Chapter 6
BMP Maintenance

Contents

1.0 Introduction

In order for stormwater BMPs to be effective, proper maintenance is essential. Maintenance includes both routinely scheduled activities, as well as non-routine repairs that may be required after large storms, or as a result of other unforeseen problems. BMP maintenance is the responsibility of the entity owning the BMP; however, local governments with municipal separate storm sewer system (MS4) permits are responsible for ensuring that maintenance of privately owned BMPs occurs within their MS4.

BMPs should be designed with maintenance as one of the key design considerations. Planning-level design guidance pertaining to maintenance is included in the individual Fact Sheets contained within this manual. This chapter focuses on maintenance of in-service BMPs and provides recommendations for private BMP owners, as well as for MS4 permittees responsible for ensuring proper maintenance for both public and private facilities within their MS4.

2.0 Defining Maintenance Responsibility for Public and Private Facilities

Identifying who is responsible for maintenance of BMPs and ensuring that an adequate budget is allocated for maintenance is critical to the long-term success of BMPs. Maintenance responsibility may be assigned in different ways:

- Publically owned BMPs are maintained by the MS4 permittee.
- Publically owned regional drainage facilities located within the UDFCD service area may be maintained by UDFCD when specific maintenance eligibility criteria are met (subject to funding limitations).
- Privately owned BMPs typically are maintained by the property owner, homeowner's association, or property manager.
- Privately owned BMPs may be maintained by the MS4 permittee under a written agreement with the owner, with appropriate fees assessed for maintenance services.

MS4 permittees can utilize a variety of legal approaches to ensure maintenance of stormwater BMPs. Representative measures include:

- Agreements establishing legally binding BMP maintenance requirements and responsibilities.
- Permit obligations specifying BMP requirements; or
- Municipal legislative action or rulemaking authority.

Examples of some of the specific requirements for BMP maintenance suggested for legal agreements by the Watershed Management Institute (1997) include:

- **General Assurances:** Identify requirements for proper operation and maintenance, conditions for modification of facilities, dedicated easements, binding covenants, operation, and maintenance plans, and inspection requirements.
- **Warranty Period:** Require the original developer to be responsible for maintenance and operation during a defined short-term period and identify the entity responsible for long-term operation. The

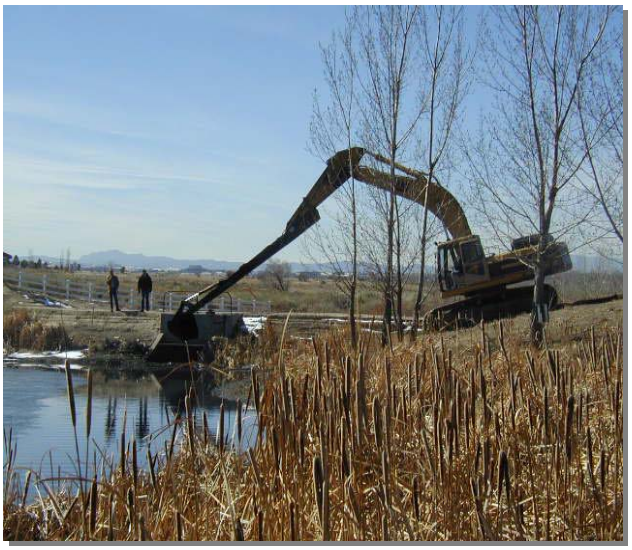
party responsible for long-term maintenance must have appropriate legal authority to own, operate maintain, and raise funds to complete needed maintenance.

- **Proof of Legal Authority:** Require that the entity meet certain conditions verifying its legal authority to ensure maintenance.

- **Conditions for Phased Projects:** Clearly specify how maintenance responsibilities are allocated over the long-term for a project that is phased in over time. This includes identifying access points during each phase.

- **Remedies:** Clearly define remedies in the event that the facility is not being properly maintained.

For public facilities, one of the key issues is ensuring that adequate staff and budget are provided to the department responsible for maintenance. Ponds, lakes, and wetland BMPs should be built only if assurances are provided that adequate maintenance staff and resources are identified in advance.



Photograph 6-1. Sediment removal from a forebay at the regional Shop Creek BMP System.

For private facilities, such as those owned and maintained by homeowners' associations, there is often a lack of understanding of maintenance required for BMPs. Maintenance plans should be prepared and submitted as part of the development review/approval process and be provided to the owner(s) upon sale of the development. It is also important to educate the general public on the purpose and function of stormwater BMPs. This is critical in cases where Low Impact Development (LID) or landscape-based BMPs are distributed throughout multiple parcels in developments. In addition to legally binding maintenance agreements, it is also helpful to have easy-to-understand informational brochures that describe the functions and maintenance requirements for these facilities.

3.0 Developing a Maintenance Plan

Maintenance plans can be prepared as stand-alone documents, or be made part of a construction set. This is typically based on the preference of the reviewing entity or MS4 permittee. The following outlines key components of a maintenance plan:

1. A simple drawing of the site development showing the locations of all stormwater quality BMPs at the site and key components such as forebays, inlets, outlets, low flow channels or other components that require inspections or maintenance. The drawing should be kept on-site at the property or the property management office. Any changes to the facility over time should be noted on the drawing.

2. A brief description of the inspection and maintenance procedures and frequencies.

3. A brief description of the maintenance requirements and expected frequency of actions, which can be obtained from discussion within this chapter. Include instruction on how to access each

component of each BMP and with what equipment. It is important to identify all maintenance requirements related directly to the water quality functions of the BMP and provide information concerning future site work that could potentially impact the integrity of the BMP. This is particularly true for landscaped BMPs. For example, the following maintenance requirements may be important for a rain garden:

- Provide frequent weed control in the first three years following installation and as needed for the life of the facility. Weeding should be performed mechanically, either by hand or by mowing (after establishment of the vegetation).
- Remove debris from area and outlet.
- Ensure cleanout caps remains watertight.

Additionally, the maintenance plans should identify constraints and considerations for future work that have the potential to affect the performance of the BMP. For example, the following prohibitions would typically be included in a maintenance plan for a rain garden:

- Do not place conventional sod on the surface of the rain garden.
- Do not plant trees within 10 feet of the rain garden.
- Do not place fill in the rain garden.
- Do not puncture impermeable liner, (if present).

4. An inspection form or checklist appropriate for the facilities in place at the site. A log of inspection forms should be kept onsite or at the property management office to demonstrate that routine inspections and maintenance are occurring.

5. Contact information for the entity responsible for maintenance of the facility. For example, this could be a homeowner's association, municipality, or other entity. (For BMPs maintained by UDFCD, the owner, rather than UDFCD, should be contacted.)

6. Copies of legally binding agreements associated with the facility that show that the facility owner is aware of, and will abide by, their maintenance responsibilities.

7. Other items as appropriate for specific conditions, which may include any of the following:

   - For ponds, include a permanent control point and other critical elevations, (i.e. bottom of pond, EURV, 100-year WSE, or overflow).
   - Provide the estimated baseflow used for the design and other hydrologic information for larger watersheds.
   - List information pertaining to materials testing for any contaminant testing requirements for removed sediment.
   - Include post-maintenance considerations, (e.g., restoration of flow paths).
   - Provide for long-term monitoring requirements, (e.g., 404 permit reports).

It is also important to note that the guidelines included in this manual should always be combined

with common sense and good judgment based on field observations and practical experience. Often, there will be maintenance requirements that are specific to a given site in addition to the general maintenance guidance provided in this manual.

On a general note with regard to BMPs that have a vegetation component or involve weed and pest control, UDFCD strongly advocates the use of Integrated Pest Management (IPM) practices that help to reduce the level of chemical applications through a variety of management practices. IPM is discussed in BMP Fact Sheet S-8 located in Chapter 5.

Although water quality monitoring is not typically required as part of maintenance agreements, it is encouraged as an effective tool for determining if the BMP is functioning effectively. Stormwater quality monitoring guidelines can be downloaded from the International Stormwater BMP Database website (www.bmpdatabase.org).

Additional References for Stormwater BMP Maintenance

City of Portland, Oregon. 2002. Maintaining Your Stormwater Management Facility: A Handbook for Private Property Owners. Portland, OR: Bureau of Environmental Services. http://www.portlandonline.com/Bes/index.cfm?a=54730&c=34980.

Low Impact Development Center. 2003. Low Impact Development Urban Design Tools. http://www.lid-stormwater.net/bio_maintain.htm; http://www.lid-stormwater.net/permpavers_maintain.htm

North Carolina State University Cooperative Extension. 2006. Bioretention Performance, Design, Construction, and Maintenance. http://www.bae.ncsu.edu/stormwater/PublicationFiles/Bioretention2006.pdf

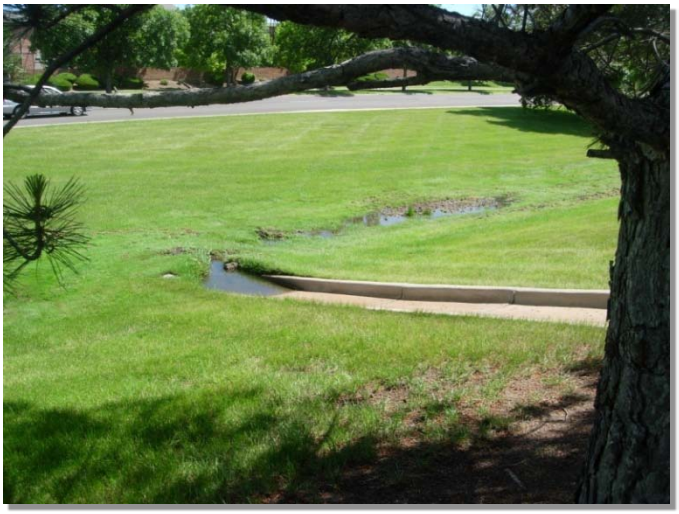
Santa Clara Valley Urban Runoff Pollution Prevention Program Example BMP Inspection and Maintenance Checklist. http://www.scvurppp-w2k.com/bmp_om_forms.htm

Southeast Metro Stormwater Authority (SEMSWA) Stormwater Management Facility Operation and Maintenance (O&M) Manual. www.semswa.org

Watershed Management Institute. 1997. Operation, Maintenance and Management of Stormwater Management Systems. Ingleside, MD: Watershed Management Institute.

4.0 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.



Photograph 6-2. A lack of sediment removal in this grass swale has resulted in a grade change due to growth over the deposition and ponding upstream.

4.1 Inspection

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

4.2 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.

4.3 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.

4.4 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.

4.5 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.

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.

4.6 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 2008 *GreenCO Best Management Practices Manual* (www.greenco.org) for a series of Colorado-based BMP fact sheets on topics such as irrigation, plant care, and soil amendments.

4.7 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.

5.0 Bioretention (Rain Garden or 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.

5.1 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.

5.2 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.

5.3 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.

5.4 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.

5.5 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.

5.6 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.

6.0 Green Roofs

A five-year maintenance plan should be established prior to the completion of all new green roofs. Both plant maintenance and inspection of various roof structural elements will be required regularly. Additionally, green roof plants require regular attention and care including irrigation, weeding, fertilizing, pruning, and replanting. While the first several years following green roof construction are critical for establishing vegetation, controlling weeds, and detecting problems such as leaks, a long-term maintenance plan will also be necessary. During the first five years, the maintenance plan should be refined and adjusted based on experience to develop an effective long-term plan.

Photograph 6-3. When inspecting roof drains, remove any surrounding rock as well as the inlet grate and visually inspect the drainpipe to ensure it is free of any extraneous materials.

6.1 Inspection

Green roof inspection should be conducted at least three times per year. At a minimum, the following areas require inspection:

- Inspect joints, borders or other features that pass through the roof to remove roots and identify damage that could lead to leaks. For example, inspect abutting vertical walls, roof vent pipes, outlets, air conditioning units, and perimeter areas. Joints with facades must provide open access for inspection, maintenance, and upkeep.

- A vegetation-free zone of approximately one foot should be maintained at the border of roof edges and at drain openings on the roof. Vegetation-free zones should be lined with pavers, stones, or gravel. Drains must remain free of vegetation and foreign objects. In order to allow for regular inspections and maintenance, drains on a green roof must remain permanently accessible.

- Because of the severe consequences of drain backups, inspection of drainage flow paths is crucial. Remove the inlet cover and visually inspect drainage pipes for roots or other material that could impede the flow of water.

- Plants are susceptible to poor drainage in the soil. If too much water is present and unable to drain, the plants will drown or rot. Routine inspections of drains should take place approximately three times per year as well as after precipitation events of 0.6 inches or more.

- Inspect the irrigation system for leaks or malfunctions. Uneven vegetative growth or dying plants should serve as indicators of potential irrigation system problems.

6.2 Plant Care and Media Replacement

As with any garden, plant replacement will be required periodically throughout the life of a green roof. For green roofs serving stormwater functions, heat-tolerant plants with shallow, spreading and fibrous

root systems are recommended. Plant selection is crucial on roofs with intense wind and light such as roofs of skyscrapers or roofs that receive reflected solar radiation from other structures. Additionally, certain portions of the roof may experience more intense sunlight and or reflected heat, requiring additional care or irrigation system adjustments.

Care of the plants on a green roof will require the most attention during the critical establishment phase. A horticultural professional should work with individuals caring for the new roof to organize schedules and routines for hand weeding, thinning, pruning, fertilizing, irrigation system scheduling and adjustments, and plant replacement. Watering and weeding are particularly important for the first two years of the green roof. For overall health of the green roof, weeds should be identified and removed early and often.

If the growing medium needs to be replaced, it should be replaced in accordance with the original design specifications, unless these specifications have been identified as a cause of poor plant growth or green roof performance. Any substitutions or adjustments to the original green roof media must be balanced carefully to meet loading limits, drainage requirements, and characteristics conducive to healthy plant growth.

When caring for plants or adjusting growing media, care should be taken to avoid use of materials likely to result in nutrient export from the green roof. For example, growing media and compost should have a low phosphorus index (P index). Appropriate plants with low fertilization requirements should be chosen. If used, fertilizer application should be minimized to levels necessary only for plant health.

6.3 Irrigation Scheduling and Maintenance

Green roofs in Colorado should be equipped with irrigation systems, even if the ultimate goal is for the plants to rely primarily on natural precipitation. Irrigation schedules should be based on the evapotranspiration (ET) requirements of the plants, the type of irrigation system used (e.g., drip or spray), and changing ET over the growing season. Irrigation systems equipped with advanced irrigation controllers based on soil moisture can help facilitate watering according to the changing water needs of the plants. If advanced systems are not used, irrigation should be manually adjusted during the growing season to replace water lost through ET. During the first two years of plant establishment, regular irrigation will likely be needed. After plant establishment, it may be possible to reduce supplemental irrigation during non-drought conditions.

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.

7.0 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.

7.1 Inspection

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

7.2 Debris and Litter Removal

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

7.3 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.

7.4 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.

7.5 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 most effective mosquito control programs include weekly inspection for signs of mosquito breeding with treatment provided when breeding is found. These inspections can be performed by a mosquito control service and typically start in mid-May and extend to mid-September. Treatment should be targeted toward mosquito larvae. Mosquitoes are more difficult to control when they are adults. This typically requires neighborhood fogging with an insecticide.

The use of larvicidal briquettes or "dunks" may be appropriate. These are typically effective for about one month and perform best when the basin has a hard bottom (e.g., concrete lined micropool).

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.

7.6 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.

7.7 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.

7.8 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.

7.9 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.

8.0 Sand Filters

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.

8.1 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.

8.2 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.

8.3 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.

8.4 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.

9.0 Retention Ponds and Constructed Wetland Ponds

9.1 Inspection

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

9.2 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.

9.3 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.

9.4 Mosquito Control

Mosquito control may be necessary if the BMP is located in proximity to outdoor amenities. The most effective mosquito control programs include weekly inspection for signs of mosquito breeding with treatment provided when breeding is found. These inspections and treatment can be performed by a mosquito control service and typically start in mid-May and extend to mid-September. The use of larvicidal briquettes or "dunks" is not recommended for ponds due to their size and configuration.

Weekly mosquito inspections with targeted treatments are frequently less costly and more effective than regular widespread application of insecticide.

9.5 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.

9.6 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.

10.0 Constructed Wetland Channels

10.1 Inspection

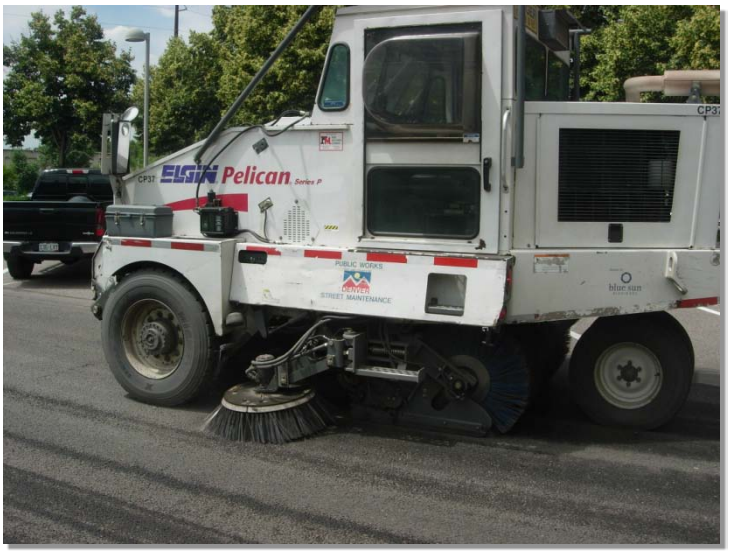
Inspect the channel at least annually. Look for signs of erosion.

10.2 Debris and Litter Removal

Remove debris and litter as needed.

10.3 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.



Photograph 6-4. This broom sweeper will only remove debris from the pavement surface. Broom sweepers are not designed to remove solids from the void space of a permeable pavement. Use a vacuum or regenerative air sweeper to help maintain or restore infiltration through the wearing course.

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.

10.4 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.

11.0 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.

11.1 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[1] can be accomplished using ASTM C1701 Standard Test Method for Infiltration Rate of In Place Pervious Concrete.

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

11.2 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 such as the one shown in Photo 6-4. Although this type of 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[1]:** 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.

11.3 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 accidently 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[2]:** Use liquid or solid deicers sparingly; mechanical snow and ice removal is preferred. Do not apply sand to porous asphalt.

11.4 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

[2] Porous asphalt is considered a provisional treatment BMP pending performance testing in Colorado and is not included in this manual at the present time.

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[3]:** Conventional asphalt may be used in patches, provided that 90 percent of the original permeable surface is maintained.

12.0 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.

12.1 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.

12.2 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.

[3] Porous asphalt is considered a provisional treatment BMP pending performance testing in Colorado and is not included in this manual at the present time.

- **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 (≥ 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.

13.0 References

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