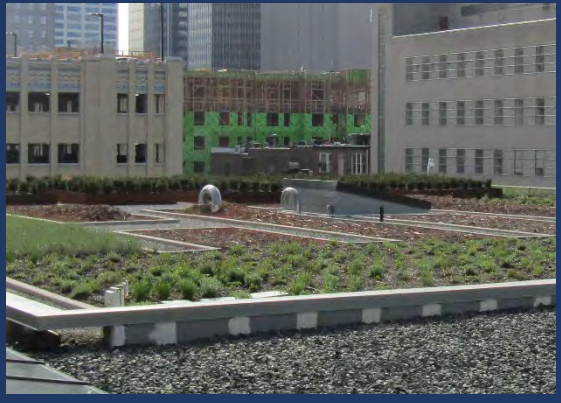

THE CITY OF COLUMBUS

# Inspection & Maintenance Guidance for Stormwater Control Practices

January 2022

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# 1. INTRODUCTION

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The desire and necessity for providing water quantity and water quality control for stormwater in the City of Columbus (City) is becoming an increasingly important part of the City's infrastructure planning, both to reduce and address downstream impacts related to flooding and excess water and to provide higher quality water to the local streams and rivers. While this is already a critical mission, the importance of stormwater infrastructure and the number of stormwater management facilities within the City of Columbus is projected to continue to grow in the future.

With the implementation of the Blueprint Columbus program in recent years, the City has been and will be constructing facilities that provide downstream flooding mitigation, address local stormwater issues, and provide treatment for stormwater runoff prior to entering into the storm system. The scope and magnitude of the number of stormwater facilities is anticipated to continue to increase in the future, meaning that the requirements for managing those facilities are only going to become more extensive over time.

The City of Columbus municipal separate storm sewer system (MS4) permit (Ohio EPA Permit No. 4PI00000*CD) requires the establishment of a Stormwater Management Plan (SWMP) which includes strategies and ordinances for the management of stormwater runoff from new development and redevelopment projects. The City has developed a Stormwater Drainage Manual (SWDM) as its primary mechanism to regulate post-construction runoff for new development and redevelopment projects that disturb more than 10,000 square feet and/or create more than 2,000 square feet of impervious surface. The SWDM includes guidance for the implementation and design of stormwater control practices (SCPs) to meet the technical requirements of the Ohio EPA Authorization for Stormwater Discharges Associated with Construction Activity under the National Pollutant Discharge Elimination System (NPDES) (Construction General Permit).

The SWDM promotes a stormwater management philosophy that can be simply summarized as "capture, detain, and release." Use of SCPs, including green infrastructure (GI), for water quantity and quality control methods is encouraged by the City and within the SWDM as an important technique to achieve these goals. SCPs are defined as schedules of activities, programs, technology, processes, siting criteria, operating methods, measures, devices, prohibitions of practices, maintenance procedures, and other management practices used to prevent, control, remove or reduce the pollution of waters of the United States. SCPs also include, but are not limited to, treatment requirements, operating procedures, practices to control site runoff, spillage or leaks, waste disposal, or drainage from raw material. SCPs may include structural or nonstructural practices.

As the number and importance of the operation of these stormwater facilities increase, the need for a robust Inspection and Maintenance (I&M) program becomes more critical. The development of a standardized approach to ensure the continued functionality and operation of SCPs is imperative to managing the large number of stormwater facilities across the City.

Similar to the I&M programs in place for the sanitary and stormwater collection systems, this Stormwater Control Practice I&M Manual will help to provide a roadmap for the City to plan their approach to maintenance and to ensure consistency among both internal City staff and outside contractors. Standardizing the approach to I&M allows for transparency and objectivity when determining the needs for SCPs.

This manual will outline I&M requirements needed for all types of SCPs, either publicly or privately owned. While not every proprietary stormwater management control is able to be explicitly covered within this document, this manual will provide an overview and guidance for all types of facilities. Individual and site specific maintenance requirements may be developed for individual assets depending on particular

manufacturer requirements or needs. These requirements can be coordinated with the activities identified in this manual for each facility type.

Each SCP type has been grouped into one of four facility categories which include:

- Surface Controls
- Underground Controls
- Media Controls
- Rooftop controls

This manual will document the work needed to promote and maintain SCP functionality including specific maintenance and inspection tasks, frequency of performing tasks and schedules to complete specific work. For the City of Columbus, documenting these required activities and implementing them on current and future stormwater projects will assist in the mission of keeping our neighborhoods strong and our streams clean.

# 2. SCP MANUAL OBJECTIVES

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Given the importance of the facilities that work to clean and control stormwater runoff, the City of Columbus developed an Inspection and Maintenance (I&M) Manual to guide the activities necessary to keep SCPs functioning as they were designed and intended.

The intent of this Stormwater Control Practice I&M Manual is to achieve the following:

- Provide I&M requirements and guidance for all types of SCPs that provide water quantity and water quality control
- Outline the minimum requirements for maintenance through the life-cycle of an asset, from initial construction warranty period through to established operation
- Identify and document the required frequency of tasks at different points in the asset life cycle to standardize I&M
- Serve as guidance in developing future scope of service descriptions for City of Columbus contracts with establishment periods for SCP installations and I&M contracts
- Characterize the required I&M activities to provide an estimate of the necessary level of effort to maintain SCPs
- Provide standard forms and documentation for inspections and maintenance activities and provide the framework for capturing the collected information for future analysis
- Be a resource for City staff, consultants, contractors, and owners/operators of private SCPs in the design, construction, startup, and ongoing operation of GI stormwater facilities
- Support any current and future reporting requirements for the documentation of inspection and maintenance activities for the City's SCPs, including the requirements of the City's 2015 Integrated Plan
- Serve as a companion to the City's Stormwater Drainage Manual and Green Infrastructure Design Guidelines, providing additional information about the assets detailed in those manuals
- Allow for the framework for an I&M program that is able to be continually updated and modified as the needs, requirements, and scope of activities change over time, serving as a guide to the data collection and long-term maintenance of assets

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# 3. INSPECTION & MAINTENANCE TYPES

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Each type of SCP has a standalone section that describes the type of maintenance required for that facility. For each type of facility, there are different requirements depending on the age of the facility. For example, for bioretention basins and other facilities that have plantings, the establishment period may require more frequent inspections and additional labor for the newly planted materials than those facilities that may have more established vegetation and have been in operation for several years.

In addition to the requirements for new facilities varying depending on where they are in the life cycle of construction and operation, there are maintenance activities that need to be completed on a regular interval while other activities will only be completed on an as-needed basis. While weeding is a relatively frequent activity that is required for facilities designed to support plants, replacement of filtration media may occur once every 5-10 years, depending on the change in performance.

As a result, this manual has been organized by GI stormwater facility type to help delineate the different types of activities that are required under different maintenance types. For each facility type, inspection and maintenance activities are organized into 3 separate types:

- Establishment Period Inspection and Maintenance
- Routine Inspection and Maintenance
- As-Needed Maintenance

The establishment period typically lasts two full growing seasons for facilities where plants are installed and two years after installation of permeable pavement. The first two growing seasons of a SCP are critical in establishing the long term stability and success of the SCP and impact the cost of future maintenance requirements. Routine inspection and maintenance are typically required to be performed for the service life of the facility. For SCPs with permeable pavement or plant installations, the routine inspection and maintenance period typically begins after the establishment period is complete. For all other SCPs, the routine inspection and maintenance period begins after the facility is constructed.

Typically, establishment period and routine maintenance should be performed when regularly scheduled inspections are conducted. As-needed maintenance must be evaluated and documented during each establishment period and routine inspection and is typically categorized as maintenance that requires specialty equipment or personnel or large quantities of material for replacement or repair. As-needed maintenance will be identified based on the results of inspections and testing and will be dependent on the identification of specific needs based on the routine inspection programs in place. As-needed maintenance will be scheduled through follow-up work orders based on information provided on inspections forms.

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# 4. SURFACE CONTROLS

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# 4.1. DRY DETENTION BASINS

Dry detention basins are designed to capture stormwater during small to moderate rain events and slowly release the captured volume over a specific period of time. By design, they contain a forebay for capturing heavier sediment and floatables and a micropool in order to minimize standing water and saturated soil conditions that impede the maintenance and trimming of the facility. Dry detention basins improve water quality through biological uptake and filtering through deep rooted native plants, sediment settling including attached pollutants, temporary detention of stormwater, reduction of volume through evapotranspiration, and reduction of release rates that reduces downstream erosion.

Examples include:

- Dry ponds
- Extended detention basins
- Dry detention ponds

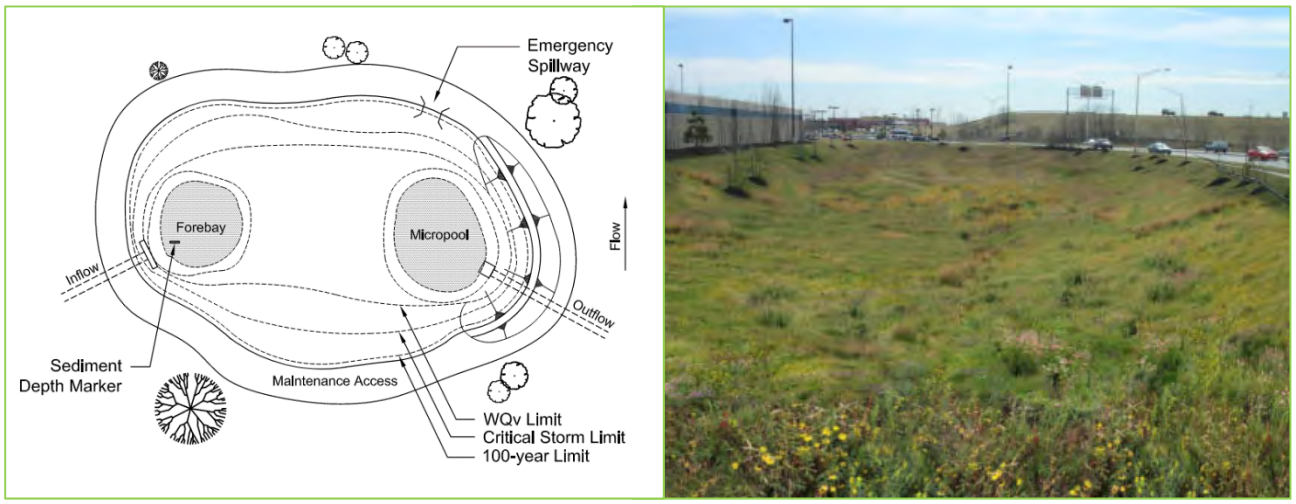


**FIGURE 4-1 PLAN VIEW OF DRY DETENTION BASIN DESIGN (LEFT) AND TYPICAL DRY DETENTION POND (RIGHT)**

## 4.1.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period inspection and maintenance (I&M) are critical to the overall success of dry detention basin facilities. The establishment period typically lasts two full growing seasons after plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the facility is included in **Appendix A**. A Dry Detention Basin Inspection Form to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

### 4.1.1.1. MONTHLY INSPECTIONS

Monthly inspections are required during the dry detention basin establishment period. The Dry Detention Basin Inspection Form in **Appendix B** must be used for performing and reporting monthly inspections at dry detention basins. The Dry Detention Basin Inspection Form must be used as a guideline for evaluating the continued

functionality and aesthetics of the dry detention facility, by providing a checklist of the key components to verify during inspections. The form is based on a rating scale of 1-5, with 1 indicating poor condition, and 5 being ideal. In addition to the quantification of each component, the form also provides a space for comments and recommended as-needed maintenance identified during the inspections. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

Recent rainfall events and current weather must be recorded on the inspection form during each inspection, as the data may serve as indications of basin functionality or maintenance concerns, such as drainage issues or slope slippage.

The overall condition of the dry detention facility must first be analyzed, focusing primarily on drainage and general aesthetics of the basin. Basin plant cover must appear healthy, with few significant weeds or invasive species present. Vegetative cover may be minimal during the establishment period, but coverage must increase over time, as the grass, and plants where applicable, reach maturity. The system must also be checked for the presence of any trash, debris, or chemical accumulation, which can hinder the aesthetics and functionality of the basin.

Following the system overview, the inlets and overflow structures must be examined for any blockages or obstructions to flow entering or exiting the basin. The pre-treatment area located at each inlet must then be checked for sediment accumulation. Because these rocks are designed to act as a primary filter for larger particles, sediment accumulation should become apparent over time. Therefore, the presence of sediment deposition is an ideal indication of filter effectiveness, although excessive sediment buildup will reduce the effectiveness of the basin at treating stormwater and must therefore be cleaned regularly.

The perimeter of the facility must be inspected for any erosion or undercutting along the basin bottom or side slopes, in addition to verifying slope stability or any changes in grading. Locations of gullying, soil instability, or unvegetated regions along the slopes due to erosion must be identified and remedied.

Facility deficiencies must be remedied during the inspection if possible. Section 4.1.1.2 includes the minimum maintenance tasks that must be performed during establishment period monthly inspections. Some establishment period maintenance tasks must only be performed during certain times of the year. Refer to the maintenance activity schedule included in Section 4.1.1.2 for guidance on when specific tasks can be performed during the establishment period. As-needed maintenance includes maintenance tasks not described in Section 4.1.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.1.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks to be performed at dry detention basins during the establishment period include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repairs
- Minor sediment/leaf removal
- Reseeding exposed soil

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation. Watering must be conducted weekly between May and October during the establishment period.

Weeding

Weeding is necessary to maintain aesthetics and to prevent the proliferation of unwanted species, which may cause hydraulic issues by blocking or obstructing inlet and outlet structures. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proactive weeding is especially critical during the establishment period.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the dry detention basin to ensure the site remains easily accessible for maintenance crews, as well as to promote the aesthetics of the facility. Regions identified as “no mow” areas must remain undisturbed and must not be mowed or trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Flooding concerns may result if water exceeding the dry detention basin capacity is unable to exit the site through the storm sewer system. Some dry detention basin overflow structures may contain traps used to collect and prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure the proper functionality of the basin.

Minor Erosion Repairs

Minor erosion from sheet flow entering and flowing through the wetland must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the sides of the dry detention basin resulting from erosion may require plant replacement to stabilize the existing soil. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the dry detention facility to prevent the system from becoming clogged, particularly near inlet and outlet structures. The sediment forebay must be regularly be cleaned of sediment to continue its function of removing suspended solids from surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Reseed Exposed Soil

The dry detention basin must maintain at least 70 percent grass cover. In regions where ground cover is less than 70 percent, exposed soil must be re-seeded in accordance with the most recent version of the *City of Columbus Construction and Material Specifications (CMSC) 659 Seeding and Mulching*.

**Table 4-1** below shows the recommended schedule and frequency of establishment period I&M tasks. This schedule reflects the minimum maintenance requirements for dry detention basins during the establishment period. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 4-1** are considered "as-needed" maintenance tasks and must be described in detail on the Dry Detention Basin Inspection Form.

**Table 4-1 Schedule and Frequency of Establishment Period I&M Activities for Dry Detention Basins**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Reseed Exposed Soil | Once/Month | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 4.1.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned dry detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification. The use of fertilizers, pesticides, and herbicides is prohibited for use in dry detention basin facilities during the establishment period.

#### 4.1.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Trimmer
- Mobile irrigation system
- Flashlight
- Leaf blower/vacuum

#### 4.1.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection & maintenance tasks are included in **Table 4-2**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-2 Dry Detention Basin Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Dry Detention Basin (Hours/Year) |
|---|---|
| **Establishment Period** | 35 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 4.1.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, dry detention basin facilities must be inspected and maintained on a routine basis after the establishment period has ended. This section focuses on the routine I&M activities that must be performed on a recurring basis after the establishment period has ended and for the rest of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the dry detention facility is included in **Appendix A**. A **Dry Detention Basin Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 4.1.2.1. QUARTERLY INSPECTIONS

After the establishment period, inspections for dry detention facilities can be reduced from monthly inspections to quarterly inspections. Quarterly inspections are required for the service life of the dry detention facility. The **Dry Detention Basin Inspection Form** in **Appendix B** must be used for performing and reporting quarterly routine inspections at dry detention basins for the duration of the life of the facility. An overview of what to inspect at dry detention basins is described in Section 4.1.1.1.

Facility deficiencies must be remedied during the inspection if possible. Section 4.1.2.2 includes the minimum maintenance tasks that must be performed during routine quarterly inspections. Some routine maintenance tasks must only be performed during certain times of the year. Refer to the routine maintenance activity schedule included in Section 4.1.2.2 for guidance on when specific routine maintenance tasks can be performed. As-needed maintenance includes maintenance tasks not described in Section 4.1.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are

required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.1.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repairs
- Minor sediment/leaf removal
- Reseeding exposed soil

Weeding

Weeding is necessary to maintain aesthetics and to prevent the proliferation of unwanted species, which may cause hydraulic issues by blocking or obstructing inlet and outlet structures. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the dry detention basin to ensure the site remains easily accessible for maintenance crews, as well as to promote the aesthetics of the wetland. Regions identified as “no mow” areas must remain undisturbed and must not be mowed or trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Flooding concerns may result if water exceeding the dry detention basin capacity is unable to exit the site through the storm sewer system. Some dry detention basin overflow structures may contain traps used to collect and prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure the proper functionality of the basin.

Minor Erosion Repairs

Minor erosion from sheet flow entering and flowing through the wetland must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the sides of the dry detention basin resulting from erosion may require plant replacements to stabilize the existing soil. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the dry detention basin to prevent the system from becoming clogged, particularly near inlet and outlet structures. The sediment forebay must be regularly be cleaned of sediment to continue its function of removing suspended solids from

surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Reseed Exposed Soil

The dry detention basin must maintain at least 70 percent grass cover. In regions where ground cover is less than 70 percent, exposed soil must be re-seeded in accordance with the most recent version of the *City of Columbus Construction and Material Specifications (CMSC) 659 Seeding and Mulching*.

**Table 4-3** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements for a dry detention basin during the establishment period. Additional maintenance activities may be required based on observations made during the required quarterly inspections. More extensive maintenance activities not listed in **Table 4-3** are considered as-needed maintenance tasks.

**Table 4-3 Schedule and Frequency of Routine I&M Activities for Dry Detention Basins**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Quarter | | | | | | | | | | | |
| | Weeding | | | Once/Quarter | | | | | | | | | |
| | Trimming | | | Once/2 Weeks | | | | | | | | | |
| | Trash & Debris Removal | Once/Quarter | | | | | | | | | | | |
| | Minor erosion repairs | Once/Quarter | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Quarter | | | | | | | | | | | |
| | Reseed Exposed Soil | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 4.1.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned dry detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in dry detention basins sites. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.1.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance task. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Trimmer
- Leaf blower/vacuum
- Flashlight

#### 4.1.2.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection and maintenance tasks are included in **Table 4-4.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-4 Dry Detention Basin Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Dry Detention Basin (Hours/Year) |
|---|---|
| **Routine** | 19 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 4.1.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.1.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/outlet structure cleaning
- Watering during drought
- Rock channel replacement
- Slope slippage repair
- Major sediment removal/leaf removal
- Major trash/debris removal
- Pest/disease/invasive species management

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the dry detention basin, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing "Abnormally Dry" or "Moderate Drought" conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Rock Channel Replacement

In locations of continued erosion, additional rock may be required to replace or strengthen the existing erosion control measures. This commonly occurs at locations of high flow velocity, such as the rock channels or rip-rap surrounding the inlet structures. Severe or continued erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as re-grading of the facility.

Slope Slippage Repair

Slope repairs must be evaluated and performed when major signs of erosion, soil instability or slope slippages are observed along the basin slope. The slope must be repaired to the original design slope or a more gradual slope ratio.

Major Sediment/Leaf Removal

Dry detention basins that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Stormwater must be able to freely move through the facility and drain through overflow structures, as intended. Therefore, it is important to keep all hydraulic components free of blockages. If water exceeding the basin capacity is unable to exit the site through the storm sewer system, severe clogging of the facility may result in the proliferation of vector (mosquito) habitat, reduced water storage volume, or flooding concerns.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Pest/Disease/Invasive Species Management

Dry detention basins must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate potential spreading to nearby plants or basins. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests within a dry detention basin, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. For example, if the as-needed maintenance issue is generating favorable conditions for the pest to inhabit, such as vector (mosquito) populations resulting from the prolonged ponding due to clogged

outlet structures, returning the dry detention basin to its properly functioning state may subsequently eliminate the pest. However, if use of pesticides is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications of chemicals shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Table 4-5** below shows a recommended schedule for when as-needed maintenance tasks must be completed. The table must be used for guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 4-5** provide guidance on when as-needed maintenance tasks can be performed throughout the year. Inspections will dictate the need and frequency of performing these as-needed tasks.

**Table 4-5 Schedule and Frequency of As-Needed Maintenance Activities for Dry Detention Basins**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Slope Slippage Repair | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasive Species Management | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed at the dry detention basin. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on when these specific tasks can be performed throughout the year.*

Additional details on the as-needed maintenance are included in the **Dry Detention Basin Fact Sheet** in **Appendix A**.

#### 4.1.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 4.1.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned dry detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in dry detention basins. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.1.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 4.1.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

## 4.2. WET DETENTION BASINS

Wet extended detention basins provide a permanent pool of water overlain with an extended detention volume that drains following rainfall events. They contain a submerged bench to provide additional storage capacity for flow control. Wet detention basins improve water quality through: biological uptake and filtering through deep rooted native plants, sediment settling including attached pollutants and temporary detention of stormwater.

Examples include:

- Wet detention pond
- Wet pond
- Wet Extended Detention basin
- Permanent pool storage

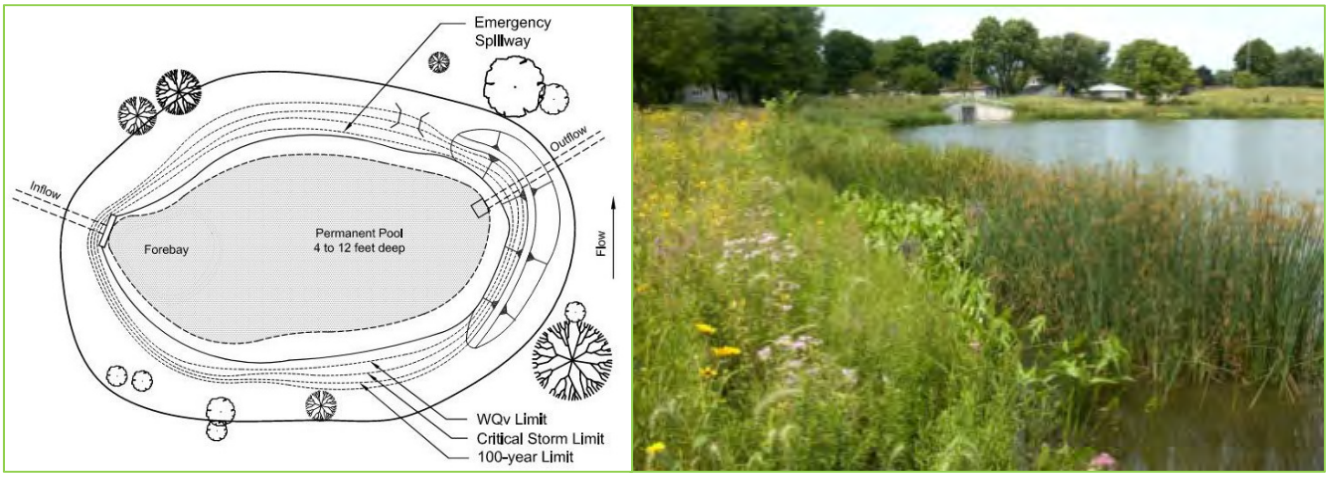


**FIGURE 4-2 WET DETENTION BASIN DESIGN PLAN VIEW (LEFT) AND TYPICAL WET DETENTION BASIN FACILITY (RIGHT)**

### 4.2.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period maintenance is critical to the plantings in wet detention basins and the success of the overall facility. The establishment period typically lasts two full growing seasons after plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the facility is included in **Appendix A**. A **Wet Detention Basin Inspection Form** to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

#### 4.2.1.1. MONTHLY INSPECTIONS

Monthly inspections are required during the wet detention basin establishment period. The **Wet Detention Basin Inspection Form** in **Appendix B** must be used for performing and reporting monthly inspections. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Wet Detention Basin Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the wet detention facility, by providing a checklist of the key metrics to assess during

inspections. The form is based on a rating scale of 1-5, with 1 indicating poor conditions, and 5 indicating proper functionality. In addition to quantifying each metric, the form also provides a space for comments and as-needed maintenance. Deficiencies must be remedied during the inspection if possible.

Recent rainfall events and current weather must be recorded on the inspection form during each inspection, as the data may serve as indications of basin functionality or maintenance concerns, such as drainage issues or slope slippage.

The overall condition of the wet detention basin must first be analyzed, focusing primarily on drainage and general aesthetics of the basin. Basin plant cover must appear healthy, with few weeds or invasive species present. The system must also be checked for the presence of any trash, debris, or chemical accumulation, in addition to mosquito proliferation, which hinder the aesthetics and functionality of the basin.

Following the system overview, the inlets and overflow structures must be examined for any blockages or obstructions to flow entering or exiting the basin.

The perimeter of the facility must be inspected for any erosion or undercutting along the basin side slopes, in addition to verifying slope stability or any changes in grading. Locations of gullying, soil instability, or unvegetated regions along the slopes due to erosion must be identified and remedied.

Facility deficiencies must be remedied during the inspection if possible. Section 4.2.1.2 includes the minimum maintenance tasks that must be performed during establishment period monthly inspections. Some establishment period maintenance tasks must only be performed during certain times of the year. Refer to the maintenance activity schedule included in Section 4.2.1.2 for guidance on when specific tasks can be performed during the establishment period. As-needed maintenance includes tasks not described in Section 4.2.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.2.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks during the establishment period typically include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repairs
- Minor sediment/leaf removal

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation along the slopes of the basin. This is critical to providing slope stability by establishing vegetation to reduce erosion. During periods of low rainfall, additional watering must be conducted as needed.

Weeding

Weeding is necessary to maintain aesthetics and to prevent the proliferation of unwanted species. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proactive weeding is especially critical during the establishment period.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the wet detention basin to ensure the site remains easily accessible for maintenance crews, as well as to promote aesthetics. Regions identified as "no mow" areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Flooding concerns may result if water exceeding the wet detention basin capacity is unable to exit the site through the storm sewer system. Some wet detention basin overflow structures may contain traps used to collect and prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure the proper functionality of the basin.

Minor Erosion Repairs

Minor erosion from sheet flow entering and flowing through the basin must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the sides of the basin resulting from erosion may require plant replacements to stabilize the existing soil. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the basin to prevent the system from becoming clogged, particularly near inlet and outlet structures. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Table 4-6** below shows the recommended schedule and frequency of establishment period maintenance tasks. This schedule reflects the minimum maintenance requirements for a wet detention basin during the establishment period. Additional operation and maintenance activities may be required based on observations made during monthly inspections. More extensive maintenance activities not listed in **Table 4-6** are considered as-needed maintenance tasks.

**Table 4-6 Schedule and Frequency of Establishment Period I&M Activities for Wet Detention Basins**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor erosion repairs | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 4.2.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned wet detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities, including outlet structure manholes, requires confined space entry permits and personnel certification. The use of fertilizers, pesticides, and herbicides is prohibited for use in wet detention basin facilities during the establishment period.

#### 4.2.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during establishment period inspection and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Trimmer
- Mobile irrigation system
- Flashlight
- Leaf blower/vacuum

#### 4.2.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection & maintenance tasks are included in **Table 4-7.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-7 Wet Detention Basin Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Wet Detention Basin (Hours/Year) |
|---|---|
| Establishment Period | 40 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 4.2.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, wet detention basin facilities must be inspected and maintained on a routine basis after the establishment period has ended. This section focuses on the routine I&M activities that must be performed on a recurring basis after the establishment period has ended and for the rest of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the wet detention facility is included in **Appendix A**. A **Wet Detention Basin Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 4.2.2.1. QUARTERLY INSPECTIONS

After the establishment period, inspections for wet detention facilities can be reduced from monthly inspections to quarterly inspections. Quarterly inspections are required for the service life of the wet detention basin. The **Wet Detention Basin Inspection Form** in **Appendix B** must be used for performing and reporting quarterly inspections at wet detention basin sites after the establishment period for the duration of the life of the facility. An overview of what to inspect at wet detention basins is provided in Section 4.2.1.1.

Deficiencies noted during the routine quarterly inspections must be remedied during the inspection if possible. Section 4.2.2.2 includes the minimum maintenance tasks that must be performed during routine quarterly inspections. Some routine maintenance tasks must only be performed during certain times of the year. Refer to the routine maintenance activity schedule included in Section 4.2.2.2 for guidance on when specific routine maintenance tasks can be performed. As-needed maintenance includes maintenance tasks not described in Section 4.2.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 4.2.3 for additional information about as-needed maintenance.

#### 4.2.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance tasks include:

- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repairs
- Minor sediment/leaf removal

Weeding

Weeding is necessary to maintain aesthetics and to preventing the proliferation of unwanted species on the slopes of the wet detention basin. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the wet detention basin to ensure the site remains easily accessible for maintenance crews, as well as to promote aesthetics. Regions identified as "no mow" areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Flooding concerns may result if water exceeding the wet detention basin capacity is unable to exit the site through the storm sewer system. Some wet detention basin overflow structures may contain traps used to collect and prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure the proper functionality of the basin.

Minor Erosion Repairs

Minor erosion from sheet flow entering and flowing through the basin must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the sides of the basin resulting from erosion may require plant replacements to stabilize the existing soil. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the basin to prevent the system from becoming clogged, particularly near inlet and outlet structures. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Table 4-8** below shows the recommended schedule and frequency of routine maintenance tasks. This schedule reflects the minimum maintenance requirements for a wet detention basin during the establishment period. Additional operation and maintenance activities may be required based on observations made during quarterly inspections. More extensive maintenance activities not listed in **Table 4-8** are considered as-needed maintenance tasks.

**Table 4-8 Schedule and Frequency of Routine I&M Activities for Wet Detention Basins**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Quarter | | | | | | | | | | | |
| | Weeding | | | Once/Quarter | | | | | | | | | |
| | Trimming | | | Once/ 2 Weeks | | | | | | | | | |
| | Trash & Debris Removal | Once/Quarter | | | | | | | | | | | |
| | Minor erosion repairs | Once/Quarter | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 4.2.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned wet detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in wet detention basins. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.2.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during performance of routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID badge
- Leaf blower/vacuum
- Flashlight
- Trimmer

#### 4.2.2.5. ESTIMATED LABOR HOURS

The estimated labor hours for routine inspection and maintenance tasks are included in **Table 4-9**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-9 Wet Detention Basin Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Wet Detention Basin (Hours/Year) |
|---|---|
| Routine | 18 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 4.2.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, they must be documented in the as-needed section of the inspection form. Provide enough detail about the as-needed maintenance requirements in the comment section of the inspection form to allow for prioritization of the observed issue and a follow-up work order to be generated.

#### 4.2.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/outlet structure cleaning
- Watering during drought
- Plant Replacement
- Rock channel replacement
- Slope slippage repair
- Major sediment removal/leaf removal
- Major trash/debris removal
- Pest/disease/invasive species management

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the wet detention basin, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing “Abnormally Dry” or “Moderate Drought” conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Plant Replacement

For facilities that include plantings, plants must be replaced if there are regions of plant mortality. Regions of significant plant mortality must be replanted with native vegetation, in accordance with the design standards of the facility. If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements must be made in accordance with the approved modified planting plan. For City-owned SCPs, modifications to the planting plan must be approved by the City of Columbus. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities* and *CMSC 661* for additional details and scheduling requirements.

Rock Channel Replacement

In locations of continued or extensive erosion, additional rock may be required to replace or strengthen the existing erosion control measures. This commonly occurs at locations of high flow velocity, such as the rock channels or rip-rap surrounding the inlet structures. Severe or continued erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as re-grading of the facility or installation of an energy dissipation feature.

Slope Slippage Repair

Slope repairs must be evaluated and performed when major signs of erosion, soil instability or slope slippages are observed along the basin slope. The slope must be repaired to the original design slope or a more gradual slope ratio.

Major Sediment/Leaf Removal

Wet detention basins that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Stormwater must be able to freely move through the facility and drain through overflow structure, as intended. Therefore, it is important to keep all hydraulic components free of blockages. If water exceeding the basin capacity is unable to exit the site through the storm sewer system, severe clogging of the facility may result in the proliferation of vector (mosquito) habitat, reduced water storage volume, or flooding concerns.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-need basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Pest/Disease/Invasive Species Management

Wet detention basins must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate potential spreading to nearby plants or basins. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of wet detention basins, and strongly discouraged following the initial establishment period. However, if use of pesticide is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus,

and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Table 4-10** below shows a recommended schedule for when as-needed maintenance tasks must be completed. The table must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 4-10** provide guidance on when as-needed maintenance tasks can be performed throughout the year. Inspections will dictate the need and frequency of performing these as-needed tasks.

**Table 4-10 Schedule and Frequency of As-Needed Maintenance Activities for Wet Detention Basins**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Plant Replacement | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Slope Slippage Repair | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasive Species Management | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency at which these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Wet Detention Basin Fact Sheet** in **Appendix A**.

#### 4.2.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 4.2.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned wet detention basins must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in wet detention basins. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.2.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 4.2.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

## 4.3. CONSTRUCTED WETLANDS

Constructed wetlands are systems that mimic the functions of natural wetlands by using physical and biological processes to treat stormwater. Constructed wetlands have both permeant pool zones and an extended detention zone which are sized to capture and release the calculated WQv. The shallow water zones in the permanent pool support emergent and riparian vegetation and the deep water zones in the permanent pool provide sediment and stormwater storage. Together, the diverse vegetative community and the storage provided combine to form an ideal environment for the removal of pollutants in stormwater. Similar in design to wet basins, constructed wetlands treat stormwater by providing an extended detention zone (above shallow permanent pools) sized to capture and release the calculated WQv. Constructed wetlands are depressed, heavily planted areas that are designed to receive flow during dry periods in order to support aquatic vegetation. In terms of size, the amount of surface area required for a constructed wetland is typically larger than that of a wet basin due to the limited allowable depths required for wetland design. Constructed wetlands that are supplied by surface water runoff from drainage areas less than 20 acres must rely on groundwater or other sources to sustain a permanent pool.

Examples Include:

- Surface flow constructed wetlands
- Shallow constructed wetlands
- Subsurface flow constructed wetlands (vertical or horizontal flow)
- Hybrid systems incorporating both subsurface and surface flow treatment methods

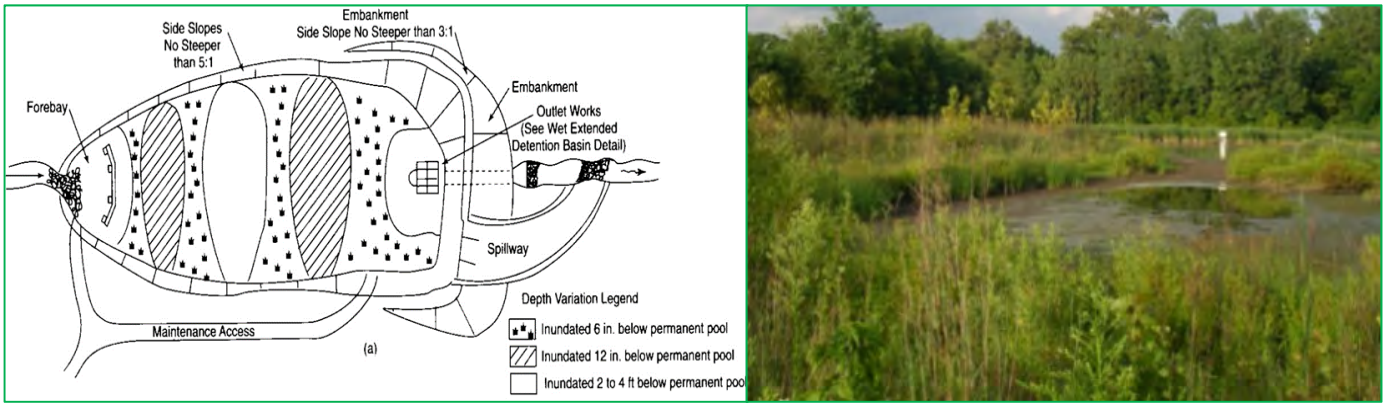


**FIGURE 4-3 CONSTRUCTED WETLAND DESIGN PLAN VIEW (LEFT) AND TYPICAL CONSTRUCTED WETLAND INSTALLATION (RIGHT)**

### 4.3.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period maintenance is critical to the plantings in constructed wetlands and the success of the overall facility at treating stormwater. The establishment period typically lasts two full growing seasons after the plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the facility is included in **Appendix A**. A **Constructed Wetlands Inspection Form** to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

#### 4.3.1.1. MONTHLY INSPECTIONS

Monthly inspections are required during the constructed wetland establishment period. The **Constructed Wetland Inspection Form** in **Appendix B** must be used for performing and reporting monthly inspections at constructed wetlands. Deficiencies must be remedied during the inspection if possible. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Constructed Wetland Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the wetland facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of wetland functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the constructed wetland must first be analyzed, focusing primarily on the general condition and aesthetics of the site. The site must be easily accessible by maintenance personnel, with all access drives and paths clear of significant vegetation or obstructions. Any harsh odors present at subsurface flow wetlands or hybrid systems designed to operate under aerobic conditions must be noted, as it may be indicative of further maintenance concerns, such as media clogging. Surface flow wetlands, however, are often designed to operate under anaerobic conditions, and may therefore exhibit hydrogen sulfide odors, particularly following the disturbance of the wetland substrate. Constructed wetland plants must appear healthy, with few weeds, invasive species, excessive brush, or trees present. Vegetative cover may be minimal during the establishment period, but coverage must increase over time, as plants reach maturity. The system must also be checked for the presence of any trash, debris, or chemical accumulation, which reduces the functionality of the facility and the overall aesthetics of the wetland. The proliferation of pests or vector (mosquito) populations must be noted during each inspection to monitor the severity of the issue. In addition to hindering the aesthetics of the facility, animal burrows or dams may clog or damage the structural components of the constructed wetland, as well as lead to bank instability.

Following the system overview, the inflow points and primary treatment components must be inspected. The inlets must be clear of any blockages, which may obstruct flow from entering the facility. The pre-treatment area and sediment forebay located near each inlet must be checked for sediment accumulation. Because these regions are designed to act as a primary filter for larger particles, sediment deposition is an ideal indication of filter effectiveness. However, these areas must be periodically cleaned or dredged of excessive sediment buildup in order to maintain their function of treating stormwater.

The bottom of the system must be examined for excessive sediment buildup, which must be periodically dredged from the system to ensure proper functionality of the wetland. A constructed wetland must maintain a shallow ponding depth throughout most of the year, due to the controlled release of water from the facility using hydraulic control components. These control components must be in proper working condition, free of any blockages or obstructions to flow.

The berm or surrounding embankment must be inspected for any erosion or undercutting along the side slopes, in addition to verifying slope stability or any changes in grading. Locations of cracking, bulging, or soil instability must be identified and remedied.

All outlet structures, including the primary and emergency spillways, outfalls, and risers must be examined for structure functionality and condition. These structures must be free of any blockages, allowing stormwater to freely move through and exit the facility as intended. In addition to keeping the outlet structures free of excess sediment, trash, and debris, these components must be clear of any woody growth or excessive vegetation overgrowth, which may obstruct flow or damage the outlet structures. During each inspection, outlet structures must be examined for signs of damage, including but not limited to, misaligned or split joints, cracks, bulging, or erosion.

As-needed maintenance includes maintenance activities not described in Section 4.3.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.3.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks during the establishment period typically include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Minor sediment/leaf removal
- Plant pruning
- Embankment/nuisance wildlife repairs

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation. During periods of low rainfall, additional watering must be conducted as needed.

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of wetland plants. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proactive weeding is especially critical during the establishment period.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the constructed wetland to ensure the site remains easily accessible for maintenance crews, as well as to promote the aesthetics of the wetland. Regions identified as “no mow” areas must remain undisturbed and must not be mowed or trimmed. These regions are necessary in establishing a mature wetland plant community. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Flooding concerns may result if water exceeding the wetland capacity is unable to exit the site through the storm sewer system. Some constructed wetland overflow structures may contain traps used to collect and

prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure their continued functionality.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the wetland to prevent the system from becoming clogged, particularly near inlet and outlet structures. The sediment forebay must be regularly cleaned of sediment to continue its function of removing suspended solids from surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

Embankment/Nuisance Wildlife Repairs

Minor erosion from sheet flow entering and flowing through the wetland must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the sides of the wetland resulting from erosion may require plant replacements to stabilize the existing soil. Any leaks or cracks in the berms must be plugged or sealed immediately. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

The surrounding embankment must be inspected for animal burrows, which may damage the existing grading, lead to bank instability, or result in the destruction of wetland vegetation. In order to maintain the integrity of the facility and its function of treating stormwater, animal burrows within close proximity to the wetland or its components must be addressed with appropriate animal control measures or an approved alternative.

**Table 4-11** below shows the recommended schedule and frequency of establishment period maintenance tasks. This schedule reflects the minimum maintenance requirements for a constructed wetland during the establishment period. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 4-11** are considered as-needed maintenance tasks.

**Table 4-11 Schedule and Frequency of Establishment Period I&M Activities for Constructed Wetlands**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |
| | Embankment/ Nuisance Wildlife Repairs | Once/Month | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 4.3.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned constructed wetlands must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification. The use of fertilizers, pesticides, and herbicides is prohibited for use in constructed wetlands during the establishment period unless otherwise approved by the City of Columbus.

#### 4.3.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available to ensure proper collection of data and completion of maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Trimmer
- Wheelbarrow
- Pruning shears
- City of Columbus ID Badge
- Leaf blower/vacuum
- Flashlight
- Mobile irrigation system

#### 4.3.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection and maintenance are included in **Table 4-12**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-12 Constructed Wetlands Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Constructed Wetland (Hours/Year) |
|---|---|
| **Establishment Period** | 60 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 4.3.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality constructed wetlands must be inspected and maintained on a routine basis after the establishment period has ended. This section focuses on the routine I&M activities that must be performed on a recurring basis after the establishment period has ended and for the rest of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the constructed wetland facility is included in **Appendix A**. **A Constructed Wetland Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 4.3.2.1. MONTHLY INSPECTIONS

Monthly inspections are required for the service life of the constructed wetland. The **Constructed Wetland Inspection Form** in **Appendix B** must be used for performing and reporting monthly inspections at constructed wetland facilities after the establishment period for the duration of the life of the site. Deficiencies noted during inspections must be remedied during the inspection if possible. As-needed maintenance includes maintenance activities not described in Section 4.3.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

The Constructed Wetland Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the wetland facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance. An overview of what to inspect at constructed wetlands is provided in Section 4.3.1.1.

Deficiencies noted during the routine monthly inspections must be remedied during the inspection if possible. Section 4.3.2.2 includes the minimum maintenance tasks that must be performed during routine monthly inspections. Some routine maintenance tasks must only be performed during certain times of the year. Refer to the routine maintenance activity schedule included in Section 4.3.2.2 for guidance on when specific routine maintenance tasks can be performed. As-needed maintenance includes maintenance activities not described in Section 4.3.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. . Refer to Section 4.3.3 for additional information about As-Needed Maintenance.

#### 4.3.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance tasks include:

- Weeding
- Trimming
- Trash & debris removal
- Minor sediment/leaf removal
- Embankment/nuisance wildlife repairs
- Plant pruning

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of wetland plants. Invasive species or non-native weeds must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.

Trimming

Routine trimming must be conducted along all access paths, drives, and lawn areas surrounding the constructed wetland, to ensure the site remains easily accessible for maintenance crews, as well as to promote the aesthetics of the wetland. Regions identified as “no mow” areas must remain undisturbed and must not be trimmed. These regions are necessary in establishing a mature wetland plant community. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

All SCP media and components must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers, as intended. Routine trash and debris removal must be conducted to maintain the functionality and aesthetics of the system. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility, which may result in flooding concerns if water exceeding the wetland capacity is unable to exit the site through the storm sewer system. Some constructed wetland overflow structures may contain traps used to collect and prevent trash or other floatable objects from clogging the structural components of the system. These traps must be regularly emptied to ensure their continued functionality.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the structural components of the wetland to prevent the system from becoming clogged, particularly near inlet and outlet structures. The sediment forebay must be regularly cleaned of sediment to continue its function of removing suspended solids from surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Embankment/Nuisance Wildlife Repairs

Minor erosion from sheet flow entering and flowing through the wetland must be evaluated and corrected along the embankment and surrounding berms. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. Unvegetated regions along the side slopes of the wetland resulting from erosion may require plant replacements to stabilize the existing soil. Any leaks or cracks in the berms must be plugged or sealed immediately. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not consist of placing new rock. The surrounding embankment must be inspected for animal burrows, which may damage the existing grading, lead to bank

instability, or result in the destruction of wetland vegetation. In order to maintain the integrity of the facility and its function of treating stormwater, animal burrows within close proximity to the wetland or its components must be addressed with appropriate animal control measures or an approved alternative.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 4-13** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a constructed wetland, after the establishment period has ended. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 4-13** are considered as-needed maintenance tasks.

**Table 4-13 Schedule and Frequency of Routine I&M Activities for Constructed Wetlands**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Month | | | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Embankment/ Nuisance Wildlife Repairs | Once/Month | | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 4.3.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on the constructed wetlands must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in constructed wetland sites. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from

the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.3.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available to ensure proper collection of data and completion of maintenance tasks. Adherence to all safety procedures during routine inspection and maintenance tasks is required.

- Proper PPE
- Safety Cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- City of Columbus ID badge
- Leaf blower/vacuum
- Flashlight
- Trimmer

#### 4.3.2.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection & maintenance tasks are included in **Table 4-14**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-14 Constructed Wetlands Routine Inspection & Maintenance Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Constructed Wetland (Hours/Year) |
|---|---|
| **Routine** | 52 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 4.3.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.3.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance includes, but is not limited to:

- Inlet/outlet structure cleaning
- Structural repair
- Plant replacement
- Harvesting
- Stake repair/replacement
- Watering during drought
- Rock channel replacement
- Media replacement
- Major sediment /leaf removal
- Major trash & debris removal
- Pest/disease/invasive species management

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the constructed wetland, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Structural Repair

Any broken or damaged structural components must be repaired to ensure the continued functionality of the system, including all inlet and outlet structures, pipes, spillways, outfalls, and risers. Structural repairs may consist of, but are not limited to, pipe, concrete, or joint repairs. If structural repairs are not possible, components must be replaced as needed.

Plant Replacement

Following the establishment period, plant survivability must stabilize, and the wetland must maintain a minimum vegetative cover of 50 percent. Regions of significant plant mortality must be replanted with native vegetation, in accordance with the design standards of the facility. If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements must be made in accordance with the approved modified planting plan. For City-owned SCPs, modifications to the planting plan must be approved by the City of Columbus. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities* and *CMSC 661* for additional details and scheduling requirements.

Harvesting

The species composition of the facility must be expected to change over time, although a mature wetland must maintain close to a 50 percent open water surface area. If the wetland becomes significantly overgrown with vegetation, harvesting must be conducted to promote the health of the desired plant species and maintain the functionality of the system.

Stake Repair/Replacement/Removal

Plant stakes broken or damaged during the establishment period must be replaced to ensure the proper growth and establishment of the affected plants. Once plants have become established, stakes must be removed from the facility to prevent girdling or other damage to the plants.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing “Abnormally Dry” or “Moderate Drought” conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Rock Channel Replacement

In locations of continued erosion, additional rock may be required to replace or strengthen the existing erosion control measures. This commonly occurs at locations of high flow velocity, such as the rock channels or rip-rap surrounding the inlet structures. Severe or continued erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as re-grading of the SCP or installation of energy dissipation features.

Media Replacement

Media replacement is only applicable to subsurface wetlands and must not be conducted for surface flow facilities. Subsurface wetlands may require soil media replacement in locations where the existing media has been relocated or removed from the wetland facility to ensure the soil remains at the required depth for stormwater treatment. Facilities experiencing significant clogging of the media may require complete replacement of the existing soil. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted after the plants and media are replaced.

Major Sediment/Leaf Removal

Constructed wetlands that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Dredging of the ponding and forebay areas will periodically be required to promote the system's ability to remove suspended solids from the water. Stormwater must be able to freely move through the facility and drain through the overflow structures as intended. Therefore, it is important to keep all structural components free of blockages, particularly inlet and outlet structures.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-need basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Pest/Disease/Invasive Species Management

Constructed wetlands must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate further spread of the unwanted species. The surrounding embankment must be inspected for animal burrows, which may damage the existing grading, lead to bank instability, or result in the destruction of wetland vegetation. In order to maintain the integrity of the facility and its function of treating stormwater, animal burrows within close proximity to the wetland or its components must be addressed with appropriate animal control measures or an approved alternative. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests within a wetland facility, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. For example, if the as-needed maintenance issue is generating favorable conditions for the pest to inhabit, such as vector (mosquito) populations resulting from the prolonged ponding due to clogged outlet structures, returning the constructed wetland to its properly functioning state may subsequently eliminate the pest. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of constructed wetlands, and strongly discouraged following the initial establishment period. However, if pesticide application is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Table 4-15** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one

work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 4-15** provide guidance on when as-needed maintenance tasks can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 4-15 Schedule and Frequency of As-Needed Maintenance Activities for Constructed Wetlands**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Structural Repair | | | | | | | | | | | | |
| | Plant Replacement | | | | | | | | | | | | |
| | Harvesting | | | | | | | | | | | | |
| | Stake Repair/Replacement | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Media Replacement | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasives | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency at which these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Wet Detention Basin Fact Sheet** in **Appendix A**.

#### 4.3.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 4.3.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned constructed wetlands must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in constructed wetlands. If use is required (i.e. all other options have been expended to address the issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 4.3.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements. Adherence to all safety procedures during as-needed maintenance tasks is required.

#### 4.3.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

# 4.4. SWALES/FILTER STRIPS

Swales are shallow, mildly sloped trapezoidal channels, and filter strips are sloped surfaces with a relatively mild longitudinal slope. The surfaces of both swales and filter strips are typically composed of plantings or dense turf grass and are effective at reducing runoff and removing pollutants. Swales and filter strips improve water quality through biological uptake, detention of stormwater, and treatment of stormwater percolating through soil and filter media.

Examples include:

- Vegetated swales
- Vegetated filter strips

## 4.4.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period inspection and maintenance are critical to the plantings in swales and filter strips and the overall success of these facilities. The establishment period typically lasts two full growing seasons after plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of these facilities is included in **Appendix A**. A **Swales/Filter Strips Inspection Form** to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

### 4.4.1.1. MONTHLY INSPECTIONS

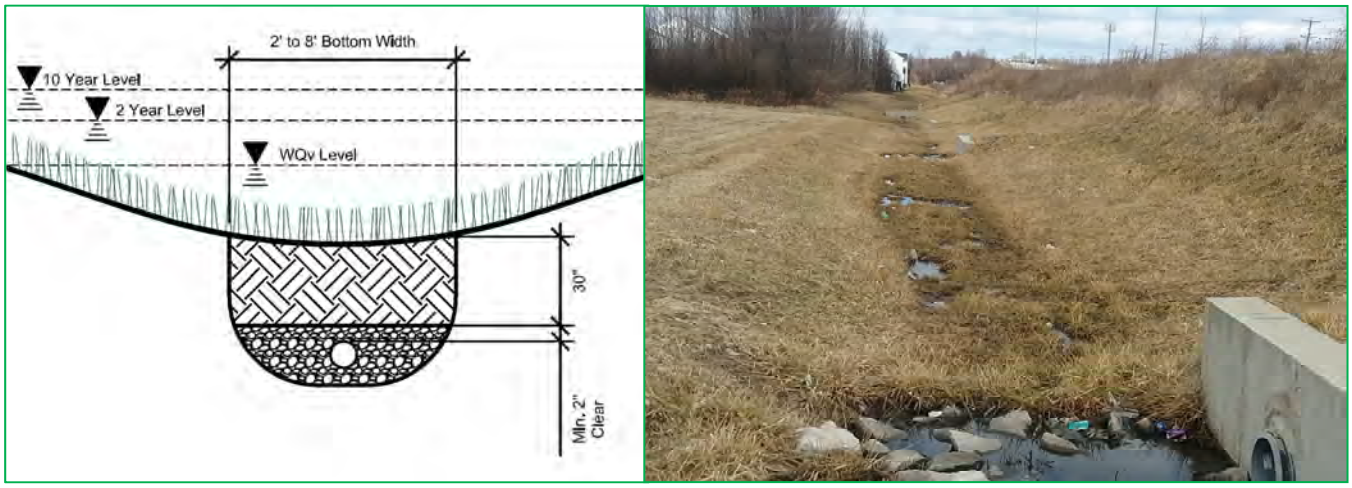


**FIGURE 4-4 TYPICAL SWALE DESIGN PLAN VIEW (LEFT) AND TYPICAL SWALE INSTALLATION (RIGHT)**

Monthly inspections are required during the swale/filter strip establishment period. The **Swale/Filter Strip Inspection Form** in **Appendix B** must be used for performing and reporting the monthly inspections at swale/filter strip facilities. Deficiencies noted during the inspections must be remedied during the inspection if possible. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Swale/Filter Strip Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of swale/filter strip functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the swale/filter strip facility must first be analyzed, focusing primarily on the vegetation present in the planting area, as well as the general aesthetics of the facility. Swale/filter strip plants must appear healthy, with few weeds or invasive species present. Vegetative cover may be minimal during the establishment period, but coverage must increase over time, as the plants reach maturity. The facility must also be checked for the presence of any trash, debris, or chemical accumulation, in addition to mosquito proliferation, which may hinder the aesthetics and functionality.

Following the system overview, the inlets and overflow structures must be examined for any blockages or obstructions to flow entering or exiting the facility. Where pre-treatment areas are presents at inlets, these must be checked for sediment accumulation. Because these rocks are designed to act as a primary filter for larger particles, sediment accumulation should become apparent over time. Therefore, the presence of sediment deposition is an ideal indication of filter effectiveness, although excessive sediment buildup will reduce the effectiveness of the swale/filter strip at treating stormwater and must therefore be cleaned regularly.

The perimeter of the facility must be inspected for any erosion or undercutting along the facility bottom or side slopes, in addition to verifying slope stability or any changes in grading. Locations of gullying, soil instability, or unvegetated regions along the slopes due to erosion must be identified and remedied.

The functionality of the swale/filter strip media must be examined during each monthly inspection. Swale and filter strip facilities with mulch must be maintained to provide an adequate, even layer of mulch cover throughout the entire planting area. The soil moisture must appear average, with no cracks or prolonged ponding. Swales/filter strips are typically designed to drain within 24 hours. The soil must also be checked for compaction, which may reduce infiltration rates and present eventual ponding concerns. Excessive sediment deposits in the bottom of the facility must be removed regularly to promote the functionality of the facility as a stormwater treatment system.

As-needed maintenance includes maintenance activities not listed in Section 4.4.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.4.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks during the establishment period typically include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repair
- Minor sediment/leaf removal

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation. During periods of low rainfall, additional watering may be conducted as needed.

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of swale/filter strip vegetation. All plants that are not specified in the vegetation must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proactive weeding is especially critical during the establishment period.

Trimming

Because many swale/filter strip systems are located in public areas such as parks, rights-of way, or neighborhoods, routine trimming of seeded lawn areas surrounding or in the swale/filter strip site is necessary to promote the aesthetics of the facility.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the facility during each inspection to prevent the clogging of the swale/filter strip media, inlets and outlets, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All media and components must be inspected to ensure stormwater can move through the facility and drain through both the swale/filter strip media and the overflow structures, as intended. Substantial clogging of the facility may result in flooding concerns if water exceeding the basin capacity is unable to exit the site through the storm sewer system. Some overflow structures may contain traps used to collect and prevent trash and other floatable objects from entering the storm sewer system. These traps must regularly be emptied to ensure their continued functionality.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the planting areas to prevent the filtration media from becoming clogged, which is necessary in maintaining the system's ability to infiltrate and treat stormwater. Rock channels, inlet protection, and other stone structures within the swale/filter strip must regularly be cleaned of sediment to continue their function of removing suspended solids from surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the stormwater SCP.

Minor Erosion Repairs

Minor erosion from sheet flow entering and traveling through the swale/filter strip must be evaluated along the side slopes and bottom. This can typically be identified as regions of displaced mulch, gullying, or unvegetated areas along the side slopes. During each inspection, existing soil must be spread or smoothed along the bottom of the swale/filter strip, which will assist in weed control and erosion protection during the establishment period. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary.

**Table 4-16** below shows the recommended schedule and frequency of establishment period inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements of a swale/filter strip facility during the establishment period. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 4-16** are considered establishment period maintenance tasks.

**Table 4-16 Schedule and Frequency of Establishment Period I&M Activities for Swale/Filter Strip Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 4.4.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned swales/filter strips must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

#### 4.4.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during establishment period inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste container
- Compostable waste container
- Recyclable material containers
- Wheelbarrow
- Leaf blower/vacuum
- Trimmer
- Flashlight
- City of Columbus ID Badge
- Mobile irrigation system

#### 4.4.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection and maintenance tasks are included in **Table 4-17**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-17 Swale/Filter Strip Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Swale/Filter Strip (Hours/Year) |
|---|---|
| **Establishment Period** | 18 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 4.4.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, swales/filter strips must be inspected and maintained on a routine basis even after the establishment period has ended. This section focuses on the routine inspection and maintenance activities that must be performed on a recurring basis after the establishment period for the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of swales and filter strips is included in **Appendix A**. A **Swale/Filter Strip Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 4.4.2.1. MONTHLY INSPECTIONS

After the establishment period, inspections for swales/filter strips must continue to be performed monthly. Monthly inspections are required for the service life of the swale/filter strip. The **Swales/Filter Strip Inspection Form** in **Appendix B** must be used for performing and reporting monthly inspections at swales/filter strips. An overview of what to inspect at swales and filter strips is provided in Section 4.4.1.1.

Deficiencies noted during inspections must be remedied during the inspection if possible. As-needed maintenance includes maintenance activities not described in Section 4.4.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

### 4.4.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Weeding
- Trimming
- Trash & debris removal
- Minor erosion repair
- Minor sediment/leaf removal

Weeding

Weeding is necessary to prevent the proliferation of unwanted species, which may choke or hinder the growth of swale/filter strip lawn. All must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.

Trimming

Since many swale/filter strip systems are located in public areas such as parks, rights-of way, or neighborhoods, routine trimming of lawn areas is necessary to promote the aesthetics of the facility.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the SCP vegetated area and forebays during each inspection to prevent the clogging of the swale/filter strip media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All media and components must be inspected to ensure stormwater can move through the facility and drain through both the swale/filter strip media and the overflow structures, as intended. Substantial clogging of the facility may result in flooding concerns if water exceeding the basin capacity is unable to exit the site through the storm sewer system. Some basin overflow structures may contain traps used to collect and prevent trash and other floatable objects from entering the storm sewer system. These traps must regularly be emptied to ensure their continued functionality.

Minor Erosion Repairs

Minor erosion from sheet flow entering and traveling through the swale/filter strip must be evaluated along the side slopes and bottom of the basin. This can typically be identified as regions of gullying or unvegetated areas along the side slopes. During each inspection, existing soil must be spread or smoothed along the bottom of the swale/filter strip, which will assist in weed control and erosion protection. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the vegetated areas to prevent the filtration media from becoming clogged, which is necessary in maintaining the system's ability to infiltrate and treat stormwater. Rock channels, inlet protection, and other stone structures within the basin must regularly be cleaned of sediment to continue their function of removing suspended solids from surface flow. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Table 4-18** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a swale and filter strip facility, after the establishment period has ended. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 4-18** are considered as-needed maintenance tasks.

**Table 4-18 Schedule and Frequency of Routine I&M Activities for Swales/Filter Strips**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Month | | | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 4.4.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned swales/filter strips must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

#### 4.4.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Leaf blower/vacuum
- City of Columbus ID Badge
- Flashlight

#### 4.4.2.5. ESTIMATED LABOR HOURS

The estimated labor hours for each routine inspection & maintenance task are included in **Table 4-19**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 4-19 Swale/Filter Strip Routine Inspection & Maintenance Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Swale/Filter Strip (Hours/Year) |
|---|---|
| **Routine** | 12 |

*Note: Estimates based on two-person crew preforming maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

## 4.4.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 4.4.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance includes, but is not limited to:

- Inlet/outlet structure cleaning
- Watering during drought
- Media replacement
- Major sediment/leaf removal
- Major trash & debris removal
- Pest/disease/invasive species management
- Soil compaction repair

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of swales and filter strips, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing "Abnormally Dry" or "Moderate Drought" conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Media Replacement

Bioretention media must be replaced in locations where the existing soil has been relocated or removed from the swale/filter strip bottom to ensure the soil remains at the required depth for stormwater treatment. Facilities experiencing significant clogging of media may require complete replacement of the existing soil.

Major Sediment/Leaf Removal

Swale/filter strip facilities that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Stormwater must be able to freely move through the facility and drain through both any soil media and overflow structures, as intended. Therefore, it is important to keep all structural components and soil media free of blockages. If water exceeding the basin capacity is unable to exit the site through the storm sewer system, severe clogging of the facility may result in the proliferation of vector (mosquito) habitat, reduced water storage volume, or flooding concerns.

Major Trash & Debris Removal

In addition to regulating the functionality of the facility, removal of excessive debris accumulations must be conducted to improve the overall aesthetics of the facility. Extensive trash and debris must be removed from the swale/filter strip during each inspection to prevent the clogging of any storage media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

Pest/Disease/Invasive Species Management

Swales and filter strips must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate potential spreading to nearby plants or basins. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests within a swale or filter strip facility, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. For example, if the as-needed maintenance issue is generating favorable conditions for the pest to inhabit, such as vector (mosquito) populations resulting from the prolonged ponding due to clogged outlet structures, returning the facility to its properly functioning state may subsequently eliminate the pest. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged following the establishment period. However, if use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

Soil Compaction Repairs

The surface media of the swale or filter strip must be inspected for indications of settling or compaction of surface materials, which will decrease soil porosity and reduce infiltration rates. If soil compaction or settling is observed, surface materials must be broken up using hand tools to increase void space.

**Table 4-20** below shows a recommended schedule for when as-needed tasks must be completed and must be used for guidance on the time of year when it would be most beneficial to perform the work. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing media at all top priority facilities). The shaded areas in **Table 4-20** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 4-20 Schedule and Frequency of As-Needed Maintenance Activities for Swales/Filter Strips**

| Maintenance Phase | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Media Replacement | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasive Species Management | | | | | | | | | | | | |
| | Soil Compaction Repairs | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency at which these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Swales/Filter Strips Fact Sheet** in **Appendix A**.

#### 4.4.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during establishment and routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 4.4.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on swales/filter strips must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

#### 4.4.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 4.4.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for personnel performing these maintenance tasks.

# 5. UNDERGROUND CONTROLS

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# 5.1. UNDERGROUND STORAGE

An underground storage system is any stormwater quantity or quality control method that employs underground chamber or chambers, either prefabricated or constructed in place, and has a designed release feature to control stormwater discharge. Underground storage may also include any void space of aggregate that is utilized in water quantity or water quality calculations. This method is most applicable where land is valuable or the site is constrained, such as in industrial, commercial, and redevelopment areas. Underground storage chambers improve stormwater management through detention of stormwater runoff and reduction of stormwater runoff volume.

Examples Include:

- Storage vaults
- Gravel beds
- Large diameter storage pipes/arches
- Perforated pipes
- Storm chambers


**FIGURE 5-1 TYPICAL UNDERGROUND STORAGE CHAMBER CONFIGURATIONS**

## 5.1.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, underground storage chambers must be inspected and maintained on a routine basis for the service life of the facility. This section focuses on the routine I&M activities that must be performed on a recurring basis after installation of the facility continuing through the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for underground storage chambers is included in **Appendix A**. An **Underground Storage Inspection Form** must be completed during inspections and is included in **Appendix B**.

### 5.1.1.1. QUARTERLY INSPECTIONS

Quarterly inspections are required for the service life of the underground storage chamber. The **Underground Storage Inspection Form** in **Appendix B** must be used for performing and reporting quarterly inspections at underground storage chamber facilities for the duration of the life of the facility. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance and inspection may also be required; refer to the manufacturer's requirements for additional information.

During routine inspections, the access hatches should be removed to inspect the underground storage chambers. Typically, access points are constructed in locations where the facility has been designed to collect sediment. These locations should be inspected for sediment, trash and debris accumulation and cleaned if necessary. In facilities where a pretreatment filter system is installed, the filter should be inspected and cleaned if necessary. Note that entrance to some underground stormwater facilities requires confined space entry permits and personnel certification.

The Underground Storage Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the system. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Deficiencies noted during the inspections must be remedied during the inspection if possible. As-needed maintenance includes maintenance activities not described in Section 5.1.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 5.1.1.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Trash & debris removal
- Filter or header row cleaning/replacement

Trash & Debris Removal

The area surrounding and above the underground storage systems must be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls and risers as intended. Any visible trash, sediment, and debris must be removed from the system to prevent the clogging of the facility and to promote the aesthetics of the facility. Some underground storage chambers may contain traps used to collect and prevent trash or other floatable objects from entering the underground storage chambers. These traps must be regularly emptied to ensure the proper functionality of the basin.

Filter or Header Row Cleaning/Replacement

Some underground storage systems include filters or header rows as part of the design that function to pretreat stormwater runoff prior to entering the chambers. Where these are present, they must be inspected during routine inspections. If a filter is present, a filter can be cleaned and replaced. If the filter is too heavily soiled it may need to be replaced. For header rows, if the sediment build-up is significant, these should be cleaned.

**Table 5-1** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of an underground storage system. Additional maintenance activities may be required based on observations made during the required quarterly inspections. More extensive maintenance activities not listed in **Table 5-1** are considered as-needed maintenance tasks.

**Table 5-1 Schedule and Frequency of Routine I&M Activities for Underground Storage Systems**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Quarter | | | | | | | | | | | |
| | Trash & Debris Removal | Once/Quarter | | | | | | | | | | | |
| | Filter Cleaning/Replacement | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 5.1.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned underground storage systems must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protection equipment as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities require confined space entry permits and personnel certification.

### 5.1.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Potable water for filter cleaning
- Shovel
- Flashlight
- Jet/vacuum truck

### 5.1.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection & maintenance tasks are included in **Table 5-2.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 5-2 Underground Storage System Routine Inspection & Maintenance Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Underground Storage Chamber (Hours/Year) |
|---|---|
| Routine | 8 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

## 5.1.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

### 5.1.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/Outlet structure cleaning
- Major sediment/leaf removal
- Major trash/debris removal

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the underground storage systems, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Major Sediment/Leaf Removal

Underground storage systems that experience severe sediment or leaf accumulation may require occasional cleaning and debris removal efforts. Stormwater must be able to freely move through the facility and drain through facility as designed. Therefore, it is important to keep inlets, storage chambers and pipes free of blockages. If major sedimentation or leaf litter has accumulated (beyond what is capable of being removed using manual hand tools, rakes and shovels) it may be necessary to use specialty equipment such as a vacuum truck. Major sediment and leaf removal must be noted during routine inspections and conducted on an as-needed basis.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive trash and debris accumulations must be conducted on an as-need basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large debris caught in inlets, etc.) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

**Table 5-3** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 5-3** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 5-3 Schedule and Frequency of As-Needed Maintenance Activities for Underground Storage Systems**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Underground Storage Fact Sheet** in **Appendix A**.

#### 5.1.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 5.1.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned underground storage chamber must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 5.1.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 5.1.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

## 5.2. PERMEABLE PAVEMENT

Permeable pavement is a type of pavement that allows water to infiltrate into the subsoil through the pavement and base layers. The system consists of a permeable surface course with an underlying storage bed in which stormwater is either infiltrated to the underlying soil or collected in underdrains and slowly released back into the sewer system through an outlet structure. Permeable pavement improves stormwater management by reducing the amount of runoff, filtering suspended solids and detention of stormwater. Permeable pavement is most commonly used as surface cover for parking lots, roadways, crosswalks, sidewalks, multi-use paths and recreational facilities (e.g. basketball court, tennis court, etc.)

Examples Include:

- Permeable pavement surfaces
- Permeable concrete
- Porous asphalt
- Interlocking concrete pavers
- Clay pavers
- Plastic grid pavers

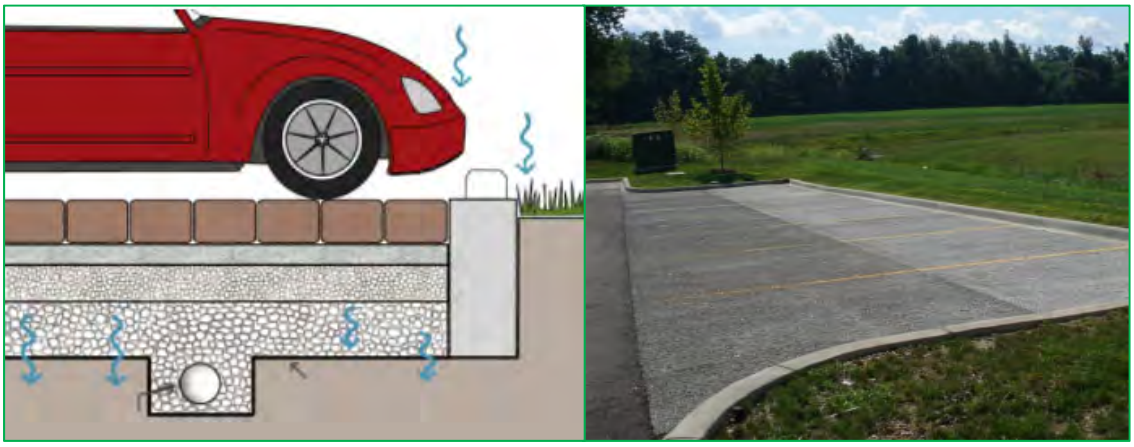

**FIGURE 5-2 TYPICAL INTERLOCKING PERVIOUS PAVER SECTION VIEW (LEFT) AND A PERVIOUS PAVEMENT FACILITY (RIGHT)**

### 5.2.1. ESTABLISHMENT PERIOD INSPECTION, TESTING & MAINTENANCE

Establishment period inspection, testing and maintenance are critical to the proper functionality and overall success of the facility. In addition to inspection and maintenance tasks required for other types of facilities in this manual, infiltration testing is also required at permeable pavement facilities to establish baseline conditions and to aid in making decisions about future routine inspection and maintenance frequencies. During the permeable pavement establishment period, standard inspections and testing must be performed quarterly to determine how often cleaning should be performed for the service life of the facility. The establishment period typically lasts two years after the permeable pavement is installed. The results of the testing performed during the establishment period will be used to determine whether the permeable surface must be cleaned semi-annually or quarterly for the service life of the facility. This section includes inspection, testing and maintenance requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of permeable pavement is included in **Appendix A**. A **Permeable Pavement Inspection Form** to be completed during inspections is included

in **Appendix B**. A **Permeable Pavement Simplified Infiltration Test Methodology** and **Permeable Pavement Infiltration Testing Form** are also included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

#### 5.2.1.1. QUARTERLY INSPECTIONS & INFILTRATION TESTING

Quarterly inspections are required during the Permeable pavement establishment period. The Permeable Pavement Inspection Form in Appendix B must be used for performing and reporting the quarterly inspections. In addition to the quarterly inspections, quarterly infiltration testing must also be performed during the establishment period. The Permeable Pavement Simplified Infiltration Testing Methodology in Appendix B must be followed when performing infiltration testing. In addition, the results of the Infiltration Testing must be reported using the Permeable Pavement Infiltration Testing Form provided in Appendix B. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Permeable Pavement Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance. In addition, infiltration testing must be performed in accordance with the Permeable Pavement Simplified Infiltration Testing Methodology included in Appendix B.

Recent rainfall events and current weather must be recorded during each inspection and infiltration test. The overall condition of the permeable pavement must first be analyzed, focusing on surface integrity, debris and solid deposition and drainage deficiencies. If large cracks, heaving, spalling, uneven surfaces, potholes, or missing pavers are observed during the inspection it should be described in the comments section of the inspection form along with the severity of the issue. If ponding or flooding is observed or stormwater is flowing off of the surface (not infiltrating) the permeable pavement may be clogged, or the outlet structure may be clogged or obstructed and must be remedied. The underlying cause must be identified, and corrective action or maintenance must be noted on the inspection form.

If the permeable pavement surface is heavily soiled with sediment, soil or any other material, street sweeping is recommended. Visible trash and debris at the permeable pavement site must be removed during quarterly inspections. The buildup of sediment, debris, trash, chemicals, or leaves must be removed. Vegetation growth on the surface must be manually removed.

During inspections, surface infiltration testing must be performed in several locations in accordance with Permeable Pavement Simplified Infiltration Testing (SIT) Methodology included in Appendix B. During the establishment period, testing must be performed and reported quarterly. In general, the infiltration testing must be performed using a wooden test frame on the permeable pavement surface. The SIT methodology is performed by pouring a 5 gallon bucket filled with potable water through the infiltration test frame and measuring and recording the amount of time the water takes to infiltrate through the permeable pavement to the point there is no longer free water on the surface. The test must be repeated at multiple test site locations based on the total area of permeable pavement at the facility.

The number of test sites for a permeable pavement application is dependent on the total area. **Table 5-4** below contains a summary of the recommended minimum number of infiltration tests to be performed based on the size of the application area. Test site locations should be selected based on the variability of the application area. For instance, if the application area has features such as a curb lane, a drive lane and a tree covered area a test should be performed near each of these features. Replicate tests are not required; however, if replicate tests are performed to validate results, they should be separated by a minimum of 24 hours. Permeable pavement application areas with numerous feature types could require additional test sites in excess of the minimums specified below in order to capture the variability of the entire application area.

**Table 5-4 Permeable Pavement Minimum Number of Infiltration Test Sites**

| Size of Permeable Pavement Application Area [1] | Minimum Number of Infiltration Test Sites[2] |
|---|---|
| < 0.5 acres | 3 |
| Between 0.5 and 1.0 acres | 4 |
| Between 1.0 and 2.0 acres | 6 |
| Between 2.0 and 3.0 acres | 8 |
| Between 3.0 and 5.0 acres | 10 |
| >5.0 acres | Perform a minimum of 1 additional infiltration test for each acre above 5 acres |

*Notes:*

*[1]Determining the size of a permeable pavement area is based on having a continuous permeable pavement application. In the event of a discontinuous application, such as permeable pavement parking lanes separated by conventional pavement or separate permeable pavement applications in a single parking lot, then the project area shall be determined based on having a common loading ratio. Permeable pavement applications with different loading ratios must be treated as separate project areas. In addition, a single project area cannot include a variation in the design of the permeable pavement (e.g., asphalt vs. concrete vs. brick pavers; varying base material or gap width between bricks).*

*[2]Additional test site locations are also encouraged when necessary to account for a higher variability of site conditions, to confirm routine maintenance is adequate to achieve target performance.*

As much as practical, testing at individual test sites should be performed at the same locations on a recurring basis as closely as possible to track infiltration performance over time.

During the establishment period, the infiltration time will be compared against the following evaluation criteria presented in the SIT methodology to determine baseline conditions and frequency of surface sweeping to be performed during routine I&M. The performance evaluation criteria based on infiltration time is summarized in **Table 5-5.**

**Table 5-5 Permeable Pavement Infiltration Time Performance Evaluation**

| Infiltration Time | Performance Evaluation |
|---|---|
| <30 seconds | Permeable pavement is performing optimally |
| 30-60 seconds | Minor clogging is occurring and maintenance may be required |
| 60-90 seconds | Clogging is occurring and the permeable pavement needs maintenance |
| >90 seconds | Clogging is occurring that will typically require remediation |

If the results of the infiltration testing indicate that the infiltration time exceeds 60 seconds, then as-needed maintenance is required and should be indicated on the Permeable Pavement Infiltration Testing Form. If the cause of clogging is apparent during testing, include information on the inspection form to indicate what type of remedy is necessary to restore the permeable pavement (i.e. sedimentation buildup requires street sweeping).

Infiltration testing must be performed immediately after installation of permeable pavement to establish a baseline infiltration rate and quarterly thereafter to record the performance of the facility during the establishment period. The results of the establishment period infiltration testing will be used to determine whether the permeable pavement surface must be cleaned semi-annually or quarterly for the service life of the facility. Typically, facilities that experience an infiltration time less than 60 seconds during the establishment period will require semi-annual surface sweeping for routine maintenance for the service life of the facility. On the other hand, permeable pavement facilities that experience an infiltration time greater than 60 seconds during the establishment period will require a more frequent routine sweeping schedule for the service life of the facility such as quarterly or more frequent. In some cases, a more frequent sweeping schedule may be required at facilities where heavy clogging and infiltration issues are observed during the establishment period.

Surface sweeping must be performed at a minimum frequency of twice per year (semi-annually) during the establishment period. Pressure washing or power washing may be used in lieu of surface sweeping for permeable pavement sites that are not accessible or must not be accessed (due to weight restriction) by a regenerative air sweeper truck.

If infiltration testing or visual inspections indicate as-needed maintenance is necessary, it must be noted on the appropriate form in enough detail for a follow-up work order to be created to resolve the issue. As-needed maintenance includes maintenance activities not listed in Section 5.2.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection or testing form; provide enough detail for a follow-up work order to be created.

Storage and stockpiling of service and maintenance materials such as mulch, sand, plants, soil, and salt on the surface of any permeable pavement site is strictly prohibited.

#### 5.2.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks during the establishment period typically include:

- Trash & debris removal
- Surface sweeping /pressure washing
- Vegetation/weed removal

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the permeable pavement surface during each inspection to prevent clogging.

Surface Sweeping/Pressure Washing

Sediment and debris removal must be conducted to prevent clogging and maintain the system's functionality to infiltrate stormwater. Substantial clogging of the facility may result in flooding concerns if water is unable to infiltrate through the permeable pavement. A regenerative air sweeper truck must be used to perform routine surface sweeping where possible. These units use a blower system to produce a high velocity air stream at an angle that removes particles and debris from the surface and uses a sweeping head with a suction tube to collect debris. For interlocking pavers, the top layer of stone must be replenished with clean stone after surface sweeping.

Leaf removal in areas adjacent to the permeable pavement surface is also important to be performed annually to prevent migration of leaf litter onto the permeable pavement surface after surface sweeping is performed.

Pressure washing or power washing may be used in lieu of surface sweeping for permeable pavement sites that are not accessible or must not be accessed (due to weight restriction) by a regenerative air sweeper truck and routine sediment and debris removal must be conducted to maintain the functionality of the system. For interlocking pavers, the top layer of stone must be replenished with clean stone after pressure washing.

Vegetation/Weed Removal

If vegetation or weeds are observed to be growing on the permeable pavement surface or in between pavers, these must be removed to prevent proliferation, which may hinder infiltration rates. The presence of vegetation/weeds must be kept below 5% of the permeable pavement site area at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of permeable pavement, and strongly discouraged following the establishment period. However, if use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Table 5-6** below shows the recommended schedule and frequency of establishment period inspection, testing and maintenance tasks. This schedule reflects the minimum maintenance requirements for a permeable pavement facility during the establishment period. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 5-6** are considered as-needed maintenance tasks.

**Table 5-6 Schedule and Frequency of Establishment Period I&M Activities for Permeable Pavement**

| Inspection, Testing & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Quarter | | | | | | | | | | | |
| | Infiltration Testing | Once/Quarter | | | | | | | | | | | |
| | Trash & Debris Removal | Once/Quarter | | | | | | | | | | | |
| | Surface Sweeping/Pressure Washing | Semi-Annual | | | | | | | | | | | |
| | Vegetation/weed removal | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 5.2.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned permeable pavement must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification. The use of fertilizers, pesticides and herbicides is prohibited for use in green roof facilities during the establishment period.

#### 5.2.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during establishment period inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID badge
- Regenerative air sweeper truck
- Leaf blower/vacuum
- Flashlight
- Power washing system
- Infiltration test frame
- Potable water for infiltration testing
- Stopwatch
- Broom for cleaning testing surface
- Clean 5-gallon bucket

#### 5.2.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection & maintenance tasks are included in **Table 5-7.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 5-7 Permeable Pavement Establishment Period Annual Labor Hours**

| Inspection, Testing & Maintenance Type | Estimated Annual Labor Hours for Permeable Pavement Sites (Hours/Year) |
|---|---|
| Establishment Period | 30 |

*Note: Estimates based on two-person crew performing maintenance, testing and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 5.2.2. ROUTINE INSPECTION, TESTING & MAINTENANCE

To maintain proper functionality, permeable pavement facilities must be inspected, tested and maintained on a routine basis. Without regular maintenance permeable pavement may become clogged causing loss of functionality or require partial or complete replacement. Permeable pavement maintenance of the design void structure is especially important in cold weather seasons as proper drainage prevents damage from freeze-thaw events. This section focuses on the routine inspection, testing and maintenance activities that must be performed on a recurring basis after the permeable pavement establishment period for the remainder of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for permeable pavement is included in **Appendix A**. A **Permeable Pavement Inspection**

**Form** to be completed during inspections is included in **Appendix B**. A **Permeable Pavement Simplified Infiltration Test Methodology** and **Permeable Pavement Infiltration Testing Form** are also included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

### 5.2.2.1. INSPECTIONS & INFILTRATION TESTING

The frequency of permeable pavement inspections will be determined based on the results of the establishment period infiltration testing. The number of test sites per facility should remain the same as the establishment period as specified in 5.2.1.1. As much as practical, testing at individual test sites should be replicated at the same locations on a recurring basis as closely as possible to track infiltration performance over time.

Typically, permeable pavement facilities that maintain an infiltration time of less than 60 seconds during the establishment period (as described in Section 5.2.1.1) will require semi-annual inspections and sweeping. Permeable pavement facilities that experience infiltration times greater than 60 seconds during the establishment period will generally require that routine inspections and maintenance be performed quarterly or at a more frequently scheduled rate. The Permeable Pavement Inspection Form in Appendix B must be used for performing and reporting the routine inspections. Routine infiltration testing must be performed following the Permeable Pavement Simplified Infiltration Test Methodology and reported on the Permeable Pavement Infiltration Testing Form included in Appendix B. An overview of how to perform inspections, testing and maintenance at permeable pavement facilities is provided in Section 5.2.1.1.

Deficiencies noted during routine inspections must be remedied during the inspection if possible. Section 5.2.2.2 includes the minimum maintenance tasks that must be performed during routine inspections. As-needed maintenance includes maintenance activities not described in Section 5.2.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection or testing form; provide enough detail for a follow-up work order to be created. Refer to Section 5.2.3 for additional information about As-Needed Maintenance for permeable pavement.

### 5.2.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Surface sweeping/pressure washing
- Trash & debris removal
- Vegetation/weed removal

<u>Surface Sweeping/Pressure Washing</u>

Routine sediment and debris removal must be conducted to prevent clogging and maintain the system's functionality to infiltrate stormwater. Substantial clogging of the facility may result in flooding concerns if water is unable to infiltrate through the permeable pavement. A regenerative air sweeper truck must be used to perform routine surface sweeping where possible. These units use a blower system to produce a high velocity air stream at an angle that removes particles and debris from the surface and uses a sweeping head with a suction tube to collect debris. For interlocking pavers, the top layer of stone must be replenished with clean stone after surface sweeping.

Pressure washing or power washing may be used in lieu of surface sweeping for permeable pavement sites that are not accessible or must not be accessed (due to weight restriction) by a sweeper truck, but routine sediment and debris removal must be conducted to maintain the functionality of the system.

Leaf removal in areas adjacent to the permeable pavement surface is also important to be performed annually to prevent migration of leaf litter onto the permeable pavement surface after surface sweeping is performed.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the permeable pavement surface during each inspection to prevent the clogging.

Vegetation/Weed Removal

If vegetation or weeds are observed to be growing on the permeable pavement surface or in between pavers, these must be removed to prevent proliferation, which may hinder infiltration rates. The presence of vegetation/weeds must be kept below 5% of the permeable pavement site area at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of permeable pavement, and strongly discouraged following the establishment period. However, if use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Table 5-8** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a permeable pavement site. Additional operation and maintenance activities may be required based on observations made during the required quarterly inspections. More extensive maintenance activities not listed in **Table 5-8** are considered “as-needed” maintenance tasks.

**Table 5-8 Schedule and Frequency of Routine I&M Activities for Permeable Pavement**

| Inspection, Testing & Maintenance Phase | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine Inspection & Maintenance | Inspection | Semi-Annual or Quarterly* | | | | | | | | | | | |
| | Infiltration Testing | Semi-Annual or Quarterly* | | | | | | | | | | | |
| | Surface Sweeping/Pressure Washing | Semi-Annual or Quarterly* | | | | | | | | | | | |
| | Trash & Debris Removal | Semi-Annual or Quarterly* | | | | | | | | | | | |
| | Vegetation/Weed Removal | Semi-Annual or Quarterly* | | | | | | | | | | | |

**- Frequency will be determined based on the results of establishment period infiltration testing. Typically, permeable pavement facilities will require semi-annual or quarterly infiltration testing and maintenance, however, in some instances a more frequent schedule may be required.*

*Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range.*

#### 5.2.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned permeable pavement sites must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PP SE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

#### 5.2.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Leaf blower/vacuum
- City of Columbus ID badge
- Flashlight
- Regenerative air sweeper truck
- Power washing system
- Infiltration test frame
- Potable water for infiltration testing
- Stopwatch
- Broom for cleaning testing surface
- Clean 5-gallon bucket

#### 5.2.2.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection, testing and maintenance tasks are included in **Table 5-9.** Estimates are based on a two-person crew performing inspection, testing and maintenance activities semi-annually.

**Table 5-9 Permeable Pavement Routine Inspection & Maintenance Annual Labor Hours**

| Inspection, Testing & Maintenance Type | Estimated Annual Labor Hours per Permeable Pavement Site (Hours/Year) |
|---|---|
| **Routine** | 12 |

*Note: Estimates based on two-person crew performing maintenance, testing and inspection tasks semi-annually. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 5.2.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 5.2.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance includes, but is not limited to:

- Snow removal
- Pavement surface repair

Snow Removal

Snow removal may be required at permeable pavement sites seasonally. The need to conduct snow removal will not require an inspection, but must be conducted along with other snow removal activities in the area the site is located in. It is important to note the following when snow removal is required on permeable pavement sites:

- Use of sand or cinders is prohibited
- Salt and de-icing agents must be used in reduced amounts to prevent build-up of toxic levels that are harmful to plant and animal life
- Snow removal must be performed with a rubber tipped shovel or plow
- Plow tips must be lifted 1 inch above the surface to prevent dislodging pavers
- Snow must not be stockpiled on the permeable pavement

Pavement Surface Repairs

Permeable pavement surfaces should be repaired in locations of significant freeze-thaw damage such as large cracks, heaving, spalling, and uneven surfaces and in locations where potholes, missing pavers, changes in grading and eroding edges are observed. Repairs should be made using the same treatment as the original permeable pavement application, or in cases of small, high grade areas replacement can be made with a standard impermeable pavement. No seal coats or new impermeable pavement layers should be applied.

**Table 5-10** below shows a recommended schedule for when as-needed tasks must be completed and must be used for guidance on the time of year when it would be most beneficial to perform the work. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection and testing forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing media at all top priority facilities). The shaded areas in **Table 5-10** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 5-10 Schedule and Frequency of As-Needed Maintenance Activities for Permeable Pavement**

| Maintenance Phase | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Snow Removal | | | | | | | | | | | | |
| | Pavement Surface Repairs | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency at which these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Permeable Pavement Fact Sheet** in **Appendix A**.

### 5.2.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during establishment period and routine inspections. The maintenance record will include specific tasks completed based on the work

order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 5.2.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned permeable pavement sites must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

#### 5.2.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 5.2.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

## 5.3. HYDRODYNAMIC SEPARATORS

Hydrodynamic separators (HDSs) are modular, prefabricated system designed to remove sediment, trash/debris, and other pollutants from storm water using vortex separation, mechanical screening, baffle walls, settling, incline plates, and other technologies. Most HDSs are designed to target specific pollutants commonly found in stormwater and most have internal bypass structures designed to provide relief points during extreme peak flow conditions. HDS systems are typically integrated with other stormwater quality control infrastructure, stormwater outfalls, and other storm sewer system components. Hydrodynamic separators should be used in areas where stormwater may convey high levels of trash, TSS, or sediment. HDSs improve stormwater quality through removal of pollutants specific to each proprietary unit design.

Examples include:

- Aqua-Swirl® XCelerator by AquaShield
- CDS®, Vortechs®, and VortSentry ® HS by Contech
- Site Saver® by StormTrap

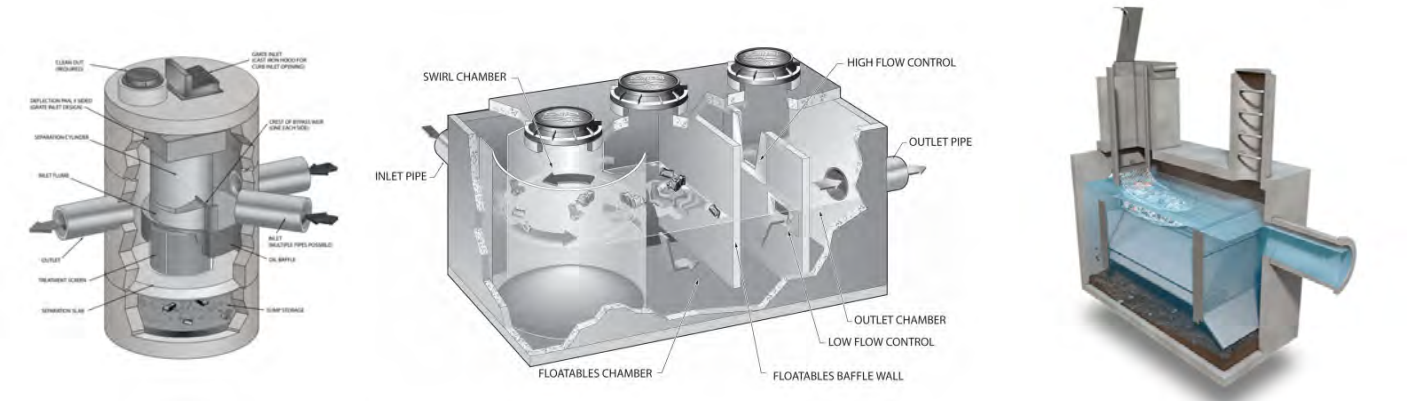


**FIGURE 5-3 CDS® (LEFT) AND VORTECHS® (MIDDLE) BY CONTECH AND SITESAVER® BY STORMTRAP (RIGHT) HYDRODYNAMIC SEPARATORS UTILIZING VORTEX SEPARATION, SCREENING, SEDIMENT SUMP STORAGE, BAFFLE WALLS, INCLINED PLATES, AND OTHER TECHNOLOGIES TO REMOVE SEDIMENT, DEBRIS, TRASH, AND OTHER SUSPENDED SOLIDS FROM STORM WATER SOURCE: CONTECH ENGINEERED SOLUTIONS AND STORMTRAP**

### 5.3.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, HDSs must be inspected and maintained on a routine basis. Most manufacturers provide HDS units with product-specific warranty periods and maintenance requirements. Refer to the manufacturer's product information for details. This section includes the minimum general I&M requirements to be implemented during the service life of the HDS unit; additional requirements may be necessary in accordance with the manufacturer's specifications. Inspections will inform future required inspection and maintenance frequency. A hydrodynamic separator located in areas with significant pollutants (trash, debris, sediment, etc.), may be subject to more frequent inspections due to the potential for maintenance needs. Grease, oil, and fuels should not be observed in these units. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for a hydrodynamic separator is included in **Appendix A**. A **Hydrodynamic Separator Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 5.3.1.1. SEMI-ANNUAL INSPECTIONS

Semi-annual inspections are required for the service life of a hydrodynamic separator. The **Hydrodynamic Separator Inspection Form** in **Appendix B** must be used for performing and reporting semi-annual inspections at HDS sites. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance and inspections may also be required; refer to the manufacturer's requirements for additional information.

The Hydrodynamic Separator Inspection Form must be used as a guideline for evaluating the continued functionality of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of stormwater volume processed by the facility or maintenance concerns, such as erosion leading to sediment accumulation.

The inspector should perform trash, sediment and debris evaluation, removal and measurement tasks in the following order during an inspection:

1. Rate the trash and debris accumulation.
2. Remove any trash/debris accessible by use of hand tools from available accessways within the HDS in order to provide better inspection of the system and to remove obstructions for proper operation. Properly dispose of these items.
3. Record the "HDS Depth" of the HDS (empty/design depth).
4. Perform a measure down from the top of casting of the HDS to collect and record a "Sediment/Trash Measurement. "
5. Calculate the Remaining Capacity of the HDS by dividing the Sediment/Trash Measurement by the HDS Depth. The resulting decimal should be used to enter the rating on the form: if the value is less than 0.5 (less than 50%) assign a rating of 1; if the value is greater than 0.5 (greater than 50% remaining) assign a rating of 5. If the rating of 1 is assigned (the remaining capacity is less than 50%), check the Sediment/Trash Removal box below in the As-Needed Maintenance Section.

A visual inspection to assess the structural condition should also be performed. Following the system overview, the inlet/outlet pipes and structures must be examined for any blockages or obstructions to flow entering or exiting the facility. Any filters on the unit should be appropriately cleaned and backwash/cleaning solution should be collected for proper disposal. Do not allow backwash/cleaning solution into the storm system.

Sediment (and remaining trash/debris) accumulations beyond what can be removed with hand tools or areas that are not accessible because of limited access will require specialty equipment for removal and therefore fall into the category of as-needed maintenance. Jet-vac maintenance is considered as-needed maintenance and is a common task requirement for HDSs. Jet-vac maintenance is categorized as 'Major Trash, Sediment & Debris Removal' and 'Sediment/Trash Removal' in the inspection form. Many HDS manufacturers provide recommended limits for accumulation of sediment (and remaining trash/debris) within the system before removal is required; refer to the manufacturers recommendations for cleaning schedules and maintenance frequency based on sediment and debris measurements. Typically, jet-vac cleaning is required when sediment and debris accumulations exceed 50% of the available sediment storage area. HDSs must be regularly cleaned to ensure continued functionality and capacity for sediment and other pollutant storage.

Deficiencies noted during inspections must be remedied during inspection if possible. As-needed maintenance includes maintenance activities not described in Section 5.3.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 5.3.2 for additional information about As-Needed Maintenance.

### 5.3.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks to be performed typically include:

- Trash & Debris Removal
- Sediment/ Trash Measurement
- Structural Inspection
- Inlet/Outlet Cleaning
- Filter Cleaning

See manufacturer I&M manuals for additional maintenance details pertaining to each proprietary unit such as the recommended water level during these maintenance tasks.

Trash & Debris Removal

The HDS must be inspected to ensure stormwater can move through the facility and drain through all mechanical components as intended. Prior to removing trash & debris, assign a rating to the debris/trash accumulation metric on the inspection form. Routine trash and debris removal must be conducted to maintain the functionality of the system and to ensure visualization of the system during inspection. This includes removal of any pollutants that are accessible with hand tools. If additional equipment, such as a jet/ vacuum truck, are needed, this should be noted in the as-needed section of the inspection form. Any trash and debris that is visible or collected within the system must be removed from the HDS during each inspection according to recommended manufacturer guidelines. Properly dispose of recovered materials. . Grease, oil and fuels are typically not present in HDS systems; if grease, oil or fuels odors or observations are found this should also be noted in the as-needed maintenance section with details for proper future actions to remedy.

Sediment/Trash Measurement

After trash & debris have been removed to the extent practical using available hand tools, perform measurement of the remaining sediment and trash. The inspector should measure down from the top of casting of the HDS to the top of trash/sediment accumulation to record the Sediment/Trash Measurement. This measurement should be done carefully as the particles at the top of the pile have less resistance to measuring tools than compacted particles below. The Sediment/Trash Measurement should be divided by the HDS Depth (the total depth of the HDS when empty or the design depth) to determine the remaining capacity in the HDS. Use the proper equipment and methodology detailed by the manufacturer's I&M manual to measure the accumulation sediment accumulation and any other measurement recommended. The resulting decimal should be used to enter the rating on the form: if the value is less than 0.5 (less than 50%) assign a rating of 1; if the value is greater than 0.5 (greater than 50% remaining) assign a rating of 5. If the rating of 1 is assigned (the remaining capacity is less than 50%), check the Sediment/Trash Removal box in the As-Needed Maintenance Section. Refer to the manufacturer's recommendations for unit specific measurement methodologies and cleaning requirements beyond these general guidelines.

Structural Inspection

All components of the system, including the bypass/overflow structures, should be visually inspected for structural condition. Any damage to the HDS shall be documented and remediated if necessary. If additional as-needed maintenance to remedy structural damage/malfunction, it should be noted on the inspection form.

Inlet/Outlet Cleaning

In order to maintain the functionality of the HDS, inlet, outlet and overflow pipes and structures must occasionally be cleaned of accumulated trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the system. Inspect the condition of these pipes and connections to the HDS, documenting and remediating any damage. If issues need specialty equipment or personnel, document the as-needed maintenance on the inspection form.

Filter Cleaning

If the HDS contains a filter in the unit, this must be inspected and periodically cleaned. The filter is a critical component to removal of certain pollutants and must be inspected regularly for damage, functionality and blockage. If the filter is visibly dirty during inspection it should be removed and cleaned according to the manufacturer's recommendations, typically by backwashing the filter. Backwash liquid should be captured in a bucket for proper disposal; backwashing should not be discharged to the storm sewer system. If a filter for oil/grease/fuel adsorption is present evaluate the filter for removal and replacement. Refer to manufacturer recommendations for replacement/useful life guidance and frequency. If the filter is damaged or does not appear to be functioning properly it should be noted on the as-needed maintenance section with instructions for follow-up (i.e. filter replacement).

**Table 5-11** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of an HDS system. Additional maintenance activities may be required based on observations made during the required semi-annual inspections. More extensive maintenance activities not listed in **Table 5-11** are considered as-needed maintenance tasks.

**Table 5-11 Schedule and Frequency of Routine I&M Activities for Hydrodynamic Separators**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Semi-annually | | | | | | | | | | | |
| | Trash & Debris Removal | Semi-annually | | | | | | | | | | | |
| | Sediment/Trash Measurement | Semi-annually | | | | | | | | | | | |
| | Inlet/Outlet Cleaning | Semi-annually | | | | | | | | | | | |
| | Filter Cleaning | Semi-annually | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range. Recommended time of year for inspection varies according to manufacturer specifications, though dry weather is often recommended.*

#### 5.3.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned HDSs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses.

#### 5.3.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Measuring device (stadia rod, etc.)
- Manhole hook (key)
- Power washer for filter cleaning
- Hand tools for trash and debris removal, if accessible
- Net
- City of Columbus ID Badge
- Shovel
- Flashlight

#### 5.3.1.5. ESTIMATED LABOR HOURS

The estimated labor hours for routine inspection & maintenance tasks are included in **Table 5-12.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 5-12 Hydrodynamic Separator Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Hydrodynamic Separator (Hours/Year) |
|---|---|
| **Routine** | 8 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 5.3.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Some examples of as-needed maintenance tasks for hydrodynamic separators are described below. Work orders will be generated for as-needed maintenance which will describe the specific tasks to be performed. Maintenance crews are responsible for completing maintenance records to document the as-needed maintenance.

#### 5.3.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Major Trash & Debris Removal
- Sediment/Trash Removal
- Oil, Grease, & Fuel Removal
- Inlet/Outlet Cleaning
- Filter Replacement

Major Trash, Sediment & Debris Removal

In addition to regular function of the facility, removal of excessive trash & debris accumulations must be conducted on an as-needed basis to ensure the functionality of the facility. When major trash and debris are present at the facility these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste). This may include use of a jet-vac truck to remove accumulated waste. The recurrence rate for jet-vac cleaning varies by product, but typically range from annual cleaning to every 3-5 years.

Sediment/Trash Removal

In addition to regular function of the facility, removal of sediment accumulations must be conducted on an as-needed basis to ensure the functionality of the facility. This may include use of a jet-vac truck to remove accumulated waste and sediment. The recurrence rate for jet-vac cleaning varies by product, but typically range from annual cleaning to every 3-5 years. Refer to the manufacturer's recommendations for depth of sediment that triggers sediment removal (typically greater than 50% of the available sediment storage area) to inform this recurrence rate.

Oil, Grease, & Fuel Removal

If oil, grease, and/or fuel are observed in the facility, the appropriate measures should be taken to remove these pollutants from the system; booms or absorbent pads are often recommended for this purpose. Refer to the manufacturer I&M guide for additional information. If the unit is in an area with operations affecting the HDS, such as a restaurant or commercial activity, include details on the business and location for follow up from the city.

Major Inlet/Outlet Cleaning

If routine inspection indicates blockages in these pipes, and blockages cannot be removed during routine inspection and maintenance, major inlet or outlet cleaning may be required. The proper cleaning methodology will need to occur based on the type and quantity of accumulated blockages. Refer to the manufacturer's recommendation on product-specific cleaning requirements and product-specific equipment.

**Table 5-13** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew cleaning inlet/outlet pipes at all top priority facilities). The shaded areas in **Table 5-13** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 5-13 Schedule and Frequency of As-Needed Maintenance Activities for Hydrodynamic Separators**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Sediment/ Trash Removal | | | | | | | | | | | | |
| | Oil, Grease, and Fuel Removal | | | | | | | | | | | | |
| | Major Inlet/Outlet Cleaning | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Hydrodynamic Separator Fact Sheet** in **Appendix A**.

#### 5.3.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 5.3.2.3. PERSONNEL REQUIREMENTS

Personnel performing maintenance activities on City-owned HDSs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 5.3.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 5.3.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

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# 6. MEDIA CONTROLS

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## 6.1. BIORETENTION

A bioretention facility consists of a soil bed planted with vegetation located above a gravel layer with an underdrain. Bioretention facilities are often sited adjacent to and used to treat runoff from paved surfaces such as parking lots. Stormwater quantity controls may either be integrated with the bioretention or provided in a separate downstream facility. Bioretention facilities improve water quality through soil and media filtration, stormwater detention, natural evapotranspiration, and biological uptake of water and nutrients. Stormwater can be conveyed to bioretention facilities via sheet flow, channelization, curb cuts, inlets, or conveyance systems.

Examples include:

- Regional bioretention facilities
- Rain gardens
- Vegetated curb extensions
- Vegetated bump-outs
- Bioswales

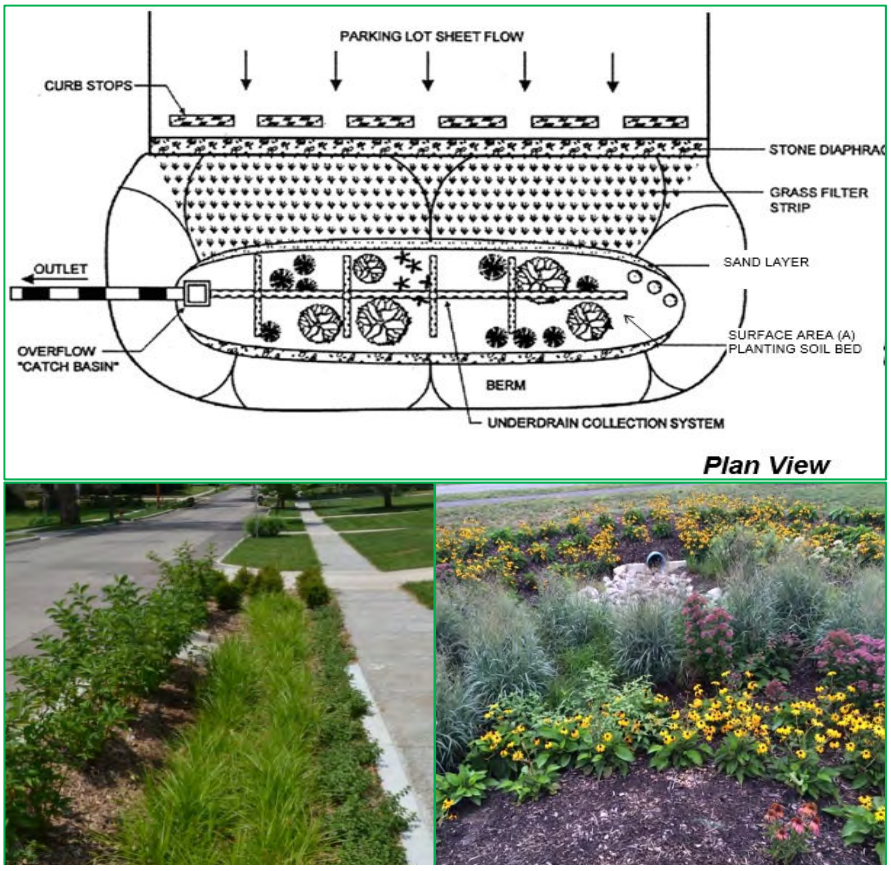


**FIGURE 6-1 BIORETENTION DESIGN PLAN VIEW, REGIONAL BIORETENTION BASIN, BIOSWALE (CLOCKWISE FROM TOP)**

## 6.1.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period inspection and maintenance (I&M) are critical to the plantings in bioretention facilities and the success of the overall facility. The establishment period typically lasts two full growing seasons after plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the facility is included in **Appendix A**. A **Bioretention Inspection Form** to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

### 6.1.1.1. MONTHLY INSPECTIONS

Monthly inspections are required during the bioretention facility establishment period. The **Bioretention Inspection Form** in **Appendix B** must be used for performing and reporting the monthly inspections at bioretention facilities. Deficiencies noted during the inspections must be remedied during the inspection if possible. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Bioretention Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of basin functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the bioretention facility must first be analyzed, focusing primarily on the vegetation present in the planting area, as well as the general aesthetics of the basin. Basin plants must appear healthy, with few weeds or invasive species present. Vegetative cover may be minimal during the establishment period, but coverage must increase over time, as the plants reach maturity. The system must also be checked for the presence of any trash, debris, or chemical accumulation, in addition to mosquito proliferation, which hinder the aesthetics and functionality of the basin.

Following the system overview, the inlets and overflow structures must be examined for any blockages or obstructions to flow entering or exiting the basin. The pre-treatment area located at each inlet must then be checked for sediment accumulation. Because these rocks are designed to act as a primary filter for larger particles, sediment accumulation must become apparent over time. Therefore, the presence of sediment deposition is an indication of filter effectiveness, although excessive sediment buildup will reduce the effectiveness of the basin at treating stormwater and must therefore be cleaned regularly.

The perimeter of the facility must be inspected for any erosion or undercutting along the basin bottom or side slopes, in addition to verifying slope stability or any changes in grading. Locations of gullying, soil instability, or unvegetated regions along the slopes due to erosion must be identified and remedied.

The functionality of the bioretention media must be examined during each monthly inspection. In accordance with the regularly scheduled maintenance, bioretention facilities with mulch must be maintained to provide an adequate, even mulch cover throughout the entire planting area. The soil moisture must appear average, with

no cracks or prolonged ponding. During storm events, bioretention facilities must fully drain within 40 hours to maintain proper vector (mosquito) control. The soil must also be checked for compaction, which may reduce infiltration rates and eventual ponding concerns. Excessive sediment deposits in the bottom of the basin must be removed regularly to promote the functionality of the basin as a stormwater treatment system.

As-needed maintenance includes maintenance activities not listed in Section 6.1.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

### 6.1.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks during the establishment period typically include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Minor sediment/leaf removal
- Minor erosion repairs
- Mulch replacement
- Plant pruning

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation. Watering must be conducted weekly between May and October during the establishment period.

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of bioretention plants. All plants that are not specified on the permitted planting plan must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proper mulch cover throughout the growing season must be maintained to aid in preventing the growth of weeds. Proactive weeding is especially critical during the establishment period.

Trimming

Because many bioretention facilities are located in public areas such as parks, rights-of way, or neighborhoods, routine trimming of seeded lawn areas surrounding the bioretention facility (where applicable) is necessary to promote the aesthetics of the facility. Regions identified as “no mow” areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the planting bed, forebays, and inlet/outlet floatable traps during each inspection to prevent the clogging of the bioretention media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All bioretention facility media and components must be inspected to ensure stormwater can move through the facility and drain through both the bioretention media and the overflow structures, as intended. Substantial clogging of the facility may result in flooding concerns if water exceeding the basin capacity is unable to exit the site through the storm sewer system. Some basin overflow structures may contain traps used to collect and prevent trash and other floatable objects from entering the storm sewer system. These traps must regularly be emptied to ensure their continued functionality.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the planting areas to prevent the biosoil layer from becoming clogged, which is necessary in maintaining the system's ability to infiltrate and treat stormwater. Rock channels, inlet protection, and other stone structures within the basin must regularly be cleaned of sediment to continue their function of removing suspended solids from surface flow. . Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Minor Soil Compaction Repairs

The surface of the basin must be inspected for indications of settling or compaction of surface materials, which will decrease soil porosity and reduce infiltration rates. If soil compaction or settling is observed, surface materials must be broken up using hand tools to increase void space.

Minor Erosion Repairs

Minor erosion from sheet flow entering and traveling through the basin must be evaluated along the side slopes and bottom of the basin. This can typically be identified as regions of displaced mulch, gullying, or unvegetated areas along the side slopes. In planted regions of the bioretention facility, surface mulch must be placed and raked around all plants, and replenished as needed, to ensure adequate ground coverage. During each inspection, existing soil and mulch must be spread or smoothed along the basin bottom, which will assist in weed control and erosion protection during the establishment period. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine establishment period maintenance does not include the placement of new rock.

Mulch Replacement

In addition to spreading or smoothing existing mulch to ensure proper coverage of the planting area, mulch must be replaced annually to maintain an adequate ground cover over the bioretention media throughout the year. In addition to preventing erosion, a proper mulch cover will assist in weed control.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 6-1** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. Additional maintenance activities may be required based on observations made during monthly inspections. More extensive maintenance activities not listed in **Table 6-1** are considered as-needed maintenance tasks and must be described in detail on the Bioretention Basin Inspection Form.

**Table 6-1 Schedule and Frequency of Establishment Period I&M Activities for Bioretention Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |
| | Mulch Replacement | | Once | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 6.1.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned bioretention facilities must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification. The use of fertilizers, pesticides, and herbicides is prohibited for use in bioretention facilities during the establishment period unless otherwise approved by the City.

#### 6.1.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available to ensure proper collection of data and completion of maintenance tasks. Adherence to all safety procedures during establishment period inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- Trimmer
- Mobile irrigation system
- Leaf blower/vacuum
- Flashlight
- City of Columbus ID badge

#### 6.1.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for performing establishment period inspection and maintenance tasks are included in **Table 6-2**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 6-2 Bioretention Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Bioretention Size | Estimated Annual Labor Hours per Bioretention Facility (Hours/Year) |
|---|---|---|
| Establishment | 0-400 sq. ft. | 38 |
| | 400-2,000 sq. ft. | 60 |
| | >2000 sq. ft. | 84 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 6.1.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality and aesthetics, bioretention systems must be inspected and maintained on a routine basis even after the establishment period ends. This section focuses on the routine I&M activities that must be performed on a recurring basis after the establishment period has ended and for the rest of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of a bioretention facility is included in **Appendix A**. A **Bioretention Facility Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 6.1.2.1. MONTHLY INSPECTIONS

After the establishment period, inspections for bioretention basins must continue to be performed monthly. Monthly inspections are required for the service life of the bioretention facility. The **Bioretention Facility Inspection Form** in **Appendix B** must be used for performing and reporting routine monthly inspections at bioretention basins after the establishment period for the duration of the life of the site. An overview of what to inspect at bioretention basins is provided in Section 6.1.1.1.

Deficiencies noted during the routine monthly inspections must be remedied during the inspection, if possible. Section 0 includes the minimum maintenance tasks that must be performed during routine monthly inspections. Some routine maintenance tasks may only be performed during certain times of the year. Refer to the routine maintenance activity schedule included in Section 0 for guidance on when specific routine maintenance tasks can be performed. As-needed maintenance includes maintenance activities not described in Section 0 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 6.1.3 for additional information about As-Needed Maintenance.

### 6.1.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Weeding
- Trimming
- Trash & debris removal
- Minor sediment/leaf removal
- Minor erosion repairs
- Mulch replacement
- Plant pruning

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of bioretention plants. All plants that are not specified on the permitted planting plan must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.

Trimming

Because many bioretention systems are located in public areas such as parks, rights-of way, or neighborhoods, routine trimming of seeded lawn areas surrounding the bioretention site (where applicable) is necessary to promote the aesthetics of the facility. Regions identified as “no mow” areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the planting bed, forebays, and inlet/outlet floatable traps during each inspection to prevent the clogging of the bioretention media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All bioretention facility media and components must be inspected to ensure stormwater can move through the facility and drain through both the bioretention media and the overflow structures, as intended. Substantial clogging of the facility may result in flooding concerns if water exceeding the basin capacity is unable to exit the site through the storm sewer system. Some basin overflow structures may contain traps used to collect and prevent trash and other floatable objects from entering the storm sewer system. These traps must regularly be emptied to ensure their continued functionality.

Minor Sediment/Leaf Removal

Organic matter, such as leaf debris, must be removed from the planting areas to prevent the biosoil layer from becoming clogged, which is necessary in maintaining the system’s ability to infiltrate and treat stormwater. Rock channels, inlet protection, and other stone structures within the basin must regularly be cleaned of sediment to continue their function of removing suspended solids from surface flow. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Minor Erosion Repairs

Minor erosion from sheet flow entering and traveling through the basin must be evaluated along the side slopes and bottom of the basin. This can typically be identified as regions of displaced mulch, gullying, or unvegetated areas along the side slopes. During each inspection, existing soil and mulch must be spread or smoothed along the basin bottom, which will assist in weed control and erosion protection for the duration of the facility service

life. In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures must be conducted by rearranging the existing stone to ensure complete coverage, as necessary. Routine maintenance does not consist of placing new rock.

Mulch Replacement

In addition to spreading or smoothing existing mulch to ensure proper coverage of the planting area, mulch must be replaced annually to maintain an adequate ground cover over the bioretention media throughout the year. In addition to preventing erosion, a proper mulch cover will assist in weed control.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 6-3** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a bioretention facility, after the establishment period has ended. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 6-3** are considered as-needed maintenance tasks.

**Table 6-3 Schedule and Frequency of Routine I&M Activities for Bioretention Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Month | | | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Minor Sediment/ Leaf Removal | Once/Month | | | | | | | | | | | |
| | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |
| | Mulch Replacement | | Once | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 6.1.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned bioretention facilities must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and

safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment/machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in bioretention facilities. If use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

#### 6.1.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available to ensure proper collection of data and completion of maintenance tasks. Adherence to all safety procedures during routine inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- City of Columbus ID badge
- Leaf blower/vacuum
- Flashlight
- Trimmer

#### 6.1.2.5. ESTIMATED LABOR HOURS

The estimated labor hours for performance of inspection & maintenance tasks are included in **Table 6-4**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 6-4 Bioretention Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Bioretention Size | Estimated Annual Labor Hours per Bioretention Facility (Hours/Year) |
|---|---|---|
| Routine | 0-400 sq. ft. | 30 |
| | 400-2,000 sq. ft. | 52 |
| | >2000 sq. ft. | 76 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 6.1.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

### 6.1.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance includes, but is not limited to:

- Inlet/outlet structure cleaning
- Plant replacement
- Stake repair/replacement
- Watering during drought
- Rock channel replacement
- Media replacement
- Major sediment/leaf removal
- Major trash & debris removal
- Pest/disease/invasive species management
- Soil compaction repair

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the bioretention facility, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Plant Replacement

Following the establishment period, plant survivability must stabilize, and plant replacement must only occur as-needed. Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan, in order to maintain proper planting density and bioretention functionality as a stormwater treatment system. If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements must be made in accordance with the approved modified planting plan. For City-owned SCPs, modifications to the planting plan must be approved by the City of Columbus. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities* and *CMSC 661* for additional details and scheduling requirements.

Stake Repair/Replacement/Removal

Plant stakes broken or damaged during the establishment period must be replaced to ensure the proper growth and establishment of the affected plants. Once plants have become established, stakes must be removed from the facility to prevent girdling or other damage to the plants.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing "Abnormally Dry" or "Moderate Drought" conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Rock Channel Replacement

In locations of continued erosion, additional rock may be required to replace or strengthen the existing erosion control measures. This commonly occurs at locations of high flow velocity, such as the rock channels or rip-rap surrounding the inlet structures. Severe or continued erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as re-grading of the SCP or installation of energy dissipation features.

Media Replacement

Bioretention media must be replaced in locations where the existing soil has been relocated or removed from the basin bottom to ensure the soil remains at the required depth for stormwater treatment. Facilities

experiencing significant clogging of the bioretention media may require complete replacement of the existing soil. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted.

Major Sediment/Leaf Removal

Bioretention facilities that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Stormwater must be able to freely move through the facility and drain through both the bioretention media and overflow structures, as intended. Therefore, it is important to keep all structural components and soil media free of blockages. If water exceeding the basin capacity is unable to exit the site through the storm sewer system, severe clogging of the facility may result in the proliferation of vector (mosquito) habitat, reduced water storage volume, or flooding concerns.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-need basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Pest/Disease/Invasive Species Management

Bioretention facilities must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate potential spreading to nearby plants or basins. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests within a bioretention facility, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. For example, if the as-needed maintenance issue is generating favorable conditions for the pest to inhabit, such as vector (mosquito) populations resulting from the prolonged ponding due to clogged outlet structures, returning the bioretention facility to its properly functioning state may subsequently eliminate the pest. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of bioretention facilities, and strongly discouraged following the initial establishment period. However, if use of pesticide is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

Soil Compaction Repairs

The surface of the basin must be inspected for indications of settling or compaction of surface materials, which will decrease soil porosity and reduce infiltration rates. If soil compaction or settling is observed, surface materials must be broken up using hand tools to increase void space.

**Table 6-5** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 6-5** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 6-5 Schedule and Frequency of As-Needed Maintenance Activities for Bioretention Facilities**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Plant Replacement | | | | | | | | | | | | |
| | Stake Repair/ Replacement | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Media Replacement | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasive Species Management | | | | | | | | | | | | |
| | Soil Compaction Repairs | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Bioretention Fact Sheet** in **Appendix A**.

### 6.1.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

### 6.1.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned bioretention facilities must be approved by the City of Columbus and must be trained and proficient in the requirements and methods detailed in this manual. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment / machinery must possess all applicable certifications and

licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

The use of fertilizers, pesticides and herbicides is strongly discouraged for use in bioretention facilities. If use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 6.1.3.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements but must include the following equipment. Adherence to all safety procedures during as-needed maintenance tasks is required.

#### 6.1.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel, resulting in a higher labor hourly rate for completion of these maintenance tasks.

## 6.2. SAND FILTERS

Stormwater sand filters are usually two-chambered facilities that include a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber. Sand filters improve water quality through effective removal of total suspended solids and effective removal of oil and grease.

Examples:

- Sand filter with underdrain
- Sand filter with subsurface infiltration

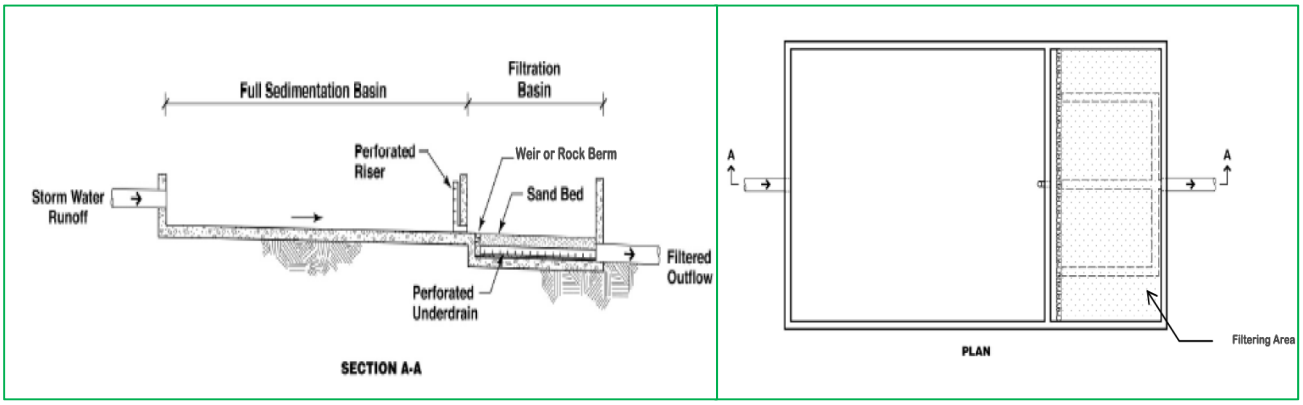


**FIGURE 6-2 SAND FILTER DESIGN SECTION (LEFT) AND PLAN VIEW (RIGHT)**

### 6.2.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, sand filters must be inspected and maintained on a routine basis. Most manufacturers provide sand filters with product-specific warranty periods and maintenance requirements. Refer to the manufacturer's product information for details. This section includes the minimum general I&M requirements to be implemented during the service life of sand filter facility; additional requirements may be necessary in accordance with the manufacturer's specifications. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for sand filter facilities is included in **Appendix A**. A **Sand Filter Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 6.2.1.1. SEMI-ANNUAL INSPECTIONS

Semi-annual inspections are required for the service life of a sand filter facility. The **Sand Filter Inspection Form** in **Appendix B** must be used for performing and reporting semi-annual inspections at sand filter facilities. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance and inspections may also be required; refer to the manufacturer's requirements for additional information. Deficiencies noted during inspections must be remedied during inspection if possible.

The Sand Filter Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the sand filter. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of basin functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the sand filter must first be analyzed, focusing primarily on accumulated sedimentation and debris, as well as the general drainage of the sand filter. The top layer of the sand filter must appear clean with few weeds or invasive species present. The system must also be checked for the presence of any trash, debris, or chemical accumulation.

Following the system overview, the inlets and sedimentation structures must be examined for any blockages, obstructions to flow entering or exiting the basin. If inlets contain pre-treatment units, these must be checked for sediment and trash accumulation. The perimeter of the facility must be inspected for any erosion or signs of overflow and issues must be remedied.

The functionality of the sand filter must be examined during each semi-annual inspection. The sand layer must appear level with no major channelization or signs of short-circuiting the treatment area.

During storm events, approximate sand filter drain times may vary by location, design type and manufacturer. Typically, water must drain through the system within 40 hours. If the drain time is longer than 40 hours, or longer than the maximum design time, corrective action must be taken to filter or replace the sand.

As-needed maintenance includes maintenance activities not described in 6.2.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 6.2.1.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance tasks include:

- Inlet Cleaning
- Minor sediment removal
- Weeding
- Trash & debris removal

Inlet Cleaning

In order to maintain the functionality of the sand filter facility, inlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Weeding

Weeding is necessary in preventing the proliferation of unwanted species which may reduce the filtration capacity of the sand filter. If weeds or plants are observed in the sand filter bed, they must be removed.

Minor Sediment Removal

The sedimentation basin and filtration basin of a sand filter are designed to filter large and fine particles from stormwater. Over time, these particles will begin to buildup and reduce the efficiency of the system. When this occurs, the particles must be removed from the filter area to prevent complete clogging or overflow, which is necessary in maintaining the system's ability to infiltrate and treat stormwater. Sediment removal must be performed after stormwater has drained from the system and the sand is dry.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the sand filter system during each inspection to prevent the clogging of the sand filter and reduction of water storage volume.

**Table 6-6** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a sand filter facility. Additional maintenance activities may be required based on observations made during the required semi-annual inspections. More extensive maintenance activities not listed in **Table 6-6** are considered as-needed maintenance tasks.

**Table 6-6 Schedule and Frequency of Routine I&M Activities for Sand Filter Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Semi-Annually | | | | | | | | | | | |
| | Inlet Cleaning | Semi-Annually | | | | | | | | | | | |
| | Weeding | Semi-Annually | | | | | | | | | | | |
| | Minor Sediment Removal | Semi-Annually | | | | | | | | | | | |
| | Trash & Debris Removal | Semi-Annually | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 6.2.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned sand filters must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 6.2.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- Shovel
- Rake
- Leaf blower/vacuum
- Sieve
- Flashlight
- City of Columbus ID badge

#### 6.2.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection & maintenance tasks are included in **Table 6-7**. Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 6-7 Sand Filter Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Sand Filter (Hours/Year) |
|---|---|
| **Routine** | 6 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 6.2.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 6.2.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/Outlet structure cleaning
- Major sediment/leaf removal
- Media replacement
- Major trash/debris removal

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the sand filters, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility. If the inlet or outlet structure becomes completely clogged or obstructed additional equipment, such as a vacuum truck, may be required to address the issue.

Major Sediment/Leaf Removal

Sand filters that experiencing severe sediment or leaf accumulation may require occasional cleaning and debris removal efforts. Stormwater must be able to freely move through the facility and drain through the sand filter as designed. Therefore, it is important to keep sedimentation basins, sand filter areas, inlets, and drainage pipes free of blockages. If major sedimentation or leaf litter has accumulated (beyond what is capable of being removed using manual hand tools, rakes and shovels) it may be necessary to use specialty equipment such as a vacuum truck. Major sediment and leaf removal must be noted during inspections and conducted on an as-needed basis.

Media Replacement

Sand filters are designed to remove particles and debris from stormwater. Over time the sand may become clogged. When drainage times exceed 40 hours, the sand media in the facility must be removed and replaced with new sand.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

**Table 6-8** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 6-8** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 6-8 Schedule and Frequency of As-Needed Maintenance Activities for Sand Filters**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Major Sediment/ Leaf Removal | | | | | | | | | | | | |
| | Media Replacement | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Sand Filter Fact Sheet** in **Appendix A**.

#### 6.2.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 6.2.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned sand filters must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 6.2.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 6.2.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completing these maintenance tasks.

## 6.3. MANUFACTURED FILTER UNITS

Manufactured filter units are manufactured bioretention facilities that are optimized for high volume/flow and high pollutant removal. By design they have a small footprint which allows them to be used on highly developed areas. One example of a manufactured filter unit is Filterra by Contech which is a bioretention cell in which water flows from the curb into a tree box, pollutants and trash are filtered out, water infiltrates through the roots and is then released into the underlying soil and irrigation systems nearby. Manufactured filter units improve water quality by filtering stormwater to remove both large and small pollutants, providing stormwater collection in highly developed areas, and using stormwater in beneficial ways.

Examples include:

- Filterra by Contech
- Silva Cells by Deep Root

### 6.3.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, filters must be inspected and maintained on a routine basis. Most manufacturers provide filters units with product-specific warranty periods and maintenance requirements. Refer to the manufacturer's product information for details. This section includes the minimum general I&M requirements to be implemented during the service life of the facility; additional requirements may be necessary in accordance with the manufacturer's specifications. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for manufactured filter units is included in **Appendix A**. A **Manufactured Filter Unit Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 6.3.1.1. SEMI-ANNUAL INSPECTIONS

Semi-annual inspections are required for the service life of the manufactured filter unit facility. The **Manufactured Filter Unit Inspection Form** in **Appendix B** must be used for performing and reporting semi-annual inspections at manufactured filter unit facilities. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance and inspections may also be required; refer to the manufacturer's requirements for additional information.

The Manufactured Filter Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of basin functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the manufactured filter unit must first be analyzed, focusing primarily on accumulated sedimentation and debris, as well as the general aesthetics and drainage of the facility. The top layer of media in the manufactured treatment unit must appear clean.

Following the system overview, the inlets and sedimentation structures must be examined for any blockages, obstructions to flow entering or exiting the unit. If inlets contain pre-treatment units, these must be checked for sediment and trash accumulation.

Approximate drain times may vary by location and design type. Typically, water must drain through the system within 48 hours. If the drain time is longer than 48 hours, or longer than the maximum manufacturers design time, troubleshooting must be performed and corrective action must be taken.

Deficiencies noted during inspections must be remedied during inspection if possible. As-needed maintenance includes maintenance activities not described in 6.3.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

### 6.3.1.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance tasks include:

- Inlet Cleaning
- Plant Pruning
- Minor sediment/leaf removal
- Trash & debris removal

Inlet Cleaning

In order to maintain the functionality of the manufactured filter unit facility, inlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Minor Sediment/Leaf Removal

The top layer of mulch or soil must be removed when visible buildup of sediment or leaf litter is observed during routine inspections. This is necessary to maintain the unit's ability to infiltrate and treat stormwater. The top layer must be replaced with fresh material. Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash and debris must be removed from the manufactured filter unit during each inspection.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 6-9** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a manufactured filter unit. Additional maintenance activities may be required based on observations made during the required semi-annual inspections. More extensive maintenance activities not listed in **Table 6-9** are considered as-needed maintenance tasks.

**Table 6-9 Schedule and Frequency of Routine I&M Activities for Manufactured Filter Units**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Semi-Annually | | | | | | | | | | | |
| | Inlet Cleaning | Semi-Annually | | | | | | | | | | | |
| | Minor Sediment/Leaf Removal | Semi-Annually | | | | | | | | | | | |
| | Trash & Debris Removal | Semi-Annually | | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range.*

#### 6.3.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned manufactured filter units must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 6.3.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- Shovel
- Rake
- Leaf blower/vacuum
- Flashlight
- City of Columbus ID badge

#### 6.3.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection & maintenance tasks are included in **Table 6-10.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 6-10 Manufactured Filter Unit Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Manufactured Filter Unit (Hours/Year) |
|---|---|
| **Routine** | 12 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 6.3.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 6.3.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/Outlet structure cleaning
- Major sediment/leaf removal
- Major trash/debris removal

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of the manufactured filter units, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Major Sediment/Leaf Removal

Manufactured filter units that experience severe sediment or leaf accumulation may require occasional cleaning and debris removal efforts. Stormwater must be able to freely move through the facility and drain through the unit as designed. Therefore, it is important to keep pretreatment units, media, inlets, and drainage pipes free of blockages. If major sedimentation or leaf litter has accumulated (beyond what is capable of being removed using manual hand tools, rakes and shovels) it may be necessary to use specialty equipment such as a vacuum truck. Major sediment and leaf removal must be noted during inspections and conducted on an as-needed basis.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

**Table 6-11** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 6-11** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 6-11 Schedule and Frequency of As-Needed Maintenance Activities for Manufactured Filter Units**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Manufactured Filter Unit Fact Sheet** in **Appendix A**.

#### 6.3.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 6.3.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned manufactured filter units must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 6.3.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 6.3.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

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# 7. ROOFTOP CONTROLS

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# 7.1. GREEN ROOFS

Green roofs are facilities used to control runoff volume, improve air and water quality, and promote energy conservation. They typically include layers of drainage material and planting media on a high-quality membrane to minimize leakage. These facilities use foliage and lightweight soil mixtures to absorb, filter, and detain rainfall. Green roofs improve water quality through significant reduction of roof runoff volume, reduction of runoff pollutant loads, reduction of impervious area, and biological uptake through drought tolerant plants.

Examples include:

- Extensive green roof
- Semi-intensive green roof
- Intensive green roof

**FIGURE 7-1 TYPICAL GREEN ROOF INSTALLATION**

## 7.1.1. ESTABLISHMENT PERIOD INSPECTION & MAINTENANCE

Establishment period inspection and maintenance (I&M) are critical to the plantings on a green roof and the success of the overall facility. The establishment period typically lasts two full growing seasons after plants are installed. This section includes I&M requirements to be implemented during the establishment period. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of the facility is included in **Appendix A**. A **Green Roof Inspection Form** to be completed during inspections is included in **Appendix B**. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities, CMSC 659, 661, 662* and individual facility construction project specifications for additional requirements.

### 7.1.1.1. MONTHLY INSPECTIONS

Monthly inspections are required during the green roof establishment period. The **Green Roof Inspection Form** in **Appendix B** must be used for performing and reporting the monthly inspections at green roof facilities. Deficiencies noted during the inspections must be remedied during the inspection if possible. Maintenance tasks must be performed during inspections at the frequency specified in the following sections.

The Green Roof Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Recent rainfall events and current weather must be recorded during each inspection, as the data may serve as indications of facility functionality or maintenance concerns, such as flooding or severe erosion.

The overall condition of the green roof must first be analyzed, focusing primarily on the vegetation present in the planting area, as well as the general aesthetics. Plants must appear healthy, with few weeds or invasive species present. Vegetative cover may be minimal during the establishment period, but coverage must increase over time, as the plants reach maturity. The system must also be checked for the presence of any trash, debris, or chemical accumulation, in addition to mosquito proliferation, which hinder the aesthetics and functionality.

The functionality of a green roof must also be examined during each monthly inspection. Following the system overview, the drainage structures must be examined for any blockages or obstructions to flow entering or exiting the planting media. The media must be inspected for any erosion. Locations of channelization, media washout or unvegetated regions due to erosion must be identified and remedied. The soil moisture must appear average, with no cracks or prolonged ponding.

As-needed maintenance includes maintenance activities not listed in Section 7.1.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. If as-needed maintenance tasks are required, it must be noted in the recommended repairs section of the inspection form. Photographs may be used to further document any as-needed maintenance concerns. Completed inspection forms must be filed and used as a means of tracking conditions for each basin.

#### 7.1.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks to be performed during the establishment period typically include:

- Watering
- Weeding
- Trimming
- Trash & debris removal
- Plant pruning

Watering

During the establishment period, routine watering during the growing season is crucial in promoting the growth and success of the newly planted vegetation. During periods of low rainfall, additional watering must be conducted as needed.

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of green roof plants. All plants that are not specified on the permitted planting plan must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Proactive weeding is especially critical during the establishment period.

Trimming

Some green roofs may include a lawn or grass feature. Routine trimming of seeded lawn areas is necessary to promote the aesthetics of the facility. Regions identified as “no mow” areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the green roof during each inspection to prevent the clogging of the drainage media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All green roof media and components must be inspected to ensure stormwater can move through the facility and drain through both the green roof media and inlet and outlet structures as intended. If trash or debris is inhibiting the proper functionality of any inlets or outlets, it must be removed.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 7-1** below shows the recommended schedule and frequency of establishment period maintenance tasks. This schedule reflects the minimum maintenance requirements for a green roof during the establishment period. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 7-1** are considered as-needed maintenance tasks.

**Table 7-1 Schedule and Frequency of Establishment Period I&M Activities for Green Roof Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Establishment Period | Inspection | Once/Month | | | | | | | | | | | |
| | Watering | | | Once/Week | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 7.1.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned green roofs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. The use of fertilizers, pesticides and herbicides is prohibited for use in green roof facilities during the establishment period.

#### 7.1.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during establishment period inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Fall protection
- Safety cones
- Shovel
- Rake
- Debris/trash containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- Trimmer
- Mobile irrigation system
- City of Columbus ID badge
- Leaf blower/vacuum
- Flashlight
- Ladder

#### 7.1.1.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for establishment period inspection & maintenance tasks are included in **Table 7-2.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 7-2 Green Roof Establishment Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Green Roof (Hours/Year) |
|---|---|
| **Establishment Period** | 30 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the establishment period are not included in the estimate above.*

### 7.1.2. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, green roof facilities must be inspected and maintained on a routine basis even after the establishment period has ended. This section focuses on the routine I&M activities that must be performed on a recurring basis after the establishment period has ended and for the rest of the service life of the facility. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for all phases of a green roof is included in **Appendix A**. A **Green Roof Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 7.1.2.1. MONTHLY INSPECTIONS

Monthly inspections are required for the service life of the green roof. The **Green Roof Inspection Form** in **Appendix B** must be used for performing and reporting monthly inspections at green roof facilities after the establishment period for the duration of the life of the facility. Deficiencies noted during inspections at green roof facilities must be remedied during the inspection if possible

After the establishment period, inspections for green roofs must continue to be performed monthly. Monthly inspections are required for the service life of the green roof. The Green Roof Inspection Form in **Appendix B** must be used for performing and reporting routine monthly inspections at green roofs. An overview of what to inspect at green roof facilities is provided in Section 7.1.1.1.

Deficiencies noted during routine monthly inspections must be remedied during the inspection if possible. Section 7.1.2.2 includes the minimum maintenance tasks that must be performed during routine monthly inspections. Some routine maintenance tasks must only be performed during certain times of the year. Refer to the routine maintenance activity schedule included in Section 7.1.2.2 for guidance on when specific routine maintenance tasks can be performed. As-needed maintenance includes maintenance activities not described in Section 7.1.2.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 7.1.3 for additional information about As-Needed Maintenance for green roofs.

### 7.1.2.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance tasks include:

- Weeding
- Trimming
- Trash & debris removal
- Plant pruning

Weeding

Weeding is necessary in preventing the proliferation of unwanted species, which may choke or hinder the growth of green roof plants. All plants that are not specified on the permitted planting plan must be removed by hand, such that no more than 5% weed coverage is present at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species. Where mulch is present at the facility, proper mulch cover throughout the growing season must be maintained to aid in preventing the growth of weeds.

Trimming

Some green roofs may include a lawn or grass feature. Routine trimming of seeded lawn areas is necessary to promote the aesthetics of the facility. Regions identified as “no mow” areas must remain undisturbed and must not be trimmed. A brush trimmer should be used to cut down brush and shrubs to a manageable height once annually between March and April.

Trash & Debris Removal

In addition to improving the aesthetics of the system, routine trash and debris removal must be conducted to maintain the functionality of the system. Any visible trash, sediment, and debris must be removed from the green roof during each inspection to prevent the clogging of the drainage media, reduction of water storage volume, and to eliminate potential habitats for vector (mosquito) larvae.

All green roof media and components must be inspected to ensure stormwater can move through the facility and drain through both the green roof media and inlet and outlet structures as intended. If trash or debris is inhibiting the proper functionality of any inlets or outlets, it must be removed.

Plant Pruning

If shrubs, perennials or trees are planted in the SCP, pruning must be performed in order to improve or maintain the health and aesthetics of the vegetative system. Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Table 7-3** below shows the recommended schedule and frequency of routine maintenance tasks. This schedule reflects the minimum maintenance requirements for a green roof after the establishment period during the service life of the facility. Additional maintenance activities may be required based on observations made during the required monthly inspections. More extensive maintenance activities not listed in **Table 7-3** are considered as-needed maintenance tasks.

**Table 7-3 Schedule and Frequency of Routine I&M Activities for Green Roof Facilities**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Month | | | | | | | | | | | |
| | Weeding | | | Once/Month | | | | | | | | | |
| | Trimming | | | Once/Week | | | | | | | | | |
| | Trash & Debris Removal | Once/Month | | | | | | | | | | | |
| | Plant Pruning | | | Once | | | | | | | Once | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 7.1.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned green roofs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use on green roof facilities. If use is required (i.e. all other options have been expanded to address an issue) approval must be obtained from the City of Columbus and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 7.1.2.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspection & maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Fall protection
- Safety cones
- Shovel
- Rake
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- Pruning shears
- City of Columbus ID badge
- Trimmers
- Flashlight
- Leaf blower/vacuum
- Ladder

#### 7.1.2.5. ESTIMATED LABOR HOURS

The estimated annual labor hours for routine inspection & maintenance tasks are included in **Table 7-4.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 7-4 Green Roof Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Green Roof (Hours/Year) |
|---|---|
| **Routine** | 34 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 7.1.3. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Establishment Period and Routine I&M Sections of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created.

#### 7.1.3.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance includes, but is not limited to:

- Inlet/outlet structure cleaning
- Plant replacement
- Stake repair/replacement
- Watering during drought
- Rock channel replacement
- Pest/disease/invasive species management
- Media replacement
- Major sediment/leaf removal
- Major trash & debris removal
- Soil compaction repair

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of green roof facilities, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the facility.

Plant Replacement

Following the establishment period, plant survivability must stabilize, and plant replacement must only occur as-needed. Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan, in order to maintain proper planting density and green roof functionality as a stormwater treatment system. If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements must be made in accordance with the approved modified planting plan. For City-owned SCPs, modifications to the planting plan must be approved by the City of Columbus. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted. Refer to the *City of Columbus Supplemental Specification SS 1609 Green Infrastructure Establishment Activities* and *CMSC 661* for additional details and scheduling requirements.

Stake Repair/Replacement/Removal

Plant stakes broken or damaged during the establishment period must be replaced to ensure the proper growth and establishment of the affected plants. Once plants have become established, stakes must be removed from the facility to prevent girdling or other damage to the plants.

Watering During Drought

Mature plants will not require scheduled watering after the initial establishment period. However, watering may be required during extreme drought conditions to ensure the survival of the vegetation within the facility. Soil cracking and plant distress are indicative of drought. If Franklin County is experiencing "Abnormally Dry" or "Moderate Drought" conditions as indicated by the United States Drought Monitor (http://droughtmonitor.unl.edu/) consult with the City of Columbus to determine if watering must be performed at City-owned SCPs.

Media Replacement

Bioretention media must be replaced in locations where the existing soil has been relocated or removed from the planting area to ensure the soil remains at the required depth for stormwater treatment. Facilities experiencing significant clogging of the planting media may require complete replacement of the existing soil. If extensive plant replacement is required in conjunction with the media replacement, establishment period maintenance must be conducted.

Major Sediment/Leaf Removal

Facilities that are experiencing severe sediment or leaf accumulation may require cleaning and debris removal efforts beyond what is regularly required. Stormwater must be able to freely move through the facility and drain through both the planting media, outlet structures and any overflow structures, as intended. Therefore, it is important to keep all structural components and soil media free of blockages.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility (e.g. illegal dumping, large downed tree branches) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Pest/Disease/Invasive Species Management

Green roofs must be closely monitored for the onset of pests, disease, or invasive species, which must be promptly addressed in order to mitigate potential spreading to nearby plants or basins. Invasive plant species must be removed entirely, including all roots and root fragments, before the plants set seed. These practices will aid in reducing further spread or establishment of the unwanted species. When managing the proliferation of pests within a green roof facility, it is important to first identify the underlying cause of the issue. In some instances, completion of as-needed maintenance tasks may resolve the pest issue without having to take additional measures. For example, if the as-needed maintenance issue is generating favorable conditions for the pest to inhabit, such as vector (mosquito) populations resulting from prolonged ponding due to clogged outlet structures, returning the green roof to its properly functioning state may subsequently eliminate the pest. The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of green roofs, and strongly discouraged following the initial establishment period. However, if use is required at City-owned facilities (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

Soil Compaction Repairs

The surface media of the green roof must be inspected for indications of settling or compaction of surface materials, which will decrease soil porosity and reduce infiltration rates. If soil compaction or settling is observed, surface materials must be broken up using hand tools to increase void space.

**Table 7-5** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing media at all top priority facilities). The shaded areas in **Table 7-5** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

**Table 7-5 Schedule and Frequency of As-Needed Maintenance Activities for Green Roofs**

| Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Plant Replacement | | | | | | | | | | | | |
| | Stake Repair/ Replacement | | | | | | | | | | | | |
| | Watering During Drought | | | | | | | | | | | | |
| | Rock Channel Replacement | | | | | | | | | | | | |
| | Media Replacement | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Pest/Disease/Invasive Species Management | | | | | | | | | | | | |
| | Soil Compaction Repairs | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

Additional details on the as-needed maintenance are included in the **Green Roof Fact Sheet** in **Appendix A.**

### 7.1.3.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

### 7.1.3.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned green roofs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications

and licenses. Entrance to underground stormwater facilities requires confined space permits and personnel certification.

The use of fertilizers, pesticides, and herbicides is strongly discouraged for use in green roof facilities. If use is required (i.e. all other options have been expanded to address an issue) approval must be obtained from the City of Columbus and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products must be approved for aquatic use.

#### 7.1.3.4. EQUIPMENT/SAFETY

As-needed maintenance labor hours will vary greatly in equipment and safety requirements.

#### 7.1.3.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in higher hourly labor rates for personnel performing these maintenance tasks.

## 7.2. RAINWATER HARVESTING SYSTEMS

Rainwater harvesting systems use cisterns or other reservoirs to capture and store stormwater for subsequent use and thereby reduce stormwater runoff from an area. If approved by the local regulatory authority, rainwater harvesting systems have been used to provide water for toilet flushing, landscape irrigation, urban garden irrigation, vehicle washing, cleaning buildings or sidewalks, street sweepers, fire suppression (sprinkler) systems, or replenishing decorative water features. Cisterns improve stormwater management by reducing stormwater runoff volume and using the stormwater in beneficial ways.

Examples include:

- Above-ground cisterns
- Underground cisterns

**FIGURE 7-2 TYPICAL ABOVE-GROUND RAINWATER HARVESTING CISTERNS**

### 7.2.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, rain harvesting systems must be inspected and maintained on a routine basis. Most manufacturers provide system equipment with product-specific warranty periods and maintenance requirements. Refer to the Manufacturers product information for details. This section includes the minimum general I&M requirements to be implemented during the service life of the system; additional requirements may be necessary in accordance with the manufacturer's specifications. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for rainwater harvesting systems is included in **Appendix A**. A **Rainwater Harvesting System Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 7.2.1.1. QUARTERLY INSPECTIONS

Quarterly inspections are required for the service life of a rain harvesting cistern. The **Rain Harvesting System Inspection Form** in **Appendix B** must be used for performing and reporting quarterly inspections at rain harvesting cistern sites. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance and inspections may also be required; refer to the manufacturer's requirements for additional information.

The Rainwater Harvesting System Inspection Form must be used as a guideline for evaluating the continued functionality and aesthetics of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Deficiencies noted during inspections must be remedied during inspection if possible. As-needed maintenance includes maintenance activities not described in Section 7.2.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 7.2.2 for additional information about As-Needed Maintenance.

### 7.2.1.2. MAINTENANCE TASKS & SCHEDULE

Routine maintenance includes:

- Exercise Valves
- Filter cleaning/replacement

Exercise Valves

During routine inspections, any equipment or tank valves included in the cistern design must be exercised to ensure they are operable and functioning.

Filter Cleaning/Replacement

Some rainwater harvesting systems include a filter as part of the design that functions to pretreat stormwater runoff prior to entering the system. Where filters are present, they must be inspected during routine inspections. Typically, the filter can be cleaned and replaced, but heavily soiled filters may need to be replaced.

**Table 7-6** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a rainwater harvesting system. Additional maintenance activities may be required based on observations made during the required quarterly inspections. More extensive maintenance activities not listed in **Table 7-6** are considered as-needed maintenance tasks.

**Table 7-6 Schedule and Frequency of Routine I&M Activities for Rainwater Harvesting Cisterns**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection | Once/Quarter | | | | | | | | | | | |
| | Exercise Valves | Once/Quarter | | | | | | | | | | | |
| | Filter Cleaning/Replacement | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

#### 7.2.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned rainwater harvesting systems must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 7.2.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Fall protection
- Ladder
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Shovel
- Flashlight
- Water for cleaning filters

#### 7.2.1.5. ESTIMATED LABOR HOURS

The estimated labor hours for routine inspection & maintenance tasks are included in **Table 7-7.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 7-7 Rainwater Harvesting System Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Rain Harvesting Cistern (Hours/Year) |
|---|---|
| **Routine** | 8 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 7.2.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for aesthetics and proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Some examples of as-needed maintenance tasks for rainwater harvesting cisterns are described below. Work orders will be generated for as-needed maintenance which will describe the specific tasks to be performed. Maintenance crews are responsible for completing maintenance records to document the as-needed maintenance.

#### 7.2.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Inlet/Outlet structure cleaning
- Major sediment/leaf removal
- Major trash/debris removal

Inlet/Outlet Structure Cleaning

In order to maintain the functionality of rainwater harvesting systems, inlet and outlet structures must occasionally be cleaned of large trash and debris. Blockages must be identified and removed before flow is severely obstructed from entering or exiting the cistern.

Major Sediment/Leaf Removal

Rainwater harvesting systems that experience severe sediment or leaf accumulation may require occasional cleaning and debris removal efforts. Stormwater must be able to freely move through the facility and drain through cistern overflow outlet and overflow structures, as intended. Therefore, it is important to keep all structural components, tank components and pipes free of blockages. If water exceeding the tank capacity is unable to exit through the storm sewer system proliferation of vector (mosquito) habitat or flooding may occur.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

**Table 7-8** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. Alternatively, scheduling may also be streamlined by performing similar tasks across multiple facilities (i.e. one crew replacing mulch at all top priority facilities). The shaded areas in **Table 7-8** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

Additional details on the as-needed maintenance are included in the **Rainwater Harvesting System Fact Sheet** in **Appendix A**.

**Table 7-8 Schedule and Frequency of As-Needed Maintenance Activities for Rainwater Harvesting Systems**

| Maintenance Tasks | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Inlet/Outlet Structure Cleaning | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

#### 7.2.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. . Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 7.2.2.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned rain harvesting systems must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 7.2.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 7.2.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

## 7.3. BLUE ROOFS

Blue Roofs are a rooftop system designed to provide stormwater detention by temporarily storing runoff above a roof waterproofing membrane. Precipitation that falls onto the roof is managed using outlet control devices, such as roof drains or scuppers, with orifices, weirs, or other types of outlet control features designed to regulate the discharge rate of runoff flowing off of the roof over a period of time. A blue roof is an effective stormwater control practices on sites where the roof covers 90% or more of the site (City of Columbus Stormwater Drainage Manual Section 3.4.5) and the roof is flat or nearly flat (less than 2% slope). Using a blue roof provides stormwater management by reducing peak flow rates. All blue roof applications will have a membrane lining, but may also include trays or partitions.

**FIGURE 7-3 BLUE ROOF SYSTEM UTILIZING CHECK DAMS TO RETAIN STORM WATER SOURCE: GEOSYNTHETIC CONSULTANTS**

### 7.3.1. ROUTINE INSPECTION & MAINTENANCE

To maintain proper functionality, a blue roof must be inspected and maintained on a routine basis. A blue roof should be inspected quarterly for the service life of the blue roof. The blue roof shall not pond water for more than 72 hours after a significant rain event in order to provide sufficient storage for the next rain event. A blue roof located in areas with significant tree cover or in areas prone to airborne debris, may be subject to more frequent inspections due to the potential for maintenance needs. This section includes the minimum general I&M requirements to be implemented during the service life of the system; additional requirements may be necessary in accordance with any membrane leak detection system and in accordance with the manufacturer's specifications. A fact sheet with additional details on inspection and maintenance requirements, tasks and schedules for a blue roof is included in **Appendix A**. A **Blue Roof Inspection Form** must be completed during inspections and is included in **Appendix B**.

#### 7.3.1.1. QUARTERLY INSPECTIONS

Quarterly inspections are required for the service life of a blue roof. The **Blue Roof Inspection Form** in **Appendix B** must be used for performing and reporting quarterly inspections at blue roof sites. Maintenance tasks must be performed during inspections at the frequency specified in the following sections. Additional maintenance

and inspections may also be required; refer to the manufacturer's requirements for rooftop membranes for additional information.

The Blue Roof Inspection Form is a guideline for evaluating the continued functionality of the facility. The inspection form provides a checklist of the key assessment metrics that must be reviewed during each inspection. The form is based on a rating scale of 1-5 with 1 indicating poor conditions, and 5 indicating ideal conditions. In addition to the quantification of each assessment metric, the form also provides a space for comments and recommended as-needed maintenance.

Deficiencies noted during inspections must be remedied during inspection if possible. As-needed maintenance includes maintenance activities not described in Section 7.3.1.2 that require additional resources to address (e.g. trained personnel, specialty equipment, etc.). If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Refer to Section 7.3.2 for additional information about As-Needed Maintenance.

### 7.3.1.2. MAINTENANCE TASKS & SCHEDULE

Maintenance tasks to be performed typically include:

- Inspection of Waterproof Membrane
- Inspection of Outflow Control Device
- Inspection of Outlet Pipe/Downspout
- Inspection of Structural Components
- Inspection of Scupper/Roof Drains

Inspection of Waterproof Membrane

Routine inspection of the suitable waterproofing membrane is crucial to the structural integrity of the building below. During the inspection of the waterproof membrane, all structural components shall be inspected for cracking, spalling and deterioration. Physical leak detection systems are to be inspected per the manufacturer's specifications.

Inspection of Outflow Control Device

A blue roof includes an outflow control device which regulates the duration and amount of water ponded on the roof. The outflow control device shall be inspected thoroughly to ensure the removal of any sediment and debris that may impede the flow of stormwater. The outflow control device will be protected with strainers to help collect debris. Any debris shall be removed during each inspection.

Inspection of Structural Components

Any mechanical or building infrastructure that is located above the waterproof membrane shall be inspected for leaks or spills that could contaminate the stormwater. Any damage to the waterproof membrane caused by the equipment shall be documented and remediated.

Inspection of Scupper/Roof Drains

A blue roof incorporates secondary outlets that function as emergency release valves to the outflow control device. These secondary outlets are typically either roof drains or scuppers and are required to be able to safely pass the entire post-developed 100-year storm event, in the occurrence that the outflow control device is blocked. Per the City of Columbus Stormwater Drainage Manual, roof drains associated with a blue roof system are required to have a strainer installed to prevent the drainpipes from becoming clogged. Inspect the strainer, scupper pipe, and roof drainpipe for any obstructions and remove them.

Inspection of Outlet Pipe/Downspouts

Routine inspection of the outlet pipe and downspouts shall be conducted to ensure there are no blockages in the system. Any clogs in the system or damage to the system shall be noted and repaired. System layouts may vary but if a downspout clean out is available, that shall be used to clear any debris through the entire system from the Outflow Control Device to the Stormwater Outfall or downstream Water Quality Treatment SCP.

**Table 7-9** below shows the recommended schedule and frequency of routine inspection and maintenance tasks. This schedule reflects the minimum maintenance requirements throughout the service life of a blue roof system. Additional maintenance activities may be required based on observations made during the required quarterly inspections. More extensive maintenance activities not listed in **Table 7-9** are considered as-needed maintenance tasks.

**Table 7-9 Schedule and Frequency of Routine I&M Activities for Blue Roofs**

| Inspection & Maintenance Type | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| Routine | Inspection of Waterproof Membrane | Once/Quarter | | | | | | | | | | | |
| | Inspection of Outflow Control Device | Once/Quarter | | | | | | | | | | | |
| | Inspection of Structural Components | Once/Quarter | | | | | | | | | | | |
| | Inspection of Scuppers/Roof Drains | Once/Quarter | | | | | | | | | | | |
| | Outlet Pipes/Downspouts | Once/Quarter | | | | | | | | | | | |

*Note: Suggested schedule includes months when maintenance tasks can be performed shown in green with the frequency indicated within the schedule range*

### 7.3.1.3. PERSONNEL REQUIREMENTS

Personnel performing work on City-owned blue roofs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses.

### 7.3.1.4. EQUIPMENT/SAFETY

The following equipment must be readily available and safety procedures must be followed during routine inspections and maintenance tasks. Adherence to all safety procedures during inspection and maintenance tasks is required.

- Proper PPE
- Safety cones
- Fall protection
- Debris/trash waste containers
- Compostable waste containers
- Recyclable material containers
- Wheelbarrow
- City of Columbus ID Badge
- Shovel
- Flashlight
- Broom

#### 7.3.1.5. ESTIMATED LABOR HOURS

The estimated labor hours for routine inspection & maintenance tasks are included in **Table 7-10.** Estimates are based on a two-person crew performing inspection and maintenance activities.

**Table 7-10 Blue Roof Routine Inspection & Maintenance Period Annual Labor Hours**

| Inspection & Maintenance Type | Estimated Annual Labor Hours per Rain Harvesting Cistern (Hours/Year) |
|---|---|
| **Routine** | 8 |

*Note: Estimates based on two-person crew performing maintenance and inspection tasks. Hours for as-needed maintenance required during the routine I&M period are not included in the estimate above.*

### 7.3.2. AS-NEEDED MAINTENANCE

During each inspection, the facility must be inspected for proper functionality. As-needed maintenance may be required when deficiencies are observed that require maintenance beyond the listed scope of tasks in the Routine I&M Section of this manual or where a follow-up work order is necessary. As-needed maintenance tasks must be evaluated and identified during each inspection. If as-needed maintenance tasks are required, it should be noted in the comment section of the inspection form; provide enough detail for a follow-up work order to be created. Some examples of as-needed maintenance tasks for blue roof systems are described below. Work orders will be generated for as-needed maintenance which will describe the specific tasks to be performed. Maintenance crews are responsible for completing maintenance records to document the as-needed maintenance.

#### 7.3.2.1. MAINTENANCE TASKS & SCHEDULE

As-needed maintenance tasks include, but are not limited to, the following:

- Outflow Control Device Repair/Replacement
- Scupper/Downspout Strainers Repair/Replacement
- Addressing Mechanical Infrastructure Leaks/Spills
- Major Trash/Debris Removal
- Waterproof Membrane Repair/Replacement

<u>Outflow Control Device Repair/Replacement</u>

In order to maintain the functionality of the blue roof, the outflow control device must remain structurally intact. If the strainer or outlet control device is damaged, it shall be repaired or replaced. During winter months, any ice formed around the outflow control device shall be broken up and moved away from the outflow control device to help minimize damage.

Scupper/Downspout Strainers Repair/Replacement

In order to maintain the functionality of blue roof, the scuppers and downspouts must remain structurally intact. If the strainer, scupper, or downspout is damaged, it shall be repaired or replaced.

Addressing Mechanical Infrastructure Leaks/Spills

Blue roofs that have any mechanical equipment located on the blue roof system shall be inspected for any leaks or spills. If spills or leaks have the potential to contaminate stormwater shall be documented and contained. In cases where trained technicians are needed, contain the spill and monitor the discharge until such time the repair can be made.

Major Trash & Debris Removal

In addition to regular function of the facility, removal of excessive debris accumulations must be conducted on an as-needed basis to improve the overall aesthetics of the facility. When major trash and debris are present at the facility) these items must be removed, and sorted for proper disposal (e.g. compost, recycling, waste).

Waterproof Membrane Repair/Replacement

In order to maintain the functionality of the blue roof, if a damaged or deteriorating waterproof membrane system is observed, it will need repaired or in some cases replaced. This would include tears, rips, cracking, and spalling. Refer to the waterproof membrane manufacturers guidelines. Physical leak detection systems are to be inspected per the manufacturer's specifications.

**Table 7-11** below shows a recommended schedule for when as-needed maintenance tasks must be completed. This schedule must be used as guidance on the time of year when it would be most beneficial to perform as-needed maintenance tasks. The schedule is not meant to be a comprehensive schedule for all possible activities. The City will schedule as-needed maintenance tasks based on field observations recorded on inspection forms, time of year, and priority for addressing the issue(s). When possible, multiple tasks must be consolidated into one work order per facility. The shaded areas in **Table 7-11** provide guidance on when as-needed maintenance activities can be performed throughout the year. Inspections will dictate the need and frequency of performing as-needed maintenance.

Additional details on the as-needed maintenance are included in the **Blue Roof Fact Sheet** in **Appendix A**.

**Table 7-11 Schedule and Frequency of As-Needed Maintenance Activities for Blue Roofs Systems**

| Maintenance Tasks | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | January | February | March | April | May | June | July | August | September | October | November | December |
| As-Needed | Outflow Control Device Cleaning | | | | | | | | | | | | |
| | Scupper/Downspout Cleaning | | | | | | | | | | | | |
| | Major Sediment/Leaf Removal | | | | | | | | | | | | |
| | Major Trash & Debris Removal | | | | | | | | | | | | |
| | Waterproof Membrane Repair/Replacement | | | | | | | | | | | | |

*Note: Inspections will dictate whether the as-needed maintenance tasks listed above are required to be performed. Inspections will dictate the frequency these tasks must be performed. The schedule above provides guidance on scheduling these specific tasks throughout the year.*

#### 7.3.2.2. MAINTENANCE RECORD

Maintenance records must be used for recording as-needed maintenance tasks. A work order will be created describing the tasks to be completed and the maintenance record will serve as verification of the actual work completed. Maintenance records are required for all as-needed maintenance identified during routine inspections. The maintenance record will include specific tasks completed based on the work order, quantities of materials utilized, and personnel responsible for completing the tasks. The maintenance record will be submitted to verify that all tasks included in the work order have been addressed. Each maintenance record will be unique based on the required task to be completed.

#### 7.3.2.3. PERSONNEL REQUIREMENTS

Personnel performing maintenance activities on City-owned blue roofs must be approved by the City of Columbus. Personnel shall follow all applicable requirements, procedures, policies, and practices set forth in the City of Columbus health and safety documents, SOPs and plans. Personnel shall wear personal protective equipment (PPE) as described in this manual. Personnel operating any equipment and/or machinery must possess all applicable certifications and licenses. Entrance to underground stormwater facilities requires confined space entry permits and personnel certification.

#### 7.3.2.4. EQUIPMENT/SAFETY

As-needed maintenance will vary greatly in equipment and safety requirements.

#### 7.3.2.5. ESTIMATED LABOR HOURS

As-needed maintenance labor hours will vary greatly depending on the severity, extent, and required equipment to perform tasks. It is anticipated that a portion of this work will require specialized training, licenses, or certification of personnel resulting in a higher hourly labor rate for completion of these maintenance tasks.

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# 8. APPENDICES

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# 8.1. APPENDIX A: FACILITY FACT SHEETS

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## 8.1.1. DRY DETENTION BASIN FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and quarterly inspections are required for the service life of all dry detention basins. During each visit and inspection, the following tasks should be performed in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Watering**

- Watering should be conducted on a routine basis during the establishment period. Watering may also be required on an as-needed basis during the service life of the facility during times of drought, but consult with the City of Columbus to determine if water conservation efforts are in effect during drought.

**Weeding**

- All plants that are not specified on the permitted planting plan should be removed entirely, including all roots and root fragments, by hand, before plants set seed.
- No more than 5% weed coverage of any facility is permitted at any time. Proactive weeding is especially critical during the establishment period.

**Trimming**

- For dry detention basin sites with seeded lawn areas, these should be regularly trimmed during the growing season
- Locations with significant vegetative growth outside of the dry detention basin and adjacent to the sites may require specific trimming if the locations are not able to be mowed.
- Regions identified as “no mow” areas should remain undisturbed and should not be mowed or trimmed.
- A brush trimmer should be used to cut down brush and shrubs once annually between March and April.

**Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the dry detention basin during every site visit and inspection.
- All SCP media and components should be inspected to ensure stormwater can move through the facility as designed.
- Any visible trash, sediment, and debris should be removed from all dry detention facility components to prevent clogging or obstructions to stormwater flowing through the system.
- Basin overflow structures containing traps used to collect trash or other floatable objects should be emptied regularly.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed.

**Minor Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the planting areas, rock channels, inlet protection, and basin structures.
- Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Reseed Exposed Soil**

- Exposed soil should be re-seeded in accordance with the most recent version of the *City of Columbus Construction and Material Specifications (CMSC) 659 Seeding and Mulching* such that no less than 70% grass coverage of any dry detention basin is permitted at any time.

**Minor Erosion Repairs**

- The surface of the dry detention basin should be inspected for indications of settling or compaction of surface materials. If settling or minor compaction has occurred, surface material should be broken up using hand tools to increase void space and promote infiltration, if applicable.
- Minor repairs to rock channels, inlet rip-rap, and other stone should be conducted during each site inspection. This would include adjustments of existing stone but not the addition of more stone
- The SCP should be inspected for erosion or gullying along the inlet and outlet flow path, including all side slopes or graded channels within the basin. Significant erosion or settling may require regrading of the dry detention basin or replacement of some surface materials over time. Continued erosion within or directly adjacent to the basin may warrant the installation of more permanent erosion control or slope stability measures.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the facility. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Slope Slippage Repair**

- Dry detention facilities should be repaired when major signs of erosion, soil instability or slope slippages are observed along the basin slope. The slope should be repaired to the original design slope or a more gradual slope ratio.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the dry detention basin.

**Schedule and Frequency of I&M Activities for Dry Detention Basins**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month or Once/Quarter | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week or As Needed | | | | | | | | | |
| X | X | | Weeding | | | Once/Month or Once/Quarter | | | | | | | | | |
| X | X | | Trimming | | | Once/ 2 Weeks | | | | | | | | | |
| X | X | X | Trash & Debris Removal | Once/Month or Once/Quarter or As Needed | | | | | | | | | | | |
| X | X | X | Minor Sediment/Leaf Removal | Once/Month or Once/Quarter or As Needed | | | | | | | | | | | |
| X | X | | Reseed Exposed Soil | Once/Month or Once/Quarter | | | | | | | | | | | |
| X | X | | Minor Erosion Repairs | Once/Month or Once/Quarter | | | | | | | | | | | |
| | | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |
| | | X | Slope Slippage Repair | | | | | As Needed | | | | | | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |

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## 8.1.2. WET DETENTION BASIN FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and quarterly inspections are required for the service life of all wet detention basins. During each visit and inspection, the following tasks should be performed in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Watering**

- Watering should be conducted on a routine basis during the establishment period. Watering may also be required on an as-needed basis during the service life of the facility during times of drought, but consult with the City of Columbus to determine if water conservation efforts are in effect during drought.

**Weeding**

- All plants that are not specified on the permitted planting plan should be removed entirely, including all roots and root fragments, by hand, before plants set seed.
- No more than 5% weed coverage of any facility is permitted at any time. Proactive weeding is especially critical during the establishment period.

**Trimming**

- For wet detention basin sites with seeded lawn areas, these should be regularly trimmed during the growing season.
- Locations with significant vegetative growth outside of the wet detention basin and adjacent to the sites may require specific trimming if the locations are not able to be mowed.
- Regions identified as “no mow” areas should remain undisturbed and should not be mowed or trimmed.
- A brush trimmer should be used to cut down brush and shrubs once annually between March and April.

**Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the wet detention basin during every site visit and inspection.
- Any visible trash, sediment, and debris should be removed from the system to allow proper entrance of stormwater into the facility and to avoid clogging of media or SCP components.
- SCP media should be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers as intended. Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.
- Basin overflow structures containing traps used to collect trash or other floatable objects should be emptied regularly.

- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed.

**Minor Erosion Repairs**

- Minor repairs to rock channels, inlet rip-rap, and other stone should be conducted during each site inspection. This would include adjustments of existing stone but not the addition of more stone.
- The wet detention basin should be inspected for erosion or gullying along the inlet and outlet flow path, including all side slopes or graded channels within the basin. Significant erosion or settling may require regrading of the wet detention basin or replacement of some surface materials over time. Continued erosion within or directly adjacent to the basin may warrant the installation of more permanent erosion control or slope stability measures.

**Minor Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the planting areas, rock channels, inlet protection, sediment forebay, and basin structures.
- Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Plant Replacement**

- Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan. If derivations must be made at City-owned SCPs, a formal request detailing why must be submitted to the City for approval.
- If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements should be in accordance with the approved modified planting plan.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the wet detention basin. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Slope Slippage Repair**

- Wet detention facilities should be repaired when major signs of erosion, soil instability or slope slippages are observed along the basin slope. The slope should be repaired to the original design slope or a more gradual slope ratio.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the wet detention basin.

**Schedule and Frequency of I&M Activities for Wet Detention Basins Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month or Once/Quarter | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week or As Needed | | | | | | | | | |
| X | X | | Weeding | | | Once/Month or Once/Quarter | | | | | | | | | |
| X | X | | Trimming | | | Once/2 Weeks | | | | | | | | | |
| X | X | X | Trash & Debris Removal | Once/Month or Once/Quarter or As Needed | | | | | | | | | | | |
| X | X | | Minor Erosion Repairs | Once/Month or Once/Quarter | | | | | | | | | | | |
| X | X | X | Minor Sediment/Leaf Removal | Once/Month or Once/Quarter or As Needed | | | | | | | | | | | |
| | | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |
| | | X | Plant Replacement | | | As Needed | | | | | | As Needed | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |
| | | X | Slope Slippage Repair | | | | | As Needed | | | | | | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |

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## 8.1.3. CONSTRUCTED WETLAND FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and for the service life of all constructed wetlands. During each visit and inspection, the following tasks should be performed or evaluated based on the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions to stormwater flow through the system.

**Watering**

- Watering should be conducted on a routine basis during the establishment period. Watering may also be required on an as-needed basis during the service life of the facility during times of drought, but consult with the City of Columbus to determine if water conservation efforts are in effect during drought.

**Weeding**

- Invasive species or non-native weeds should be removed entirely including all roots and root fragments, before plants set seed, such that no more than 5% weed coverage is present at any time. Proactive weeding is especially critical during the establishment period.

**Trimming**

- Routine trimming should be conducted along all access paths, drives, and lawn areas surrounding the constructed wetland to ensure maintenance accessibility. Regions identified as “no mow” areas should remain undisturbed.
- A brush trimmer should be used to cut down brush and shrubs once annually between March and April.

**Harvesting**

- Harvesting should be conducted as needed to prevent the facility from becoming significantly overgrown with vegetation. It is anticipated that the wetland will maintain close to a 50% open water surface area.

**Plant Pruning**

- All shrubs and trees within and adjacent to the constructed wetland should be pruned routinely.
- Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Plant Replacement**

- An established wetland should maintain a minimum vegetative cover of 50%. Regions of significant plant mortality should be replanted with native vegetation, in accordance with the establishment criteria of the facility.
- Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan. If derivations must be made at City-owned SCPs, a formal request detailing why must be submitted to the City for approval.

- If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements should be in accordance with the approved modified planting plan.

**Stake Repair/Replacement**

- Plant stakes broken or damaged during the establishment period must be replaced. Following the establishment period, mature plants will no longer require stakes.

**Embankment/Nuisance Wildlife Repairs**

- Animal burrows along the surrounding embankment of the wetland should be addressed with appropriate animal control measures or an approved alternative to mitigate potential bank instability, damage to the existing grading, or destruction of wetland vegetation.
- Unvegetated regions along the embankment of the wetland resulting from erosion may require plant replacements to stabilize the existing soil. Any leaks or cracks in the berms should be plugged or sealed immediately.
- In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures should be conducted by rearranging the existing stone to ensure complete coverage. Routine maintenance does not include placing additional rock.

**Media Replacement**

- Media replacement is only applicable to subsurface wetlands and should not be conducted for surface flow facilities.
- Soil media should be replaced in locations where significant volumes of existing soil have been relocated or removed from the wetland by stormwater flows.
- Facilities experiencing significant clogging of the media may require complete replacement of the existing soil. Extensive plant replacements resulting from the media replacement will require establishment period maintenance.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the wetland.

**Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the forebay, rock channels, inlet protection, and wetland structures.
- Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.
- Dredging of the ponding area and forebay areas will periodically be required to mitigate excessive sediment accumulations.

**Trash & Debris Removal**

- All SCP media and components should be inspected to ensure stormwater can move through the facility and drain through all inlets, outlets, spillways, outfalls, and risers, as intended.
- Any visible trash, sediment, and debris should be removed from all components of the facility to prevent clogging.
- Wetland overflow structures containing traps used to collect trash or other floatable objects should be emptied regularly.

- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Structural Repair**

- Any broken or damaged structural component must be repaired or replaced, as needed. Structural components include but are not limited to inlet and outlet structures, pipes, spillways, outfalls, and risers.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the facility. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

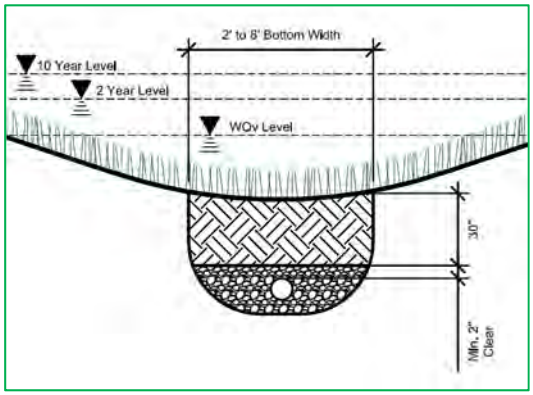
**Schedule and Frequency of I&M Activities for Constructed Wetland Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week or As Needed | | | | | | | | | |
| X | X | | Weeding | | | Once/Month | | | | | | | | | |
| X | X | | Trimming | | | Once/Week | | | | | | | | | |
| | | X | Harvesting | | | As Needed | | | | | | | | | |
| X | X | | Plant Pruning | | | Once | | | | | | | Once | | |
| | | X | Plant Replacement | | | As Needed | | | | | | As Needed | | | |
| | | X | Stake Repair/Replacement | As Needed | | | | | | | | | | | |
| X | X | | Embankment/Nuisance Wildlife Repairs | Once/Month | | | | | | | | | | | |
| | | X | Media Replacement | | | | As Needed | | | | | | As Needed | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |
| X | X | X | Sediment/Leaf Removal | Once/Month or As Needed | | | | | | | | | | | |
| X | X | X | Trash & Debris Removal | Once/Month or As Needed | | | | | | | | | | | |
| | | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |
| | | X | Structural Repair | As Needed | | | | | | | | | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |

## 8.1.4. SWALES/FILTER STRIPS FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and for the service life of all swales/filter strips. . During each visit and inspection, the following tasks should be performed or evaluated in accordance with the schedule included in this fact sheet:




**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Weeding**

- All invasive species should be removed entirely including all roots and root fragments, by hand, before plants set seed.
- No more than 5% weed coverage of any facility is permitted at any time. Proactive weeding is especially critical during the establishment period.

**Trimming**

- For swale/filter strip sites with seeded lawn areas, these should be regularly trimmed during the growing season.

**Major Trash & Debris Removal**

- All SCP media and components should be inspected to ensure stormwater can move through the facility and drain through both the swale/filter strip media and the overflow structures, as intended.
- Any visible trash, sediment, and debris should be removed from all swale/filter strip facility components to prevent clogging or obstructions to stormwater flowing through the system.
- Swale/filter strip overflow structures containing traps used to collect trash or other floatable objects should be emptied regularly.
- All trash and debris should be collected and sorted into compostable or non-compostable containers and properly disposed of.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must be removed from the vegetated areas, rock channels, inlet protection, and other stone structures within the swale/filter strip.
- Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Soil Compaction Repairs**

- In areas where soil compaction or settling is observed, surface materials should be broken up using hand tools to increase void space.

**Minor Erosion Repairs**

- Existing soil should be smoothed/spread along the swale/filter strip sides and bottom in places of gullying or displaced media to ensure adequate ground coverage and mitigate any minor erosion or slope undercutting.
- In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures should be conducted by rearranging the existing stone to ensure complete coverage. Routine maintenance does not include placing additional rock.

**Media Replacement**

- Swale/filter strip media should be replaced in locations where significant volumes of existing soil have been relocated or removed from the bottom of the facility by stormwater flows.
- Facilities experiencing significant clogging of the swale/filter strip media may require complete replacement of the existing soil.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the swale/filter strip.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the facility. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Schedule and Frequency of I&M Activities for Swales/Filter Strips Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week | | | | | | | | | |
| X | X | | Weeding | | | Once/Month | | | | | | | | | |
| X | X | | Trimming | | | Once/Week | | | | | | | | | |
| X | X | X | Major Trash & Debris Removal | Once/Month or As Needed | | | | | | | | | | | |
| | | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |
| X | X | X | Sediment/Leaf Removal | Once/Month or As Needed | | | | | | | | | | | |
| | | X | Soil Compaction Repairs | As Needed | | | | | | | | | | | |
| X | X | | Minor Erosion Repairs | Once/Month | | | | | | | | | | | |
| | | X | Media Replacement | | | | As Needed | | | | | | As Needed | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |

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## 8.1.5. UNDERGROUND STORAGE FACT SHEET

**Inspections and Maintenance**

As a general standard, quarterly inspections are required for all underground storage systems for the duration of the life of the facility. During each visit and inspection, the following tasks should be performed or evaluated based on the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during system inspection that details the condition of the system, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the underground storage system during every site visit and inspection.
- Any visible trash, sediment, and debris should be removed from all inlets/outlets to allow proper entrance of stormwater into the system and to avoid clogging of SCP components.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Filter Cleaning/Replacement**

- Where filters are present, they must routinely be cleaned and replaced. In cases where the filter is too heavily soiled it may need to be replaced.

**Major Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the surface areas and inlet protection.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Schedule and Frequency of I&M Activities for Underground Storage Chamber**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection | Once/Quarter | | | | | | | | | | | |
| X | X | Major Trash & Debris Removal | Once/Quarter or As Needed | | | | | | | | | | | |
| X | | Filter Cleaning/Replacement | Once/Quarter | | | | | | | | | | | |
| | X | Major Sediment/Leaf Removal | As Needed | | | | | | | | | | | |
| | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |

## 8.1.6. PERMEABLE PAVEMENT FACT SHEET

**Inspections and Maintenance**

As a general standard, quarterly inspections are required during the establishment period and semi-annual or quarterly inspections are required for the service life of all permeable pavement sites. During each visit and inspection, the following tasks should be performed or evaluated in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- The pavement surface should be inspected for physical damage such as missing infill material or broken pavers, spalling, rutting, or slumping of the surface and repair needs. Contributing impermeable and drainage areas should be inspected for sediment buildup and structural damage or for areas that may need better stabilization with erosion control.

**Trash & Debris Removal**

- Any visible trash, sediment, and debris should be removed from the surface of the permeable pavement during every site visit and inspection.
- SCP media should be inspected to ensure stormwater can move through the facility as designed. Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Surface Sweeping/Pressure Washing**

- A regenerative air sweeper truck should be used to perform routine surface sweeping where possible. For interlocking pavers, the top layer of stone should be replenished with clean stone after surface sweeping.
- Pressure washing or power washing may be used in lieu of surface sweeping for permeable pavement sites that are not accessible or should not be accessed (due to weight restriction) by a regenerative air sweeper truck.
- Leaf removal in areas adjacent to the permeable pavement surface is also important to be performed annually to prevent migration of leaf litter onto the permeable pavement surface after surface sweeping is performed.

**Vegetation/Weed Removal**

- If vegetation or weeds are observed to be growing on the permeable pavement surface or in between pavers, these must be removed to prevent proliferation, which may hinder infiltration rates. The presence of vegetation/weeds must be kept below 5% of the permeable pavement site area at any given time. Weeds must be removed entirely, including all roots and root fragments, before the plants set seed to minimize further spread of the species.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period of permeable pavement, and strongly discouraged following the initial establishment period. However, if use is required (i.e. all other options have been expended to address an issue) approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Infiltration Testing _SIT Methodology**

- Refer to the Permeable Pavement Simplified Infiltration Testing (SIT) Methodology for information and specific criteria to perform the infiltration testing.
- The SIT testing uses a sealed wooden frame and 5 gallons of water to determine the infiltration rate of permeable pavement. See Section 5.2.1.1 for a table that states the acceptable infiltration times. See **Appendix B** Section 8.2.7 for more details on SIT.
- During the establishment period, infiltration testing must be performed immediately after installation of Permeable pavement to establish a baseline infiltration rate.
- The results of the testing must be reported on the Permeable Pavement Infiltration Testing Form.
- The results of the establishment period infiltration testing will be used to determine whether the Permeable pavement surface must be cleaned semi-annually, quarterly, or at a more frequent interval for the service life of the facility.

**Infiltration Testing – Number of Test Sites**

The number of test sites for a permeable pavement application is dependent on the total area. The table below contains a summary of the recommended minimum number of infiltration tests to be performed based on the size of the application area. Test site locations should be selected based on the variability of the application area. For instance, if the application area has features such as a curb lane, a drive lane and a tree covered area a test should be performed near each of these features. Replicate tests are not required; however, if replicate tests are performed to validate results, they should be separated by a minimum of 24 hours. Permeable pavement application areas with numerous feature types could require additional test sites in excess of the minimums specified below in order to capture the variability of the entire application area.

As much as practical, testing at individual test sites should be performed at the same locations on a recurring basis as closely as possible to track infiltration performance over time.

| Size of Permeable Pavement Application Area [1] | Minimum Number of Infiltration Test Sites[2] |
|---|---|
| < 0.5 acres | 3 |
| Between 0.5 and 1.0 acres | 4 |
| Between 1.0 and 2.0 acres | 6 |
| Between 2.0 and 3.0 acres | 8 |
| Between 3.0 and 5.0 acres | 10 |
| >5.0 acres | Perform a minimum of 1 additional infiltration test for each acre above 5 acres |

*[1]Determining the size of a permeable pavement area is based on having a continuous permeable pavement application. In the event of a discontinuous application, such as permeable pavement parking lanes separated by conventional pavement or separate permeable pavement applications in a single parking lot, then the project area shall be determined based on having a common loading ratio. Permeable pavement applications with different loading ratios must be treated as separate project areas. In addition, a single project area cannot include a variation in the design of the permeable pavement (e.g., asphalt vs. concrete vs. brick pavers; varying base material or gap width between bricks).*

*[2]Additional test site locations are also encouraged when necessary to account for a higher variability of site conditions, to confirm routine maintenance is adequate to achieve target performance.*

**Pavement Surface Repairs**

- Permeable pavement surfaces should be repaired in locations of significant freeze-thaw damage such as large cracks, heaving, spalling, and uneven surfaces and in locations where potholes, missing pavers, changes in grading and eroding edges are observed.
- Repairs should be made using the same treatment as the original permeable pavement application, or in cases of small, high grade areas replacement can be made with a standard impermeable pavement.
- No seal coats or new impermeable pavement layers should be applied.

**Schedule and Frequency of I&M Activities for Permeable Pavement Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Quarterly or Semi-Annually* | | | | | | | | | | | |
| X | X | | Trash & Debris Removal | Quarterly or Semi-Annually* | | | | | | | | | | | |
| X | | | Vegetation/Weed Removal | Quarterly or Semi-Annually* | | | | | | | | | | | |
| X | X | | Surface Sweeping/Pressure Washing | Quarterly or Semi-Annually* | | | | | | | | | | | |
| | | X | Pavement Surface Repairs | | | As Needed | | | | | | | | | |
| | | X | Snow Removal | As-Needed | | | | | | | | | As-Needed | | |

*Note: * -Typically, permeable pavement facilities that maintain an infiltration time of less than 60 seconds during the establishment period (as described in Section 5.2.1.1) will require semi-annual inspections and sweeping for the service life of the SCP. Permeable pavement that experiences infiltration times greater than 60 seconds during the establishment period will generally require that routine inspections and maintenance be performed quarterly or at a more frequently scheduled rate.*

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## 8.1.7. HYDRODYNAMIC SEPARATORS

**Inspections and Maintenance**

As a general standard, semi-annual inspections are required for the service life of all hydrodynamic separators (HDSs), but may vary based on manufacturer's recommendations. Refer to the product-specific inspection and maintenance requirements for additional information. During each visit and inspection, the following tasks should be performed or evaluated at a minimum based on the schedule included in this fact sheet:

Source: HydroInternational – Downstream Defender®

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- Any measurements recommended by the manufacturer should be recorded, such as for sediment accumulation and trash.
- All SCP design components including area protection, stormwater entrances, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

The inspector should perform trash, sediment and debris evaluation, removal and measurement tasks in the following order during an inspection:

- Rate the trash and debris accumulation.
- Remove any trash/debris accessible by use of hand tools from available accessways within the HDS in order to provide better inspection of the system and to remove obstructions for proper operation. Properly dispose of these items.
- Record the "HDS Depth" of the HDS (empty/design depth).
- Perform a measure down from the top of casting of the HDS to collect and record a Sediment/Trash Measurement.
- Calculate the Remaining Capacity of the HDS by dividing the Sediment/Trash Measurement by the HDS Depth. The resulting decimal should be used to enter the rating on the form: if the value is less than 0.5 (less than 50%) assign a rating of 1; if the value is greater than 0.5 (greater than 50% remaining) assign a rating of 5. If the rating of 1 is assigned (the remaining capacity is less than 50%), check the Sediment/Trash Removal box in the As-Needed Maintenance Section.

**Debris/Trash Accumulation**

- The accumulation of debris and trash should be evaluated, and a rating provided based on visual observation prior to removing any trash or debris in the HDS.

**Trash & Debris Removal**

- The accumulation of trash and debris, including leaves, should be recorded during every site visit and inspection.
- Any visible trash and debris should be removed with hand tools from the HDS structures to allow stormwater to flow through the facility and to avoid clogging of SCP components.
- All trash and debris should be collected and sorted into appropriately designated compostable, recyclable, or trash containers and properly disposed of.

**HDS Depth**

- The HDS depth should be recorded on the inspection form and used to calculate the remaining capacity in the HDS – this is the depth of the empty HDS or the design depth. Refer to city approved engineering plans and Stormwater Control Practice (SCP) Maintenance Plans for HDS depth features.

**Sediment/Trash Measurement**

- The level of sediment should be measured during every inspection. The inspector should measure down from the top of casting of the HDS to the top of trash/sediment accumulation to record the Sediment/Trash Measurement. This measurement should be done carefully as the particles at the top of the pile have less resistance to measuring tools than compacted particles below.

**Remaining Capacity**

- Calculate the Remaining Capacity of the HDS by dividing the Sediment/Trash Measurement by the HDS Depth. The resulting decimal should be used to enter the rating on the form: if the value is less than 0.5 (less than 50%) assign a rating of 1; if the value is greater than 0.5 (greater than 50% remaining) assign a rating of 5. If the rating of 1 is assigned (the remaining capacity is less than 50%), check the Sediment/Trash Removal box in the As-Needed Maintenance Section.
- Refer to the manufacturer's recommendations for unit specific triggers for Sediment/Trash Removal.

**Inlet/Outlet Cleaning**

- Inlet, outlet, and overflow structures must be inspected for large trash and debris and functionality. When necessary, major cleaning requiring specialty equipment (i.e. vac truck) should be noted on the inspection form for follow up as-needed work.
- Any visible trash, sediment, grease, oil and debris should be removed from all inlets/outlets and internal structures to allow stormwater to flow through the facility and to avoid clogging of SCP components.
- Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.

**Structural Inspection**

- Infrastructure upstream and downstream of the system should be visually inspected for structural and operation and maintenance condition. Any damage or debris accumulation shall be documented and remediated/removed in the field where possible. If as-needed maintenance is required, it should be noted on the inspection form.

**Filter Cleaning**

- If a filter is present in the HDS, it must be inspected and periodically cleaned when signs of clogging or blinding are observed.
- Most filters can be cleaned using a backwashing methodology, but the manufacturer's product-specific recommendations should be followed for filter cleaning/replacement. Any filters on the unit should be appropriately cleaned and backwash/cleaning solution should be collected for proper disposal. Do not allow backwash/cleaning solution into the storm system. If filter replacement is needed and a replacement is not available, indicate the type of filter to be replaced in the As-Needed Maintenance Section of the inspection form.
- If a filter for oil/grease/fuel adsorption is present evaluate the filter for removal and replacement. Refer to manufacturer recommendations for replacement/useful life guidance and frequency.
- If damage or functionality is observed for the filter, it should be noted on the as-needed maintenance section with instructions for follow-up (i.e. filter replacement).

**Schedule and Frequency of I&M Activities for Hydrodynamic Separators**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection | Semi-Annually | | | | | | | | | | | |
| X | X | Trash & Debris Removal | Semi-Annually or As Needed | | | | | | | | | | | |
| X | X | Inlet/Outlet Cleaning | Semi-Annually or As Needed | | | | | | | | | | | |
| X | X | Filter Cleaning | Semi-Annually or As Needed | | | | | | | | | | | |
| | X | Major Trash & Debris Removal | As Needed | | | | | | | | | | | |
| | X | Sediment/Trash Removal | As Needed | | | | | | | | | | | |
| | X | Oil, Grease, and Fuel Removal | As Needed | | | | | | | | | | | |
| | X | Major inlet/Outlet Cleaning | As Needed | | | | | | | | | | | |

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## 8.1.8. BIORETENTION FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and for the service life of all bioretention facilities. During each visit and inspection, the following tasks should be performed in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, work performed during the inspection, and any recommendations for as-needed maintenance.
- During each inspection, all Stormwater control practice design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets, should be inspected for physical damage, repair needs, or disruptions to stormwater flow through the system.

**Watering**

- Watering should be conducted on a routine basis during the establishment period. Watering may also be required on an as-needed basis during the service life of the facility during times of drought, but consult with the City of Columbus to determine if water conservation efforts are in effect during drought.

**Weeding**

- All plants that are not specified on the permitted planting plan should be removed entirely including all roots and root fragments, before plants set seed, such that no more than 5% weed coverage is present at any time.
- Proactive weeding is especially critical during the establishment period.

**Trimming**

- Seeded lawn areas surrounding the bioretention facility should be routinely trimmed during the growing season.
- A brush trimmer should be used to cut down brush and shrubs once annually between March and April.

**Plant Pruning**

- All shrubs, perennials, and trees within and adjacent to the bioretention facility should be pruned routinely.
- Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Plant Replacement**

- Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan. If derivations must be made at City-owned SCPs, a formal request detailing why must be submitted to the City for approval.
- If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements should be in accordance with the approved modified planting plan.

**Stake Repair/Replacement**

- Plant stakes broken or damaged during the establishment period must be replaced. Following the establishment period, mature plants will no longer require stakes.

**Mulch Replacement**

- Mulch should be replaced annually and spread/smoothed along the basin sides and bottom during each inspection, to ensure adequate ground coverage. Mulch should be refreshed to a depth of 2-4 inches on an annual basis or as-needed.

**Media Replacement**

- Bioretention media should be replaced in locations where significant volumes of existing soil have been relocated or removed from the bottom of the basin by stormwater flows.
- Facilities experiencing significant clogging of the bioretention media may require complete replacement of the existing soil. Extensive plant replacements resulting from the media replacement will require establishment period maintenance.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the bioretention.

**Minor Soil Compaction Repairs**

- Locations of settling or compaction of surface material should be broken up using hand tools, to increase void space.

**Minor Erosion Repairs**

- Existing mulch and soil should be smoothed/spread along the basin sides and bottom in places of gullying or displaced media to ensure adequate ground coverage and mitigate any minor erosion or slope undercutting.
- In regions of heavily concentrated flow, such as near inlet structures, minor repairs to rock structures should be conducted by rearranging the existing stone to ensure complete coverage. Routine maintenance does not include placing additional rock.

**Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the planting areas, rock channels, inlet protection, and basin structures.
- Minor sediment removal from the facility may be accomplished by using a shovel or vacuum system to collect dry accumulated sediment. Leaf removal must be conducted if leaf litter exceeds four (4) inches in depth or if the accumulated leaf debris is impeding the filtration or functionality of the SCP.

**Trash & Debris Removal**

- All SCP media and components should be inspected to ensure stormwater can move through the facility as designed.
- Any visible trash, sediment, and debris should be removed from all bioretention facility components to prevent clogging or obstructions to stormwater flowing through the system.

- Basin overflow structures containing traps used to collect trash or other floatable objects should be emptied regularly.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the facility. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

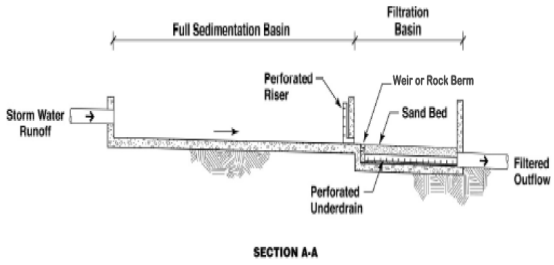
**Schedule and Frequency of I&M Activities for Bioretention Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week or As Needed | | | | | | | | | |
| X | X | | Weeding | | | Once/Month | | | | | | | | | |
| X | X | | Trimming | | | Once/Week | | | | | | | | | |
| X | X | | Plant Pruning | | | Once | | | | | | | Once | | |
| | | X | Plant Replacement | | | As Needed | | | | | | As Needed | | | |
| | | X | Stake Repair/Replacement | As Needed | | | | | | | | | | | |
| X | X | | Mulch Replacement | | Once | | | | | | | | | | |
| | | X | Media Replacement | | | | As Needed | | | | | | As Needed | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |
| | | X | Minor Soil Compaction Repairs | As Needed | | | | | | | | | | | |
| X | X | | Minor Erosion Repairs | As Needed | | | | | | | | | | | |
| X | X | X | Sediment/Leaf Removal | As Needed | | | | | | | | | | | |
| X | X | X | Trash & Debris Removal | As Needed | | | | | | | | | | | |
| | | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |

## 8.1.9. SAND FILTER FACT SHEET

**Inspections and Maintenance**

As a general standard, semi-annual inspections are required for the service life of all sand filters. During each visit and inspection, the following tasks should be performed or evaluated in accordance with the schedule included in this fact sheet:



SECTION A-A

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Weeding**

- All plants and weeds that are observed in the sand filter bed that are not specified on the permitted planting plan should be removed entirely including all roots and root fragments.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the sand filter system during every site visit and inspection.
- Any visible trash, sediment, and debris should be removed from all inlets/outlets and SCP media surface areas to allow proper entrance of stormwater into the facility and to avoid clogging of media or SCP components.
- SCP media should be inspected to ensure stormwater can move through the facility as designed. Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Minor Sediment Removal**

- Particles must be removed from the sedimentation basin and filtration basin of a sand filter. Risers, weirs, rock berms, inlet protection, and other structures within the facility must also be regularly be cleaned of sediment.
- Sediment removal should be performed after stormwater has drained from the system and the sand is dry.

**Media Replacement**

- When drainage times exceed 40 hours, the sand media in the facility must be removed and replaced with new sand.

**Schedule and Frequency of I&M Activities for Sand Filter Facilities**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection | Semi-Annually | | | | | | | | | | | |
| X | | Weeding | Semi-Annually | | | | | | | | | | | |
| X | X | Inlet/Outlet Structure | Semi-Annually or As Needed | | | | | | | | | | | |
| X | X | Trash & Debris Removal | Semi-Annually or As Needed | | | | | | | | | | | |
| X | X | Minor Sediment Removal | Semi-Annually or As Needed | | | | | | | | | | | |
| | X | Media Replacement | | | | As Needed | | | | | | | | |

## 8.1.10. MANUFACTURED FILTER UNIT FACT SHEET

**Inspections and Maintenance**

As a general standard, semi-annual inspections are required for the service life of all manufactured filter units. Refer to the manufacturer's operation and maintenance recommendations for additional requirements not included in this fact sheet. During each visit and inspection, the following tasks should be performed or evaluated in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Inlet/Outlet Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Plant Pruning**

- All shrubs, perennials, and trees within and adjacent to the manufactured filter unit should be pruned routinely.
- Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Major Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the manufactured filter unit during every site visit and inspection.
- Any visible trash, sediment, and debris should be removed from all inlets/outlets and SCP media surface areas to allow proper entrance of stormwater into the facility and to avoid clogging of media or SCP components.
- SCP I media should be inspected to ensure stormwater can move through the facility as designed. Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Major Sediment/Leaf Removal**

- The top layer of mulch or soil should be removed when visible buildup of sediment or leaf litter is observed during routine inspections. The top layer must be replaced with fresh material.

**Schedule and Frequency of I&M Activities for Manufactured Filter Units**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection | Semi-Annually | | | | | | | | | | | |
| X | X | Inlet/Outlet Cleaning | Semi-Annually or As Needed | | | | | | | | | | | |
| X | | Plant Pruning | | | Once | | | | | | | Once | | |
| X | X | Major Trash & Debris Removal | Semi-Annually or As Needed | | | | | | | | | | | |
| X | X | Major Sediment/Leaf Removal | Semi-Annually or As Needed | | | | | | | | | | | |

## 8.1.11. GREEN ROOF FACT SHEET

**Inspections and Maintenance**

As a general standard, monthly inspections are required during the establishment period and for the service life of all green roofs. During each visit and inspection, the following tasks should be performed or evaluated in accordance with the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Watering**

- Watering should be conducted on a routine basis during the establishment period. Watering may also be required on an as-needed basis during the service life of the facility during times of drought, but consult with the City of Columbus to determine if water conservation efforts are in effect during drought.

**Weeding**

- All plants that are not specified on the permitted planting plan should be removed entirely, including all roots and root fragments, by hand, before plants set seed.
- No more than 5% weed coverage of any facility is permitted at any time. Proactive weeding is especially critical during the establishment period.

**Plant Pruning**

- All shrubs, perennials, and trees within and adjacent to the green roof should be pruned routinely.
- Woody species require pruning and branches should be inspected to remove crossed or dead branches. Shrubs and perennials require pruning/dead-heading to encourage new growth and promote the health of the plants.

**Trimming**

- Routine trimming of seeded lawn areas installed on the green roof (where applicable) is necessary.
- A brush trimmer should be used to cut down brush and shrubs once annually between March and April.

**Major Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the green roof during every site visit and inspection.
- Any visible trash, sediment, and debris should be removed from all inlets/outlets and SCP planting bed or media surface areas to allow proper entrance of stormwater into the facility and to avoid clogging of media or SCP components.
- SCP media should be inspected to ensure stormwater can move through the facility as designed. Downstream or outlet structures should be inspected to ensure no debris is prohibiting stormwater from exiting the SCP.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Soil Compaction Repairs**

- In areas where soil compaction or settling is observed, surface materials should be broken up using hand tools to increase void space.

**Inlet/Outlet Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Media Replacement**

- Green roof media should be replaced in locations where significant volumes of existing soil have been relocated or removed from the bottom of the facility by stormwater flows.
- Facilities experiencing significant clogging of the green roof media may require complete replacement of the existing soil. Extensive plant replacements resulting from the media replacement will require establishment period maintenance.

**Plant Replacement**

- Any plants that do not survive must be replaced with the identical number of plants lost and species specified on the permitted planting plan. If derivations must be made at City-owned SCPs, a formal request detailing why must be submitted to the City for approval.
- If a plant survivability study has been conducted to identify recommended species substitutions, plant replacements should be in accordance with the approved modified planting plan.

**Stake Repair/Replacement**

- Plant stakes broken or damaged during the establishment period must be replaced. Following the establishment period, mature plants will no longer require stakes.

**Rock Channel Replacement**

- Additional rock should be placed, as needed, in locations of continued erosion to replace or strengthen the existing erosion control measures.
- Severe erosion and settling may require the installation of more permanent erosion control or slope stability measures, such as regrading of the green roof.
-

**Major Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the planting areas, rock channels, inlet protection, and green roof structures.

**Pest/Disease/Invasive Species Management**

- The onset of pests, disease, or invasive species should be promptly addressed to prevent further spread of the issue.
- Invasive plant species should be removed entirely, including all roots and root fragments, before the plants set seed.
- In some instances, performing as-needed maintenance tasks may eliminate the proliferation of pests within the facility. Therefore, any related maintenance issues should be resolved before implementing direct pest-control measures.
- The use of fertilizers, pesticides, and herbicides is prohibited during the establishment period, and strongly discouraged throughout the service life of the facility. If use is required, approval must be obtained from the City of Columbus, and applications shall be made in accordance with all applicable local, state, and federal regulations by a licensed applicator. Products used must be approved for aquatic use.

**Schedule and Frequency of I&M Activities for Green Roof Facilities**

| Phase | | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Establishment | Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | X | | Inspection | Once/Month | | | | | | | | | | | |
| X | | X | Watering | | | Once/Week or As Needed | | | | | | | | | |
| X | X | | Weeding | | | Once/Month | | | | | | | | | |
| X | X | | Plant Pruning | | | Once | | | | | | | Once | | |
| X | X | | Trimming | | | Once/Month | | | | | | | | | |
| X | X | X | Major Trash & Debris Removal | Once/Month or As Needed | | | | | | | | | | | |
| | | X | Soil Compaction Repairs | As Needed | | | | | | | | | | | |
| | | X | Inlet/Outlet Cleaning | As Needed | | | | | | | | | | | |
| | | X | Media Replacement | | | | As Needed | | | | | | As Needed | | |
| | | X | Plant Replacement | | | As Needed | | | | | | As Needed | | | |
| | | X | Stake Repair/Replacement | As Needed | | | | | | | | | | | |
| | | X | Rock Channel Replacement | As Needed | | | | | | | | | | | |
| | | X | Major Sediment/Leaf Removal | As Needed | | | | | | | | | | | |
| | | X | Pest/Disease/Invasive Species Management | As Needed | | | | | | | | | | | |

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# 8.1.12. RAINWATER HARVESTING SYSTEM FACT SHEET

**Inspections and Maintenance**

As a general standard, quarterly inspections are required for the service life of all rainwater harvesting cisterns. During each visit and inspection, the following tasks should be performed or evaluated based on the schedule included in this fact sheet:

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, pervious surfaces, energy dissipation devices, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Exercise Valves**

- Any equipment or tank valves included in the cistern design must be exercised to ensure they are operable and functioning.

**Filter Cleaning/Replacement**

- Where filters are present, any visible sediment buildup should be removed. In cases where the filter is too heavily soiled it may need to be replaced.

**Major Sediment/Leaf Removal**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the inlet protection and cistern facilities.

**Major Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the rainwater harvesting cistern during every site visit and inspection.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Inlet/Outlet Structure Cleaning**

- Inlet and outlet structures must be inspected for large trash and debris. When necessary, cleaning should be noted on the inspection form for follow up as-needed work.

**Schedule and Frequency of I&M Activities for Rainwater Harvesting Cisterns**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection | Once/Quarter | | | | | | | | | | | |
| X | | Exercise Valves | Once/Quarter | | | | | | | | | | | |
| X | | Filter Cleaning/Replacement | Once/Quarter | | | | | | | | | | | |
| | X | Major Sediment/Leaf Removal | As Needed | | | | | | | | | | | |
| | X | Major Trash & Debris Removal | As Needed | | | | | | | | | | | |
| | X | Inlet/Outlet Structure Cleaning | As Needed | | | | | | | | | | | |

## 8.1.13. BLUE ROOF FACT SHEET

**Inspections and Maintenance**

As a general standard, quarterly inspections are required for the service life of all blue roofs. During each visit and inspection, the following tasks should be performed or evaluated based on the schedule included in this fact sheet:

Source: NYC Environmental Protection Green Infrastructure

**Inspection Form**

- Complete an inspection form during facility inspection that details the condition of the facility, the work performed during the inspection, and any recommendations for as-needed maintenance.
- All SCP design components including area protection, stormwater entrances, piping and appurtenances, and outlets should be inspected for physical damage and repair needs. Accessible piping joints should be inspected for cracking or disruptions of stormwater flow through the system.

**Waterproof Membrane**

- Inspect the Waterproof membrane for cracking, spalling, or deterioration.
- Physical leak detection systems are to be inspected per the manufacturer's specifications.

**Structural Components**

- Where building mechanical or infrastructure is present, any visible leaks or damage that may contaminate stormwater shall be repaired. In cases where trained technicians are needed, contain the spill and monitor discharge.

**Outflow Control Device**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the Outflow Control Device and surrounding strainer. During winter months, break up and remove any accumulated ice around the Outflow Control Device.

**Scupper/Roof Drains**

- Organic matter, such as leaf debris and sediment accumulations, must routinely be removed from the Scupper/Roof Drains and surrounding strainer.

**Outlet Pipe/Downspouts**

- Debris and blockages shall be removed from the outlet pipe routinely to ensure positive drainage form blue roof to stormwater outfall or downstream water quality SCP.

**Trash & Debris Removal**

- Trash and debris, including leaves, should be removed from the surface of the blue roof during every site visit and inspection.
- All trash and debris should be collected and sorted into appropriately designated compostable or non-compostable containers and properly disposed of.

**Schedule and Frequency of I&M Activities for Blue Roofs**

| Phase | | Task | Suggested Schedule | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine | As-Needed | | January | February | March | April | May | June | July | August | September | October | November | December |
| X | | Inspection of Waterproof Membrane | Once/Quarter | | | | | | | | | | | |
| X | | Inspection of Outflow Control Device | Once/Quarter | | | | | | | | | | | |
| X | | Inspection of Structural Components | Once/Quarter | | | | | | | | | | | |
| X | | Inspection of Scuppers/Roof Drains | Once/Quarter | | | | | | | | | | | |
| X | | Outlet Pipes/Downspouts | Once/Quarter | | | | | | | | | | | |
| | X | Outflow Control Device Repair/Replacement | As Needed | | | | | | | | | | | |
| | X | Scupper/Downspout Strainers Repair/Replacement | As Needed | | | | | | | | | | | |
| | X | Addressing Mechanical Infrastructure Leaks/Spills | As Needed | | | | | | | | | | | |
| | X | Major Trash/Debris Removal | As Needed | | | | | | | | | | | |
| | X | Waterproof Membrane Repair/Replacement | As Needed | | | | | | | | | | | |

# 8.2. APPENDIX B: INSPECTION, TESTING AND DOCUMENTATION FORMS

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## 8.2.1. DRY DETENTION BASIN INSPECTION FORM

**Facility Name/Asset ID: _____ Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Plant Cover | | |
| | Vegetation Health | | |
| | Weeds/ Invasives | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| | Erosion | | |
| Outlet/ Overflow Structures* | Outlet Functionality | | |
| | Structural Condition | | |
| | Erosion/ Undercutting | | |
| | Slope Stability & Grading | | |
| Bottom of System | Drainage | | |
| | Sediment Buildup | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Establishme | Routine |
|---|---|---|
| Watering | ☐ | |
| Minor Erosion Repair | ☐ | ☐ |
| Trimming | ☐ | ☐ |
| Weeding | ☐ | ☐ |
| Trash & Debris Removal | ☐ | ☐ |
| Sediment/Leaf Removal | ☐ | ☐ |
| Reseed Exposed Soil | ☐ | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Rock Channel Replacement | Slope Slippage Repair | Pest/Disease/ Invasive Species Management | Other |
|---|---|---|---|---|
| | | | | |

## Comments/Description of As-Needed Maintenance

## DRY DETENTION BASIN INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Plant Cover | 80-100% | 60-80% | 40-60% | 20-40% | 0-20% |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| | Erosion | None | | Minor- Lack of Vegetated Cover | | Major – Erosion Rills and Gullies |
| Outlet/ Overflow Structures | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| | Structural Condition | Excellent | | Deteriorating | | Poor |
| | Erosion/ Undercutting | None | Ground Cover Missing | Slight Channelization | Heavily Channelized | Substantial Scouring |
| | Slope Stability/Grading | Well Defined | | Moderately Defined | | Poorly Defined |
| Bottom of System | Drainage | Drains ≤ 48 Hours | | Ponding >72 Hours | | No Drainage/ Extensive Ponding |
| | Sediment Buildup** | None | <5% | 5%-10% | 10%-20% | >20% |

**Reference the basin forebay, micropool, or alternative pretreatment SCP details, elevations and sediment monitoring procedures provided within the City approved engineering plan and/or Stormwater Control Practice Maintenance Plan.

## 8.2.2. WET DETENTION BASIN INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Weeds/Invasives | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| | Erosion | | |
| Outlet/ Overflow Structures* | Outlet Functionality | | |
| | Structural Condition | | |
| Perimeter/ Embankment | Erosion/ Undercutting | | |
| | Slope Stability & Grading | | |
| | Submerged Bench | | |
| Bottom of System | Drainage | | |
| | Sediment Buildup | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Establishme | Routine |
|---|---|---|
| Watering | ☐ | |
| Minor Erosion Repair | ☐ | ☐ |
| Trimming | ☐ | ☐ |
| Weeding | ☐ | ☐ |
| Trash & Debris Removal | ☐ | ☐ |
| | | |
| Sediment/Leaf Removal | ☐ | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Plant Replacement | Rock Channel Replacement | Slope Slippage Repair | Pest/ Disease/ Invasive Species Management | Other |
|---|---|---|---|---|---|
| | | | | | |

## Comments/Description of As-Needed Maintenance

## WET DETENTION BASIN INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| | Erosion | None | | Minor- Lack of Vegetated Cover | | Major – Erosion Rills and Gullies |
| Outlet/ Overflow Structures | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| | Structural Condition | Excellent | | Deteriorating | | Poor |
| Perimeter/ Embankment | Erosion/ Undercutting | None | Ground Cover Missing | Slight Channelization | Heavily Channelized | Substantial Scouring |
| | Slope Stability/Grading | Well Defined | | Moderately Defined | | Poorly Defined |
| | Submerged Bench** | Plant Coverage >80% | | Plant Coverage >50% | | Plant Coverage <25% |
| Bottom of System | Drainage | Drains ≤ 24 Hours | | Ponding > 72 Hours | | No Drainage - Extensive Ponding |
| | Sediment Buildup*** | Storage Zone Reduction of <25% | | Storage Zone Reduction of >50% | | Storage Zone Reduction of >100% |

**Reference the City's approved engineering plan and/or Stormwater Control Practice Maintenance Plan for the submerged bench planting plan.

***Reference the City's approved engineering plan and/or Stormwater Control Practice Maintenance Plan for basin elevations and sediment monitoring procedures.

## 8.2.3. CONSTRUCTED WETLAND INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Maintenance Access | | |
| | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Plant Cover | | |
| | Vegetation Health | | |
| | Mosquito Proliferation | | |
| | Weeds/ Invasives | | |
| | Animal Burrows | | |
| | Water Depth | | |
| Inflow Points | Inlet Functionality | | |
| | Erosion | | |
| Pre-Treatment Area & Forebay | Sediment Buildup | | |
| Bottom of System/Pond | Drainage/Water Level | | |
| | Sediment Buildup | | |
| Berm/ Embankment | Erosion/ Undercutting | | |
| | Slope Stability & Grading | | |
| Spillways/ Outfalls & Risers* | Outlet Functionality | | |
| | Structural Condition | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Establishme | Routine |
|---|---|---|
| Watering | ☐ | |
| Trimming | ☐ | ☐ |
| Embankment/ Nuisance Wildlife Repair | ☐ | ☐ |
| Weeding | ☐ | ☐ |
| Trash & Debris Removal | ☐ | ☐ |
| Sediment/Leaf Removal | ☐ | ☐ |
| Plant Pruning | ☐ | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

## As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Plant Replacement | Vegetation Clearing | Sediment /Debris Removal | Inlet or Outlet Cleaning | Structural Repair | Pest/Vector Control | Other |
|---|---|---|---|---|---|---|
| | | | | | | |

## Comments/Description of As-Needed Maintenance

| |
|---|
| |

## 8.2.4. CONSTRUCTED WETLAND INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Maintenance Access | Clear | | Overgrown | | Blocked |
| | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Plant Cover** | 80-100% | 60-80% | 40-60% | 20-40% | 0-20% |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Mosquito Proliferation | Absent | | | | Present |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Animal Burrows | None | | <10 | | ≥10 |
| | Water Depth | Average | | Nearing Berm Height | | Flooding |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| | Erosion | None | | Minor- Lack of Vegetated Cover | | Major – Erosion Rills and Gullies |
| Pre-Treatment Area & Forebay | Sediment Buildup | Empty/ Minimal Accumulation | | Moderate/ Half Full | | Full / Nearly Full |
| Bottom of System | Drainage | Drains ≤ 24 Hours | | Ponding > 72 Hours | | No Drainage - Extensive Ponding |
| | Sediment Buildup*** | Storage Zone Reduction of <25% | | Storage Zone Reduction of >50% | | Storage Zone Reduction of >100% |
| Berm/ Embankment | Erosion/ Undercutting | None | Ground Cover Missing | Slight Channelization | Heavily Channelized | Substantial Scouring |
| | Slope Stability/Grading | Well Defined | | Moderately Defined | | Poorly Defined |
| Spillways/ Outfalls & Risers | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| | Structural Condition | Excellent | | Deteriorating | | Poor |

**Reference the City's approved engineering plan and/or Stormwater Control Practice Maintenance Plan for the wetland planting plan.
***Reference the City's approved engineering plan and/or Stormwater Control Practice Maintenance Plan for basin elevations and sediment monitoring procedures.

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## 8.2.5. SWALE/FILTER STRIP INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Evaluation

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | | | |
| | Vegetation Health | | |
| | Weeds/ Invasives | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| Outlet/ Overflow Structures* | Outlet Functionality | | |
| Pre-Treatment Area | Sediment Buildup | | |
| Perimeter/ Embankment | Erosion/ Undercutting | | |
| | Slope Stability & Grading | | |
| Bottom of System | | | |
| | Soil Moisture | | |
| | Drainage | | |
| | Soil Compaction | | |
| | Sediment Buildup | | |

| Maintenance Performed (Check all that apply) | | Routine |
|---|---|---|
| | | |
| Trash & Debris Removal | | ☐ |
| Weeding | ☐ | ☐ |
| Trimming | | ☐ |
| Minor Erosion Repairs | | ☐ |
| Sediment/ Leaf Removal | | ☐ |
| | | |
| | | |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | | Rock Channel Replacement | Media Replacement | Pest/Disease/Invasive Species Management | Other |
|---|---|---|---|---|---|
| | | | | | |

## Comments/Description of As-Needed Maintenance

## SWALE/FILTER STRIP INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| Outlet/ Overflow Structures | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Pre-Treatment Area | Sediment Buildup | Empty/ Minimal Accumulation | | Moderate/ Half Full | | Full / Nearly Full |
| Perimeter/ Embankment | Erosion/ Undercutting | None | Ground Cover Missing | Slight Channelization | Heavily Channelized | Substantial Scouring |
| | Slope Stability/Grading | Well Defined | | Moderately Defined | | Poorly Defined |
| | Soil Moisture | Moist | | Dry and Cracked | | Cracked Soil - Extremely Hard |
| | Drainage | Under 24 Hours | Ponding > 24 Hours | Ponding > 48 Hours | Ponding >72 Hours | No Drainage - Extensive Ponding |
| | Soil Compaction | None | | Slight | | Extreme |
| | Sediment Buildup | None | <2” | 2”-4” | 4”-6” | >6” |

## 8.2.6. UNDERGROUND STORAGE INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview* | Aesthetics | | |
| | Uneven Settling | | |
| | Access | | |
| Inflow Points | Inlet Functionality | | |
| Outlet/ Overflow Structures* | Outlet Functionality | | |
| Bottom of System | Sediment Buildup | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Routine |
|---|---|
| Trash & Debris Removal | ☐ |
| Filter Cleaning/ Replacement | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/outlet cleaning | Major Trash & debris removal | Major sediment/ Leaf Removal | Other |
|---|---|---|---|
| | | | |

### Comments/Description of As-Needed Maintenance

# UNDERGROUND STORAGE INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Uneven Settling | None | | Observed | | Excessive |
| | Access | Unobstructed | | Obstructed | | Blocked |
| Inflow Points** | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| Outlet/ Overflow Structures | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Bottom of System*** | Sediment Buildup | None | <5% | 5%-10% | 10%-20% | >20% |

**Reference the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan to determine if a pretreatment SCP is installed prior to the storage chamber and needs to be inspected.

***Reference the SCP details, elevations and sediment monitoring procedures provided within the City approved engineering plan and/or Stormwater Control Practice Maintenance Plan.

# 8.2.7. PERMEABLE PAVEMENT SIMPLIFIED INFILTRATION TEST (SIT) METHODOLOGY

## Infiltration Test Frame

### Standard Test Frame Configuration

NC State University developed the Simple Infiltration Test (NCST-SIT) to address issues with ASTM C 1701. The NCST-SIT utilizes a square wooden test frame constructed from a single 8-foot-long piece of 2"x4" dimensional lumber (See Figure 1). The area inside the resultant test frame is 3.5 square feet (see Figure 2). To provide an adequate seal between the test frame and the pavemet, weather stripping is affixed with staples to the bottom of the test frame. The additional weight necessary to complete the seal will be applied to the top of the frame during testing.

**FIGURE 1 STANDARD TEST FRAME FOR INFILTRATION TEST**

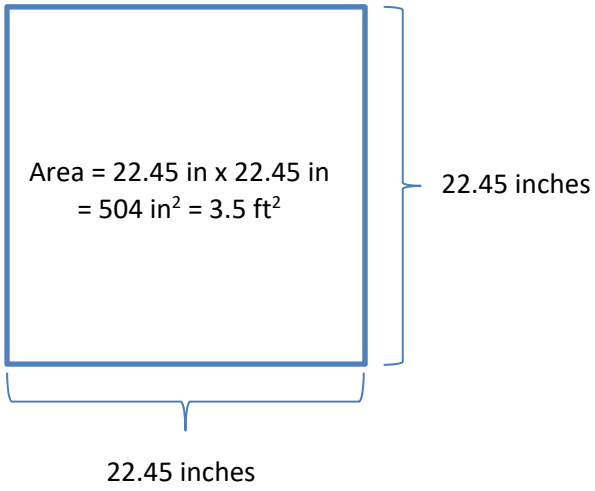


**FIGURE 2 SQUARE WOOD TESTING FRAME**

### Alternate Test Frame Configuration

For testing of narrow sections of permeable pavement, such as exfiltration trenches or concrete curb gutters, a square frame is not suitable. A modifed frame (see Figure 3) with interior dimensions of 63 inches long and 8 inches wide, with a resultant area of 3.5 sqaure feet can be utilized instead. To provide an adequate seal between the test frame and the pavemet, weather stripping is affixed with staples to the bottom of the test frame. The additional weight necessary to complete the seal will be applied to the top of the frame during testing (see Figure 4).

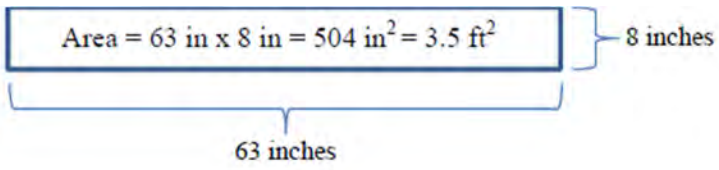


**FIGURE 3 MODIFIED WOOD TESTING FRAME**

**FIGURE 4 ALTERNATE TEST FRAME FOR INFILTRATION TEST**

## Infiltration Test Objectives

1. Perform a simplified infiltration test (SIT) on permeable pavement following the procedure in this methodology.
2. Complete the Permeable Pavement Infiltration Testing Form.
3. Evaluate the results of the infiltration test using the evaluation criteria in this methodology to determine if street cleaning or as-needed maintenance is required.

## Infiltration Testing Frequency

Testing will occur quarterly during the establishment period (first two years) and at minimum of semi-annually for the remainder of the service life of the facility.

## Infiltration Test Sites

The number of test sites for a permeable pavement application is dependent on the total area. The table below contains a summary of the recommended minimum number of infiltration tests to be performed based on the size of the application area. Test site locations should be selected based on the variability of the application area. For instance, if the application area has features such as a curb lane, a drive lane and a tree covered area a test should be performed near each of these features. Replicate tests are not required; however, if replicate tests are performed to validate results, they should be separated by a minimum of 24 hours. Permeable pavement application areas with numerous feature types could require additional test sites in excess of the minimums specified below in order to capture the variability of the entire application area.

| Size of Permeable Pavement Application Area [1] | Minimum Number of Infiltration Test Sites[2] |
|---|---|
| < 0.5 acres | 3 |
| Between 0.5 and 1.0 acres | 4 |
| Between 1.0 and 2.0 acres | 6 |
| Between 2.0 and 3.0 acres | 8 |
| Between 3.0 and 5.0 acres | 10 |
| >5.0 acres | Perform a minimum of 1 additional infiltration test for each acre above 5 acres |

*[1]Determining the size of a permeable pavement area is based on having a continuous permeable pavement application. In the event of a discontinuous application, such as permeable pavement parking lanes separated by conventional pavement or separate permeable pavement applications in a single parking lot, then the project area shall be determined based on having a common loading ratio. Permeable pavement applications with different loading ratios must be treated as separate project areas. In addition, a single project area cannot include a variation in the design of the permeable pavement (e.g., asphalt vs. concrete vs. brick pavers; varying base material or gap width between bricks).*

*[2]Additional test site locations are also encouraged when necessary to account for a higher variability of site conditions, to confirm routine maintenance is adequate to achieve target performance.*

As much as practical, testing at individual test sites should be performed at the same locations on a recurring basis as closely as possible to track infiltration performance over time.

## Infiltration Test Procedure

**Prior to beginning the Infiltration Test Procedure:**

- *Testing shall only be performed if there has been no more than 0.1 inches of precipitation in the preceding 48 hours.*
- *Record the current weather conditions on the Permeable Pavement Inspection Form.*
- *Perform a visual inspection of the permeable pavement and record observations on the Permeable Pavement Inspection Form.*
- *Do not pre-wet the surface to be tested*.

**Infiltration Testing Procedure:**

1) Perform a visual inspection of the facility and complete the Permeable Pavement Facility Inspection Form.
2) Fill out all required information at the top of the Permeable Pavement Infiltration Testing Form including the time that the testing procedure begins.
3) Clean the test location of any surface debris with by hand with a broom.
4) Lay the wood test frame on the section of permeable pavement to be tested.
5) One crew member prepares a bucket with 5 gallons of water.
6) Two other crew members, one with a stopwatch, stand on opposite ends of the frame to assist in sealing the frame to the pavement (See Figure 1 & 4 for reference).
7) The entire 5 gallons of water is poured into the frame at a constant rate (approximately 50 gpm) that will allow the area within the frame to become fully soaked.
8) The stopwatch will start the moment the water hits the permeable pavement and stop when the ponded water is no longer present on the permeable pavement surface. Time will be recorded to the nearest 0.1 second. Record on the Permeable Pavement Infiltration Testing Form, the time required for all 5 gallons to infiltrate within the test frame.
9) Repeat steps 3-8 for each required test site location and record results on the Permeable Pavement Infiltration Testing Form.

## Evaluation Criteria

The following criteria shall be used to determine to correlate the infiltration time with how the permeable pavement is performing and if maintenance is necessary:

| Infiltration Time | Performance Evaluation |
|---|---|
| <30 seconds | Permeable pavement is performing optimally |
| 30-60 seconds | Some minor impacts are observed |
| 60-90 seconds | Clogging is occurring and the permeable pavement needs maintenance |
| >90 seconds | Clogging is occurring that will typically require remediation |

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## 8.2.8. PERMEABLE PAVEMENT INFILTRATION TESTING FORM

**Facility Name/Asset ID:** _____

**City of Columbus Record Plan No.:**_____ **Date:** _____

| Infiltration Test Type (Check One) | Testing Performed By | Date | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | | | |

*Refer to the Permeable Pavement Simplified Infiltration Testing Methodology for infiltration testing instructions*

### Infiltration Testing

Time Testing Started: AM/PM

| | Infiltration Time (Seconds) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Test Site 1 | Test Site 2 | Test Site 3 | Test Site 4 | Test Site 5 | Test Site 6 | Test Site 7 | Test Site 8 | Test Site 9 | Test Site 10 |
| Infiltration Time | | | | | | | | | | |
| *Check boxes below if the infiltration time above meets the following criteria* | | | | | | | | | | |
| 60-90 sec | | | | | | | | | | |
| >90 sec | | | | | | | | | | |

*Note: Refer to the Permeable Pavement Simplified Infiltration Testing Methodology to determine the number of test site locations required. Perform testing at a minimum of 3 test sites. Use additional forms if the number of test sites exceeds 10*

### As-Needed Maintenance *(Check all that apply and describe in comment box below)*

| Surface Sweeping *(check if any site infiltration times exceed 60 seconds)* | Pressure Washing | Other |
|---|---|---|
| | | |

### Comments/Description of As-Needed Maintenance

*(Provide enough detail for a follow-up work order to be created)*

| |
|---|
| |

Time Testing Completed: _____AM/PM

Inspector: _____

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## 8.2.9. PERMEABLE PAVEMENT INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Evaluation

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| Pavement Surface | Sediment Accumulation | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Standing Water | | |
| | Weeds/Vegetation Growing in Pavement | | |
| | Damaged Surface | | |
| | Stone Missing Between Pavers | | |
| | Heavy Vehicles Parked | | |
| Adjacent Area | Evidence of Erosion | | |
| Underdrains and Outlet Structure* | Underdrain Failure | | |
| | Outlet Functionality | | |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### Maintenance Log *(Check if these tasks were performed while on-site)*

| Trash & Debris Removal | Vegetation/Weed Removal |
|---|---|
| | |

### As-Needed Maintenance *(Mark all that apply & describe in the comment section below)*

| Stone Replacement | Structure/ Underdrain Repair | Pressure Washing | Surface Sweeping | Adjacent Site Restoration | Other |
|---|---|---|---|---|---|
| | | | | | |

### Comments/Description of As-Needed Maintenance

| |
|---|
| |

# PERMEABLE PAVEMENT INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| Pavement Surface | Sediment Accumulation | None | <2” | 2”-4” | 4”-6” | >6” |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Standing Water | None | | Ponding | | Flooding |
| | Weeds/ Vegetation Growing in Pavement | None | | Slight | | Overgrown |
| | Damaged Surface | None | | Minor Damage Observed | | Major Damage Observed |
| | Stone Missing Between Pavers | None | | Slight | | Severe |
| | Heavy Vehicles Parked | None | | One | | Several |
| Adjacent Area | Evidence of Erosion | None | | Channelization/ Sedimentation | | Exposed Soil/Displaced Materials |
| Underdrains and Outlet Structure | Underdrain Failure | None | | Slight Clogging | | Severe Clogging |
| | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |

# 8.2.10. HYDRODYNAMIC SEPARATOR INSPECTION FORM

**Facility Name/Asset ID: _____Time In:____**am/pm **Out:___**am/pm
**City of Columbus Record Plan No.:_____ Date:_____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type | Weather | Temperature (°F) | Date of Last Rainfall | Precipitation (in) | Maintenance Performed (Y/N) |
|---|---|---|---|---|---|
| ☐ **Routine** | | | | | |

## Site Inspection

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Measurement (include units) | Comments |
|---|---|---|---|---|
| System Overview | Debris/Trash Accumulation | | N/A | |
| | HDS Depth | N/A | | |
| | Sediment/ Trash Measurement* | N/A- | | |
| | Remaining Capacity | | N/A | |
| | Structural Components*** | | N/A | |
| Inlet/ Outlet/ Overflow Structures | Outflow/Overflow Control Device | | N/A | |
| | Inlet Pipe/ Connection | | N/A | |
| | Outlet Pipe/ Connection | | N/A | |

## Maintenance Log

| Maintenance Performed (Check All that Apply) | Routine |
|---|---|
| **Trash & Debris Removal** | ☐ |
| **Inlet/Outlet Cleaning** | ☐ |
| **Filter Cleaning** | ☐ |

* Sediment buildup levels that require maintenance/removal will vary by HDS product; Less than 50% buildup is a general guideline that typically does not require sediment removal. Refer to the manufacturer's maintenance guidance for sediment depth action levels. To collect the sediment/trash measurement from the top of the HDS casting to the top of the sediment and trash pile, carefully lower the measuring device to the top of the trash and sediment in the HDS. Note that particles and trash at the top of pile will provide minimal resistance so do not extend the measuring device beyond the top of the accumulation pile.

** Calculate the remaining capacity of the HDS by dividing the Sediment/Trash Measurement by the HDS Depth. The resulting decimal should be used to enter the rating on the form: if the value is less than 0.5 (less than 50%) assign a rating of 1; if the value is greater than 0.5 (greater than 50% remaining) assign a rating of 5. If the rating of 1 is assigned (the remaining capacity is less than 50%), check the Sediment/Trash Removal box below in the As-Needed Maintenance Section.

*** Reference the manufacturer recommendations, City approved engineering plan and Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

## As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Major Trash & Debris Removal | Inspection of Upstream/ Downstream Pipes & Structures | Oil/grease/ fuel removal | Sediment/ Trash Removal | Other |
|---|---|---|---|---|---|
| | | | | | |

## Comments/Description of As-Needed Maintenance

| |
|---|
| |

# HYDRODYNAMIC SEPARATOR DEVICE INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Debris/Trash Accumulation | Unobstructed | | Obstructed | | Blocked |
| | Remaining Capacity | >50% (calculated as greater than 0.5) | | | | <50% (calculated as less than 0.5) |
| | Structural Components | Good | | Signs of Wear | | Damaged |
| Inlet/ Outlet/ Overflow Structures | Outflow Control Device | Clear | Sediment Buildup | Slight Obstruction/ Signs of Wear | Severe Obstruction | Blocked/ Damaged |
| | Inlet Pipe/ Connection | Clear | Sediment Buildup | Slight Obstruction/ Signs of Wear | Severe Obstruction | Blocked/ Damaged |
| | Outlet Pipe/ Connection | Clear | Sediment Buildup | Slight Obstruction/ Signs of Wear | Severe Obstruction | Blocked/ Damaged |

*

## 8.2.11. BIORETENTION INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Plant Cover | | |
| | Vegetation Health | | |
| | Weeds/ Invasives | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| | Erosion | | |
| Outlet Structures and Underdrains* | Outlet Functionality | | |
| Pre-Treatment Area | Sediment Buildup | | |
| Perimeter/ Embankment | Erosion/ Undercutting | | |
| | Slope Stability & Grading | | |
| Bottom of System | Mulch | | |
| | Soil Moisture | | |
| | Drainage | | |
| | Soil Compaction | | |
| | Sediment Buildup | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Establishme | Routine |
|---|---|---|
| Watering | ☐ | |
| Minor Erosion Repair | ☐ | ☐ |
| Trimming | ☐ | ☐ |
| Weeding | ☐ | ☐ |
| Trash & Debris Removal | ☐ | ☐ |
| Sediment/Leaf Removal | ☐ | ☐ |
| Mulch Replacement | ☐ | ☐ |
| | | |
| Plant Pruning | ☐ | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

## As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Plant Replacement | Mulch Replacement | Media Replacement | Sediment /Debris Removal | Inlet or Outlet Cleaning | Structural Repair | Other |
|---|---|---|---|---|---|---|
| | | | | | | |

## As-Needed Maintenance/ Work Order Description/ Comments

| |
|---|
| |

# BIORETENTION INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Plant Cover | 80-100% | 60-80% | 40-60% | 20-40% | 0-20% |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Mosquito proliferation | Absent | | | | Present |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| | Erosion | None | | Minor | | Major – Erosion Rills and Gullies |
| Outlet/ Overflow Structures and Underdrains | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Pre-Treatment Area | Sediment Buildup | Empty/ Minimal Accumulation | | Moderate/ Half Full | | Full / Nearly Full |
| Perimeter/ Embankment | Erosion/ Undercutting | None | Ground Cover Missing | Slight Channelization | Heavily Channelized | Substantial Scouring |
| | Slope Stability/Grade | Well Defined | | Moderately Defined | | Poorly Defined |
| Bottom of System | Mulch | Good | Slightly Eroded | Uneven, Loose Edges | Heavily Eroded | Missing |
| | Soil Moisture | Moist | | Dry and Cracked | | Cracked Soil - Extremely Hard |
| | Drainage | Under 24 Hours | Ponding > 24 Hours | Ponding > 48 Hours | Ponding >72 Hours | No Drainage - Extensive Ponding |
| | Soil Compaction | None | | Slight | | Extreme |
| | Sediment Buildup | None | <2” | 2”-4” | 4”-6” | >6” |

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## 8.2.12. SAND FILTER INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Evaluation

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| | Erosion | | |
| Outlet/ Overflow Structures and Underdrains* | Outlet Functionality | | |
| Pre-Treatment Area | Sediment Buildup | | |
| Bottom of System | Drainage | | |

### Maintenance Log

| Maintenance Performed (Check All that Apply) | Routine |
|---|---|
| Inlet Cleaning | ☐ |
| Minor Sediment Removal | ☐ |
| Trash & Debris Removal | ☐ |

*Reference the outlet structure details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan for structure features to inspect and maintain.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Media Replacement | Major Trash & Debris Removal | Major Sediment/ Leaf Removal | Other |
|---|---|---|---|---|
| | | | | |

## Comments/Description of As-Needed Maintenance

## SAND FILTER INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| | Erosion | Absent | | | | Present |
| Outlet/ Overflow Structures and Underdrains | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Pre-Treatment Area | Sediment Buildup | Empty/ Minimal Accumulation | | Moderate/ Half Full | | Full / Nearly Full |
| Bottom of System | Drainage | Under 24 Hours | Ponding > 24 Hours | Ponding > 48 Hours | Ponding >72 Hours | No Drainage - Extensive Ponding |

# 8.2.13. MANUFACTURED FILTER UNIT INSPECTION FORM

**Facility Name/Asset ID:** _____ **Time In:**_____am/pm **Out:**_____am/pm

**City of Columbus Record Plan No.:**_____ **Date:** _____

**Inspector Name & Contact Information:** _____

| Inspection & Maintenance Type | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Routine | | | | |

## Site Evaluation

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Vegetation Health | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| Outlet/ Overflow Structures | Outlet Functionality | | |
| Pre-Treatment Area | Sediment Buildup | | |
| Bottom of System | Mulch | | |
| | Drainage | | |
| | Sediment Buildup | | |

| Maintenance Performed (Check All that Apply) | Routine |
|---|---|
| Inlet Cleaning | ☐ |
| Plant Pruning | ☐ |
| Sediment/Leaf Removal | ☐ |
| Trash & Debris Removal | ☐ |

## As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/outlet cleaning | Major Trash & Debris Removal | Major Sediment/Leaf Removal | Other |
|---|---|---|---|
| | | | |

## Comments/Description of As-Needed Maintenance

# MANUFACTURED FILTER UNIT INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview* | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points* | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| Outlet/ Overflow Structures* | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Pre-Treatment Area* | Sediment Buildup | Empty/ Minimal Accumulation | | Moderate/ Half Full | | Full / Nearly Full |
| Bottom of System* | Mulch | Good | Slightly Eroded | Uneven, Loose Edges | Heavily Eroded | Missing |
| | Drainage | Under 24 Hours | Ponding > 24 Hours | Ponding > 48 Hours | Ponding >72 Hours | No Drainage - Extensive Ponding |
| | Sediment Buildup | None | <2” | 2”-4” | 4”-6” | >6” |

*Reference the details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan.

## 8.2.14. GREEN ROOF INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type (Check One) | Weather | Temp (°F) | Days Since Last Rainfall | Most Recent Precipitation (in) |
|---|---|---|---|---|
| ☐Establishment<br>☐Routine | | | | |

### Site Evaluation

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Aesthetics | | |
| | Debris/Trash & Oil/Chemical Accumulation | | |
| | Plant Cover | | |
| | Vegetation Health | | |
| | Weeds/ Invasives | | |
| | Mosquito Proliferation | | |
| Inflow Points | Inlet Functionality | | |
| Outlet/ Overflow Structures | Outlet Functionality | | |
| Bottom of System | Soil Media | | |
| | Soil Moisture | | |
| | Drainage | | |
| | Soil Compaction | | |
| | Sediment Buildup | | |

| Maintenance Performed (Check All that Apply) | Establishment | Routine |
|---|---|---|
| Watering | ☐ | |
| Weeding | ☐ | ☐ |
| Trimming | ☐ | ☐ |
| Trash & Debris Removal | ☐ | ☐ |
| Plant Pruning | ☐ | ☐ |

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Plant Replacement | Media Replacement | Major Trash & debris removal | Major sediment/ leaf removal | Pest/ disease/ invasive species management | Other |
|---|---|---|---|---|---|
| | | | | | |

## Comments/Description of As-Needed Maintenance

## GREEN ROOF INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview* | Aesthetics | Excellent | Good | Neglected | Deteriorating | Poor |
| | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| | Plant Cover | 80-100% | 60-80% | 40-60% | 20-40% | 0-20% |
| | Vegetation Health | Well Established/ Mature | Mostly Healthy | Sparse/ Stressed | Many Dying | Dead/Absent |
| | Weeds/ Invasives | None | | Slight | | Overgrown |
| | Mosquito Proliferation | Absent | | | | Present |
| Inflow Points* | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| Outlet/ Overflow Structures* | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Bottom of System* | Soil Media | Good | | Deteriorating/ Sparse | | Absent |
| | Soil Moisture | Moist | | Dry and Cracked | | Cracked Soil - Extremely Hard |
| | Drainage | Under 24 Hours | Ponding > 24 Hours | Ponding > 48 Hours | Ponding >72 Hours | No Drainage - Extensive Ponding |
| | Soil Compaction | None | | Slight | | Extreme |
| | Sediment Buildup | None | <2” | 2”-4” | 4”-6” | >6” |

*Reference the details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan.

## 8.2.15. RAINWATER HARVESTING SYSTEM INSPECTION FORM

**Facility Name/Asset ID: _____Time In:_____**am/pm **Out:_____**am/pm
**City of Columbus Record Plan No.:_____ Date: _____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type | Weather | Temperature (°F) | Date of Last Rainfall | Precipitation (in) | Maintenance Performed (Y/N) |
|---|---|---|---|---|---|
| ☐ **Routine** | | | | | |

### Site Inspection

| Category | Assessment Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| **System Overview*** | Debris/Trash & Oil/Chemical Accumulation | | |
| **Inflow Points** | Inlet Functionality | | |
| **Outlet/ Overflow Structures** | Outlet Functionality | | |
| **Bottom of System** | Sediment Buildup | | |

### Maintenance Log

| Maintenance Performed (Check all that apply) | Routine |
|---|---|
| **Exercise Valves** | ☐ |
| **Filter Cleaning/ Replacement** | ☐ |

*Reference the cistern details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Major Trash & Debris Removal | Major Sediment/ Leaf Removal | Other |
|---|---|---|---|
| | | | |

### Comments/Description of As-Needed Maintenance

# RAINWATER HARVESTING SYSTEM INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Debris/Trash & Oil/Chemical Accumulation | None | | Slight | | Excessive |
| Inflow Points** | Inlet Functionality | Unobstructed | | Obstructed | | Blocked |
| Outlet/ Overflow Structures | Outlet Functionality | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| Bottom of System | Sediment Buildup | None | <2” | 2”-4” | 4”-6” | >6” |

**Reference the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan to determine if a pretreatment SCP is installed prior to the cistern and needs to be inspected.

## 8.2.16. BLUE ROOF INSPECTION FORM

**Facility Name/Asset ID: _____Time In:____**am/pm **Out:___**am/pm
**City of Columbus Record Plan No.:_____ Date:_____**
**Inspector Name & Contact Information: _____**

| Inspection & Maintenance Type | Weather | Temperature (°F) | Date of Last Rainfall | Precipitation (in) | Maintenance Performed (Y/N) |
|---|---|---|---|---|---|
| ☐ **Routine** | | | | | |
| ☐ **As-Needed** | | | | | |

### Site Inspection

| Category | Metric | Rating 1 (Poor) – 5 (Excellent) | Comments |
|---|---|---|---|
| System Overview | Waterproof Membrane | | |
| | Debris/Trash Accumulation | | |
| | Mosquito Proliferation | | |
| | Spills from Mechanical Equipment | | |
| Outlet/ Overflow Structures | Outflow Control Device | | |
| | Scuppers/Roof Drains | | |
| | Outlet Pipes/Downspouts | | |

### Maintenance Log

| Maintenance Performed (Check All that Apply) | Routine |
|---|---|
| Trash/Debris Removal | ☐ |
| Waterproof Membrane Repair | ☐ |

*Reference the Blue Roof details provided within the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan.

### As-Needed Maintenance *(Check all that apply & describe in comment box)*

| Inlet/Outlet Cleaning | Major Trash & Debris Removal | Major Sediment/ Leaf Removal | Other |
|---|---|---|---|
| | | | |

### Comments/Description of As-Needed Maintenance

# BLUE ROOF SYSTEM INSPECTION FORM RATING SYSTEM

| Category | Assessment Metric | Rating Scale | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| System Overview | Waterproof Membrane | None | | Signs of Wear | | Damaged |
| | Debris/Trash Accumulation | Unobstructed | | Obstructed | | Blocked |
| | Structural Components | None | | Signs of Wear | | Damaged |
| | Mosquito Proliferation | None | | Minor | | Major |
| | Spills From Mechanical Equipment | None | | Minor | | Major |
| Outlet/ Overflow Structures | Outflow Control Device | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| | Scuppers/Roof Drains | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |
| | Outlet Pipes/Downspouts | Clear | Sediment Buildup | Slight Obstruction | Severe Obstruction | Blocked |

**Reference the City approved engineering plan and/or Stormwater Control Practice (SCP) Maintenance Plan to determine if a pretreatment SCP is installed downstream of the Blue Roof and needs to be inspected.