City Center (top photo) is planted with sedum (bottom photo), which is a sun-loving, low-maintenance, perennial succulent that needs little water to grow (Source: Music City Center).*

Routine Maintenance

The routine maintenance activities described below can ensure the green roof's operation and maintenance standards are easily achieved when performed regularly. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Weed, prune, and clean** plant beds to remove weeds, invasive plants, and dead or dying plant debris. Cut back dead stems of herbaceous plants. Remove leaves. Unless they are part of the design, remove deep rooted vegetation, like sprouting trees. Deep root systems can damage the waterproof membrane.
- ☑ **Replace dead or dying plants** so the entire (100%) plant area is covered.
- ☑ **Water plants** during drought if they need it. Maintain irrigation systems according to manufacturer's recommendations. Skip the fertilizers and pesticides unless necessary.

Cleaning

- ☑ **Clean the outlets (gutters and roof drains)** of accumulated sediment and debris whenever the roof plants are being maintained.
- ☑ **Clear trash, litter, and plant debris** from plant areas and outlets and place them in the trash.
- ☑ **Keep the area clean.** If the green roof is used as an amenity, provide trash cans and empty them before they overfill. Sweep pedestrian areas regularly and remove trash often.

Other Activities

- ☑ **Check the entire roof system** for mass plant disease or death, sagging, bulging, cracking, sloughing, or other signs of water damage, and long-standing, ponded water in any location. Immediately determine the source of any problems and repair them as quickly as possible.
- ☑ **Verify that required green roof signs are in place**. SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the green roof's components after every major storm** for debris and damage. Clean and repair components as needed. Contact the roof manufacturer or installer if you have concerns.

Troubleshooting

Green roofs are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems can occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for green roofs and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Standing water in the plant area after 3 days with no rain.	The growing media or drainage layers may be compacted or otherwise damaged, or the outlet (gutters and drain pipes) may be clogged. Clear clogged gutters and outlets. Repair or replace compacted or damaged plants. Restore eroded areas with soil and healthy vegetation. Limit access or educate users to prevent damage and compaction.
Plants are not able to establish; or large areas of dead or dying plants	Newly installed roofs – The stock of plants used on the roof may not be appropriate for the roof conditions or may be in poor health and need to be replaced. Consult the green roof installer. The plants may not be getting enough water. Water the plants in keeping with manufacturer's recommendations for the first several months after its construction, during the growing season, and during periods of drought. The plants may be smothered by weeds or affected by pests. Manually remove weeds as often as necessary to prevent them overtaking desired plant species or damaging the roof. Consult the manufacturer's recommendations on pesticide use. The growing media may need to be refreshed or fertilized. Consult the manufacturer's recommendations on growing media care and fertilizer use.
Erosion or bare soil in the planting area	Erosion must be stopped as soon as it is noticed. Determine and correct the cause of erosion and re-establish a health stand of plants in the eroded areas.
Leaks inside the building	The underlying waterproof membrane may have been damaged. Identify the location and repair the roof (see Table 3). Then, re-establish roof layers and plants.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

For significant component repairs or to determine a solution to a frequent, unsolved problem, consult the manufacturer or installer of the green roof system installed on your property, or a licensed professional (civil) engineer or landscape architect. Advise them that maintenance and repair of the roof must be done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Green Roof

This checklist guides an evaluation of the operation and maintenance standards for green roofs and is organized by primary component. It can be used for green roofs. **For its design to be considered compliant by the city, a green roof must meet ALL applicable standards. Non-compliant green roofs are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The green roof name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Green Roof 1" or "SCM A." Otherwise, describe the location of the green roof on the property (e.g., Green roof on the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company): Phone #:	Contact Name (If Different): Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company): Street Address:	Contact Name (If Different): City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number	Name of Staff Approving This Inspection Report	Has the City Entered and Approved This Inspection?	Date of Inspection Approval:	Is a Follow-Up Inspection by Staff Required? Circle one	Reason for Follow-Up?
		Yes / No		Yes / No	

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Green Roof

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the green roof needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	*The* **Plant Area** *is the entire area covered by plants. It has multiple underlayers, each having a specific purpose. Consult the manufacturer's guidance to determine the number, name, and placement of the layers in the green roof being inspected.*				
	a. Are the plants healthy with no (or very few) signs of disease, infestation by pests, and poor care/conditions? (Signs of distress could include: wilted, limp, or scorched leaves; leaves with discoloration; damaged leaves due to pest consumption; foul or uncharacteristic odor; slimy or consistently wet roots, bark, or stems; brittle or discolored leaves, roots, or stems)				
	b. Is the plant area free of large areas covered by weeds and other undesirable vegetation?				
	c. Is the plant area free of ponded-water or other evidence of plant/growing media compaction? Do the plant and growing media layers have the proper depth?				
	d. Is the plant area free of areas of erosion?				
	e. Are all areas of the plant area and its irrigation system (if any) easy to access for inspection and maintenance?				
	f. Is the roof free of leaks (as reported by the building owner, tenant, or facilities manager)?				
	g. Does the area appear to function properly given the recent rainfall conditions? • Wet conditions are not present *(if inspection is performed at least 48 hours after a storm)*; or, • Wet conditions present but discharging as expected through the outlet structure *(if the inspection is performed within 48 hours after a storm or within a prolonged period of wet weather)*.				
	h. Is the plant area clean and free of litter, trash, pet waste, cigarette butts, debris, sediment, grass or plant clippings, or other waste materials?				
	i. Is the green roof accessible for inspection and maintenance?				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
2	*The* **Outlets** *let stormwater exit the roof safely, usually through gutters, downspouts, and roof drains. Some green roofs have underdrains as part of the outlet structure.*				
	a. Are the outlet components free from damage (disconnected components, cracks, breaks, bulges, dents, etc.) and modifications that may impair their intended functions?				
	b. Are the structures clean and free of deposits of sediment, trash, debris, and other materials that may cause them to clog and backup water?				
	c. Are the gutters, downspouts, and roof drains easy to access for inspection and maintenance?				
	d. Are the areas below the outlet downspouts free of erosion and scour (only for outlets that discharge to the ground surface)				
	e. Does the outlet remain dry during dry conditions (i.e., no frequent water flow during dry periods)?				

Use the remainder of this page to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs. Attach additional pages if needed.

Infiltration basins are stormwater control measures (SCMs) that capture stormwater from other areas of a property and let it soak into the soil. Typically, the basins are designed as long, narrow trenches (see Figure 1). When constructed, they are excavated, filled with stone, and topped with a layer of stone or uncompacted topsoil and healthy grass. Stormwater soaks into the grass or stone, trickles into the basin below, and then percolates from the bottom and sides into the surrounding soil. Most infiltration basins will manage about one (1) inch of rain but can be designed for larger storms. They should drain completely within 48 hours after a rain.

Benefits of Infiltration Basins

- Reduce stormwater volume and pollutants
- Recharge groundwater
- Reduce flooding

Property Owner Responsibilities

The city regulates infiltration basins located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's infiltration basin(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Infiltration Basin. *(Source: City of Nashville, TN)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this infiltration basin *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and cities determine if an infiltration basin is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of infiltration basin components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand an infiltration basin's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Thus, using the checklist for routine inspections is the best way to keep an infiltration basin functioning properly as required by local ordinance. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, an infiltration basin must meet ALL applicable operation and maintenance standards. Non-compliant infiltration basins are subject to city enforcement.

Primary Components

To inspect an infiltration basin using the *Operation & Maintenance Standards Checklist*, it is important to know the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand infiltration basin(s) on their property and the components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Infiltration Basin Components

1. **Inlet structures** let water flow into the SCM.
2. **Pretreatment areas** remove debris and course sediment to reduce clogging of the main basin.
3. The **main basin** is where stormwater is collected and soaks into the surrounding soil.
4. The **emergency overflow** allows water to safely drain from the SCM during heavy rainfall.
5. The **observation well** is used to inspect for standing water in the main basin.
6. The **drainage area** is the area of land that drains to the SCM when it rains.
7. The **access easement** (not shown) extends from a public road to the basin. It allows access to the basin by the city when necessary.

Figure 2. Infiltration Basin Components In this depiction of an infiltration basin, stormwater from the drainage areas run through grassed pretreatment areas and into the main basin, which is topped with stone. Water soaks into and through the stone, eventually leaving the bottom and sides of the basin by percolating into the surrounding soil. The observation well extends to the basin bottom. *(Adapted from the NCDEQ Stormwater Design Manual, North Carolina Department of Environmental Quality)*

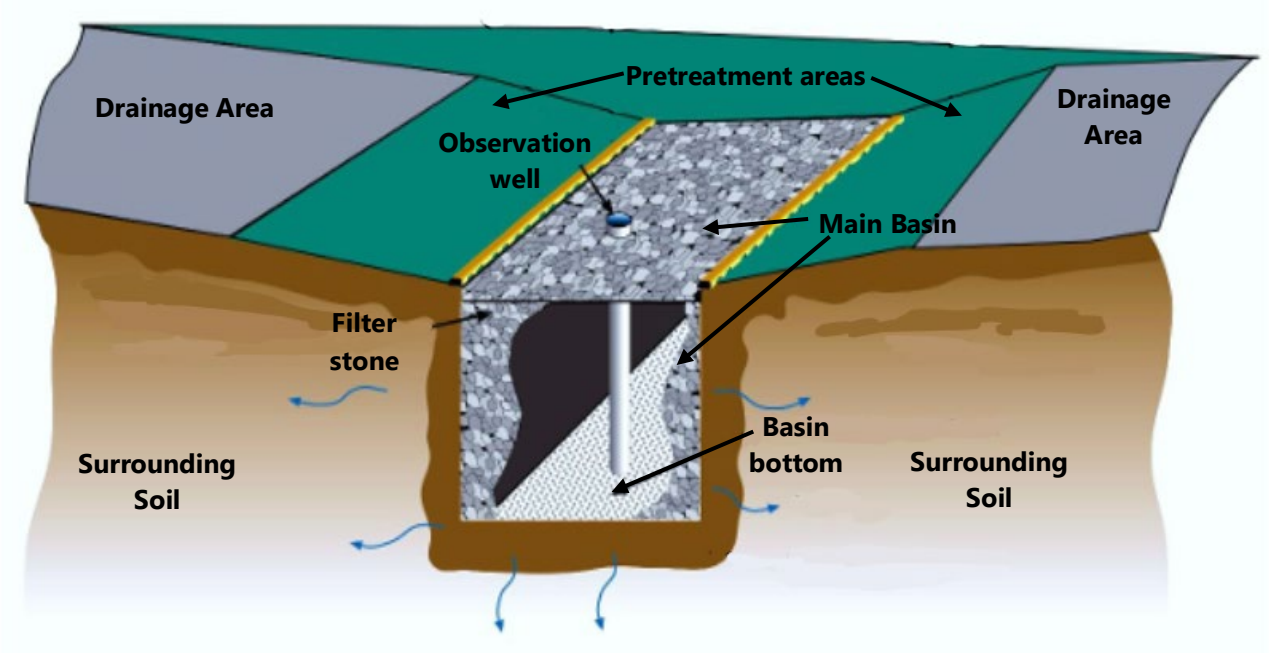


Figure 3. Infiltration Basin Examples *Left: Dense grass is used as a pretreatment area to capture sediment and trash before the stormwater from the nearby drainage area (not shown) reaches the infiltration basin (Source: California Stormwater BMP Handbook, 2003). Right: The observation wells and cleanout for the underdrain can be seen in the basin that collects runoff from a parking lot (Source: U.S. Army Corps of Engineers).*

Routine Maintenance

When performed regularly, The routine maintenance activities described below can ensure the infiltration basin's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Mow** the grass (if present) as needed for health. Bag clippings to prevent clogs. **Do not use a riding mower**—heavy equipment can cause compaction.
- ☑ **Cover** areas of bare soil with sod and repair eroded areas with grass or other appropriate ground cover as soon as they are noticed. Sod is preferred over seed and straw to avoid clogging. If possible, skip the fertilizer.
- ☑ Remove **weeds, trees, and woody vegetation** growing on the basin (unless part of the design).

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment.** Dispose of landscape debris (e.g., bagged clippings, fall leaves, brush) in the trash.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep hard surfaces regularly.
- ☑ **Pick up pet waste.** If pet waste is a problem, consider signs to alert pet owners.

Other Activities

- ☑ **Cover potential pollutants in the drainage area** to prevent runoff contamination. Use tarps and berms outdoors or store indoors. Park leaking vehicles/equipment on drip pans and empty them regularly using proper disposal methods.
- ☑ **Do not store anything in or near the basin**, including temporary stockpiles of landscape material.
- ☑ **Verify that required signs are in place**. SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the infiltration basin components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.
- ☑ **Inform work crews** on your property of the infiltration basin's location so they do not accidentally run over it with vehicles or equipment, deposit snow or other materials in it, or otherwise damage it.

Troubleshooting

Infiltration basins are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for infiltration basins and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Ponded water on the basin's surface for more than 2 days after a storm	Water may pond on the basin surface during prolonged periods of wet weather. The surrounding soil may be so wet that water will not percolate well until drier conditions prevail. However, for normal weather conditions water should not pond for long. Frequent, ponded water is a sign the surface of the basin has been compacted, or sediment is clogging the main basin. For surface compaction, remove surface vegetation and debris, loosen the compacted area with rakes or shovels, and replace the topsoil and grass (if part of the design). Continue to observe the area after rainfall to determine if the basin is repaired. For a clogged basin, see Table 3.
Trash, debris, and sediment frequently accumulate in the main treatment area.	For trash, determine the source (e.g., litter, frequently overflowing trash cans, etc.) and take steps to reduce the problem (e.g., add trash cans, pick up litter, and empty trash cans more frequently, etc.). Clean the pretreatment area more often. Maintain the landscape in the drainage area and around the basin. Require landscapers to cover stockpiles and dispose of debris in the trash or remove it from the premises. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Erosion along stormwater flow paths or dead/dying vegetation	Erosion may indicate that runoff is moving too fast into the basin. Vegetation may need to be replanted on adjacent areas, and flow paths may need to be re-graded.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** to provide sod (for grassed basins) or stone, or repair erosion within the main basin, pretreatment areas, or drainage area.	**For significant component repairs, consult a licensed professional (civil) engineer or landscape architect** to ensure it is done properly and in accordance with the SCM's original design.

Operation & Maintenance Standards Checklist
Infiltration Basin

This checklist guides an evaluation of the operation and maintenance standards for infiltration basins, organized by primary component. **Infiltration basins must meet ALL applicable standards for its design to be considered compliant by the city. Non-compliant infiltration basins are subject to city enforcement.**

SCM Name and Location		Today's Date:
	The infiltration basin name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Infiltration Basin 1" or "SCM A." Otherwise, describe the location of the infiltration basin on the property (e.g., Infiltration basin behind the main office building).	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:

SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only		
Identification Number	Name of Staff Approving This Inspection Report	
Has the City Entered and Approved This Inspection? Yes / No	Date of Inspection Approval:	
Is a Follow-Up Inspection by Staff Required? Circle one Yes / No		
Reason for Follow-Up?		

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Infiltration Basin

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the infiltration basin needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact the city's stormwater department for corrective actions that will take longer than 30 days. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel, or an area lined with dense grass or stone.*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are inlets free of erosion and areas of bare soil?				
	c. Are the inlets free of damage or modifications that may impair their intended operation?				
2	*The* **Pretreatment Area** *removes trash, debris, and dirt from stormwater flowing in. This helps to prevent clogging of the main treatment area. Pretreatment areas are usually lined with dense grass or stone or may be a small stilling well.*				
	a. Is the area free of trash, landscape debris, weeds, pet waste, and significant deposits of sediment?				
	b. Is the area fully lined with concrete, rocks, or dense grass, and free of damage, erosion, and areas of bare soil?				
	c. Are the areas where stormwater enters and exits the pretreatment area free from obstructions, modifications, and damage, allowing water to easily flow through it?				
3	*The* **Main Basin** *area is where stormwater is collected and soaks into the soil. Infiltration basins are either covered by dense grass or clean, weed-free stone.*				
	a. If the basin surface is grassed, is the area densely grassed and free of bare patches, erosion, weeds, and non-grassy plants? Does the grass appear healthy? If the basin surface is stone, is the area free of weeds and other plants?				
	b. Is the area free of evidence of compaction (compacted grass/stones, tire tracks, ponded water)?				
	c. Is the area free of significant deposits of sediment, trash, pet waste and debris?				
	d. Does the area appear to function properly given recent rainfall conditions? • Standing water/wet conditions are not present on the surface of the basin and in the observation well *(if inspection is performed at least 48 hours after a storm)*; or,				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	• Standing water is present in the observation well but discharging as expected *(if inspection is performed within 48 hours after a storm or within prolonged period of wet weather)*.				
	e. Is the observation well undamaged, unmodified, and easy to access?				
	f. Are required SCM signs present and readable?				
	g. Is the underdrain free of damage, sediment, and debris?				
4	*The* **Drainage Area** *is the land that drains stormwater to the infiltration basin during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lead to lower maintenance and repair needs for the infiltration basin.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the infiltration basin during a storm?				
5	*The* **Access Easement** *extends from a public roadway to the infiltration basin, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the infiltration basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the infiltration basin by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to person(s) performing maintenance or repairs.

4.8 Manufactured Treatment Device (MTD)

SCM Inspection & Maintenance Guide

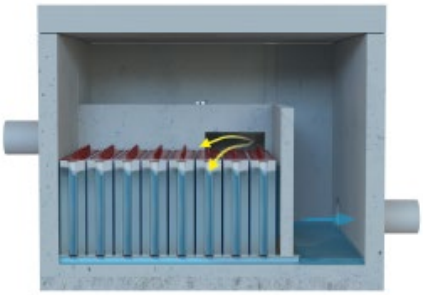
Manufactured treatment devices (MTDs) are pre-constructed stormwater control measures (SCMs) that remove pollutants from stormwater but do not provide flood control. They drain quickly, usually within hours, and are mostly underground.

Benefits of MTDs

- Remove pollutants from stormwater
- May serve as landscaping (Green MTDs only)
- Maximizes available land for uses other than stormwater control

Table 1 categorizes MTDs by pollutant removal technology. Each type includes various makes and models from different manufacturers and is needed to understand maintenance needs. (see the bottom row for examples). Maintenance details for a specific MTD can be found in the property's Record Drawing and Operations & Maintenance Plan.

Table 1. MTD Types and Pollutant Removal Mechanisms

Type	Pollutant Removal Method	Example
Infiltration or Biofiltration MTDs	Plant evaporation, transpiration, and nutrient uptake, and: • soil media filtration (drainage via underdrain); or, • soil infiltration (no underdrain, percolation into the surrounding soil)	
Media or Cartridge Filtration MTDs	Physical (or sometimes chemical) filtration using filter media, a screen, or cartridge filter system	
Hydrodynamic Separation MTDs	Mechanical or gravity separation by swirling, baffling, or other means	

Photos and sources – Top: BioPod™ Planter Module by Oldcastle Infrastructure; Middle: Kraken® Filter vault by Contech Engineered Solutions; Bottom: Downstream Defender® vortex separator by Hydro International.

MTD Primary Components

To inspect am MTD using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. The components are explained in Table 2 and shown in Figures 1 and 2; however, their looks will differ depending on the MTD type, make, and model. Most will be underground and will require access through a manhole, observation well, or inlet/outlet structure. **Use the manufacturer's information provided in the property's Record Drawing or Operations & Maintenance Plan along with the checklist at the end of this document to guide your understanding, inspection, and maintenance of the MTD.**

Table 2. Manufactured Treatment Device Components

1. **Inlets** let water flow into the SCM. They may be covered with grates or look like curb openings.
2. **Pretreatment areas** catch trash, debris, and heavy sediment flowing in, reducing the propensity for clogs in the main treatment area.
3. The **main treatment area** is where pollutants are removed from stormwater. See Table 1 for pollutant removal methods.
4. When the MTD's capacity is exceeded, the **overflow** lets stormwater safely bypass the main treatment area. Water drains directly to the outlet.
5. The **outlet** lets water exit the SCM.
6. The **drainage area** (not shown) is the area of land that drains to the MTD when it rains.
7. The **access easement** (not shown) allows the city to access the MTD when necessary.

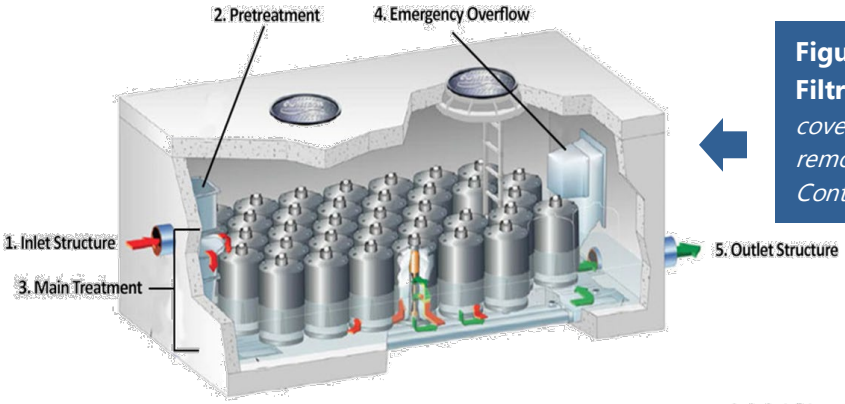


Figure 1. Example of MTD Components (Cartridge Filtration MTD). *The unit is accessed through manhole covers at the ground level. The filter cartridges are removable and must be replaced when dirty. (Source: Contech Engineered Solutions)*

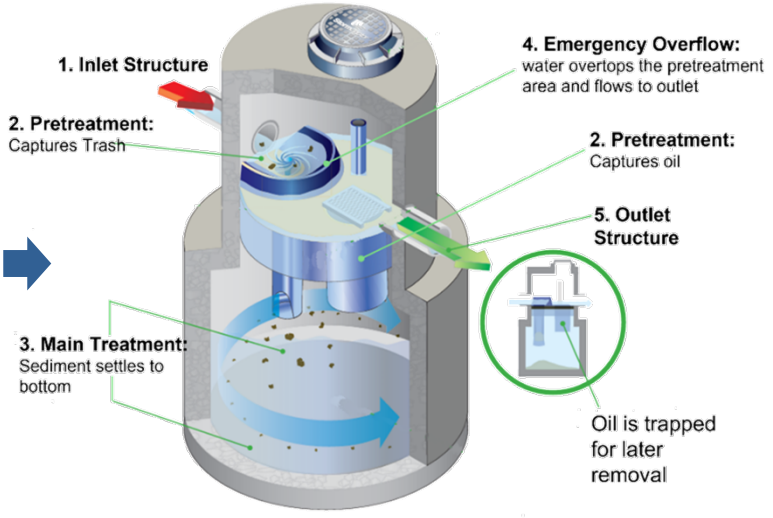


Figure 2. Example of MTD Components (Hydrodynamic Separation MTD). *The unit is accessed through a manhole cover at the ground level. This unit swirls stormwater to separate oil, debris, and sediment. Oil and debris stay at the top of the unit while sediment settles to the bottom. (Source: Contech Engineered Solutions)*

MTD Property Owner Responsibilities

The city regulates MTDs located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring the MTD(s) on their property are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

MTD Routine Maintenance

When performed regularly, The routine maintenance activities described below can ensure the MTD's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

MTDs can be large enough for a person to enter. Some can meet the definition of a confined space under 29 CFR 1926.1202, and therefore present a safety hazard. **ONLY PERSONS WITH OSHA CONFINED SPACE TRAINING CAN ENTER AN MTD AND MUST HAVE A SAFETY CREW AND APPROPRIATE EQUIPMENT PRESENT.**

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment** from all components using the manufacturer's instructions on cleaning the device. Most material will be in the pretreatment area. Note: Some MTDs require a vacuum truck for cleaning. *(Picture courtesy of jgenvironmental.net).*
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly. Do not store anything, including temporary stockpiles of landscape material (e.g., mulch), near the inlets. Dispose of landscape debris (e.g., bagged clippings, fall leaves, brush) in the trash.

Other Activities

- ☑ **Cover potential pollutants in the drainage area** that can be washed into the MTD during a storm. Use a tarp and berm if they are outside or store them inside a building. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Replace MTD components** in accordance with the manufacturer's maintenance guidance and when they are damaged. Some MTDs include components that must be replaced periodically to ensure the device operates properly. Examples of these components include cartridge filters and biofiltration soil media.
- ☑ **Verify that required MTD signs**. SCM signs that are required by the city should be shown on the property's As-Built Plan. Replace them if they are unreadable or lost.

MTD Troubleshooting

MTDs areas are designed to have a long operational life. However, problems and damage can occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 3 describes the most common problems for MTDs and how to resolve them.

Table 3. Common Problems and Resolutions	
Observation	**Potential Problem and Resolution**
Significant or frequent over-accumulation of trash, litter, sediment, or other materials in the pretreatment area	The drainage area is dirty. Increase cleaning frequency for the pretreatment area or drainage area as needed. • Determine the source of trash (e.g., litter, frequently overflowing trash cans, etc.) and take steps to reduce the problem (e.g., add trash cans, pick up litter and empty trash cans more frequently, etc.). • Maintain the landscape regularly and require landscapers to cover stockpiles and dispose of debris in the trash or remove it from the premises. • Find the source of sediment (bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Significant or frequent over-accumulation of materials in the main treatment area	If the pretreatment area is dirty, it will not work properly and these materials can flow into the main treatment area. Clean out the main treatment area, then clean the pretreatment area, repeating this cleaning more often. If this does not resolve the issue, consult the manufacturer.
Stormwater bypasses the MTD inlet	The inlet or other components are blocked or clogged. Inspect the device and remove the clog. For filtration MTDs only, the filters may be so dirty that they prevent water flow. Replace the filters.

When to Call an Expert

Sometimes problems occur that require an expert to figure out or correct, either because they present a safety issue, are too complex or difficult to manage alone, or require replacement parts. Repairs must be done using parts for the exact MTD make and model. Failure to do so may result in city enforcement. Consult the MTD manufacturer and always ensure properly trained people are performing MTD repairs.

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this MTD *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city to determine if a MTD is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of MTD components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a cistern's maintenance and repair needs.
- **Use this checklist document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

MTDs must meet ALL applicable operation and maintenance standards for it to be considered compliant by the city. Non-compliant MTDs are subject to city enforcement.

Operation & Maintenance Standards Checklist
Manufactured Treatment Device (MTD)

This checklist guides an evaluation of the operation and maintenance standards for MTDs and is organized by primary component. **For its design to be considered compliant by the city, an MTD must meet ALL applicable standards. Non-compliant MTDs are subject to city enforcement.**

SCM Name and Location	*The MTD name should be shown on a SCM location map that is included with the Record Drawing for this property. A typical name would be "MTD 1," "MTD A," or the name of the device. Otherwise, describe the location of the MTD on the property (e.g., MTD behind the main office building).* ***If you use a manufacturer's inspection instead of this one, include it along with this first page.***	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:

SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only			
Identification Number	Name of Staff Approving This Inspection Report	Has the City Entered and Approved This Inspection? Yes No	Date of Inspection Approval:
Is a Follow-Up Inspection by Staff Required? Circle one Yes No			
Reason for Follow-Up?			

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Manufactured Treatment Device (MTD)

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the MTD needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30-days of the date of this inspection.** Contact your city stormwater department for corrective actions that will take longer than 30-days to complete. **You may use the manufacturer's inspection instead of this one. You must submit that inspection along with the SCM information sheet on the previous page.**

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the MTD. See the manufacturer's guidance for the inlet configuration on the MTD being inspected.*				
	a. Is the inlet free of trash, debris, and accumulations of sediment, and other materials?				
	b. Is the inlet undamaged and unmodified? (e.g., are they securely affixed; free of holes, cracks, bulges, blockages, joint separation, or standing water).				
	c. Are there signs of spilling, dumping, or discharging non-stormwater materials into the inlet (e.g., paint stains, oil stains, foam, odor, etc.)?				
2	*The* **Pretreatment Area** *removes trash and debris flowing into the MTD. See the manufacturer's guidance for the pretreatment location and configuration on the MTD being inspected*				
	a. Is the pretreatment area clean and free of caked (i.e., hardened and encrusted) sediment, trash, landscape debris, and other materials that can impede the MTD's intended function as designed? *(The presence of deep, caked material is an indication that the pretreatment area needs more frequent cleaning.)*				
	b. Is the pretreatment area undamaged and unmodified? (e.g., is it securely affixed, free of holes, cracks, bulges, blockages, joint separation, or standing water).				
	c. Is the pretreatment area's access covering intact and free from damage? (e.g., manhole cover is in place and undamaged)				
3	*The* **Main Treatment Area** *is where stormwater is collected and pollutants are filtered out.*				
	a. Is the main treatment area clean and free of caked (i.e., hardened and encrusted) sediment and other materials that can impede the MTD's intended function as designed? *(The presence of deep, caked material is an indication that the pretreatment area and main treatment area need more frequent cleaning.)*				
	b. Is the main treatment area undamaged and unmodified? (e.g., is it securely affixed, free of holes, cracks, bulges, blockages, joint separation, or standing water).				

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	c. Is the access covering intact and free from damage? (e.g., manhole cover is in place and undamaged)				
	d. Are ladders/steps (if present) free from damage?				
	e. Can you confirm that there is no standing water above the device's outlet pipe? (note: standing water may be present below the outlet between storms)				
	f. *For biofiltration and infiltration MTDs only:* Is the soil media loose, uncompacted, and draining well?				
	g. *For biofiltration and infiltration MTDs only:* Do the plants appear healthy? Are they overgrown and require pruning or clipping? Are they largely free of weeds, pet waste, animal burrows, and other pests/materials that can impair the MTD's function or introduce pollutants (such as fecal material) the MTD is not designed to treat?				
	h. *For filtration MTDs only:* Are the filtration screens/cartridges/devices undamaged, unmodified, and unclogged with pollutants?				
4	*The* **Overflow** *allows stormwater to bypass the main treatment area and, in some MTDs, the pretreatment area. The* **Outlet Structure** *lets water exit the MTD.*				
	a. Are the overflow and outlet(s) undamaged, unblocked/unclogged, and unmodified?				
	b. Are the overflow and outlet(s) free of trash, debris, and accumulations of sediment, and other materials?				
	c. Is the area below the outlet fully connected to the stormwater conveyance system?				
5	*The* **Drainage Area** *is the land that drains stormwater to MTD during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the MTD's maintenance and repair needs .*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				

6	*The* **Access Easement** *extends from a public roadway to the MTD, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the MTD be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the MTD by maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.9 Permeable Pavement System

SCM Inspection & Maintenance Guide

Permeable pavement systems are stormwater control measures (SCMs) and include modular pavers, concrete grids, pervious concrete, porous asphalt, and gravel- or grass-filled cellular confinement systems. Stormwater "soaks" into the pavement surface through voids (holes), joints (gaps), or soil, and is filtered by underlying media. Most systems have an underdrain that directs filtered water to the stormwater system. For most rainfall events in Tennessee, the pavement surface should be dry within a few hours after a storm.

Benefits of Permeable Pavement Systems

- Reduce stormwater pollution
- Reduce flooding (depends on design)
- May reduce the potential for black ice
- May have a longer service life than standard pavements
- Better traction when wet

Property Owner Responsibilities

The city regulates permeable pavement systems located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's permeable pavement system(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this *SCM Inspection & Maintenance Guide* can be used by property owners and persons maintaining SCMs to determine if a permeable pavement system is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of pavement system components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand the SCM's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

Figure 1. Modular Pavement System Demonstration. *(Source: WSP)*

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must ensure that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a permeable pavement system must meet ALL applicable operation and maintenance standards. Non-compliant systems are subject to city enforcement.

Primary Components

To inspect a permeable pavement system using the *Operation & Maintenance Standards Checklist*, it is important to understand its primary components and function. The checklist guides this process. Owners should obtain a copy of the property's Record Drawing, and any maintenance guidance provided by the pavement manufacturer to better understand the basin(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Permeable Pavement System Components

1. If the pavement system is designed to receive stormwater from other areas of the property, **inlets** let water flow onto the pavement surface.
2. The **pavement surface** can be solid, gravel/grid, or grass/grid, with **joints** or **voids** that let stormwater flow into the main treatment area.
3. The **main treatment area** consists of multiple layers: a bedding layer for pavement support, a reservoir for temporary water storage, and a filter layer that directs water to the underdrain and surrounding soil.
4. The **underdrain** collects filtered stormwater and moves it to the outlet to be released from the SCM.
5. The **outlet structure** (or storm grate) allows water to exit the SCM through the underdrain or surface entrance (for emergency overflow).
6. The **underdrain cleanout** is used to access the underdrain in case of clogging issues.
7. The **drainage area** (not shown) is the entire pavement system itself, as well as any other areas of the property (e.g., driveways, sidewalks, rooftops) that are designed so stormwater flows to the pavement system. Not every system is designed to receive stormwater from other areas.
8. The **access easement** (not shown) extends from a public road to the pavement system. It allows the city access to the SCM when necessary.

Figure 2. Permeable Pavement System Components. *The figure displays a modular permeable pavement system and its components. The drainage area (#7) and access easement (#8) are not shown. (Graphic credit: WSP)*

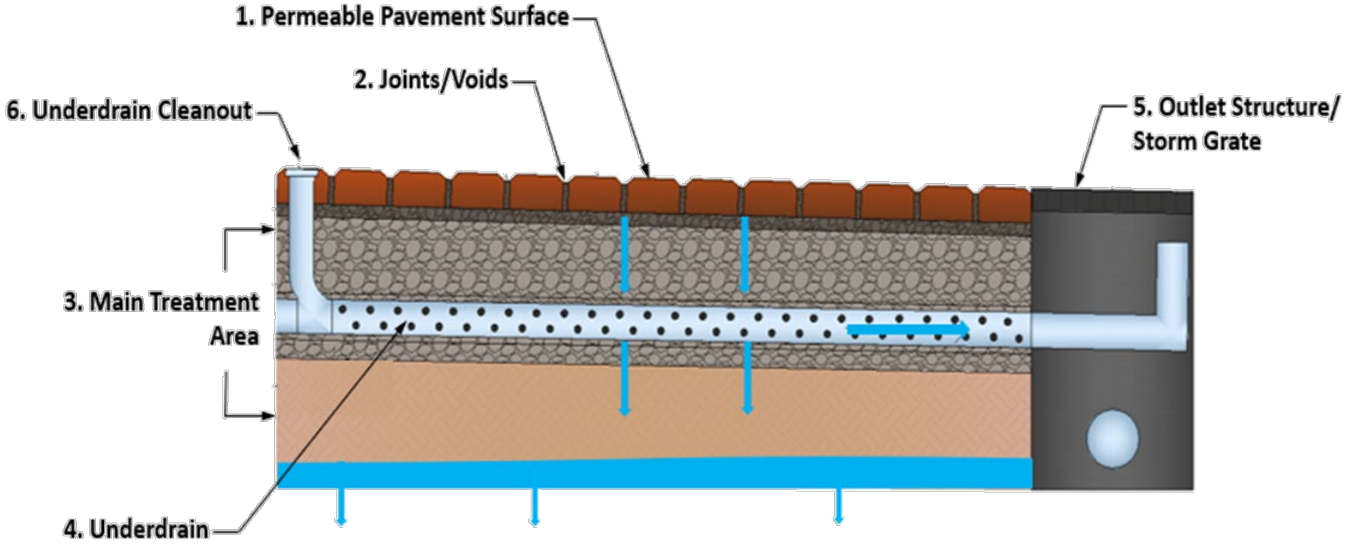
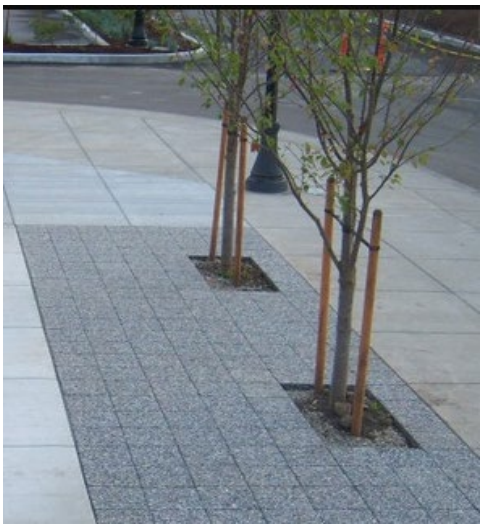


Figure 3. Examples of Different Permeable Pavement Systems *Left: Grassed concrete grid pavers (Source: Checker Block® pavers from Nicolock); Middle: Xeripave Super Pervious Pavers (Source: Xeripave LLC); Right: Comparison of porous asphalt with standard asphalt (Source; Virginia Asphalt Association)*



Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the permeable pavement system's operation and maintenance standards are achieved. **Make routine maintenance a habit!**

Cleaning

- ☑ **Remove trash, litter, and landscape debris** as often as possible and dispose in the trash. Use a landscape blower regularly to move small debris and dust off the pavement surface.
- ☑ **Vacuum permeable pavers and porous concrete/asphalt twice a year** using a commercial pavement vacuum (i.e., a true vacuum street sweeper or vacuum attachment). *Do not use regenerative air sweepers or pressure washers, as they can damage the system. Do not vacuum grid and cellular confinement systems.*

Other Activities

- ☑ **Do not store anything on the pavement surface**, including temporary stockpiles of landscape material (e.g., mulch). Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Repair areas of bare soil and erosion** in areas of the property that drain to the pavement system as soon as they are noticed. **Cover potential pollutants in these areas** that can be washed onto the pavement during a storm. Use a tarp and berm if they are outside or store them inside a building.
- ☑ **Do not use sand and avoid applying salt** (if possible) on pavement systems during the winter. Sand will clog the system, and salt can harm the surface of the pavement. Use a rubber tipped shovel to remove snow.
- ☑ **Verify that required SCM signs are in place.** Educational signs required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.

Vegetation Management

- ☑ If the pavement system is grassed, **maintain the grass** by mowing, weeding, and re-seeding when necessary. Fertilize if needed, using only water-friendly products.

Permeable Pavement Troubleshooting

Permeable pavement systems are designed to function well in any season, including winter. However, problems can occur. Performing the maintenance activities described previously on a regular basis should limit problems. Table 2 describes the most common problems of pavement systems and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Standing water, or slow draining water, on limited areas of the pavement	The voids/joints area where this occurs is clogged with sediment. • Vacuum the area to remove dust/sediment from the voids and joints *(see the previous page regarding appropriate vacuum equipment).* • If vacuuming does not resolve the problem, the underlayers in the problem area may be compacted need repair. See Table 3.
Water flows off most of the pavement during most storms, rather than soaking into the voids or joints	Stormwater may runoff permeable pavement during heavy rain or extended wet periods if the system is full and unable to drain. However, during normal weather conditions, this problem indicates that the system may be clogged. • Blow or sweep dust, debris, and sediment from the pavement system. Remove trash. If this does not resolve the issue, vacuum the system *(see the previous page regarding appropriate vacuum equipment).* • If sweeping, blowing, and vacuuming does not resolve the problem, the pavement surface, underlayer(s), and/or underdrain may be clogged. Pavement system repair is required. See Table 3.
Plants are growing in the void spaces of the pavement *(non-grassed pavements only)*	This is a sign that the pavement system is not being maintained well enough, and sediment and plant seeds have accumulated in the voids/joints. Manually remove the weeds and vacuum the pavement *(see the previous page regarding appropriate vacuum equipment).*
Settling, sinking, bulging, or significant cracking	These are signs of damage to the underlayers of the pavement system. Damage can be caused by excessive vehicle loads, growing tree roots, sinkhole formation, and other issues. Pavement system repair is required. See Table 3.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM Maintenance.

Table 3. Issues and Experts

The **pavement manufacturer** will be able to answer questions about maintenance and repair. A **landscape company** can blow/sweep pavement. A **commercial parking lot sweeping company** can vacuum pavement systems *(see the previous page regarding appropriate vacuum equipment).*	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult the pavement manufacturer or installer** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Permeable Pavement System

This checklist guides an evaluation of the operation and maintenance standards for permeable pavement system, organized by primary component. **For its design to be considered compliant by the city, a basin must meet ALL applicable standards. Non-compliant permeable pavement systems are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The permeable pavement system name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Permeable Pavement 1" or "SCM A." Otherwise, describe the location of the permeable pavement system on the property (e.g., Permeable pavement behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company): Phone #:	Contact Name (If Different): Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company): Street Address:	Contact Name (If Different): City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number

Has the City Entered and Approved This Inspection? Yes / No

Name of Staff Approving This Inspection Report

Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one Yes / No

Reason for Follow-Up?

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Permeable Pavement System

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the permeable pavement needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete.

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	*If the permeable pavement system accepts stormwater from other areas of the property,* **Inlets** *convey the water onto the permeable pavement system. An inlet can be a pipe, channel, or roof downspout. Or there may not be a defined inlet at all (e.g., an asphalt driving lane in a parking lot abutting permeable pavement parking spaces). If the permeable pavement system being inspected does not have inlets, answer by checking the "NA" boxes.*				
	a. Are inlets free of trash, debris, sediment accumulation, and other materials?				
	b. Are the inlet pipes undamaged and unmodified?				
	c. Are ditch inlets fully lined with dense grass or stone (mulch is prohibited)? There must be no erosion and large areas with bare soil (channel inlets only).				
	d. Are the areas just upstream and downstream of the inlets free of soil erosion and standing water?				
2	*The* **Pavement Surface** *is solid, gravel/grid, or grass/grid surface. It has* **Joints/Void Spaces** *that allow water to get under the pavement and enter the* **Main Treatment Area.**				
	a. Is the pavement surface intact and free of deterioration, cracking, bulging, uplift, raveling, sinking, or settling?				
	b. Is the pavement surface free of large debris (e.g., trash, leaves, mulch, grass clippings, stockpiled material)?				
	c. Is the pavement surface free from sealants that would prevent water getting into the system?				
	d. Is the pavement surface free of standing water or evidence of long-standing water (e.g., dust, dirt, and debris accumulation in concentrated areas)? (Water should drain off the surface within 2 hours after a rain event.)				
	e. Is the pavement surface free of stains indicating oil, paint, or other pollutants spilled, dripped, leaked, or were dumped on the surface?				
	f. *Non-grassed pavement systems only: Are* the joints/voids free of sediment and debris?				
	g. Non-grassed pavement systems only: Are the joints/voids free of weeds/vegetation?				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	h. Non-grassed pavement systems only: Is the pavement surface free of moss? (Moss indicates the pavement has wet/damp surface conditions and does not necessarily indicate standing water. Regardless, moss can be a slip/fall hazard and should be removed as often as needed.)				
	i. Gravel-filled pavement systems only: Does the gravel between pavers or paver cells appear uncompacted (loose) and clean of sediment and debris?				
	j. Grassed pavement systems only: Does the grass appear dense and healthy? Does it cover the entire pavement system (without large bare areas)?				
3	*The* **Underdrain** *allows water to exit the SCM and can become clogged. The* **Underdrain Cleanout** *is used to access the underdrain in case of clogging issues.*				
	a. Are the cleanout caps in place?				
	b. Is the underdrain free of trash or debris that could cause clogging?				
	c. Is the underdrain free of water if inspected at least 5 days after a rainfall event?				
4	*The* **Outlet Structure** *allows cleaner water to exit the SCM. Note: the outlet structure may be constructed underground and is therefore not visible.*				
	a. Is the outlet structure free of accumulated sediment, trash, and debris?				
	b. Does the outlet structure appear to be undamaged and has not been modified in any way that would change its function?				
	c. Is the area around the outlet structure or below the outlet pipe free of erosion or scour holes?				
5	*The* **Drainage Area** *includes the permeable pavement system itself and all other areas of the property that drain stormwater to it. Consult the Record Drawing to determine if other areas drain into the system.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				

Continued on next page

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	The **Access Easement** *extends from a public roadway to the permeable pavement system, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
6	**a.** Can the basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the basin by large maintenance equipment?				

Use this page to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.10 Sand Filter

SCM Inspection & Maintenance Guide

Sand filters are stormwater control measures (SCMs) that filter stormwater through a sand bed (see Figure 1). Runoff is guided into the SCM where it is collected, cleaned by being filtered through the sand, and drained through a stone layer or underdrain beneath the filter into the property's stormwater system. There are three types of sand filters: 1) underground sand filters that use several chambers, 2) sand filters installed on the edge of an impervious surface, like a parking lot, and 3) pocket sand filters used specifically for small site projects (for these, stormwater is pretreated by a sediment basin or filter strip before entering a pocket sand filter). Sand filters should drain fully within 48 hours after rain.

Benefits of Sand Filters

- Removes pollutants from stormwater

Property Owner Responsibilities

The city regulates sand filters located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's sand filter(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Sand Filter. *(Source: Department of Environmental Protection, Montgomery County, Maryland)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this sand filter *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city to determine if a sand filter is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of sand filter components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a sand filter's maintenance and repair needs.
- **The checklist must be used to document the Five-Year Professional SCM Inspections required by the city to evaluate SCM compliance with its operation and maintenance standards.** Thus, using the checklist for routine inspections is the best way to keep a sand filter functioning properly as local ordinance require. See Chapter 3 of this manual for general information on SCM inspections.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a sand filter must meet ALL applicable operation and maintenance standards. Non-compliant sand filters are subject to city enforcement.

Primary Components

To inspect a sand filter using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the sand filter on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Sand Filter Components

1. **Inlets** let water flow into the SCM. There can be multiple inlets in a sand filter.
2. **Pretreatment areas** remove trash, debris, and dirt from stormwater flowing in. This helps to prevent clogging of the main treatment area. These areas can be lined with rock or dense grass.
3. The **filter bed** is where stormwater is collected and soaks into the sand before being discharged from the bed through a stone bed (or underdrain). Observation wells may be present to check for sediment buildup and stagnant water.
4. The **emergency overflow** lets stormwater discharge from the SCM safely and quickly during intense storms or prolonged wet periods.
5. The **outlet structure** is connected to the underdrain to allow water to exit the system. The outlet structure may be underground.
6. The **drainage area** (not shown) is the area of land that drains to the sand filter when it rains.
7. The **access easement** (not shown) extends from a public road to the sand filter. It allows the city to access the SCM when necessary.

Figure 2. Sand Filter Components *Sand filters are typically depressions in the ground filed with sand that helps manage polluted stormwater. All the components are shown except the drainage area (#6) and access easement (#7). (Illustration adapted from Minnesota Stormwater Manual, 2008).*

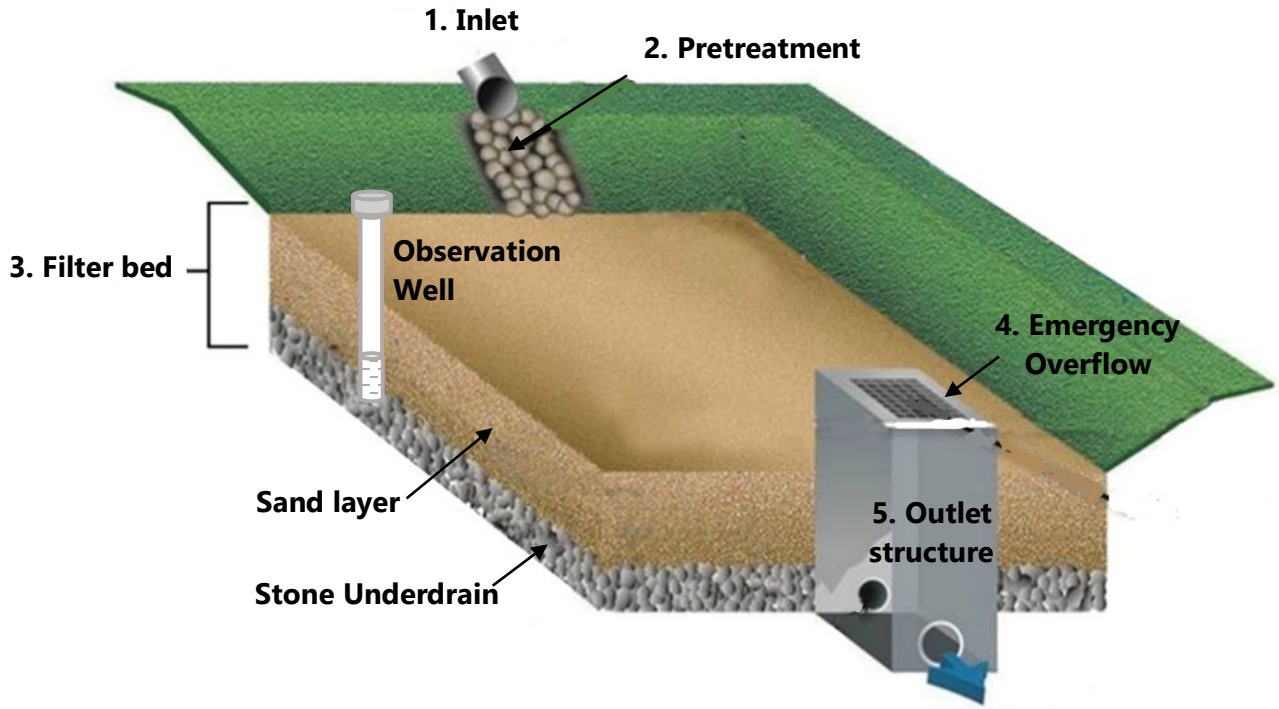


Figure 3. Examples of Sand Filter Components *The photos show sand filters shown before and immediately after a storm. Stormwater flows off the parking lot into the filter bed where it is briefly held and cleaned as it filters through the sand. The outlet (not shown) is underground at the bottom of the outlet structure. (Source: Wentworth Watershed Association, Wolfeboro, NH)*

Routine Maintenance

When performed regularly, The routine maintenance activities described below can ensure the sand filter's operation and maintenance standards are easily achieved. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Maintain the landscape** around the perimeter of the sand filter. Bag grass clippings and place all landscape waste in the trash or in an area that will not wash into the filter during a storm.
- ☑ **Seed, sod, or cover areas of bare soil and repair eroded areas** around the sand filter and in its drainage area with grass or other appropriate ground cover as soon as they are noticed. Sediment accumulation can clog the sand filter.
- ☑ **Remove all vegetation** that sprouts in the sand filter bed unless the SCM was designed with vegetation.

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment.** Do not store anything, including temporary stockpiles of landscape material (e.g., mulch), in the sand filter and its drainage area. Dispose of collected material in the trash.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Check observation wells** for sediment buildup or stagnant water. See Table 3 for repair help.
- ☑ **Cover potential pollutants in the drainage area** to prevent contamination of the sand filter. Use a tarp and berm outdoors or store items indoors. Park leaking vehicles or equipment inside or cover them, using drip pans to collect fluids. Dispose of fluids properly and empty pans regularly..
- ☑ **Prevent people and animals from entering the sand filter.** Fencing, curbing, and landscaping can be used to prevent encroachment into the filter. Remove burrowing animals as they can damage the SCM.
- ☑ **Verify that the required signs are in place**. SCM signs required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the sand filter components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Sand filters are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for sand filters and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Frequent standing water on the surface for more than 2-days after rainfall	The filter bed, its underdrain (stone layer or pipe), or outlet structure may be clogged. If the observation well is dry, the filter bed surface may be compacted or clogged. Try to determine the location of the clog and clear it. This may require additional expertise. See Table 3.
Trash, debris, and sediment frequently accumulate in the pretreatment area or filter bed.	If the filter bed is frequently dirty, clean the pretreatment area more often. If this does not solve the issue, additional expertise may be needed (Table 3). Identify the trash source (e.g., litter, overflowing bins) and take corrective actions like adding bins, picking up litter, and emptying trash cans more often.). Maintain the landscape in the drainage area and around the SCM. Require landscapers to cover stockpiles and dispose of debris in the trash or remove it from the premises so it does not into the sand filter. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Water is not flowing into the filter bed	Leaves, sediment, or other debris may be blocking the inlet(s). Remove visible debris.
Plants often growing in the filter bed	Significant plant growth is an indication the sand filter is not operating well. Sediment and debris have accumulated at or near the surface of the filter bed and/or water is not draining well enough to return the bed to a dry condition between rains. Check the bed, underdrain, and outlet for clogs and remove them. The sand may need to be replaced. See Table 3.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** for landscape and erosion repair	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Sand Filter

This checklist guides an evaluation of the operation and maintenance standards for sand filters, organized by primary component. **For its design to be considered compliant by the city, a sand filter must meet ALL applicable standards. Non-compliant sand filters are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The sand filter name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Sand Filter 1" or "SCM A." Otherwise, describe the location of the sand filter on the property (e.g., Sand filter behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):		
	Phone #:	Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number

Has the City Entered and Approved This Inspection? Yes / No

Name of Staff Approving This Inspection Report

Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one Yes / No

Reason for Follow-Up?

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Sand Filter

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the sand filter needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet may be a pipe, or small area lined with grass, stone, or concrete.*				
	a. Are inlets free of trash, debris, sediment accumulation, and other materials?				
	b. Are inlets free of erosion and areas of bare soil?				
	c. Are the inlets free of damage or modifications that may impair their intended operation?				
2	*The* **Pretreatment Area** *removes trash, debris, and dirt from stormwater, helping to prevent clogging of the main treatment area.*				
	a. Is the area free of trash, landscape debris, weeds, pet waste, and significant sediment deposits?				
	b. Is the area fully lined with concrete, rocks, or dense grass, and free of damage, erosion, and areas of bare soil?				
	c. Are the areas where stormwater enters and exits the pretreatment area free from obstructions, modifications, and damage, allowing water to easily flow through it?				
3	*The* **Filter Bed** *is where stormwater is collected and soaks into the sand. It drains to a stone or pipe underdrain which is connected to the outlet(s).*				
	a. Is the area free of evidence of compaction (compacted grass/stones, tire tracks, ponded water)?				
	b. Is the bed free of burrowing animals and free of vegetation and significant deposits of sediment, trash, pet waste and debris?				
	c. Does the area appear to function properly given recent rainfall conditions? • Standing water/wet conditions are not present on the surface of the sand filter and in the observation well *(if inspection is performed at least 48 hours after a storm)*; or, • Standing water is present in the observation well but discharging as expected *(if the inspection is performed within 48 hours after a storm or within a prolonged period of wet weather)*.				
	d. Is the observation well undamaged, unmodified, and easy to access?				

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	e. Is the observation well free of sediment buildup?				
	f. Are required SCM signs present and readable?				
4	*The* **Emergency Overflow** *allows water to safely escape the filter bed so it does not flood. It is also used to access the* **Outlet Structure**, *which may need to be periodically cleaned out if it becomes clogged with debris and sediment.*				
	a. Is the emergency overflow free from trash, sediment, or debris that could block water flow?				
	b. Are the grates, chambers, and orifices free of modifications and damage that could impair their intended function?				
5	*The* **Drainage Area** *is the land that drains stormwater to the sand filter during a storm. It may include parking areas, roadways/driveways, buildings, and landscaped areas. Keeping the drainage area clean will lower the SCM's maintenance and repair needs.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the sand filter during a storm?				
6	*The* **Access Easement** *extends from a public roadway to the sand filter, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the sand filter be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the sand filter by large maintenance equipment?				

Attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.11 Stormwater Wetland

SCM Inspection & Maintenance Guide

Stormwater wetlands are stormwater control measures (SCMs) that mimic natural wetlands to reduce pollution and flooding. They have shallow pools and gentle slopes, slowing runoff to let pollutants settle or be absorbed by plants. Stormwater wetlands can also be designed to operate like detention basins for large storms, to prevent flooding of the surrounding area. When designed to prevent flooding, larger flows move through the wetland quickly, leaving water only in the low flow permanent pools (see Figure 1). Stormwater wetlands are not naturally occurring and therefore do not require State and Federal permits[1].

Benefits of Stormwater Wetlands

- Remove pollutants from stormwater
- Control erosion and flooding
- Provide habitat for butterflies & birds
- Create an interesting landscape

Figure 1. Stormwater Wetland.
(Source: DragonFlyPondWorks.com)

Property Owner Responsibilities

The city regulates stormwater wetlands located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's stormwater wetland(s) are maintained in proper operating condition**. See Chapter 2 for more information on local regulations for SCMs and property owner responsibilities.

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this stormwater wetland *SCM Inspection & Maintenance Guide* can be used by property owners and persons maintaining SCMs to determine if a wetland is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of stormwater wetland components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand the wetland's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a stormwater wetland must meet ALL applicable operation and maintenance standards. Non-compliant wetlands are subject to enforcement.

[1] USEPA, Stormwater Best Management Practice Stormwater Wetland, EPA-832-F-21-031AA, December 2021.

Primary Components

To inspect a stormwater wetland using the *Operation & Maintenance Standards Checklist*, it is important to understand the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the basin(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Stormwater Wetland Components

1. **Inlets** let water flow into the wetland. There can be multiple inlets to a single basin.
2. **Forebays** are shallow depressions of concrete, grass, or rock below each inlet. They prevent substantial amounts of trash, debris, and sediment from washing into the main basin.
3. The **main basin** is where stormwater is collected and temporarily detained. It has **permanent pools** and **high and low marshes** of variable water depths. **Upland areas** tend to stay dry except during exceptionally wet periods.
4. The **outlet structure** allows water to exit the wetland in a controlled way. It may have multiple openings to allow different flow rates.
5. The **emergency spillway** (not shown) lets stormwater safely exit the wetland before it floods. It can be located on the outlet structure or may be a shallow, wide, concrete or grassed depression on top of the dam.
6. The **embankments** are the berms (usually grassed, earthen berms) that keep water in the main basin. The **dam** is the embankment nearest the outlet structure.
7. The **drainage area** (not shown) is the area of land that drains through the inlet(s) and into the stormwater wetland when it rains.
8. The **access easement** (not shown) extends from a public road to the wetland. It allows the city access to the wetland when necessary.

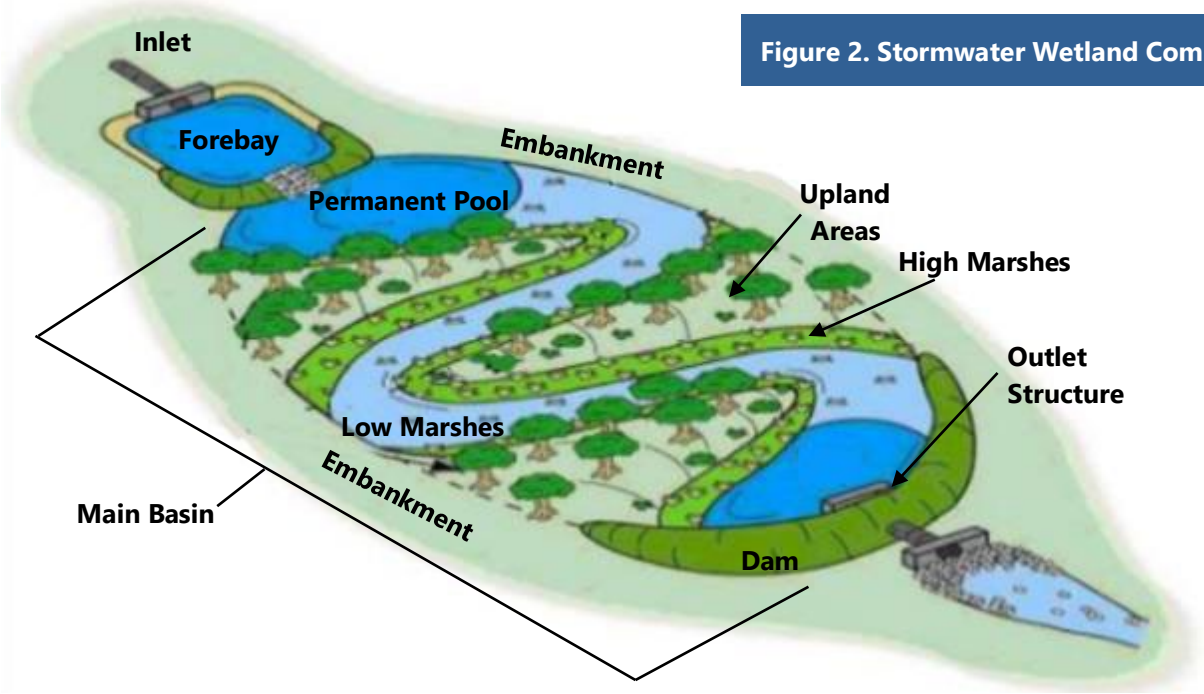


Figure 2. Stormwater Wetland Components

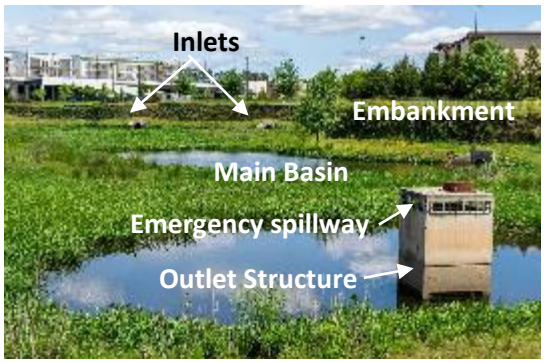


Figure 3. Stormwater Wetland Components *Wetland plants are critical to removing pollutants in a stormwater wetland. To keep plants thriving, forebays are important features because they capture trash, debris, and heavy sediments before the water flows into the main basin. (Left: Dragonfly Pond Works; Right: www.constructedwetlands.com)*

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the stormwater wetland's operation and maintenance standards are easily achieved. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Repair areas of bare soil and erosion** on the embankments and in the drainage area to the wetland.
- ☑ **Keep woody vegetation and trees to a minimum on the embankments**; when removing these plants, backfill holes with clay soil.
- ☑ **Remove overgrown and invasive plants.** Overgrown vegetation can hide animal burrows and clog the wetland. Herbicides should only be applied by a professional.
- ☑ **Water plants** during initial establishment of plant growth (1 to 3 years). Watering should only be needed when it has not rained for more than 10 days. Avoid using fertilizers and pesticides.

Cleaning

- ☑ **Clean the forebay regularly.** If sediment and debris build up, the forebay will not work properly and discharge sediment into the main basin, smothering wetland plants.
- ☑ **Clear litter, landscape materials, debris** from the area so they do not clog the wetland components.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Verify that required signs are in place**. Safety and SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Keep an eye on the water level.** If the wetland begins holding too much water for extended periods or it frequently dries up, there may be a clog or damage to the outlet structure. Check the embankments for damage as well.
- ☑ **Control burrowing animals, beavers, and fire ants**, especially on the embankments and around the outlet structure. A licensed Animal Control Operator (ACO) can help with animals, especially beavers and waterfowl.
- ☑ **Inspect the wetland's components** after every major storm for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Stormwater wetlands are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for stormwater wetlands and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Frequent high water or frequent dry marshes and/or permanent pool areas	For high water, there may be a clog within the main basin or outlet structure. Ensure these areas can be safely accessed, then remove visible debris. If the wetland is too dry, check the outlet structure, dam, and embankments for damage, leaks, or holes. Significant repairs may be needed (see Table 3).
Trash, debris, and sediment frequently accumulate in the forebay	Identify the trash source (e.g., litter, overflowing bins) and take corrective actions like adding bins, picking up litter, and emptying trash cans more often). Maintain landscaping in and around the wetland. Ensure landscapers cover stockpiles and properly dispose of or remove debris. For sediment, find the source (e.g., bare, or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Dead or dying plants	The water levels in the wetland may not be correct for the plants. The outlet may need adjusting to better manage water flow. See Table 3. Salt or sand used during winter months may be washing into the SCM. Plants may need to be thinned and/or invasive species removed to allow for better plant growth. Consult a landscape company for help if needed.
Damaged or clogged inlet, outlet, and/or trash racks.	Clogging due to leaf litter, sediment, or debris accumulation. Remove any visible debris from the surface. Repair or replace damaged structures to prevent failure. See Table 3.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts (Table 3).

Table 3. Issues and Experts

Call a **landscape company** for: • Plant, landscape, and erosion repair • Removal of large accumulations of sediment A **tree service company** can remove large trees. A **licensed Animal Control Officer** can help with burrowing animals and waterfowl.	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Stormwater Wetland

This checklist guides an evaluation of the operation and maintenance standards for stormwater wetlands, organized by primary component. **For its design to be considered compliant by the city, a basin must meet ALL applicable standards. Non-compliant stormwater wetlands are subject to city enforcement.**

SCM Name and Location		Today's Date:
	The stormwater wetland name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Stormwater Wetland 1" or "SCM A." Otherwise, describe the location of the stormwater wetland on the property (e.g., Stormwater wetland behind the main office building).	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:

Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only		
Identification Number	Name of Staff Approving This Inspection Report	
Has the City Entered and Approved This Inspection? Yes / No	Date of Inspection Approval:	
Is a Follow-Up Inspection by Staff Required? Circle one Yes / No		
Reason for Follow-Up?		

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Stormwater Wetland

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the SCM needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel lined with dense grass or stone. There may be multiple inlets to a stormwater wetland.*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are the inlet pipes and headwalls undamaged and not modified?				
	c. Are ditch inlets fully lined with dense grass or stone (mulch is prohibited)? There must be no erosion and large areas with bare soil *(channel inlets only)*.				
	d. Are the areas just upstream and downstream of the inlets free of soil erosion and standing water?				
2	*The* **Forebay** *slows down stormwater before it enters the main basin. A forebay can be made of concrete, riprap stone, or (less often) dense grass. There should be a forebay downstream of every inlet to the basin.*				
	a. Is the forebay kept clean (no buildup of trash, landscape debris, sediment, and standing water)?				
	b. Are grassed areas densely vegetated and free of soil erosion?				
	c. Are the entrances and exits to the forebay free of obstructions and modifications?				
3	*The* **Main Basin** *is where stormwater is temporarily stored. It has permanent pools, high and low marshes, and upland areas. It is surrounded by the embankments.*				
	a. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and large populations of waterfowl (or evidence of prolonged waterfowl presence)?				
	b. Is the area free of trash, debris, and significant accumulations of sediment?				
	c. Is the area free of dumped, stored, or stockpiled materials, (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	d. Is the area free of any intentionally built structures (e.g., sheds, storage pads, fences, etc.) that were not included in the original property design?				
	e. Do healthy, dense wetland and upland plants cover at least 90% of the area above the permanent pools? Is the area free of large bare spots and areas of dead/dying vegetation?				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	f. Is the water level appropriate considering recent weather conditions (i.e., the water level will be higher than normal within 2 to 3 days after a storm or during prolonged periods of wet weather; the water weather will be lower than normal (but the basin will not be completely dry) after prolonged periods of dry weather.				
	g. Can the property owner, tenant, or property manager confirm the wetland does not have frequent periods of long-standing high water or frequently go completely dry?				
4	*The* **Embankments** *surround the main treatment area and hold the water in the basin. Most embankments are earthen and lined with dense grass or riprap stone. More decorative embankments, incorporating boulders, retaining walls, and other hardscaping may also be incorporated in the embankments, if included in the original design.*				
	a. Are the embankments (including the dam) free of erosion (e.g., rills/gullies), burrowing animals, fire ant mounds, and large populations of waterfowl?				
	b. Are the embankments free of trash and debris, structures (e.g., sheds, storage pads, walls, etc.) and fences that were not included in the original property design?				
	c. Do the embankments appear undamaged and stable? (no erosion, sloughing, sliding, bulging, cracking, leaking, fire ant mounds, evidence of burrowing animals, wet areas, etc.)				
	d. Is the dam entirely free of trees and plants with woody stems?				
	e. Are vegetated areas on embankments entirely (100%) with healthy, dense grass or another grassy groundcover? Are they free of large bare spots or areas of dead/dying grass? Are they mostly covered by grass/groundcover with few trees and plants with woody stems? Are the non-vegetated areas fully covered by riprap stone or concrete?				
5	*The* **Emergency Spillway** *is typically located on top of an embankment and covered with concrete or dense grass, or it may be the opening at the top of the outlet structure. There is usually only one emergency spillway; however, exceptionally large basins may have multiple spillways.*				
	a. Is the emergency spillway undamaged and not modified in any way that changes its proper function (i.e., blocked by a fence, excavated lower than it should be, etc.)?				
	b. Is the area just below the spillway free of soil erosion or scour holes?				
	c. Is the spillway fully lined with dense grass (mulch is prohibited) or concrete?				
6	*The* **Outlet Structure** *is usually located within the basin as a concrete pipe or box (or corrugated metal pipe) that sits on the bottom of the basin, usually in the water, near the toe of an embankment. It connects to an outlet pipe that extends through the embankment to allow water to exit the basin in a controlled way. Outlet structures will have multiple openings that gradually get larger (and may even have different shapes) as they get near the top of the structure.*				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	a. Are all of the orifices (or the trash racks or filter boxes that may cover them) free of trash, debris, sediment, or other material that would cause the water to back up and not drain properly?				
	b. Are skimmers (if present) unclogged, show evidence of regular cleaning, and fully operational?				
	c. Does the outlet structure appear to be undamaged and has not been modified in any way that would change its function?				
	d. Is the area around the outlet structure or below the outlet pipe free of erosion or scour holes?				
7	*The* **Drainage Area** *is the land that drains stormwater to the basin during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lead to lower maintenance and repair needs for the stormwater wetland.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				
8	*The* **Access Easement** *extends from a public roadway to the basin, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the basin by large maintenance equipment?				

Use additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.12 Submerged Gravel Wetland

SCM Inspection & Maintenance Guide

Submerged gravel wetlands are stormwater control measures (SCMs) designed to reduce pollutants in stormwater. They have the look and function of natural wetlands (see Figure 1). They have one or more treatment cells filled with crushed rock or gravel, topped with soil, and densely vegetated with wetland plants. Stormwater flows through the root zone of the plants, where pollutants are removed by filtration and plant roots. They are highly effective for stormwater pollutant removal. However, they do not detain large volumes of water, and thus, do not provide flood control like a detention pond. Since they are not naturally occurring, State and Federal permits are not required.

Submerged Gravel Wetland Benefits

- Remove pollutants from stormwater in a relatively small area
- Provide habitat for butterflies & birds
- Create an interesting landscape

Property Owner Responsibilities

The city regulates submerged gravel wetlands located on private properties to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's SCM(s) are maintained in proper operating condition**. See Chapter 2 for more information on local regulations for SCMs and property owner responsibilities.

Figure 1. Submerged Gravel Wetland. *(Source: Georgia Stormwater Management Manual, 2016)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this *SCM Inspection & Maintenance Guide* can be used by property owners and persons maintaining SCMs to determine if a submerged gravel wetland is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of submerged gravel wetland components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand its maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must ensure that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a submerged gravel wetland must meet ALL applicable operation and maintenance standards. Non-compliant wetlands are subject to enforcement.

Primary Components

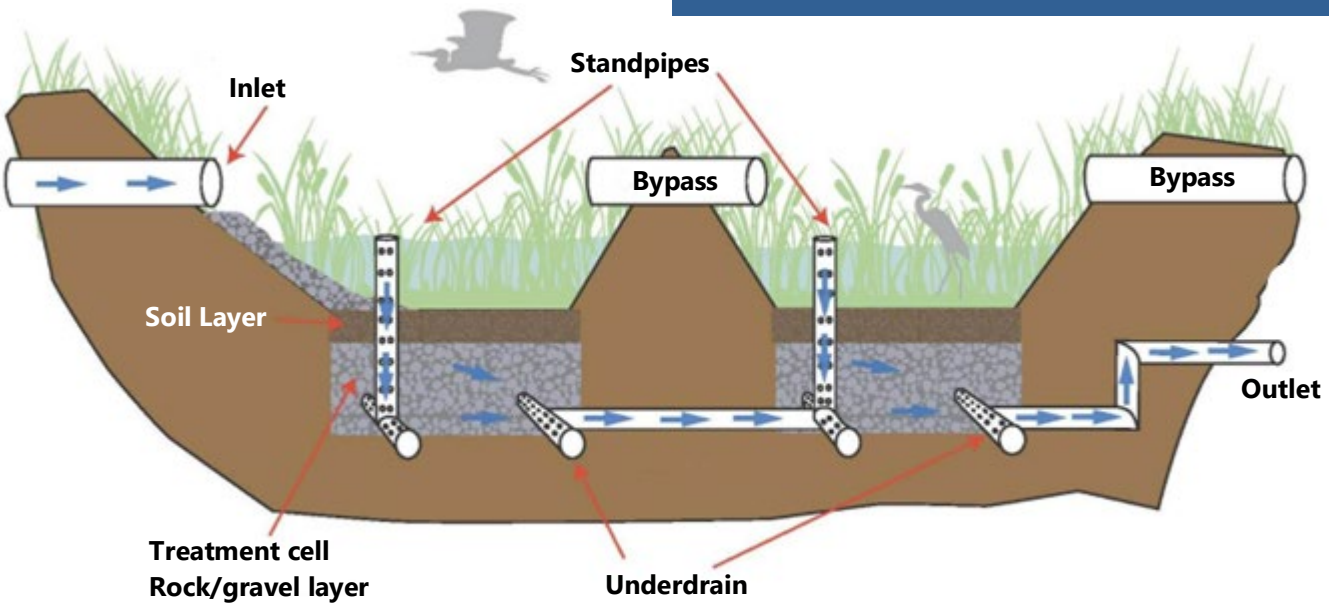
To inspect a submerged gravel wetland using the *Operation & Maintenance Standards Checklist*, it is important to know it's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the SCM(s) on their property and their components.

The components are explained in Table 1, and some of them are shown in Figure 2.

Table 1. Submerged Gravel Wetland Components

1. **Inlets** let water flow into the wetland from a forebay. There can be multiple inlets.
2. **Forebays** (not shown) are shallow concrete, grass, or rock depressions above each inlet. They prevent large amounts of trash, debris, and sediment from entering the treatment cell.
3. The **treatment cell** is where stormwater is collected for treatment, and some may have multiple cells. Each cell includes a gravel/rock layer, soil layer, and wetland plants.
4. Stormwater flows through the wetland via **underdrains** embedded in the gravel/rock layer of each treatment cell. **Standpipes** in each cell extend from the underdrains to just above the water's surface. Underdrain pipes and standpipes are perforated to facilitate water flow.
5. **Outlets** allow water to exit the wetland in a controlled way. Outlets drain to the property's stormwater drainage system via a swale, ditch, pipe, or manhole. Outlets may not be visible if they are connected underground to a pipe or manhole.
6. The **overflow bypass** (or bypass) lets stormwater safely exit the wetland after large storms before it floods. Bypasses can be pipes or a wide, concrete or grassed depression on top of a berm or wall.
7. The **drainage area** (not shown) is the area of land that drains stormwater to the inlet(s) and into the stormwater wetland when it rains.
8. The **access easement** (not shown) extends from a public road to the wetland. It allows access to the wetland by the city when necessary.

Figure 2. Submerged Gravel Wetland Components



Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the submerged gravel wetland's operation and maintenance standards are easily achieved. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Remove unhealthy, overgrown, and invasive plants monthly. Also, remove trees and woody vegetation that have taken root in the treatment cell(s).** Dead or overgrown vegetation can clog the soil layer, standpipes, outlets, and bypasses. Invasive plants can overtake wetland plants, leading to wetland failure. Trees and woody vegetation (shrubs, vines, etc.) can damage wetland components.
- ☑ **Water plants** during initial establishment of plant growth (first 18 months) to avoid plant stress during overly dry periods. After that, watering should only be needed during periods of extreme drought.
- ☑ **Repair eroded areas the wetland and drainage area as needed.** Sediment from erosion can cause clogs.
- ☒ **Don't use fertilizer, pesticides, or chemical animal control treatments** as these chemicals may drain with the water into the drainage system and, ultimately, local waterways.

Cleaning

- ☑ **Remove sediment, trash, and debris monthly.** If sediment and debris build up, the forebay will not work properly and discharge sediment into the treatment cell, smothering wetland plants.
- ☑ **Remove dropped leaves in the fall.** Leaf buildup will clog the wetland.
- ☑ **Remove blockages in inlets, outlets, and bypasses, and around standpipes as needed** to keep the water in the wetland flowing normally.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Verify that the required signs are in place**. Safety and SCM signs required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Keep an eye on the water level.** If the submerged gravel wetland begins holding too much water for extended periods or it frequently dries up, there may be a clog or damage to the outlet structure.
- ☑ **Control burrowing animals and fire ants**, especially on any earthen embankments around or between treatment cells. A licensed Animal Control Operator (ACO) can help with animals if needed. Avoid using chemical animal control treatments.
- ☑ **Inspect the wetland's components monthly and after every major storm** for debris and damage, and to make sure that water is draining through the wetland properly. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.
- ☒ **Don't apply excess salt and sand during the winter months.** Salt can kill wetland plants, and sand can smother the plants or clog wetland components.
- ☒ **Don't pile plowed snow and ice in the wetland.** Heavy loads can kill wetland plants or break their components.

Troubleshooting

Submerged gravel wetlands function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for submerged gravel wetlands and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Frequent high water or frequent dry areas	For high water, a treatment cell, underdrain, outlet, or bypass may be clogged. Ensure these components can be safely accessed, then remove debris. For overly dry conditions, the outlets or underdrains may be damaged, allowing water to exit the wetland too quickly. Check all of these components for damage, leaks, holes, etc. A significant repair may be needed. See Table 3.
Trash, debris, and sediment frequently accumulate in the forebay	Identify the trash source (e.g., litter, overflowing bins) and take corrective actions like adding bins, picking up litter, and emptying trash cans more often. Maintain landscaping in and around the wetland. Ensure landscapers cover stockpiles and properly dispose of or remove debris. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Dead or dying plants	The water level may not be correct for the plants. The underdrains or outlets may need adjusting to better manage water flow. See Table 3. Salt or sand used during winter months may be washed into the SCM. Plants may need to be thinned and/or invasive species removed to allow for better plant growth. Consult a landscape company for help if needed.
Damaged or clogged inlet, outlet, and/or trash racks.	Clogging due to leaf litter, sediment, or debris accumulation. Remove any visible debris from the surface. Repair or replace damaged structures to prevent failure. See Table 3.

When to Call an Expert

Sometimes problems require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts (Table 3).

Table 3. Issues and Experts

Call a **landscape company** for: • Plant care and erosion repair • Leaf removal and general landscape cleaning • Removal of sediment accumulations A **licensed Animal Control Officer** can help with burrowing animals and waterfowl.	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Submerged Gravel Wetland

This checklist guides an evaluation of the operation and maintenance standards for submerged gravel wetlands, organized by primary component. **For its design to be considered compliant by the city, a submerged gravel wetland must meet ALL applicable standards. Non-compliant submerged gravel wetlands are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The SCM name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Submerged Gravel Wetland 1" or "SCM A." Otherwise, describe the location of the wetland on the property (e.g., Stormwater wetland behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company): Phone #:	Contact Name (If Different): Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
Owner Information	Name (Person(s) or Company): Street Address:	Contact Name (If Different): City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number	Has the City Entered and Approved This Inspection?	Name of Staff Approving This Inspection Report	Is a Follow-Up Inspection by Staff Required? Circle one	Reason for Follow-Up?
	Yes / No	Date of Inspection Approval:	Yes / No	

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Submerged Gravel Wetland

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the SCM needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel lined with dense grass or stone. There may be multiple inlets to a submerged gravel wetland.*				
	a. Are inlets free of trash, debris, and accumulation of sediment, and other materials?				
	b. Are the inlet pipes and headwalls (if present) undamaged and not modified?				
	c. Are ditch inlets fully lined with dense grass or stone (mulch is prohibited)? There must be no erosion and large areas with bare soil *(ditch inlets only)*.				
	d. Are the areas just upstream and downstream of the inlets free of soil erosion and standing water?				
2	*The* **Forebay** *slows down stormwater before it enters a treatment cell. A forebay can be made of concrete, riprap stone, or (less often) dense grass. There should be a forebay for every inlet to the submerged gravel wetland.*				
	a. Are forebays kept clean (no large buildup of trash, landscape debris, and sediment)?				
	b. Are grassed areas around forebays densely vegetated and free of soil erosion?				
	c. Are the entrances and exits to the forebay free of obstructions and modifications?				
3	*The* **Treatment Cell** *is where stormwater is temporarily stored. Visually, it looks like a confined area with dense wetland plants and standing water. A single submerged gravel wetland may have multiple interconnected treatment cells.*				
	a. Are cells free of erosion (e.g., rills/gullies), burrowing animals, and large waterfowl populations (or evidence of prolonged waterfowl presence)?				
	b. Is the area free of trash, debris, and significant sediment accumulations?				
	c. Is the area free of dumped, stored, or stockpiled materials, (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	d. Is the area free of any intentionally built structures (e.g., sheds, storage pads, fences, etc.) that were not included in the original property or SCM design?				
	e. Do healthy, dense wetland plants cover at least 90% of the cell? Is the area free of large bare spots, dead/dying vegetation, and trees/woody plants? Is there sufficient water in the wetland?				

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Submerged Gravel Wetland

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	f. Is the water level in each cell appropriate considering recent weather conditions? For example, the water level will be higher than normal within 2 to 3 days after a storm or during prolonged periods of wet weather; the water will be lower than normal (but the cells should not be completely dry) after periods of dry weather.				
	g. Can the property owner, tenant, or property manager confirm the wetland does not have frequent periods of long-standing high water or frequently go completely dry?				
4	*The* **Standpipes** *extend from the perforated pipe underdrain located in a treatment cell's rock/gravel layer to above the water level. Standpipes are also perforated below the water's surface but may have solid walls that extend higher to facilitate inspection and cleaning. Standpipe perforations should not be blocked or clogged.*				
	a. Are standpipe perforations and openings at their tops free of blockages and clogs?				
	b. Are the interiors of standpipes free of blockages, growing plants, and sediment buildup?				
	c. Are the water levels inside standpipes the same as those in their treatment cell? (Differing water levels could indicate a clogged or damaged standpipe or underdrain.)				
	d. Are all standpipes free of damage and modifications?				
5	*The* **Bypass** *is typically located on top of or embedded within berms or walls that separate treatment cells and at the lower end (i.e., outlet end) of the wetland. A bypass can be one or more pipes or constructed as a low area of concrete or dense grass at the top of a berm.*				
	a. Are the bypasses undamaged and not modified in any way that changes their proper function (i.e., broken pipe, severe erosion, holes or burrows, shrubs or trees growing in them, etc.)?				
	b. Is the area just below the bypass of soil erosion and scour holes?				
	c. If constructed as low areas at the top of berms, are the bypasses fully lined with dense grass (mulch is prohibited) or concrete?				
6	**Outlets** *are located at the lower end of the wetland. They discharge water from the wetland into a drainage ditch or manhole. Outlets connected to a manhole will not be visible without removing the manhole cover. INSPECTORS SHALL NOT ENTER A MANHOLE without proper training and certifications, equipment, and additional personnel.*				
	a. Are all outlets (or the trash racks or filter boxes that may cover them) free of trash, debris, sediment, or other material that would cause the water to back up and not drain properly?				
	b. Are skimmers (if present) unclogged, show evidence of regular cleaning, and fully operational?				
	c. Does the outlet structure appear to be undamaged and has not been modified in any way that would change its function?				

Operation & Maintenance Standards Checklist
Submerged Gravel Wetland

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	d. For outlets that drain to a ditch or swale, is the area around and below the outlet free of erosion or scour holes?				
7	*The* **Drainage Area** *is the land that drains stormwater to the submerged gravel wetland during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the wetland's maintenance and repair.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the wetland during a storm?				
8	*The* **Access Easement** *extends from a public roadway to the submerged gravel wetland, allowing access by maintainers and the city for purposes of inspection and maintenance enforcement.*				
	a. Can the submerged gravel wetland be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the wetland by large maintenance equipment?				

Use additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.13 Underground Detention Basin

SCM Inspection & Maintenance Guide

Underground detention basins are stormwater control measures (SCMs) that temporarily store stormwater in underground vaults and release it in a controlled manner (see Figure 1). Vaults are made of reinforced, high-strength concrete, polypropylene, or other materials. The basin should fully drain in two days after a storm. These SCMs are commonly used under parking lots or grassed areas, which allows for further site development without sacrificing land area. They can be quite large, allowing them to prevent flooding by detaining stormwater produced by heavy or prolonged rains.

Benefits of Underground Detention

- May reduce erosion (if designed to do so)
- Reduces flooding
- Maximizes available land for uses other than stormwater control

Property Owner Responsibilities

Underground detention basins located on private properties are regulated by the city to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring the underground detention basins on their property are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this underground detention basin *SCM Inspection & Maintenance Guide* can be used by property owners and persons maintaining SCMs to determine if an underground detention basin is operating properly. The checklist serves two purposes:

Figure 1. Underground Detention *(Source: CULTEC, Inc.)*

- **The checklist guides an evaluation of underground detention basin components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a basin's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must ensure that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, an underground detention basin must meet ALL applicable operation and maintenance standards. Non-compliant basins are subject to city enforcement.

Primary Components

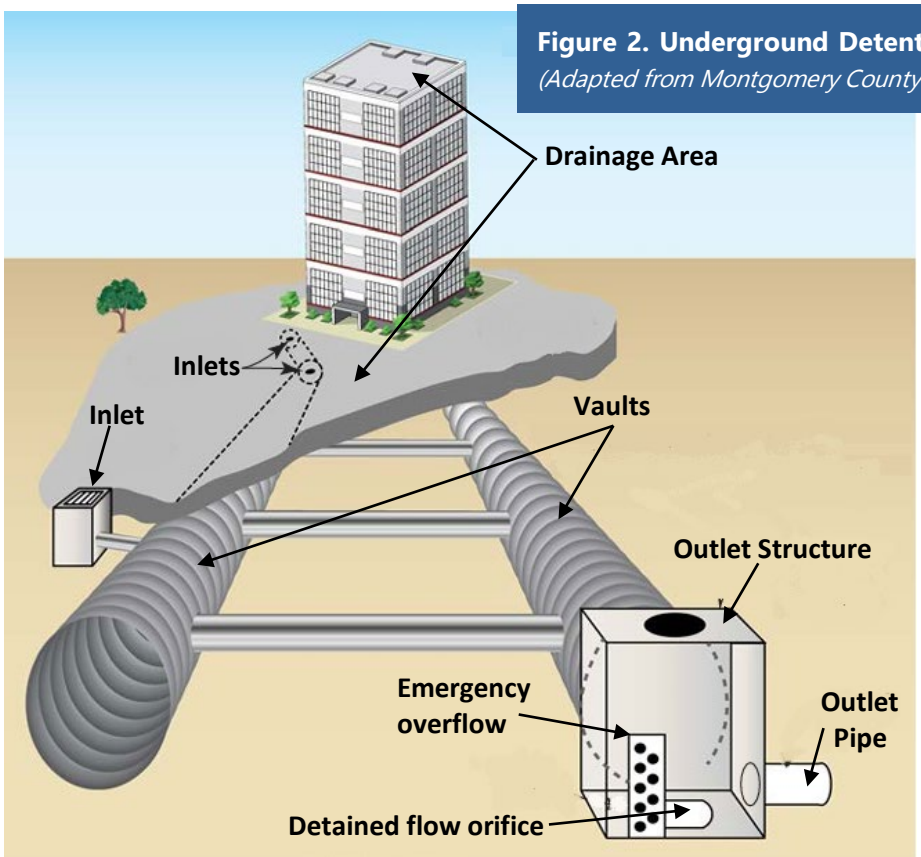
To inspect an underground detention basin using the *Operation & Maintenance Standards Checklist*, it is important to know the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the basin(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 shows more examples of underground detention basins.

Table 1. Underground Detention Basin Components

1. **Inlet structures** let water flow into the basin. A single basin may have multiple inlets.
2. **Pretreatment devices** (not shown) remove trash, debris, and dirt from stormwater flowing into the basin. There may be another SCM located inside the inlets, such as a manufactured treatment device (MTD, see section 4.8 of this manual).
3. **Vaults** temporarily store stormwater. They are typically high strength, pre-cast concrete modules or petroleum-based plastic cylinders.
4. The **emergency overflow** lets excess stormwater safely exit the basin when its storage volume is exceeded.
5. The **outlet structure** lets water exit the SCM.
6. The **drainage area** (not shown) is the area of land that drains to the SCM when it rains.
7. The **access easement** (not shown) allows the city to access the SCM when necessary.

Figure 2. Underground Detention Components
(Adapted from Montgomery County MD)



4.13 Underground Detention Basin

SCM Inspection & Maintenance Guide

Figure 3. Examples of Underground Detention Basin *Left: A graphic depiction of an underground detention system constructed with modular concrete vaults (Source: StormTrap® in Romeoville IL); Right: This picture shows the installation of stormwater detention vaults. The closed bottomed cylinders rest on a gravel bed laid over geotextile fabric. (Source: Philadelphia Water Department)*

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure the underground detention basin's operation and maintenance standards are achieved. **Make routine maintenance a habit!**

Underground detention basins are not designed for regular occupancy yet can be large enough for a person to enter. The basin meets the definition of a confined space under 29 CFR 1926.1202, and therefore present a safety hazard. **DO NOT ENTER THE BASIN! ONLY PERSONS WITH OSHA CONFINED SPACE TRAINING CAN ENTER AND MUST HAVE A SAFETY CREW PRESENT.**

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment from inlets and pretreatment devices** at least four times a year. If inlets or devices fill with materials after each cleaning, clean more often. Dispose of removed materials in the trash. Replace pretreatment device filters (if any) regularly.
- ☑ **Keep the drainage area clean.** Pick up trash regularly and empty cans before they overflow. Maintain the landscape. Keep storage, including temporary landscape stockpiles (e.g., mulch), away from inlets.
- ☑ **Repair erosion and bare spots.** If landscaped beds and grassed areas are in the drainage area to the basin, cover bare soil and repair erosion as soon as it is noticed.

Other Activities

- ☑ **Sweep driveways and parking lots** in the drainage area at least twice a year; more often for high litter areas (such as fast-food parking lots) or if open construction activities are located nearby.
- ☑ **Cover potential pollutants in the drainage** area to prevent contamination of the sand filter. Use a tarp and berm outdoors or store items indoors. Park leaking vehicles or equipment inside or cover them, using drip pans to collect fluids. Dispose of fluids properly and empty pans regularly.
- ☑ **Verify that the required signs are in place**. SCM signs required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Check visible** components **after major storms** for debris and damage. Look inside inlets and outlets for sediment and debris accumulation, scour, and erosion. Clean and repair them as needed.
- ☑ **Check for damage, settling,** cracks**, bulges, and other signs of structural issues** on the ground surface above the system. Contact the basin manufacturer or installer immediately if you have concerns.

Troubleshooting

Underground detention basins are designed to function year-round without fail. However, problems can occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for underground detention and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
The basin frequently does not return to a dry condition within 48 hours of a storm.	This condition is likely not a concern observed during or after a prolonged series of storms. The outlet structure may be clogged. Wait until it is safe to check and remove the clog. Assistance may be needed (see Table 3).
Trash, debris, and sediment frequently accumulate in the inlets or pretreatment devices.	Identify the trash source (e.g., litter, overflowing bins) and take corrective actions like adding bins, picking up litter, and emptying trash cans more often. Maintain the landscape more often, sweep parking lots and roads, and ensure landscapers cover or remove stockpiles and dispose of debris properly. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Trash, debris, and sediment frequently accumulate in the vaults or outlet structure.	Increase the frequency of pretreatment device cleaning. If the device is full of trash, debris, and sediment, it will not function properly. Add pretreatment devices if none are present in the inlets. Over time, this problem can lead to costly repairs of the vaults and outlet structure. So, it must be addressed as soon as it is noticed.
Inlet grates or manhole covers are missing or damaged.	Grates and manhole covers are susceptible to vandalism and theft. If you notice these are missing or damaged, install temporary protection measures (e.g., traffic cones to warn vehicles and pedestrians and/or something to cover the openings). Contact your city's stormwater department immediately.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts (Table 3). Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

For significant component repairs or to determine a solution to a frequent, unsolved problem, consult the manufacturer of the underground detention basin or a licensed professional (civil) engineer to ensure repairs are effective and done in accordance with the SCM's approved design.
Only professionals with confined space training may enter an underground detention basin!

Operation & Maintenance Standards Checklist
Underground Detention Basin

This checklist guides an evaluation of the operation and maintenance standards for underground detention basins, organized by primary component. **For its design to be considered compliant by the city, a basin must meet ALL applicable standards. Non-compliant underground detention basins are subject to city enforcement.**

SCM Name and Location				Today's Date:
	The underground detention basin name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Underground Detention Basin 1" or "SCM A." Otherwise, describe the location of the dry detention basin on the property (e.g., Underground detention basin behind the main office building).			Date of Last Inspection:
SCM Property Address	Street Address:	City:	State:	Zip:
SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):		
	Phone #:	Email:		
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:		
SCM Owner Information	Name (Person(s) or Company):	Contact Name (If Different):		
	Street Address:	City:	State:	Zip:
	Phone #:	Email:		

This Section is for Stormwater Staff Use Only

Identification Number

Has the City Entered and Approved This Inspection? Yes / No

Name of Staff Approving This Inspection Report

Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one Yes / No

Reason for Follow-Up?

Submit inspection forms to your local stormwater department

Johnson City	Kingsport	Bristol	Elizabethton
stormwater.scm@johnsoncitytn.org	WSEngineers@KingsportTN.gov	engineering@bristoltn.org	stormwater@cityofelizabethton.org
Questions? Call (423) 975-2700	Questions? Call (423) 229-9454	Questions? Call (423) 989-5523	Questions? Call (423) 547-6238

Operation & Maintenance Standards Checklist
Underground Detention Basin

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the underground detention basin needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete.

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the basin. There may be multiple inlets to an underground detention basin.*				
	a. Are inlets free of trash, debris, and sediment accumulation, and other materials?				
	b. Are the inlets free of damage (e.g., loose grates, pavement degradation, missing covers) and modifications?				
	c. Are the inlets free of evidence of standing water (muck or caked debris, debris ponding lines around the inlet)?				
	d. Are the inlets free of stains or odors indicating that materials or liquids other than stormwater have been spilled or dumped in or near the inlet?				
2	**Pretreatment Devices** *remove trash, debris, and heavy sediment from stormwater before it enters the basin's vaults. Basins designed to address stormwater pollution will have a pretreatment device for each inlet, sometimes within the inlet itself. If the basin being inspected is not designed to address stormwater pollution, check "NA" for each question and indicate that pretreatment devices are not a part of the basin's Record Drawing in the blank area on the right.*				
	a. Are pretreatment devices clean (no significant buildup of trash, landscape debris, sediment, and standing water)?				
	b. Are the inlets free of damage and modifications?				
	c. Are the entrances and exits to pretreatment devices free of obstructions?				
3	*The* **Vaults** *are where stormwater is temporarily stored in the basin. Vaults may be visible to inspectors through the inlets or via observation ports. Complete this section ONLY if the vaults can be observed safely.* ***DO NOT ENTER THE VAULTS WITHOUT PROPER TRAINING, EQUIPMENT, AND SAFETY PERSONNEL. DO NOT INSPECT AND ENTER A VAULT WITHIN THREE DAYS OF A RAINFALL.***				
	a. Are the vaults free of trash, debris, vegetation, and significant sediment accumulation?				
	b. Are the vaults undamaged and unchanged from the original design?				
	c. Is the vault free of standing/stagnant water?				
	d. Are the vaults free of stains or odors indicating materials or liquids other than stormwater have been spilled or dumped into the basin?				

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Underground Detention Basin

	Operation & Maintenance Standard	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
4	*The* **Outlet Structure** *allows water to exit the basin in a controlled manner. Outlet structures may have multiple openings. Most basins will have a detained flow orifice or weir (or a series or orifices) located near the bottom of the structure and an* **Emergency Overflow** *orifice or flow device higher up.*				
	a. Are the orifices and emergency overflow free of blockages and clogs allowing water to drain through or past them easily ?				
	b. Are trash racks (if present) free of trash, debris, sediment, or other material that would cause the water to back up and not drain properly?				
	c. Are skimmers (if present) unclogged, show evidence of regular cleaning, and fully operational?				
	d. Does the outlet structure is undamaged and has not been modified in any way that would change its function?				
	e. If observable, is the area around the outlet structure or below the outlet pipe free of erosion or scour holes?				
5	*The* **Drainage Area** *is the land that drains stormwater to the underground detention basin during a storm. It may include parking areas, roadways/driveways, buildings, and landscaped areas. Keeping the drainage area clean will lower the basin's maintenance and repair needs .*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				
6	*The* **Access Easement** *extends from a public roadway to the basin, allowing maintainers and the city to access the basin for inspection and maintenance enforcement.*				
	a. Can the basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the basin by large maintenance equipment?				

Operation & Maintenance Standard	Answer			Description of "No" Answers and Corrective Action to be Performed
	Y	N	NA	

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.14 Urban Bioretention

SCM Inspection & Maintenance Guide

Urban bioretention areas are stormwater control measures (SCMs) that protect water quality by filtering pollutants from stormwater. Urban bioretention is designed as shallow, vegetated areas that are typically surrounded by hard surfaces, like roadways and sidewalks. They can even be located next to a building. Urban bioretention areas are sometimes called planter boxes or stormwater islands. Stormwater is captured in the island soaks into an engineered soil medium where pollutants are filtered out. It discharges from the SCM via an underdrain. An urban bioretention area will manage about one (1) inch of rainfall and should drain completely in about 48 hours after a storm.

Benefits of Urban Bioretention

- Removes pollutants from stormwater
- May reduce erosion in nearby streams
- May decrease flooding
- Provides habitat for butterflies & birds

Property Owner Responsibilities

The city regulates urban bioretention areas located on private property to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's urban bioretention area(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

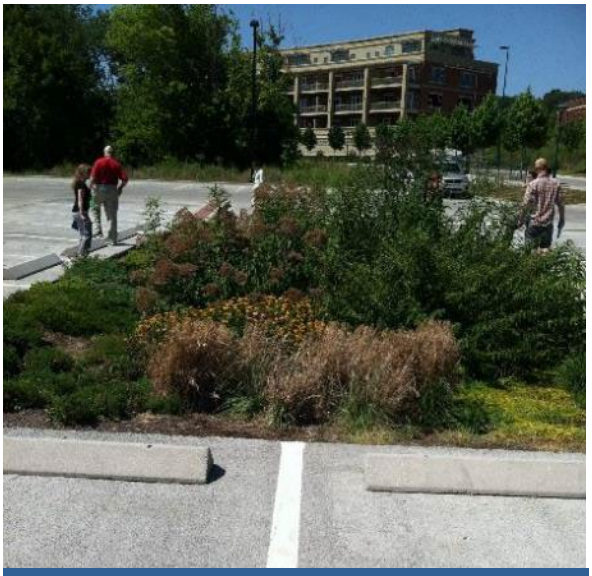


Figure 1. Urban Bioretention in City Bus Station Parking Lot in Chattanooga TN *(Source: WSP)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this urban bioretention *SCM Inspection & Maintenance Guide* was designed to help property owners, SCM maintainers, and the city to determine if an urban bioretention area is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of urban bioretention area components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand an urban bioretention area's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must focus on ensuring that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, an urban bioretention area must meet ALL applicable operation and maintenance standards. Non-compliant SCMs are subject to city enforcement.

Primary Components

To inspect an urban bioretention area using the *Operation & Maintenance Standards Checklist*, it is important to know the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the urban bioretention area(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Urban Bioretention Components

1. **Inlets** let water flow into the SCM. There can be multiple inlets in an urban bioretention area.
2. **Pretreatment areas** remove trash, debris, and dirt from stormwater. This helps prevent clogging of the main treatment area. These areas can be lined with rock or dense grass.
3. In the **main treatment area,** stormwater soaks into an **engineered soil media** which filters out pollutants. **Plants** also remove pollutants and keep the soil healthy and loose.
4. **Underdrains** drain treated water. **Cleanouts** *(not shown)* allow inspection and cleaning of the underdrain.
5. **Outlet(s)** let water exit the SCM and drain to the property's stormwater system. The outlet to the underdrain may not be visible.
6. **Emergency overflows** allow water in excess of the areas design capacity to drain out of the SCM safely. This prevents flooding of the SCM and surrounding area.
7. The **drainage area** *(not shown)* is the area of land that drains to the urban bioretention area when it rains.
8. The **access easement** *(not shown)* extends from a public road to the urban bioretention area, allowing access by the city when necessary.

Figure 2. Urban Bioretention Components. *The figure displays an urban bioretention with an underdrain that connects to the stormwater conveyance system. All the components are shown except the drainage area (#6) an access easement (#7). In many cases, the drainage area is a parking lot, street, or building adjacent to the urban bioretention. (Graphic Credit: WSP)*

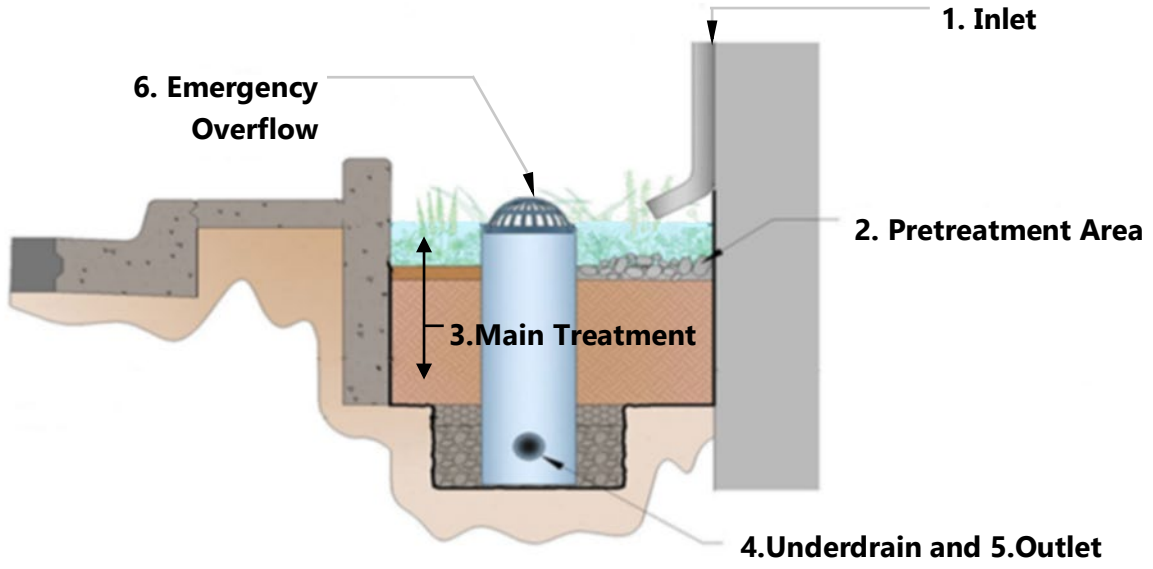


Figure 3. Examples of Urban Bioretention Components *Left: The tree box's two pretreatment areas allow sediment to settle out before entering the main treatment area. Healthy plants in the tree box also help remove pollutants (Source: FL Dept of Environmental Protection). Right: A planter box accepts roof top runoff via the downspout. Runoff is treated and cleaner water released via the outlet (not shown) (Source: National Assoc. of City Transportation Officials).*

Routine Maintenance

When performed regularly, the routine maintenance activities described below can ensure that the urban bioretention's operation and maintenance standards are easily achieved. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Weed & prune** to remove weeds and invasive plants. Cut back dead stems of herbaceous plants. Remove any leaves.
- ☑ **Seed, sod, or cover areas of bare soil and repair eroded areas** with grass or other appropriate ground cover as soon as they are noticed. Do this in the main treatment and pretreatment areas. Replenish and redistribute mulch to a total depth of 3 inches in the main treatment area.
- ☑ **Water plants** during initial establishment of plant growth (first 18 months). Watering should only be needed when it has not rained for more than 10 days. Skip the fertilizers and pesticides.

Cleaning

- ☑ **Remove trash, debris, and sediment.** Do not store materials, including landscape stockpiles, in or around the bioretention area. Dispose of landscape debris properly.
- ☑ **Keep the drainage area clean.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Cover potential pollutants in the drainage area** that can be washed into the SCM during a storm. Use a tarp and berm if they are stored outside or store them inside a building. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Verify that required SCM signs are in place**. SCM signs that are required by the city should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the urban bioretention components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Urban bioretention areas are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. **Table 2** describes the most common problems for urban bioretention and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
Standing water in the urban bioretention after 3 days with no rain.	The underdrain may be clogged. Use the cleanout to remove any clogs. The main treatment area may be clogged with surface sediment that has washed into the urban bioretention over time. See Table 3.
Trash, debris, and sediment frequently accumulate in the main treatment area.	Clean the pretreatment area more often to ensure it works properly. Determine the source of trash (e.g., litter, frequently overflowing trash cans, etc.) and take steps to reduce the problem (e.g., add trash cans, pick up litter, and empty trash cans more frequently, etc.). For landscape debris, clean the SCM and drainage area more frequently. Ensure landscape debris is disposed of in the trash or remove it from the premises so it cannot wash into the SCM. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Dead or dying plants	Determine and correct the problem if possible (too much/little water, too much/little sun, abundance of weeds, pests, disease, fertilizer, etc.). Replace dead and dying plants with healthy plants that are appropriate for use in an SCM. Species diversity can help with plant survival.
Erosion or bare soil in the main treatment area	Erosion may indicate that runoff is moving too fast into the main treatment area. Make sure the plants in the SCM are healthy, and the pretreatment area is lined with rock or dense grass (depending on the SCM design).

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see Table 3.

Table 3. Issues and Experts

Call a **landscape company** if you notice any of the following: • Frequent standing water • Plants are often unhealthy or die quickly • Erosion occurs frequently	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Urban Bioretention

This checklist guides an evaluation of the operation and maintenance standards for urban bioretention areas, organized by primary component. **Urban bioretention must meet ALL applicable standards for its design to be considered compliant by the city. Non-compliant urban bioretention areas are subject to city enforcement.**

SCM Name and Location		Today's Date:
	The urban bioretention name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Urban Bioretention 1" or "SCM A." Otherwise, describe the location of the urban bioretention on the property (e.g., Urban bioretention behind the main office building).	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:

SCM Owner Information	Name (Person(s) or Company):		Contact Name (If Different):	
	Street Address:	City:	State:	Zip:
	Phone #:		Email:	

This Section is for Stormwater Staff Use Only

Identification Number

Has the City Entered and Approved This Inspection? Yes / No

Name of Staff Approving This Inspection Report

Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one Yes / No

Reason for Follow-Up?

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Urban Bioretention

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the urban bioretention area needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city's stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) does not apply to the inspected SCM.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe, channel, or an area lined with dense grass or stone.*				
	a. Are inlets free of trash, debris, and accumulations of sediment, and other materials?				
	b. Are inlets free of erosion and areas of bare soil?				
	c. Are the inlets free of damage or modifications that may impair their intended operation?				
2	*The* **Pretreatment Area** *removes trash, debris, and dirt from stormwater flowing in. This helps to prevent clogging of the main treatment area. Pretreatment areas are lined with dense grass or stone or may be a small stilling well.*				
	a. Is the area free of trash, landscape debris, weeds, pet waste, and significant deposits of sediment?				
	b. Is the area fully lined with concrete, rocks, or dense grass, and free of damage, erosion, and areas of bare soil?				
	c. Are the areas where stormwater enters and exits the pretreatment area free from obstructions, modifications, and damage, allowing water to easily flow through it?				
3	*The* **Main Treatment Area** *is where stormwater is collected and soaks into the soil. Engineered soil media, plants, underdrains, and cleanouts are all part of this area.*				
	a. Do plants cover at least 70% of the surface area of the main treatment area? Are the remaining areas covered by mulch or landscape stone? (Areas of bare soil are not allowed.)				
	b. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and fire ant mounds?				
	c. Do most plants appear to be healthy with no (or very few) signs of disease, distress, and poor care/conditions? (Signs of distress could include: wilted, limp or scorched leaves; leaves with discoloration; damaged leaves due to pest consumption; foul or uncharacteristic odor; slimy or consistently wet roots, bark, trunks or stems; brittle or discolored roots, bark, trunks or stems.)				
	d. Is the main treatment area free of weeds and entirely free of cattails? (Cattails are evidence that the SCM is not draining properly after a storm and that wetland conditions are forming.)				

Submit inspection forms to your local stormwater department

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	e. Are trees (if specified and allowed) limited to about one per 50 square feet?				
	f. Are check dams (if present) free of damage and free of weeds and accumulated debris and sediment? (Check dams usually look like rock dams designed to slow down water)				
	g. Is the area free of significant deposits of sediment, trash, pet waste, and debris from inflowing stormwater and no outlet openings are buried or covered by accumulated sediment/mulch?				
	h. Does the area appear to function properly given recent rainfall conditions? • Standing water is not present on the surface of the main treatment area and not visible in the underdrain (viewed via the cleanout, if a cleanout is included) *(if inspection is performed at least 72 hours after a storm)*; or, • Standing water or wet conditions are present but discharging as expected through the underdrain (viewed via the cleanout) or outlet (if visible) *(if inspection is performed within 72 hours after a storm or within prolonged period of wet weather)*				
	i. Is the main treatment area free of damage, evidence of soil compaction (e.g., compressed mulch, tire tracks) and sinkhole/throats or drop-outs (i.e., depressions or openings in the ground surface that form on their own, especially after rainfall)?				
	j. Is the cleanout free from damage? (the cap is on and can be removed without issue, and the pipe is not cracked or broken)				
	k. Is the inside of the cleanout pipe free of sediment and debris?				
	l. When observed through the cleanout, is the underdrain free of damage and significant accumulations of sediment?				
4	*The* **Outlet Structure and Emergency Overflow** *let stormwater exit the SCM and bypass the SCM during intense or long storms without flooding the surrounding area. Some urban bioretention areas have underdrains as part of the outlet structure.*				
	a. Are the outlet structures (if visible) and emergency overflow free of damage and modifications that may impair their function as originally designed?				
	b. Is the emergency overflow buried (partially or fully) by accumulated sediment or mulch?				
	c. Are the outlet structures (if visible) and emergency overflow free of trash, landscape debris, sediment deposits, and other materials that may impede flow out of the main treatment area?				
	d. Is the area downstream of the outlet(s) free from erosion caused by water flowing from the outlet(s)?				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	The **Drainage Area** *is the land that drains stormwater to the urban bioretention area during a storm. It may include parking areas, roadways/driveways, buildings, and even landscaped areas. Keeping the drainage area clean will lower the maintenance and repair needs for the urban bioretention area.*				
5	**a.** Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the urban bioretention area during a storm?				
	The **Access Easement** *extends from a public roadway to the urban bioretention, allowing maintainers and the city access for inspection and maintenance enforcement.*				
6	**a.** Can the urban bioretention area be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the urban bioretention by large maintenance equipment?				

Use this page or attach additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.

4.15 Water Quality Basin

SCM Inspection & Maintenance Guide

Water quality basins are stormwater control measures (SCMs) typically constructed to manage both stormwater pollutants and flooding. While these basins are similar to dry detention basins in that they detain stormwater, water quality basins have a permanent pool of water (Figure 1). Stormwater is temporarily stored above the permanent pool surface and released slowly below the basin's dam. Plants around the basin prevent erosion and filter stormwater flowing into the basin. Some water quality basins are constructed with fountains or air bubblers to provide constant water movement to prevent mosquito breeding. When properly maintained, these basins can be attractive amenities. However, they can attract large waterfowl populations, which may cause pollution and erosion problems.

Benefits of Water Quality Basins

- Remove pollutants from stormwater
- May reduce erosion in nearby streams
- May decrease flooding
- Provide habitat for butterflies & birds
- Create an interesting landscape

Property Owner Responsibilities

The city regulates water quality basins located on private properties to ensure they are maintained and continue to meet their operating standards. **The property owner is responsible for ensuring their property's water quality basin(s) are maintained in proper operating condition**. See Chapter 2 for more information on city regulations for SCMs and property owner responsibilities.

Figure 1. Water Quality Basin *(Source: City of Lenexa, Kansas)*

SCM Inspections

The *Operation & Maintenance Standards Checklist* provided at the end of this water quality basin *SCM Inspection & Maintenance Guide* can be used by property owners and persons maintaining SCMs to determine if a water quality basin is operating properly. The checklist serves two purposes:

- **The checklist guides an evaluation of water quality basin components, describing the city's standards for proper operation and maintenance of each.** This allows inspectors and maintainers to understand a water quality basin's maintenance and repair needs.
- **Use this checklist to document the Five-Year Professional SCM Inspections required for compliance with local operation and maintenance standards.** Regular use for routine inspections helps keep MTDs functioning properly. See Chapter 3 for general SCM inspection details.

The checklist describes the operation and maintenance standards in a question format. A "Yes" answer means the standard in the question has been met. A "No" answer means maintenance or repair is needed. Therefore, maintenance activities must ensure that all the questions can be answered with a "Yes."

For its design to be considered compliant by the city, a water quality basin must meet ALL applicable operation and maintenance standards. Non-compliant basins are subject to city enforcement.

Primary Components

To inspect a water quality basin using the *Operation & Maintenance Standards Checklist*, it is important to know the SCM's primary components and their function. The checklist guides the inspection of these primary components. Owners should obtain a copy of the property's Record Drawing to better understand the basin(s) on their property and its components.

Table 1 explains the components, and Figure 2 shows most of them. Figure 3 provides more detailed examples of some components.

Table 1. Water Quality Basin Area Components

1. **Inlets** let water flow into the basin. Multiple inlets can exist in a single basin.
2. **Forebays** are shallow concrete, grass, or rock depressions above each inlet. They prevent large amounts of trash, debris, and sediment from entering the treatment cell.
3. The **main basin** is where stormwater is collected and detained. Plants slow down and treat stormwater to remove pollutants.
4. The **outlet structure** allows water to exit the basin in a controlled way. It is located in the main basin and may have multiple openings.
5. The **emergency spillway** lets stormwater safely exit the basin before it floods. It can be located on the outlet structure or in a shallow, wide, concrete or grassed depression on top of the dam.
6. The **embankments** are usually grassed, earthen berms or walls that keep water in the basin. The **dam** is the embankment near the outlet structure.
7. The **drainage area** (not shown) is the area of land that drains to the basin when it rains.
8. The **access easement** (not shown) extends from a public road to the basin. It allows the city to access the basin when necessary.

Figure 2. Water Quality Basin Components *All the components are shown except the drainage area (#6) and the access easement (#7). In many cases, the drainage area is a residential or commercial development upstream of the basin. (Adapted from the City of Birmingham Post-Construction Stormwater Manual)*

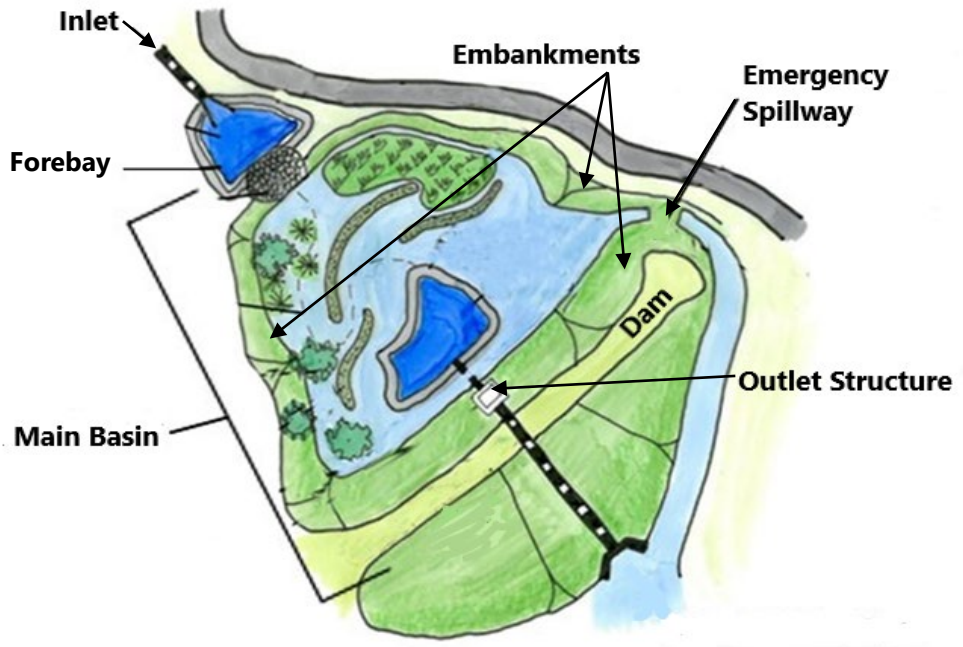
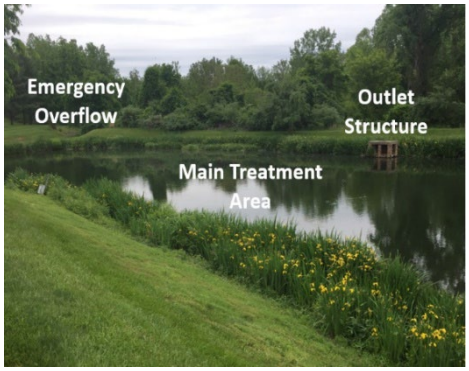


Figure 3. Water Quality Basin Components.
Left: This basin has an emergency overflow spillway and emergency overflow built into the outlet structure (Source: WSP). Right: The main treatment area in this basin is overgrown and needs maintenance. Too much vegetation can reduce the basin's capacity (Source: Georgia Department of Transpiration). The drainage area for both pictures is the parking lot and grounds of a commercial area.



Routine Maintenance

The routine maintenance activities described below can ensure the water quality basin's operation and maintenance standards are easily achieved when performed regularly. **Make routine maintenance a habit!**

Vegetation Management

- ☑ **Mow** all grassed areas at least twice a year; turf grasses should be mowed more frequently. Tall grass around the pond will discourage waterfowl from gathering. **Weed & prune** to remove weeds and invasive plants. Cut back dead stems of herbaceous plants.
- ☑ **Seed, sod, or cover areas of bare soil and repair eroded areas** with grass or other appropriate ground cover as soon as they are noticed. Do this on the side slopes and berms.
- ☑ **Water plants** during the initial establishment of plant growth (first 1 to 3 years). Watering should only be needed when it has not rained for more than 10 days. Skip the fertilizers if possible or use water-friendly fertilizers.

Cleaning

- ☑ **Remove trash, debris, and accumulated sediment.** Do not store materials, including landscape stockpiles, in or around the water q. Dispose of landscape debris properly.
- ☑ **Keep the drainage area clean, too.** Pick up trash frequently. Empty trash cans before they overfill. Keep the landscape maintained and sweep parking lots regularly.

Other Activities

- ☑ **Maintain fountains, aerators, and filter systems** if they are part of the basin design.
- ☑ **Control waterfowl, burrowing animals, beavers, and fire ants,** especially on the embankments and around the outlet structure. A licensed Animal Control Operator (ACO) can help.
- ☑ **Cover potential pollutants in the drainage area** so they are not washed into the SCM during a storm. Use a tarp and berm if they are outside or store them inside. Park vehicles or equipment in disrepair inside or cover them and use drip pans to capture leaking fluids. Empty the pans frequently using appropriate fluid disposal methods.
- ☑ **Verify that the required signs are in place**. Required SCM and safety signs that the city requires should be shown on the property's Record Drawing. Replace them if they are unreadable or lost.
- ☑ **Inspect the basin components after every major storm** for debris and damage. Clean and repair components as needed. Contact the city's stormwater department if you have concerns.

Troubleshooting

Water quality basins are designed to function in tough conditions, from small, gentle winter rains to large, strong spring storms. Although they are designed to withstand these conditions, problems will occur. Regularly performing the routine maintenance activities described previously should reduce the severity of problems. Table 2 describes the most common problems for water quality basins and how to resolve them.

Table 2. Common Problems and Resolutions

Observation	Potential Problem and Resolution
The water level in the basin is frequently higher than the permanent pool level	This condition is likely not a concern if observed during or after a prolonged series of storms. The outlet structure may be clogged. Wait until it is safe to check the structure and remove the clog. Call an expert if this cannot be done safely.
Trash, debris, and sediment frequently accumulate in the basin.	Identify the trash source (e.g., litter, overflowing bins) and take corrective actions like adding bins, picking up litter, and emptying trash cans more often. Maintain landscaping in and around the SCM. Ensure landscapers cover stockpiles and properly dispose of or remove debris. For sediment, find the source (e.g., bare or eroding soil, dirt stockpiles, etc.) and cover or repair it appropriately.
Burrowing animals or fire ants are present in the main basin or embankments.	Safely remove annoying wildlife using methods that do not contaminate water (e.g., no pesticides). Call an expert if needed. Over time, these pests can degrade the structural ability of the embankments. Address these issues as soon as they are noticed.
Erosion or bare soil on/around slopes, berms, inlets, and outlets.	Erosion on slide slopes and berms may result from poor vegetation management. Re-seed or resod and water. Erosion or scour around inlets and outlets can damage the components. Check that inlets/outlets have proper protection.

When to Call an Expert

Sometimes problems occur that require an expert to understand or correct, either because they present a safety issue, or they are too complex or difficult to manage alone. For help, see the list of issues and experts in Table 3. Refer also to Chapter 3 for more information on helpful resources for SCM maintenance.

Table 3. Issues and Experts

Call a **landscape company** for: • Grass, landscape, and erosion repair • Removal of large accumulations of sediment A **tree service company** can remove large trees. A **licensed Animal Control Officer** can help with burrowing animals and waterfowl.	**For significant component repairs or to determine a solution to a frequent, unsolved problem, consult a licensed professional (civil) engineer or landscape architect** to ensure repairs are effective and done in accordance with the SCM's approved design.

Operation & Maintenance Standards Checklist
Water Quality Basin

This checklist, organized by primary component, guides an evaluation of the operation and maintenance standards for water quality basins. **For its design to be considered compliant by the city, a water quality basin must meet ALL applicable standards. Non-compliant basins are subject to city enforcement.**

SCM Name and Location		Today's Date:
	The water quality basin name should be shown on an SCM location map that is included with the Record Drawing for this property. A typical name would be "Water Quality Basin 1" or "SCM A." Otherwise, describe the location of the water quality basin on the property (e.g., Water quality basin behind the main office building).	Date of Last Inspection:

SCM Property Address	Street Address:	City:	State:	Zip:

SCM Inspector Information	Name (Owner, Tenant, Property Manager or Landscape Company):	Contact Name (If Different):
	Phone #:	Email:
	Check one ☐ PE ☐ PLA ☐ Certified SCM Inspection & Maintenance Professional ☐ Other License or Certification #	License or Certification Expiration Date:

SCM Owner Information	Name (Person(s) or Company):		Contact Name (If Different):	
	Street Address:	City:	State:	Zip:
	Phone #:		Email:	

This Section is for Stormwater Staff Use Only

Identification Number

Has the City Entered and Approved This Inspection? Yes / No

Name of Staff Approving This Inspection Report

Date of Inspection Approval:

Is a Follow-Up Inspection by Staff Required? Circle one Yes / No

Reason for Follow-Up?

Submit inspection forms to your local stormwater department

Operation & Maintenance Standards Checklist
Water Quality Basin

This checklist must be completed in full before submittal to the city. **A "Yes" answer indicates compliance with an Operation and Maintenance standard, while a "No" indicates a standard is NOT being met and the water quality basin needs maintenance or repair.** Describe all "No" answers and the action(s) needed to correct them. **Corrective actions must be completed within 30 days of the date of this inspection.** Contact your city stormwater department for corrective actions that will take longer than 30 days to complete. "NA" indicates the question (standard) is not applicable to the SCM being inspected.

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
1	**Inlets** *let stormwater flow into the SCM. An inlet can be a pipe or channel lined with dense grass or stone. There may be multiple inlets to a water quality basin.*				
	a. Are inlets free of trash, debris, sediment accumulations, and other materials?				
	b. Are the inlet pipes and headwalls undamaged and not modified?				
	c. Are ditch inlets fully lined with dense grass or stone (mulch is prohibited)? There must be no erosion or large areas with bare soil *(channel inlets only)*.				
	d. Are the areas just upstream and downstream of the inlets free of soil erosion and standing water?				
2	*The* **Forebay** *slows down stormwater before it enters the main basin. A forebay can be made of concrete, riprap stone, or (less often) dense grass. There should be a forebay downstream of every inlet to the basin.*				
	a. Is the forebay kept clean (no buildup of trash, landscape debris, sediment, and standing water)?				
	b. Are grassed areas densely vegetated and free of soil erosion?				
	c. Are the entrances and exits to the forebay free of obstructions and modifications?				
3	*The* **Main Basin** *is where stormwater is temporarily stored It has a permanent pool and is surrounded by embankments.*				
	a. Is the area free of erosion (e.g., rills/gullies), burrowing animals, and waterfowl populations (or evidence of prolonged waterfowl presence)?				
	b. Is the area free of trash, debris, and significant sediment accumulations?				
	c. Is the area free of dumped, stored, or stockpiled materials, (e.g., grass clippings and other landscape waste, mulch piles, etc.) and equipment (vehicles, vehicle parts, household trash, etc.)?				
	d. Is the area free of any intentionally built structures (e.g., sheds, storage pads, fences, etc.) that were not included in the original property design?				
	e. Do healthy, dense grasses and shrubs cover at least 90% of the area above the permanent pool?				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	f. Is the area free of large bare spots and areas of dead/dying vegetation?				
	g. Is the water level appropriate considering recent weather conditions (i.e., the water level will be higher than normal within 2 to 3 days after a storm or during prolonged periods of wet weather; the water weather will be lower than normal (but the basin will not be completely dry) after prolonged periods of dry weather.				
	h. Can the property owner, tenant, or property manager confirm the basin does not frequently overfill or go dry?				
4	*The* **Embankments** *surround the main treatment area and hold the water in the basin. Most embankments are earthen and lined with dense grass or riprap stone. If included in the original design, more decorative embankments incorporating boulders, retaining walls, and other hardscaping may also be incorporated .*				
	a. Are the embankments (including the dam) free of erosion (e.g., rills/gullies), burrowing animals, fire ant mounds, and waterfowl populations?				
	b. Are the embankments free of trash and debris, structures (e.g., sheds, storage pads, walls, etc.) and fences that were not included in the original property design?				
	c. Do the embankments appear undamaged and stable? (no erosion, sloughing, sliding, bulging, cracking, leaking, fire ant mounds, evidence of burrowing animals, wet areas, etc.)				
	d. Are the embankments entirely free of trees and plants with woody stems?				
	e. Are vegetated embankment areas covered entirely (100%) with healthy, dense grass or another grassy groundcover? Are they free of large bare spots or dead/dying grass areas? Are they mostly covered by grass/groundcover with few trees and plants with woody stems? Are the non-vegetated areas fully covered by riprap stone or concrete?				
5	*The* **Emergency Spillway** *is typically located on top of an embankment and covered with concrete or dense grass, or it may be the opening at the top of the outlet structure. There is usually only one emergency spillway; however, large basins may have multiple spillways.*				
	a. Is the emergency spillway undamaged and not modified in any way that changes its proper function (i.e., blocked by a fence, excavated lower than it should be, etc.)?				
	b. Is the area just below the spillway free of soil erosion or scour holes?				
	c. Is the spillway fully lined with dense grass (mulch is prohibited) or concrete?				
6	*The* **Outlet Structure** *is usually located within the basin as a concrete pipe or box (or corrugated metal pipe) that sits on the bottom of the basin, usually in the water, near the toe of an embankment. It connects to an outlet pipe that*				

	Operation & Maintenance Standard Question	Answer Y	Answer N	Answer NA	Description of "No" Answers and Corrective Action to be Performed
	extends through the embankment to allow water to exit the basin in a controlled way. Outlet structures will have multiple openings. that gradually get larger (and may even have different shapes) as they get near the top of the structure.				
	a. Are all of the orifices (or the trash racks or filter boxes that may cover them) free of trash, debris, sediment, or other material that would cause the water to back up and not drain properly?				
	b. Are skimmers (if present) unclogged, show evidence of regular cleaning, and fully operational?				
	c. Does the outlet structure appear undamaged and has not been modified in any way that would change its function?				
	d. Is the area around the outlet structure or below the outlet pipe free of erosion or scour holes?				
7	*The* **Drainage Area** *is the land that drains stormwater to the basin during a storm. It may include parking areas, roadways/driveways, buildings, and landscaped areas. Keeping the drainage area clean will lower the maintenance and repair needs for the water quality basin.*				
	a. Is the area free of litter, trash, pet waste, cigarette butts, debris, sediment, grass clippings, or other waste materials?				
	b. Is the area free of uncovered stockpiles or storage areas for chemicals, waste/trash, landscape materials or debris, salt/sand or other materials?				
	c. Is the area free of erosion, exposed soil or sparsely vegetated areas that could be a source of sediment washing into the basin during a storm?				
8	*The* **Access Easement** *extends from a public roadway to the basin, allowing maintainers and the city access for inspection and maintenance enforcement.*				
	a. Can the basin be accessed easily for routine inspections and maintenance?				
	b. Is the easement free of permanent obstructions, such as trees, landscaped areas, walls, or fences (without gates) that would limit access to the basin by large maintenance equipment?				

Use additional pages to document any other observations or corrective actions not captured above. Include pictures, diagrams, and sketches if necessary to provide clear instructions to the person(s) performing maintenance or repairs.