# *Appendix 9-D*

# *FROM THE DRAFTING BOARD TO THE FIELD – DESIGNING BMPs TO FACILITATE AND SIMPLIFY MAINTENANCE*

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## 9-D.1.0 INTRODUCTION

Maintenance must be considered throughout the entire stormwater program – from early program policy decisions, to design standards, to the development review process, and, most important, to inspection of BMPs in the field. The following section provides tips on how to tailor design and field procedures to minimize long-term maintenance needs. **Figures 9-D.1 and 9-D.2** show some good and bad examples of design features related to maintenance.

Issues related to BMP location are discussed in **Chapter 6*, Site Planning and Design Considerations***. Typical design issues that have been observed in the field include the following (examples in **Figure 9-D.3**):

- An appropriate BMP selection was made, but the BMP was located so it was not receiving and treating runoff from much of or important parts of the site.
- The BMP's geometry was incorrect (includes the flow path, short-circuiting or bypassing of the treatment mechanism, the residence time of runoff within the BMP, etc.).
- The size of the contributing drainage area (CDA) may have contributed to performance issues.
- The BMP was not sized correctly for the Treatment Volume.
- An incorrect type and depth of media was specified for filters.
- An improper type of pre-treatment was used and/or designed incorrectly.

Among the observed construction issues were the following:

- BMPs were installed differently than called for on the plans.
- Inappropriate types of filter media were used, or the media was installed at incorrect depths.
- The BMP site was not graded properly, resulting in backup of water, excessive erosion and clogging at/around inlets.

**POOR EXAMPLES**

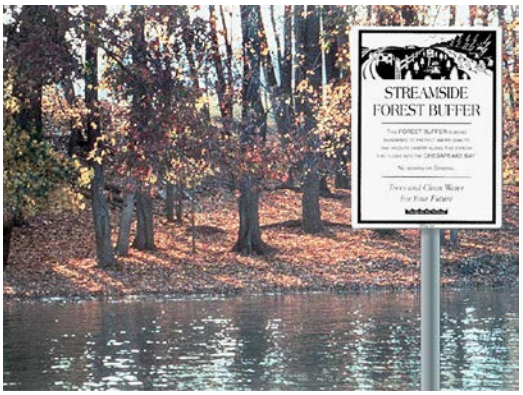
**Maintenance Access and Safety:**
Steep side slopes make maintenance
difficult and are a safety hazard.

**Practice Selection:**
Underground BMPs can be out of sight, out
of mind when it comes to maintenance.

**No Pretreatment:**
Without pretreatment, sediment can enter
The main treatment cell and inlets can erode.

**GOOD EXAMPLES**

**Maintenance Access and Safety:**
Shallow side slopes and wetland benches
Are a maintenance and safety feature.




**Practice Selection:**
Nonstructural BMPs, such as riparian
Restoration, can be low-maintenance
Options and community amenities.


**Pretreatment:**
Forebays and pretreatment cells help protect
The main pond and ease future maintenance.

***Figure 9-D.1. Examples of Poor and Good Maintenance Features Related to the Design Process***
Source: CWP 2008

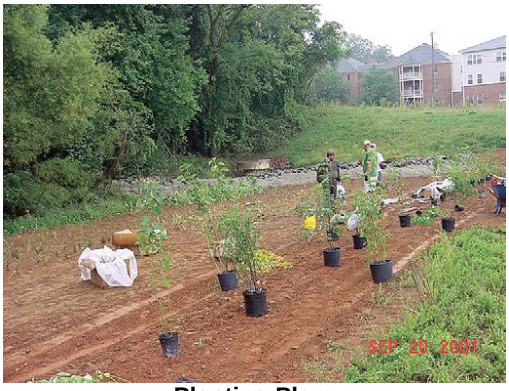
**POOR EXAMPLES**

**Not a Community Amenity:**
Unsightly basins in residential areas tend to become nuisances and generate complaints.

**GOOD EXAMPLES**

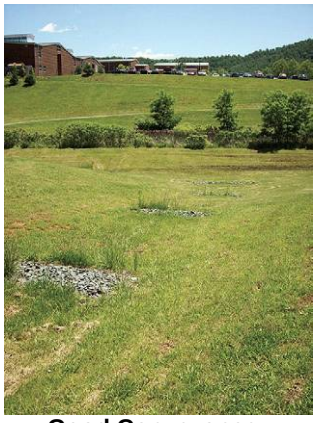
**Community Amenity:**
Stormwater BMPs, such as this rain garden, can be Designed as amenities, with plantings, interpretive Signage, and public access.

**No Planting Plan:**
Lack of plants and landscaping make BMPs Unattractive and undesirable to maintain.



**Planting Plan:**
Plants are being added to this regional basin to Enhance aesthetics and water quality functions.

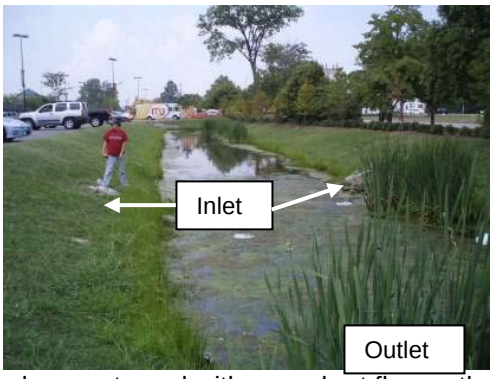
**Poor Conveyance:**
Improperly designed conveyances become Maintenance problems in the future.



**Good Conveyance:**
Good conveyance design can include check dams, Vegetation, and adequate channel lining.

***Figure 9-D.2. More Examples of Poor and Good Maintenance Features Related to Design Process***
Source: CWP 2008

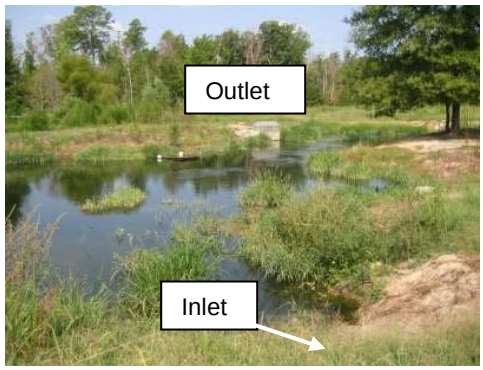
**POOR EXAMPLES**



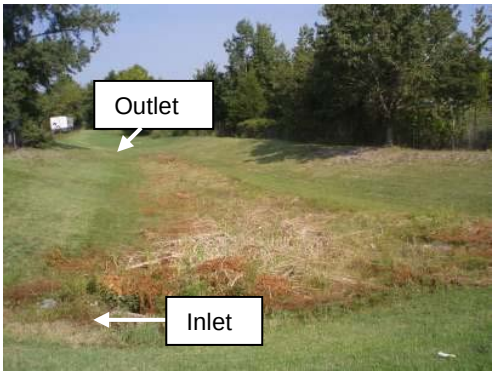

Very long wet pond with very short flow path; shortest flow path is 25' out a total pond length of 315'.

Dry pond with curb cuts very close to outlet, bypassing treatment mechanism.

**GOOD EXAMPLES**




Wet pond with a good length/width ratio of 3.4:1




Dry pond with length/width ratio = 8.9 and long flow path.

***Figure 9-D.3. Examples of Improper BMP Design***
(Source: CWP, 2009)

## 9-D.2.0 AUTHORIZE BMPs THE PROGRAM IS PREPARED TO MAINTAIN

Selecting or approving the right stormwater BMP is the key to ensuring success. Historically, poor selection of BMPs has usually contributed to failures and chronic maintenance problems. Adding nonstructural BMPs – such as conserving natural areas, restoring riparian areas, and disconnecting impervious surfaces – to the list of approved BMPs can also help reduce maintenance costs.

Designing BMPs as multifunctional and aesthetically pleasing facilities promotes maintenance because the public uses and takes interest in these areas. For instance, BMPs that are designed as components of greenways, walking trails, recreation areas, parks, streetscapes, and courtyards have a higher likelihood of receiving maintenance. **Table 9-D.1** outlines some of the key maintenance considerations for various BMPs. Specific design features are addressed in the BMP Specifications on the Virginia Stormwater BMP Clearinghouse web site. These maintenance items are also included in the various BMP Inspection/Maintenance Checklists found in **Appendix 9-C** of this chapter.

***Table 9-D.1. Key Maintenance Considerations for Various BMPs***

| Type of Practice | Overall Maintenance Burden* | Key Maintenance Considerations |
|---|---|---|
| Stormwater Ponds | M | • Periodically remove and dispose of sediments<br>• Control woody vegetation on dam<br>• Repair slumping, animal burrows, and seepage associated with dam<br>• Prevent clogging of orifices<br>• Prevent unauthorized access to deep water areas, risers, pipes, and manholes due to safety concerns<br>• Manage vegetation and remove trash<br>• Prevent standing water and mosquito habitat (mostly associated with dry extended detention ponds) |
| Stormwater Wetlands | M | • See above for ponds<br>• Manage invasive species |
| Filtering Practices | H | • Prevent clogging of filter surface through frequent cleaning and removal of top layer<br>• Replace filter media when clogged<br>• Pump out sedimentation chamber (e.g., sand filters)<br>• Use confined-space entry procedures for some designs |
| Infiltration Practices | L - M | • Repair and restore clogged practices<br>• Prevent standing water |
| Bioretention | M | • Prune, replace, and enhance vegetation<br>• Replace mulch layer frequently<br>• Keep inflow points (e.g., curb cuts) flowing and free of sediment and debris<br>• Replace filter surface or install wick drains, if clogged<br>• Keep underdrain clear<br>• Control impacts from road salt and snow plows in cold climates |
| Open Channels | M | • Remove sediment periodically<br>• Manage vegetation<br>• Repair erosion after heavy storms<br>• Clear debris from upstream face of check dams, if applicable<br>• Minimize standing water and mosquito habitat |
| Grass Channels | L - M | • Remove sediment periodically<br>• Repair erosion after heavy storms<br>• Manage vegetation<br>• Minimize standing water and mosquito habitat |
| Impervious Area Disconnection | M | • Ensure runoff enters pervious area<br>• Remove sediment and debris build-up at points where runoff enters pervious area<br>• Prevent adjacent uses from piping through or around pervious areas<br>• Manage vegetation in pervious area<br>• Maintain any “structural” elements in design: (e.g., level spreaders, energy dissipators, cisterns, rain gardens, etc.) |
| Sheet flow to Buffer or Open Space (e.g., Preserving Open Space Designed to Intercept and Treat Runoff) | L | • Maintain runoff as sheet flow; repair erosion rills and gullies<br>• Maintain energy dissipators, level spreaders, and other devices to maintain sheet flow<br>• Prevent adjacent uses from piping runoff through open space or buffer |
| Natural Area Conservation and Restoration | L | • Prevent encroachments, such as dumping yard waste, cutting of trees, clearing and minor encroachments (e.g., sheds, decks, etc.)<br>• Manage invasive species |
| **Proprietary Devices** | H | • Conduct frequent to periodic pump-outs and disposal; requires approved disposal method for liquids and solids<br>• Clean or replace cartridges, filter media, etc., depending on device<br>• Repair clogged orifices and by-passes<br>• Use confined-space entry procedures for some designs |
| * L = low; M = medium; H = high | | |

Source: CWP 2008

## 9-D.3.0 DEVELOP BMP-SPECIFIC MAINTENANCE PLANS

Maintenance plans can be incorporated into approved design plans and/or as a component of maintenance agreements. Maintenance plans should identify the responsible party, include a list and schedule for both routine and structural maintenance, and outline any legal mechanisms in place that guide long-term maintenance (i.e., maintenance agreements, easements, and/or deeds of easement). Checklists can assist with typical maintenance tasks for specific categories of BMPs.

## 9-D.4.0 OVER-SIZE BMP STORAGE

Over-sizing the storage provided in a BMP, as compared to what is required to achieve the BMP's performance targets, will decrease the maintenance frequency in a BMP and, thus, the potential life-cycle costs. It is left to the discretion of municipalities to increase design volume requirements for reduced maintenance frequency (if desired) beyond state stormwater management design requirements.

Extended detention outlets should be designed to allow for the adjustment of detention times. Information about the effects of detention times on water quality enhancement, erosion, and flooding is still evolving, and there may be a need for operational changes in the field to address site-specific or sub-watershed related concerns on a case-by-case basis (especially when sub-watershed planning has not been undertaken).

## 9-D.5.0 ENSURE LONG-TERM MAINTENANCE ACCESS

As noted in the body of this chapter, site access must be safe and must provide enough room for construction vehicles to perform maintenance. Access should include a dedicated easement that guarantees right-of-entry. These requirements are adequate for filtration and open-channel devices, but the access requirements for underground and above-ground (or open-air) BMPs and surface treatments are slightly different.

For example, for ponds and wetlands it is important that the access paths/roads have adequate width (12-foot minimum is common) and appropriate longitudinal slopes (no steeper than 15% is recommended) to allow maintenance vehicles to enter and turn around.

Programs can also consider surface treatments, such as reinforced turf, that do not increase a site's impervious cover. Maintenance access should extend to the forebay, safety bench, riser/outlet, and emergency spillway. Risers should be located in embankments for access from land, and they should include access to all elements via a manhole and steps.

A maintenance route should be established to allow vehiclular access to BMP. The slope of the access route should accommodate maintenance vehicles (i.e., 4H:1V or flatter). Access to stormwater lot-level controls may not be possible, given the tendency for homeowners to construct fences, gardens, landscaping, etc. If stormwater lot-level or conveyance controls (i.e., enhanced swales or trenches) are proposed along rear lot lines, municipalities can obtain an easement for maintenance. The logistics of maintaining access to such an easement may require considerable effort on the part of the municipality and may not be feasible.

Access to inlet and outlet structures, flow splitters, and by-pass manholes/chambers is also important. Access to an outlet structure for a pond or wetland can be provided by placing the outlet in a chamber in the embankment. Locating the outlet in a chamber enhances the aesthetics of the BMP and reduces the potential for vandalism.

## 9-D.6.0 PROVIDE RUNOFF PRE-TREATMENT

*Pre-treatment* refers to the techniques used to provide storage or to filter out coarse materials before stormwater enters the BMP. Proper pre-treatment preserves a greater fraction of the water Treatment Volume over time and prevents large particles from clogging orifices, filter material, and infiltration sites. The specific techniques and volumes of stormwater treated vary according to the type of BMP used.

Common pre-treatment practices include forebays, vegetated filter strips, stone filter strips (for higher velocities), and grass channels. One important consideration is that pre-treatment practices usually require frequent maintenance, such as sediment and trash removal. Practically all of the new BMP Specifications on the Virginia Stormwater BMP Clearinghouse web site require at least one type of pre-treatment. Adequate pre-treatment (oil/grit separators, roof leader filter traps, grass swales, etc.) must be provided for infiltration or filtration BMPs.

### 9-D.6.1 Forebays

Forebays are applicable for most large end-of-pipe stormwater management facilities (wetlands, wet ponds, dry ponds, infiltration basins). Forebays allow sediment deposits to be concentrated in one location, thereby simplifying maintenance operations. To minimize the potential for scour and re-suspension, forebays may have a deep permanent pool which should be lowered for maintenance. If water will remain in the downstream portion of the facility during maintenance, the berm between the forebay and the rest of the facility will need to be designed as a small dam.

In cases where the forebay releases to a dry pond or infiltration basin, a gravity drainable pipe can be installed in the berm (if physically feasible) to lower the water level of the forebay. In cases where the forebay releases to a wet pond or wetland, there are two options. The water level in the downstream portion of the facility can be lowered until the berm is emergent. Water can then be pumped from the forebay to the downstream portion of the facility until the forebay is dry. Maintaining water in the downstream portion of the facility has the benefit of reducing the impacts to the aquatic and shoreline fringe vegetation. The second option would be to drain both facilities. This could be accomplished by either valved gravity-draining maintenance pipes (if feasible) in both the forebay and the downstream portion of the facility, or by pumping if the facilities cannot be gravity drained.

### 9-D.6.2 Forebay Maintenance/Drawdown Pipe

A maintenance pipe should be provided to lower the level of a forebay's permanent pool for maintenance. This maintenance pipe should be set near or at the bottom of the facility. If gravity drainage is not feasible, the facility will have to be pumped when maintenance is required. If possible, the pond water level should be lowered early in the morning or overnight to reduce downstream thermal impacts. A geotextile filter bag should be attached to the end of the maintenance pipe to prevent the discharge of sediment from the facility into the receiving waters.

## 9-D.7.0 PROVIDE A MAINTENANCE BY-PASS

Maintenance may take from several days to a week to perform. Storms during this time should be *routed around* the BMP. The by-pass should be located either at the inlet or slightly upstream of the BMP. In piped systems, this is accommodated by fitting sluice gates to the by-pass pipe and BMP inlet pipe in an upstream manhole. For maintenance operations, the gate to the BMP can be closed and the gate to the by-pass pipe opened. This type of system can also be used for the seasonal operation of infiltration systems that accept roadway runoff.

## 9-D.8.0 CAREFULLY DESIGN CONVEYANCE SYSTEMS

High flows into, through, and out of the BMP often cause downstream erosion in off-site areas where access may be difficult. This increases the maintenance burden. To minimize erosion, designs should consider inlet and outlet protection, conveyance channels, and seepage prevention.

Conveyance channels can be an important part of the treatment train, but they require special design considerations to minimize maintenance. Otherwise, they can be a maintenance burden, particularly if sediment accumulates within the channel or if flows cause erosion within the channel. Good design can eliminate or at least minimize such problems.

Keep in mind that while check dams or inter-channel berms may be useful flow control devices, they can also increase the maintenance burden, clogging quickly with sediment and debris that must be removed to sustain design flows. Therefore, only use these devices when they are absolutely necessary, because they make the maintenance worker's job more difficult.

## 9-D.9.0 INCLUDE SAFETY FEATURES

The best overall approach is to select BMPs that include appropriate safety features. Many BMPs do not involve standing water, steep drop-offs, or large risers and barrels, and they should be considered as the best (and safest) options.

When ponds or basins are used, however, the design should incorporate safety features that prevent easy access to confined spaces (e.g., risers and barrels), limit drowning hazards associated with permanent pools of water, and protect the BMP from vandalism.

Many communities use fences to prevent access to ponds or basins. Alternative approaches include the use of mild side slopes, wetland or safety benches, and thick vegetation.

Riser structures can also be used, but methods to prevent vandalism must be implemented. Riser manholes should be locked, and any openings in the riser should be covered with an appropriate trash rack. In addition, the operator valves for pond drains should be chained and locked to prevent unauthorized use.

## 9-D.10.0 INCLUDE BENCHMARKS AND MARKERS IN THE DESIGN

Benchmarks must be established for tracking and monitoring BMPs. For example, in ponds and wetlands, sediment markers (graded measuring sticks) placed in forebays or permanent pools can be used to consistently measure the depth of sediment during inspections. Similar markers can be used to ensure that the elevation of the permanent pool remains relatively constant over time. Sediment clean-out markers should also be used in underground vaults and in the sediment chambers of sand filters.

## 9-D.11.0 PLAN FOR SEDIMENT REMOVAL AND DISPOSAL

Removing sediment and debris is a common maintenance item for many types of BMPs. Minor debris removal is relatively simple, but removing large quantities of sediment can be an involved and costly undertaking. Design features should enhance access, as described above, and include features that simplify removal efforts. For example, a pond drain is an important design feature that allows maintenance crews to drain ponds or wetlands before removing accumulated sediment.

Sediment removal is usually the largest single cost of maintaining a BMP facility, so the necessary funds should be allocated in advance. Since sediment removal costs are so site-specific and dependent on disposal plans, it is difficult to provide specific cost estimates. Actual estimates should be obtained from sediment removal contractors during the BMP's design phase, based on the planned situation. The estimates should include the following:

- Mobilization expenses
- Sediment removal expenses
- Material transport expenses (if applicable)
- Disposal expenses (if applicable).

More specific information about sediment removal is provided in **Section 7.4** of this chapter.

## 9-D.12.0 INCLUDE A PLANTING PLAN

All BMP designs should incorporate appropriate vegetation to improve both function and aesthetics. If designed correctly, planting plans can reduce future maintenance liabilities. Landscaping can help prevent access to ponds by geese and children, stabilize banks, and prevent upland erosion. Ponds may benefit from adjacent trees and shrubs (or on planted tree mounds within wetlands) for shading to reduce ambient water temperatures. Planting plans designed for bioretention should identify and recommend species that can tolerate both wet and dry conditions. Specify plant materials that are native to the area. Such plants will be more vigorous and hardy and less prone to pests and disease in the site environment than non-native plants. This will

minimize the need to replace failing plants. However, all planting plans should specify a care and replacement warranty.

## 9-D.13.0 REFERENCES

Center for Watershed Protection (CWP). July, 2008. *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program*. Ellicott City, MD.

Center for Watershed protection (CWP). *Technical Report on Stormwater BMPs in Virginia's James River Basin: An Assessment of Field Conditions & Programs*. Ellicott City, MD.