

# **Stormwater Management Facility Operation and Maintenance (O&M) General Guidelines**

Castle Rock Water  
**Stormwater Division**

**175 Kellogg Court  
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## Reference:

**This manual is adapted from the following documents:**

**Douglas County, Colorado**, STORMWATER MANAGEMENT FACILITY OPERATION AND MAINTENANCE MANUAL, October 2010

**Town of Parker, Colorado**, STORMWATER PERMANENT BEST MANAGEMENT PRACTICES (PBMP) LONG-TERM OPERATION AND MAINTENANCE MANUAL, October 2004

**Urban Drainage and Flood Control District**, URBAN STORM DRAINAGE CRITERIA MANUAL, VOLUME 3, November 2010

# Stormwater Management Facility Operation and Maintenance (O&M) Standard Guidelines

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# Stormwater Management Facility Operation and Maintenance (O&M) Standard Guidelines

## I. Background

This document provides General Guidelines and Standard Operating Procedures (SOPs) for Operation and Maintenance (O&M) of stormwater facilities. Additional information regarding O&M of site specific features may be found on approved Construction Drawings and in the Phase III Drainage Report.

### A. Compliance with the Town of Castle Rock Storm Drainage Design and Technical Criteria Manual

Owners or managers of developed property located within the incorporated limits of Castle Rock are required to comply with the Town's Storm Drainage Design and Technical Criteria Manual (Storm Manual) adopted by reference in accordance with Ordinance 2012-16 of the Municipal Code. The purpose of the ordinance is to ensure property owners follow proper operation and maintenance procedures for stormwater management facilities located on their sites. Requirements for inspection and maintenance are located in these O&M Standard Guidelines. Additional information can be obtained by contacting the Town's Utilities Department Stormwater Division at 720-733-6011.

### B. Preventive and Prompt Maintenance Activities Reduce Overall Maintenance Costs

The most effective way to maintain your stormwater facility is to prevent pollutants from entering the facility in the first place. Common pollutants include sediment, trash and debris, chemicals, pet wastes, runoff from stored materials, illicit discharges into the storm drainage system and many others. A thorough maintenance program will include measures to address these potential contaminants, and will save money and time in the long run. Key points to consider in your maintenance program include:

- Educate employees/residents on how their actions impact water quality and how they can help reduce maintenance costs.
- Keep properties, streets, curb & gutters and parking lots free of trash, debris and lawn clippings.
- Ensure the proper disposal of hazardous wastes and chemicals.
- Plan lawn care to minimize the use of chemicals and pesticides.
- Sweep or blow grass clippings from paved surfaces and put the clippings in a compost pile or back on the lawn.
- Be aware of automobiles leaking fluids. Use absorbents such as clay cat litter to soak up drippings and dispose of properly.

- Re-vegetate disturbed and bare areas to maintain vegetative stabilization.
- Clean out the upstream components of the storm drainage system, including inlets, storm sewers and outfalls.
- Do not store materials outdoors (including landscaping materials) unless they are properly protected from stormwater runoff.

## II. **General Description of Stormwater Management Facilities**

The following are brief descriptions of commonly used stormwater management facilities. For more detailed information refer to the Town's Storm Manual Chapters 12-14.

### A. **Volume Reduction Facilities (Filtration BMPs)**

1. **Grass Buffers and Swales** – Grass buffers are densely vegetated strips of grass designed to provide filtration, infiltration and settling to reduce runoff pollutants through sheet flow over the grass. Grass swales are densely vegetated trapezoidal or triangular channels designed to slow runoff, promote infiltration and facilitate sedimentation while limiting erosion. Buffers differ from swales in that they are designed to accommodate overland sheet flow rather than concentrated or channelized flow.
2. **Permeable Pavement Systems** – Permeable pavement consists of a permeable pavement layer, usually underlain by gravel and sand layers, designed to promote volume reduction, provide treatment and slow release of water quality capture volume (WQCV). Uses include parking lots and low traffic areas to accommodate vehicles while facilitating stormwater infiltration near its source.

### B. **Water Quality and Flood Control Facilities**

1. **Extended Detention Basins (EDBs)** – EDBs are sedimentation basins with forebays, micropools and a slow release outlet designed to detain stormwater for many hours after storm runoff ends. The basins are considered to be “dry” because the majority of the basin is designed not to have a significant permanent pool of water remaining between runoff events.
2. **Porous Landscape Detention (Rain Gardens or Bioretention)** – Porous landscape detention (PLD) is depressed landscaped areas designed to capture and filter or infiltrate the WQCV through an engineered granular filtration layer. PLDs are often landscaped with ornamental grasses and shrubs.
3. **Sand Filter Basins** – Sand filter basins consist of a surcharge zone underlain by a sand bed with an underdrain system. Stormwater runoff accumulates in the surcharge zone and gradually infiltrates into the underlying sand bed. The underdrain system gradually dewateres the sand bed and discharges the runoff.

4. Retention Ponds and Constructed Wetland Ponds – Retention ponds, “wet ponds”, have a permanent pool of water with additional capacity designed to capture and slowly release the WQCV. Constructed wetland ponds are shallow retention ponds designed to permit the growth of wetland plants such as rushes, willows and cattails, and slow runoff allowing time for sedimentation, filtering and biological uptake.
5. Underground BMPs and Storage – Underground stormwater BMPs include proprietary and non-proprietary devices installed below ground that provide water quality treatment via sedimentation, screening, filtration, hydrodynamic separation and other physical and chemical processes. These may be in the form of a vault, storm drain insert and/or pipe galleries.

### **C. Open Channels**

1. Stabilized Channels – Stabilized channels utilize grade control structures as a means of establishing a mild slope for the baseflow channel and arresting stream degradation. Severe bends or cut banks may also need to be stabilized. Stabilized Channels may be grass-lined, riprap, concrete or a combination thereof.
2. Constructed Wetland Channels – Constructed wetlands channels have wetland bottoms which use dense natural vegetation to slow runoff and promote biological uptake and settling of sediment.

## **III. Ownership and Easements**

Maintenance responsibility lies with the owner of the land, except as modified by specific agreement. Maintenance responsibility shall be defined on Final Plats and Final Development Plans. The property owner or designee shall be responsible for the maintenance of all drainage facilities including inlets, pipes, culverts, channels, ditches, hydraulic structures, and detention basins located on their land unless modified by specific agreement. Maintenance access for all facilities must be adequate for the anticipated maintenance vehicles and equipment and should be shown on the Final Plats and Final Development Plans. The Operation and Maintenance Manual, as described in Section 4.6 of the Town’s Storm Manual, shall define those entities responsible for the maintenance and management of stormwater facilities. If the property owner fails to maintain a facility, the Town will complete maintenance and charge the owner at 1.25 times the cost of maintenance.

Drainage easements are required in order to ensure for the proper construction, maintenance and access to drainage improvements that have the potential to affect the public drainage system and other properties. Drainage easements shall be granted to the Town for inspection and maintenance purposes and shall be shown on the Drainage Plan, Final Plat and Site Improvement Plan, as applicable. The drainage easement shall state that the Town has the right of access on the easements for inspection and maintenance purposes. In general,

easements are required for detention or retention ponds, water quality enhancement ponds and other Best Management Practice facilities, storm sewers, swales, channels, parking lot areas that convey runoff from adjacent properties (blanket type easements), major drainageways and floodplains. Easement requirements are specific to the type of stormwater management facility and are discussed in more detail in later chapters.

Refer to Section 4.6 of the Storm Manual for more information on maintenance responsibility (ownership) and easements, respectively.

#### **IV. Access**

Refer to approved Plat, Drainage Plan and/or Site Plan for location of designated maintenance access. Contact the Town's Utilities Department Stormwater Division at 720-733-6011 with any questions regarding access to a facility.

#### **V. Safety**

Keep safety considerations at the forefront of inspection and maintenance procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present.

If a highly toxic or flammable substance is discovered, the inspector(s) should leave the immediate area and contact the **Town's Fire Department** at **911**. If there is any question about a substance, leave the area immediately and contact the **Town's Fire Department** at **303-660-1066**. Also, never open a sealed container to check the contents.

**Potentially dangerous** (e.g., fuel, chemicals, hazardous materials) substances found in the areas **must be** referred to the **Town's Fire Department** immediately for response by the Hazardous Materials Unit. The emergency contact number is **303-660-1066**.

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the stormwater management facility that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

**If any hazard is found within the facility area that poses an immediate threat to public safety, contact the Town's Fire Department immediately!**

#### **VI. Field Inspection Equipment**

It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of a Stormwater Management Facilities:

- Town Approved Drainage Report and Construction Drawings
- Typical Inspection & Maintenance Requirements (See Appendix B)
- Protective clothing and boots
- Safety equipment (vest, hard hat, confined space entry equipment)
- Communication equipment
- Clipboard
- Manhole Lid Remover
- Shovel
- First Aid Kit

Some of the items identified above need not be carried by the inspector (manhole lid remover, shovel, and confined space entry equipment). However, this equipment should be available in the vehicle driven to the site.

## **VII. Inspecting and Maintaining Stormwater Management Facilities**

The quality of stormwater discharging to waterways relies heavily on the proper operation and maintenance of permanent Best Management Practices (BMPs).

This section contains a general overview of stormwater management facility inspection, operation and maintenance guidelines. Appendix A contains Standard Operating Procedures (SOPs) for the facilities identified in Section II. Refer to the approved Drainage Report and Construction Drawings prior to performing inspections and/or maintenance.

### **A. Inspection Procedures**

All stormwater management facilities shall be inspected by a qualified individual at a minimum of one time per year. Inspections should follow the inspection guidance found in the SOPs located in Appendix A of this manual.

### **B. Maintenance Procedures**

Stormwater Management Facility Maintenance Programs are separated into three broad categories of work. These categories were based largely on the Urban Drainage and Flood Control District's Maintenance Program for regional drainage facilities. The categories are separated based upon the magnitude and type of the maintenance activities performed. A description of each category follows:

1. Routine Work

The majority of this work consists of regularly scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This work also includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It may also include activities such as weed control, mosquito treatment and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior notification to the Town.

## 2. Minor Work

This work consists of a variety of isolated or small-scale maintenance/operational problems. Most of this work can be completed by a small crew, hand tools, and small equipment. **These items require notification, at least 7 days prior to the start of work, to the Town's Utilities Department Stormwater Division at 720-733-6011.**

## 3. Major Work

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. **All of this work requires notification, at least 14 days prior to the start of work, to the Town's Utilities Department Stormwater Division at 720-733-6011 to ensure the proper maintenance is performed.** Some of this work requires that the engineering staff review the original design and construction drawings to assess the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

### **C. Maintenance Personnel**

Maintenance personnel must be qualified to properly maintain stormwater management facilities. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

## **VIII. References**

CONTECH Stormwater Solutions. 2007. *StormFilter Inspection and Maintenance Procedures*. [www.contech-cpi.org](http://www.contech-cpi.org).

Koski, T. and Skinner, V. 2003. Colorado State University Extension. Fact Sheet no.7.202, Lawn Care. <http://www.ext.colostate.edu/pubs/garden/07202.html>.

Law, N.L., K. DiBlasi, and U. Ghosh. 2008. *Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin*. Center for Watershed Protection. Prepared for U.S.

EPA Chesapeake Bay Program Grant CB-973222-01: Ellicott City, MD.  
[www.cpw.org](http://www.cpw.org).

Wright Water Engineers, Inc., Wenk Associates, Muller Engineering Company, Inc.,  
Matrix Design Group, and Smith Environmental. 2004. *City and County of  
Denver Water Quality Management Plan*. Denver, CO

## **IX. Appendices**

## **Appendix A – Standard Operating Procedures**

## **Grass Buffers and Swales**

Grass buffers and swales require maintenance of the turf cover and repair of rill or gully development. Healthy vegetation can often be maintained without using fertilizers because runoff from lawns and other areas contains the needed nutrients. Periodically inspecting the vegetation over the first few years will help to identify emerging problems and help to plan for long-term restorative maintenance needs. This section presents a summary of specific maintenance requirements and a suggested frequency of action.

### **Inspection**

Inspect vegetation at least twice annually for uniform cover and traffic impacts. Check for sediment accumulation and rill and gully development.

### **Debris and Litter Removal**

Remove litter and debris to prevent rill and gully development from preferential flow paths around accumulated debris, enhance aesthetics, and prevent floatables from being washed offsite. This should be done as needed based on inspection, but no less than two times per year.

### **Aeration**

Aerating manicured grass will supply the soil and roots with air. It reduces soil compaction and helps control thatch while helping water move into the root zone. Aeration is done by punching holes in the ground using an aerator with hollow punches that pull the soil cores or "plugs" from the ground. Holes should be at least 2 inches deep and no more than 4 inches apart.

Aeration should be performed at least once per year when the ground is not frozen. Water the turf thoroughly prior to aeration. Mark sprinkler heads and shallow utilities such as irrigation lines and cable TV lines to ensure those lines will not be damaged. Avoid aerating in extremely hot and dry conditions. Heavy traffic areas may require aeration more frequently.

### **Mowing**

When starting from seed, mow native/drought-tolerant grasses only when required to deter weeds during the first three years. Following this period, mowing of native/drought tolerant grass may stop or be reduced to maintain a length of no less than six inches. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See the inset for additional recommendations from the CSU Extension.

#### **CSU Extension Recommendations for Mowing Manicured Turf** (Source: T. Koski and V. Skinner, 2003)

The two most important facets of mowing are mowing height and frequency. The minimum height for any lawn is 2 inches. The preferred mowing height for all Colorado species is 2.5 to 3 inches. Mowing to less than 2 inches can result in decreased drought and heat tolerance and higher incidence of insects, diseases and weeds. Mow the lawn at the same height all year. There is no reason to mow the turf shorter in late fall.

Mow the turf often enough so no more than 1/3 of the grass height is removed at any single mowing. If your mowing height is 2 inches, mow the grass when it is 3 inches tall. You may have to mow a bluegrass or fescue lawn every three to four days during the spring when it is actively growing but only once every seven to 10 days when growth is slowed by heat, drought or cold. Buffalograss lawns may require mowing once every 10 to 20 days, depending on how much they are watered.

If weather or another factor prevents mowing at the proper time, raise the height of the mower temporarily to avoid cutting too much at one time. Cut the grass again a few days later at the normal mowing height.

## Irrigation Scheduling and Maintenance

Adjust irrigation schedules throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, with more irrigation needed during July and August. Native grass should not require irrigation after establishment, except during prolonged dry periods when supplemental, temporary irrigation may aid in maintaining healthy vegetation cover. Check for broken sprinkler heads and repair them, as needed. Do not overwater. Signs of overwatering and/or broken sprinkler heads may include soggy areas and unevenly distributed areas of lush growth.

Completely drain and blowout the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

## Fertilizer, Herbicide, and Pesticide Application

Use the minimum amount of biodegradable nontoxic fertilizers and herbicides needed to establish and maintain dense vegetation cover that is reasonably free of weeds. Fertilizer application may be significantly reduced or eliminated by the use of mulch-mowers, as opposed to bagging and removing clippings. To keep clippings out of receiving waters, maintain a 25-foot buffer adjacent to open water areas where clippings are bagged. Hand-pull the weeds in areas with limited weed problems.

Frequency of fertilizer, herbicide, and pesticide application should be on an as-needed basis only and should decrease following establishment of vegetation. See BMP Fact Sheet S-8 in Chapter 5 for additional information. For additional information on managing vegetation in a manner that conserves water and protects water quality, see the *GreenCO Best Management Practices Manual* ([www.greenco.org](http://www.greenco.org)) for a series of Colorado-based BMP fact sheets on topics such as irrigation, plant care, and soil amendments.

## Sediment Removal

Remove sediment as needed based on inspection. Frequency depends on site-specific conditions. For planning purposes, it can be estimated that 3 to 10% of the swale length or buffer interface length will require sediment removal on an annual basis.

- **For Grass Buffers:** Using a shovel, remove sediment at the interface between the impervious area and buffer.
- **For Grass Swales:** Remove accumulated sediment near culverts and in channels to maintain flow capacity. Spot replace the grass areas as necessary.

Reseed and/or patch damaged areas in buffer, sideslopes, and/or channel to maintain healthy vegetative cover. This should be conducted as needed based on inspection. Over time, and depending on pollutant loads, a portion of the buffer or swale may need to be rehabilitated due to sediment deposition. Periodic sediment removal will reduce the frequency of revegetation required. Expect turf replacement for the buffer interface area every 10 to 20 years.

## **Bioretention (Rain Gardens and Porous Landscape Detention)**

The primary maintenance objective for bioretention, also known as porous landscape detention, is to keep vegetation healthy, remove sediment and trash, and ensure that the facility is draining properly. The growing medium may need to be replaced eventually to maintain performance. This section summarizes key maintenance considerations for bioretention.

### **Inspection**

Inspect the infiltrating surface at least twice annually following precipitation events to determine if the bioretention area is providing acceptable infiltration. Bioretention facilities are designed with a maximum depth for the WQCV of one foot and soils that will typically drain the WQCV over approximately 12 hours. If standing water persists for more than 24 hours after runoff has ceased, clogging should be further investigated and remedied. Additionally, check for erosion and repair as necessary.

### **Debris and Litter Removal**

Remove debris and litter from the infiltrating surface to minimize clogging of the media. Remove debris and litter from the overflow structure.

### **Mowing and Plant Care**

- **All vegetation:** Maintain healthy, weed-free vegetation. Weeds should be removed before they flower. The frequency of weeding will depend on the planting scheme and cover. When the growing media is covered with mulch or densely vegetated, less frequent weeding will be required.
- **Grasses:** When started from seed, allow time for germination and establishment of grass prior to mowing. If mowing is required during this period for weed control, it should be accomplished with hand-held string trimmers to minimize disturbance to the seedbed. After established, mow as desired or as needed for weed control. Following this period, mowing of native/drought tolerant grasses may stop or be reduced to maintain a length of no less than 6 inches. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See Section 4.4 for additional guidance on mowing.

### **Irrigation Scheduling and Maintenance**

Adjust irrigation throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, while more irrigation is needed during the peak summer months. Native grasses and other drought tolerant plantings should not typically require routine irrigation after establishment, except during prolonged dry periods.

Check for broken sprinkler heads and repair them, as needed. Completely drain the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

### **Replacement of Wood Mulch**

Replace wood mulch only when needed to maintain a mulch depth of up to approximately 3 inches. Excess mulch will reduce the volume available for storage.

## **Sediment Removal and Growing Media Replacement**

If ponded water is observed in a bioretention cell more than 24 hours after the end of a runoff event, check underdrain outfall locations and clean-outs for blockages. Maintenance activities to restore infiltration capacity of bioretention facilities will vary with the degree and nature of the clogging. If clogging is primarily related to sediment accumulation on the filter surface, infiltration may be improved by removing excess accumulated sediment and scarifying the surface of the filter with a rake. If the clogging is due to migration of sediments deeper into the pore spaces of the media, removal and replacement of all or a portion of the media may be required. The frequency of media replacement will depend on site-specific pollutant loading characteristics. Based on experience to date in the metro Denver area, the required frequency of media replacement is not known. To date UDFCD is not aware of any rain gardens constructed to the recommendations of these criteria that have required full replacement of the growing media. Although surface clogging of the media is expected over time, established root systems promote infiltration. This means that mature vegetation that covers the filter surface should increase the life span of the growing media, serving to promote infiltration even as the media surface clogs.

## **Extended Detention Basins (EDBs)**

EDBs have low to moderate maintenance requirements on a routine basis, but may require significant maintenance once every 15 to 25 years. Maintenance frequency depends on the amount of construction activity within the tributary watershed, the erosion control measures implemented, the size of the watershed, and the design of the facility.

### **Inspection**

Inspect the EDB at least twice annually, observing the amount of sediment in the forebay and checking for debris at the outlet structure.

### **Debris and Litter Removal**

Remove debris and litter from the detention area as required to minimize clogging of the outlet.

### **Mowing and Plant Care**

When starting from seed, mow native/drought tolerant grasses only when required to deter weeds during the first three years. Following this period, mowing of native/drought tolerant grass may stop or be reduced to maintain a height of no less than 6 inches (higher mowing heights are associated with deeper roots and greater drought tolerance). In general, mowing should be done as needed to maintain appropriate height and control weeds. Mowing of manicured grasses may vary from as frequently as weekly during the summer, to no mowing during the winter. See Section 4 of this chapter for additional recommendations from the CSU Extension.

### **Aeration**

For EDBs with manicured grass, aeration will supply the soil and roots with air and increase infiltration. It reduces soil compaction and helps control thatch while helping water move into the root zone. Aeration is done by punching holes in the ground using an aerator with hollow punches that pull the soil cores or "plugs" from the ground. Holes should be at least 2 inches deep and no more than 4 inches apart.

Aeration should be performed at least once per year when the ground is not frozen. Water the turf thoroughly prior to aeration. Mark sprinkler heads and shallow utilities such as irrigation lines and cable TV lines to ensure those lines will not be damaged. Avoid aerating in extremely hot and dry conditions. Heavy traffic areas may require aeration more frequently.

### **Mosquito Control**

Although the design provided in this manual implements practices specifically developed to deter mosquito breeding, some level of mosquito control may be necessary if the BMP is located in close proximity to outdoor amenities.

The Town provides annual mosquito control for all public and private facilities. This program includes larvae control only. Mosquitos are more difficult to control when they are adults. This typically requires neighborhood fogging with an insecticide. Therefore, no adult mosquito

#### **Facts on Mosquito Breeding**

Although mosquitoes prefer shallow, stagnant water, they can breed within the top 6 to 8 inches of deeper pools.

Mosquitoes need nutrients and prefer shelter from direct sunlight.

Mosquitoes can go from egg to adult within 72 hours.

The most common mosquitoes in Colorado include the *Aedes Vexans* and the *Culex Tarsalis*. Both have similar needs for breeding and development.

control is provided. For questions regarding the Town's mosquito control program, please contact the Utilities Department Stormwater Division at 720-733-6011.

### **Irrigation Scheduling and Maintenance**

Adjust irrigation throughout the growing season to provide the proper irrigation application rate to maintain healthy vegetation. Less irrigation is typically needed in early summer and fall, with more irrigation needed during July and August. Native grass and other drought tolerant plantings should not require irrigation after establishment.

Check for broken sprinkler heads and repair them, as needed. Completely drain the irrigation system before the first winter freeze each year. Upon reactivation of the irrigation system in the spring, inspect all components and replace damaged parts, as needed.

### **Sediment Removal from the Forebay, Trickle Channel, and Micropool**

Remove sediment from the forebay and trickle channel annually. If portions of the watershed are not developed or if roadway or landscaping projects are taking place in the watershed, the required frequency of sediment removal in the forebay may be as often as after each storm event. The forebay should be maintained in such a way that it does not provide a significant source of resuspended sediment in the stormwater runoff.

Sediment removal from the micropool is required about once every one to four years, and should occur when the depth of the pool has been reduced to approximately 18 inches. Small micropools may be vacuumed and larger pools may need to be pumped in order to remove all sediment from the micropool bottom. Removing sediment from the micropool will benefit mosquito control. Ensure that the sediment is disposed of properly and not placed elsewhere in the basin.

### **Sediment Removal from the Basin Bottom**

Remove sediment from the bottom of the basin when accumulated sediment occupies about 20% of the water quality design volume or when sediment accumulation results in poor drainage within the basin. The required frequency may be every 15 to 25 years or more frequently in basins where construction activities are occurring.

### **Erosion and Structural Repairs**

Repair basin inlets, outlets, trickle channels, and all other structural components required for the basin to operate as intended. Repair and vegetate eroded areas as needed following inspection.

## **Sand Filter Basins**

Sand filters have relatively low routine maintenance requirements. Maintenance frequency depends on pollutant loads in runoff, the amount of construction activity within the tributary watershed, the erosion control measures implemented, the size of the watershed, and the design of the facility.

### **Inspection**

Inspect the detention area once or twice annually following precipitation events to determine if the sand filter is providing acceptable infiltration. Also check for erosion and repair as necessary.

### **Debris and Litter Removal**

Remove debris and litter from detention area to minimize clogging of the media. Remove debris and litter from the overflow structure.

### **Filter Surface Maintenance**

Scarify the top 2 inches of sand on the surface of the filter. This may be required once every two to five years depending on observed drain times. After this has been done two or three times, replenish the top few inches of the filter with clean coarse sand (AASHTO C-33 or CDOT Class C filter material) to the original elevation. Maintain a minimum sand depth of 12 inches. Eventually, the entire sand layer may require replacement.

### **Erosion and Structural Repairs**

Repair basin inlets, outlets, and all other structural components required for the BMP to operate as intended. Repair and vegetate any eroded side slopes as needed following inspection.

# Retention Ponds and Constructed Wetland Ponds

## **Inspection**

Inspect the pond at least annually. Note the amount of sediment in the forebay and look for debris at the outlet structure.

## **Debris and Litter Removal**

Remove debris and litter from the pond as needed. This includes floating debris that could clog the outlet or overflow structure.

## **Aquatic Plant Harvesting**

Harvesting plants will permanently remove nutrients from the system, although removal of vegetation can also resuspend sediment and leave areas susceptible to erosion. Additionally, the plants growing on the safety wetland bench of a retention pond help prevent drowning accidents by demarking the pond boundary and creating a visual barrier. For this reason, UDFCD does not recommend harvesting vegetation completely as routine maintenance. However, aquatic plant harvesting can be performed if desired to maintain volume or eliminate nuisances related to overgrowth of vegetation. When this is the case, perform this activity during the dry season (November to February). This can be performed manually or with specialized machinery.

If a reduction in cattails is desired, harvest them annually, especially in areas of new growth. Cut them at the base of the plant just below the waterline, or slowly pull the shoot out from the base. Cattail removal should be done during late summer to deprive the roots of food and reduce their ability to survive winter.

## **Mosquito Control**

Mosquito control may be necessary if the BMP is located in proximity to outdoor amenities.

The Town provides annual mosquito control for all public and private facilities. This program includes larvae control only. Mosquitos are more difficult to control when they are adults. This typically requires neighborhood fogging with an insecticide. Therefore, no adult mosquito control is provided. For questions regarding the Town's mosquito control program, please contact the Utilities Department Stormwater Division at 720-733-6011.

## **Sediment Removal from the Forebay**

Remove sediment from the forebay before it becomes a significant source of pollutants for the remainder of the pond. More frequent removal will benefit long-term maintenance practices. For dry forebays, sediment removal should occur once a year. Sediment removal in wet forebays should occur approximately once every four years or when build up of sediment results in excessive algae growth or mosquito production. Ensure that the sediment is disposed of properly and not placed elsewhere in the pond.

### **Facts on Mosquito Breeding**

Although mosquitoes prefer shallow, stagnant water, they can breed within the top 6 to 8 inches of deeper pools.

Mosquitoes need nutrients and prefer shelter from direct sunlight.

Mosquitoes can go from egg to adult within 72 hours.

The most common mosquitoes in Colorado include the *Aedes Vexans* and the *Culex Tarsalis*. Both have similar needs for breeding and development.

## **Sediment Removal from the Pond Bottom**

Removal of sediment from the bottom of the pond may be required every 10 to 20 years to maintain volume and deter algae growth. This typically requires heavy equipment, designated corridors, and considerable expense. Harvesting of vegetation may also be desirable for nutrient removal. When removing vegetation from the pond, take care not to create or leave areas of disturbed soil susceptible to erosion. If removal of vegetation results in disturbed soils, implement proper erosion and sediment control BMPs until vegetative cover is reestablished.

For constructed wetland ponds, reestablish growth zone depths and replant if necessary.

## **Stabilized Channels & Constructed Wetland Channels**

### **Inspection**

Inspect the channel at least annually. Look for signs of erosion.

### **Debris and Litter Removal**

Remove debris and litter as needed.

### **Aquatic Plant Harvesting**

Harvesting plants will permanently remove nutrients from the system although removal of vegetation can also resuspend sediment and leave areas susceptible to erosion. For this reason, UDFCD does not recommend harvesting vegetation as routine maintenance. However, aquatic plant harvesting can be performed if desired to maintain volume or eliminate nuisances related to overgrowth of vegetation. When this is the case, perform this activity during the dry season (November to February). This can be performed manually or with specialized machinery.

If a reduction in cattails is desired, harvest them annually, especially in areas of new growth. Cut them at the base of the plant just below the waterline, or slowly pull the shoot out from the base. Cattail removal should be done during late summer to deprive the roots of food and reduce their ability to survive winter.

### **Sediment Removal**

If the channel becomes overgrown with plants and sediment, it may need to be graded back to the original design and revegetated. The frequency of this activity is dependent on the site characteristics and should not be more than once every 10 to 20 years.

## Permeable Pavement Systems

The key maintenance objective for any permeable pavement system is to know when runoff is no longer rapidly infiltrating into the surface, which is typically due to void spaces becoming clogged and requiring sediment removal. This section identifies key maintenance considerations for various types of permeable pavement BMPs.

### **Inspection**

Inspect pavement condition and observe infiltration at least annually, either during a rain event or with a garden hose to ensure that water infiltrates into the surface. Video, photographs, or notes can be helpful in measuring loss of infiltration over time. Systematic measurement of surface infiltration of pervious concrete, Permeable Interlocking Concrete Pavers (PICP), concrete grid pavement, and porous asphalt<sup>1</sup> can be accomplished using ASTM C1701 Standard Test Method for Infiltration Rate of In Place Pervious Concrete.

### **Debris Removal, Sweeping, and Vacuuming**

- **All Pavements:** Debris should be removed, routinely, as a source control measure. Typically, sites that require frequent sweeping already plan for this activity as part of their ongoing maintenance program. For example, a grocery store may sweep weekly or monthly. Depending on the season, city streets also may have a monthly plan for sweeping. This is frequently performed with a broom sweeper. Although a sweeper can be effective at removing solids and debris from the surface, it will not remove solids from the void space of a permeable pavement. Use a vacuum or regenerative air sweeper to help maintain or restore infiltration. If the pavement has not been properly maintained, a vacuum sweeper will likely be needed.
- **PICP, Concrete Grid Pavements (with aggregate infill), Pervious Concrete, and Porous Asphalt<sup>1</sup>:** Use a regenerative air or vacuum sweeper after any significant site work (e.g., landscaping) and approximately twice per year to maintain infiltration rates. This should be done on a warm dry day for best results. Do not use water with the sweeper. The frequency is site specific and inspections of the pavement may show that biannual vacuuming is more frequent than necessary. After vacuuming PICP and Concrete Grid Pavers, replace infill aggregate as needed.

### **Snow Removal**

In general, permeable pavements do not form ice to the same extent as conventional pavements. Additionally, conventional liquid treatments (deicers) will not stay at the surface of a permeable pavement as needed for the treatment to be effective. Sand should not be applied to a permeable pavement as it can reduce infiltration. Plowing is the recommended snow removal process. Conventional plowing operations should not cause damage to the pavements.

- **PICP and Concrete Grid:** Deicers may be used on PICP and grid pavers; however, it may not be effective for the reason stated above. Sand should not be used. If sand is accidentally used, use a vacuum sweeper to remove the sand. Mechanical snow and ice removal should be used.
- **Pervious Concrete:** Do not use liquid or solid deicers or sand on pervious concrete. Deicers can damage the concrete and sand will reduce infiltration. Mechanical snow and ice removal should be used.
- **Porous Asphalt<sup>1</sup>:** Use liquid or solid deicers sparingly; mechanical snow and ice removal is preferred. Do not apply sand to porous asphalt.

## Full and Partial Replacement of the Pavement or Infill Material

- **PICP and Concrete Grid:** Concrete pavers, when installed correctly, should have a long service life. If a repair is required, it is frequently due to poor placement of the paver blocks. Follow industry guidelines for installation and replacement after underground repairs.

If surface is completely clogged and rendering a minimal surface infiltration rate, restoration of surface infiltration can be achieved by removing the first ½ to 1 inch of soiled aggregate infill material with a vacuum sweeper. After cleaning, the openings in the PICP will need to be refilled with clean aggregate infill materials. Replacement of the infill is best accomplished with push brooms.

- **Porous Gravel:** Remove and replace areas of excessive wear or reduced infiltration as needed. The frequency is dependent on site characteristics including site uses, vegetation, and materials.
- **Pervious Concrete:** Partial replacement of pervious concrete should be avoided. If clogged, power washing or power blowing should be attempted prior to partial replacement because saw cutting will cause raveling of the concrete. Any patches should extend to existing isolated joints. Conventional concrete may be used in patches, provided that 90 percent of the original pervious surface is maintained.
- **Reinforced Grass:** Remove and replace the sod cover as needed to maintain a healthy vegetative cover or when the sod layer accumulates significant amount of sediment (i.e., >1.5 inches). Maintenance and routine repairs should be performed annually, with sod replacement approximately every 10 to 25 years. When replacing sod, use a high infiltration variety such as sod grown in sandy loam.
- **Porous Asphalt<sup>1</sup>:** Conventional asphalt may be used in patches, provided that 90 percent of the original permeable surface is maintained.

<sup>1</sup> Porous asphalt is considered a provisional treatment BMP pending performance testing in Colorado and is not included in this manual at the present time.

## Underground BMPs

Maintenance requirements of underground BMPs can vary greatly depending on the type of BMP. Frequent inspections (approximately every three months) are recommended in the first two years in order to determine the appropriate interval of maintenance for a given BMP. This section provides general recommendations for assorted underground BMPs. For proprietary devices, the manufacturer should provide detailed maintenance requirements specific for the BMP.

### **Inspection**

- **All Underground BMPs:** Inspect underground BMPs at least quarterly for the first two years of operation and then twice a year for the life of the BMP, if a reduced inspection schedule is warranted based on the initial two years. Specifically look for debris that could cause the structure to bypass water quality flows. Strong odors may also indicate that the facility is not draining properly. Inspection should be performed by a person who is familiar with the operation and configuration of the BMP.
- **Inlet Inserts:** Inspect inlet inserts frequently; at a minimum, inspect after every storm event exceeding 0.6 inches. Removal of flow blocking debris is critical for flood control.

### **Debris Removal, Cartridge Replacement, and Vacuuming**

- **All Underground BMPs:** Follow the manufacturer's recommended maintenance requirements and remove any flow blocking debris as soon as possible following inspection.
- **Filter Cartridges:** Inspection of filter cartridges is recommended twice yearly. Replacement of filter cartridges is anticipated on an annual basis. Depending on site characteristics, the replacement frequency may be extended to no less than once every three years. However, semi-annual inspection should continue to ensure that proper function of the system is maintained. Maintenance is required when any of the following conditions exist:
  - If there is more than 4 inches of accumulated sediment on the vault floor.
  - If there is more than ¼ inch of accumulation on the top of the cartridge.
  - If there is more than 4 inches of standing water in the cartridge bay for more than 24 hours after the end of a rain event.
  - If the pore space between media granules is full.
  - If inspection is conducted during an average rainfall event and the system remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges).
  - If hazardous material release (automotive fluids or other) is reported.
  - If pronounced scum line ( $\geq 1/4$ " thick) is present above top cap.
  - If system has not been maintained for three years.
- **Hydrodynamic Separators:** Vacuum units at least once annually and more frequently as needed, based on inspections.

## **Appendix B – Stormwater Facility Maintenance Inspection Forms**

## Typical Inspection & Maintenance Requirements

### Grass Buffers and Swales

Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Low-flow channel							
Upper Stage							

### Extended Detention Basins (EDBs)

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Forebay							
Low-flow channel							
Bottom Stage							
Micropool							
Outlet Works							
Emergency Spillway							
Upper Stage							
Embankment							

### Rain Gardens and Porous Landscape Detention (PLDs)

PLD Features	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points							
Landscaping							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

### Sand Filter Basin (SFBs)

SFB Features	Sediment Removal	Mowing/ Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points/ Splitter Box							
Sedimentation Chamber							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

### Retention Ponds and Constructed Wetland Ponds

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Forebay							
Low-flow channel							
Bottom Stage							
Permanent Pool							
Outlet Works							
Emergency Spillway							
Upper Stage							
Embankment							

### Constructed Wetland Channels

EDB Features	Sediment Removal	Mowing/ Weed Control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/algae control)	Structure Repair
Inflow Points (outfalls)							
Bottom Stage							
Permanent Pool							
Upper Stage							

## Permeable Pavement Systems

PLD Features	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points							
Landscaping							
Filter Media							
Underdrain System							
Overflow Outlet Works							
Embankment							

Note: For more information regarding facility features refer to the Town's Storm Manual or UDFCD Urban Storm Drainage Criteria Manual.