Prince George's County Government Department of Environmental Resources

Stormwater Best Management Practices Inspection Manual

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CONSULTING ENGINEERS
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1. INTRODUCTION

This section provides procedures for inspection of private Stormwater Best Management Practices (BMPs). The manual includes recommended procedures to conduct visual inspection of private BMP facilities for the purpose of maintenance, repair, or retrofit. The following provides methodology to evaluate the physical condition of BMP facilities so that inspections are performed consistently countywide. The Stormwater best management practices require regular inspections and maintenance to ensure long-term proper function. Inspections are the most effective way to detect and avoid potential problems before they become a liability.

Inspectors should be familiar with the contents of this inspection manual to ensure accurate and consistent inspections are conducted. It is assumed that all of the BMPs to be inspected will follow the guidelines presented herein.

2. PREPARATION

2.1 Pre-Field Investigation

The goal of this segment is to collect all suitable and available information in preparation for the field investigation. Available information may include construction plans (grading, detail, and profile sheets), as-builts, stormwater management reports, access permits, and Geographic Information System (GIS) information such as location of BMPs, storm drainage systems dates of previous inspection. Inspectors should review the plans prior to field work to have a basic understanding of the function of the BMP. Guidelines for the pre-field investigation are as follows:

- Initial notification letter from the county to the property owner should be sent prior to field work, at least two weeks before.
- Gather all available information such as as-built plans, Declaration of Covenant, owner details, property details, maintaining agency details, contact information, GIS maps in preparation for the field investigation, if available.
- Identify the locations of all BMPs.
- Digital or paper field maps should be prepared. The maps should include BMP locations, county roads, and hydrographic features such as stream crossings. Aerial images may also be helpful. Examples are shown in Appendix C.
- The pre-field investigation should identify potential issues such as road access, traffic hazards, and BMP site conditions.
- The inspector should obtain a copy of Declaration of Covenants (maintenance agreement), if available, to access private BMP's.
- Use BMP facility identification previously assigned.
- Prepare/Collect field inspection equipment (detailed list is included in Section 3.1)

2.2 Field Inspection Teams

Inspection teams should have at least two field inspectors and at least one inspector should have experience in performing BMP inspections. Field crews should be familiar with BMP design and the *Maryland 2000 Stormwater Design Manual* and *The Prince George's County Stormwater Design Manual.*

3. FIELD OPERATIONS

3.1 Field Equipment

Field equipment must be on hand to ensure proper collection of data and to give inspectors the ability to complete the inspection. The equipment list shown below includes both field inspection equipment as well as health and safety equipment.

1. Field maps
2. Inspection field forms
3. Digital camera with back-up batteries
4. Global Positioning System (GPS) handheld units
5. BMP inspection manual
6. Orange safety vests
7. Orange traffic cones
8. Measuring tape
9. Manhole cover pick tool
10. Two-way radios or cell phones
11. ADC map
12. Pen, pencils, and clip board
13. Amber flashing safety lights
14. Insect repellent
15. Flash lights
16. Field PC (*Optional*)

GPS equipment should be used to collect the location of each BMP in the field. The GPS unit should be in the NAD83 Maryland State Plane Coordinate System, feet with a minimum accuracy of ± 10 feet. In areas where a GPS signal is not available to collect the point, other suitable alternatives can be used such as compass or aerial images.

3.2 Log Book

A field log book is required to record field information and site-specific data. All entries should be entered in the field book in a clear and easily understood format. Any changes in the field log book should be made after the investigation is completed.

The daily field information to be entered in the log book is as follows:

1. Date
2. Identification of field personnel
3. Weather conditions, including date of last storm event
4. Identification number of each BMP
5. Type of BMP facility
6. Number of pictures taken

3.3 Safety and Security

Safety and security are two issues that need to be considered during the field inspection. Precautions should always be taken while locating and inspecting BMPs. Field crews must wear orange safety vests and should carry work IDs or driver's licenses at all times during the field investigation.

Prince George's County Department of Environmental Resources (DER) will select the private BMPs that require inspection and notify property owners about the inspection. If a private facility is locked and the field crew does not have a key, the field inspectors should move to another facility. It should be noted in the log book that the locked facility was not inspected, so a follow-up notification letter can be generated.

3.4 Inspection Forms

Field inspection form is included in this section of the manual. The inspector should inspect the facility based on the information needed on the form. Most BMPs will fall into one of the following categories:

- Stormwater Management (SWM) ponds
- Wetland
- Infiltration practices
- Filtering practices
- Hydrodynamic Structures
- Other

The parameters on the field inspection form are specific to the particular BMP category. Sub-categories for the above BMPs are as follows:

Subcategories of BMPs

- **SWM Ponds**
    1. Detention Structure (Dry)
    2. Extended Detention Structure Wet
    3. Extended Detention Structure Dry
    4. Wet Pond
    5. Forebay
- **Wetland Facilities**
    1. Artificial Wetlands
    2. Shallow Marsh
- **Infiltration Facilities**
    1. Dry Well
    2. Infiltration Basin
    3. Infiltration Trench Complete Exfiltration
    4. Infiltration Trench Partial Exfiltration
    5. Infiltration Trench WQ Exfiltration
- **Filtering Devices**
    1. Attenuation/Dry Swale
    2. Bio-retention
    3. Filter Strip
    4. Landscape
    5. Sand Filter
    6. Grass Swale

7. Vegetated Buffer

- **Hydrodynamic Structures**
    1. Bay Saver
    2. Oil Grit Separator/ Water Quality Inlet
    3. Stormceptor
    4. Underground Storage
- **Other**
    1. Other

3.4.1 BMP Inspection Form

Prince George's County Government
Department of Environmental Resources,
Environmental Services Group
9400 Peppercorn Place, Suite 500
Largo, Maryland 20774

CASE NUMBER:

STRU_NO.:

WEATHER CONDITION ❑ **SUNNY** ❑ **CLOUDY**

BMP INSPECTION REPORT

INSPECTION/ INVESTIGATION TYPE	Date:	Time:
INSPECTOR'S NAME:	INSPECTOR'S PHONE:	
❑ INITIAL ❑ FOLLOW-UP ❑ ROUTINE ❑ COMPLAINT ❑ OTHER		

SITE LOCATION INFORMATION AND OWNER

STREET ADDRESS:	CITY:	STATE: MARYLAND	ZIP:
OWNER/ LESSEE:			

BMP TYPE

SWM Pond	**Filtering Practices**	**Infiltration Practices**	**Hydrodynamic Structure**
❑ Detention Structure (Dry Pond)	❑ Attenuation Swale/ Dry Swale	❑ Dry Well	❑ Bay Saver
❑ Retention Pond (Wet Pond)	❑ Bio-retention	❑ Infiltration Basin	❑ Oil grit Separator
❑ Extended Detention Structure Dry	❑ Filter Strip	❑ Infiltration Trench Complete Exfiltration	❑ Stormceptor
❑ Extended Detention Structure Wet	❑ Landscape	❑ Infiltration Trench Partial Exfiltration	❑ Underground Storage
❑ Forebay	❑ Sand Filter	❑ Infiltration Trench Water Quality Exfiltration	**Wetlands**
	❑ Grass Swale	**Other**	❑ Artificial Wetlands
	❑ Vegetated Buffer	❑ Other_____	❑ Shallow Marsh

INSPECTION RESULTS

❑ PASS. NO APPARENT PROBLEMS NOTICED.
❑ NOT FOUND/NOT AVAILABLE.
❑ FAIL. COMPLETE THE REPAIR AND/OR MAINTENANCE ITEMS INDICATED ON **ATTACHMENT "A"** BY_____

OBSERVATIONS

_____
_____
_____

THE UNDERSIGNED CERTIFIES THAT THE INSPECOR PERFORMED THE INVESTIGATION OF THE BMP TODAY AND THE INVESTIGATION REPORT IS AS STATED HEREIN.

PRINT NAME:_____ **DATE:**_____

SIGNATURE:_____

OWNER/ LESSEE/ PERMITEE/ REPRESENTATIVE:_____ **DATE:**_____

COPY SENT VIA: ❑ MAIL ❑ LEFT AT SITE

ATTACHMENT A:	**REPAIRS/ MAINTENANCE REQUIRED**
❑ **GENERAL**	
❑ Unauthorized modifications to BMP resulted in reduced effectiveness.	
❑ BMP destroyed, removed, or eliminated from the property.	
❑ Access to BMP obstructed or limited.	
❑ Defect or damage to fence/ gate/ lock permits easy entry to the facility.	
❑ BMP cannot be located for inspection.	
❑ **STRUCTURAL DETERIORATION**	
❑ Structures/ BMP components is/ are cracking/ spalling/ damaged/ misaligned/ deteriorated.	
❑ **VEGETATION MANAGEMENT**	
❑ Poor vegetation coverage. Seed/ sod void areas.	
❑ Invasive/ poisonous/ nuisance vegetation or weeds observed.	
❑ Planted vegetation is excessively tall, needs removal/ trimming.	
❑ Unauthorized plantings observed.	
❑ Mowing required.	
❑ Maintain protected vegetated buffer around pond.	
❑ Dead, diseased, or dying trees need removal/ replacement.	
❑ Remove vegetation blocking flow at inlet/ outlet or components of the facility.	
❑ Remove and replace the top soil layers/ mulch layer or the entire media.	
❑ **SEDIMENT CONTROL/ REMOVAL**	
❑ Sediment accumulation interferes with BMP performance.	
❑ **EROSION CONTROL**	
❑ Evidence of excessive erosion/ slumping/ piping in/ around elements of BMP.	
❑ **DEBRIS/ LITTER REMOVAL**	
❑ Trash and debris accumulation within and/ or on BMP interferes with proper BMP functions.	
❑ **POLLUTANT REMOVAL**	
❑ Excess oil sheen/ gasoline/ grease/ petroleum product/ contaminants/ pollutants observed.	
❑ Remove pollutants that emit foul/ unpleasant odors within/ from the BMP.	
❑ **WATER PONDING/ PERMANENT POOL**	
❑ Standing water in inappropriate areas.	
❑ Water not observed in appropriate areas.	
❑ Permanent pool depth is at less than designed minimum.	
❑ Excessive algal growth/ proliferation of single species of plant in the permanent pool of wet pond.	
❑ After storm event, water drawdown time observed to have increased significantly over design drawdown time.	
❑ After storm event, water filters at faster rate than designed.	
❑ **EMBANKMENT/ DAM MANAGEMENT**	
❑ Leak/ seepage/ settlement observed on the compacted berm embankment.	
❑ Observed cracking/ sliding/ bulging of the dam.	
❑ Observed animal burrows on embankment.	
❑ **OTHER**	
❑ Water flow diverted away from the BMP.	
❑ Access cover damaged/ not working/ cannot be opened.	
❑ _____	

3.5 BMP Data Collection

BMPs are to be inspected during a dry time (at least after 72 hours without precipitation). This allows them to recover to their normal state.

The BMP inspection forms collect BMP Inspection Data which consists of existing conditions that the inspector evaluates and records.

Each inspection condition should be carefully reviewed by visual inspection and physical testing where necessary. All features of the BMP should be observed closely, including the riser, facility inflow points, both sides of the embankments, observation wells, and downstream outlet.

This program is not intended to perform detailed inspection of the insides of risers or pipes as this requires OSHA certification. If field inspectors find issues that require further investigation, these should be documented in the log book and the county notified. Figure 3.1 shows the BMP inspection work flow.

3.5.1 BMP Ownership

This section concerns ownership of BMPs and treatment of impervious areas. All BMPs should have a seven-digit BMP ID, also called Structure Number. The first four digits identify the site followed by three-digit BMP number in that site. The structure number is listed as "STRU_NO" at BMP inspection form. For private facilities, a copy of the Declaration of Covenants (maintenance agreement) must be obtained prior to the field inspection. Prince George's County DER should send a notification of inspection letter to inform the BMP owner that an inspection is scheduled. The letter should be sent at least 2 weeks ahead of the inspection. The letter should provide detailed information about what the BMP owner can expect, encourage the completion of routine inspection, and other pertinent information (facility owner, facility address, facility ID number) relating to the inspection.

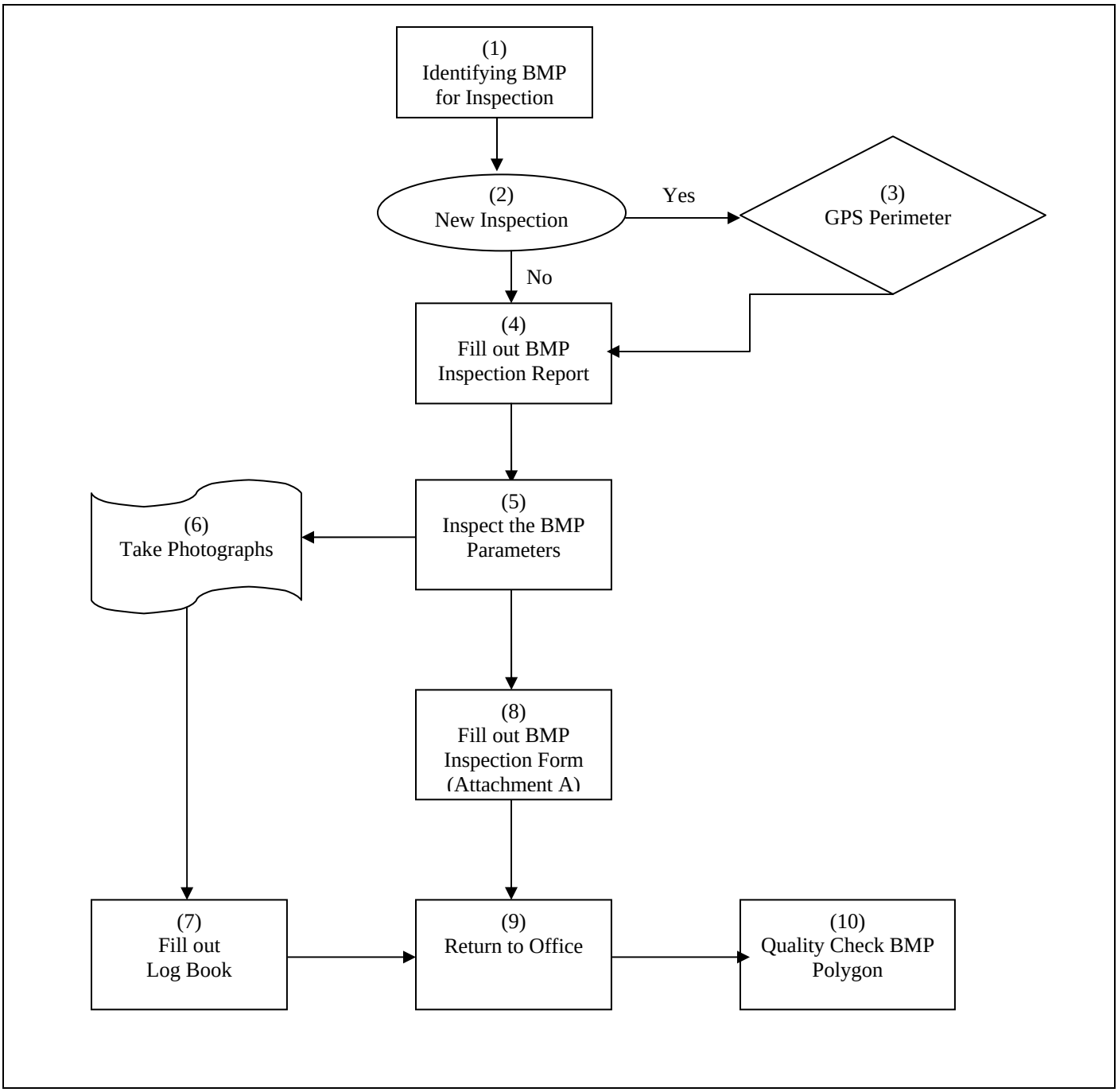


Figure 1 BMP Inspection Work Flow

The elements of the BMP inspection work flow, as illustrated in figure are:

1. BMP has been identified for inspection and located in the field.
2. New inspection (Yes or No).
3. If this is a new inspection, then GPS the perimeter of the BMP.
4. Fill out the BMP inspection report.
5. Inspect the BMP Parameters (Such as Sediment, Embankment, Vegetation, Structures, etc).
6. Take photographs of the BMP and of any issues requiring documentation.

7. Enter number of photographs or pictures into the field log book.
8. Fill the BMP inspection form (Attachment A).
9. Return to the office for the post processing of the data.
10. Create the smooth shape of the polygon obtained through GPS. There should not be self -overlapping polygons.

3.5.2 BMP Inspection Report

BMP inspection report has general information collected in the field and entered into the BMP Inspection Form.

Case Number – It is a Stormwater Management (SWM) number which can be found on the as-built drawings, Declaration of Covenants, and Construction Completion Certificate. This number is already available in BMP database before BMP inspection is schedule for inspection.

Structure Number – This is a seven-digit BMP ID followed by first four digits site ID and three-digit BMP number. The structure number is listed as "STRU_NO" at BMP inspection form.

Date of Inspection – The date that inspection was performed. Format of the date is mm/dd/yyyy.

Time – The time that inspection was performed. Format of the time is HR: MIN.

Inspector's Name – The name of the inspector that performed inspection.

Inspector's Phone – Office contact number of the inspector that performed inspection.

Inspection Purpose – Check one of the following: Initial, Follow-up, Routine, Complaint, Other.

Site Location Information – BMP location or nearest property/street address.

Ownership – Name, address, and contact information of the person or company legally responsible for maintenance.

Category – Type of a facility (see Section 3.4).

Sub-Category – Description of the facility category (see Section 3.4).

Inspection Results – Check if the BMP inspection is Pass, Fail or Not Found

Observations – Additional comments about the facility.

Dated Signatures – Both inspector and owners should sign and date the inspection form.

Copy Sent– Check if the inspection form sent via mail or left at site.

3.5.3 BMP Fact Sheets

The purpose of this section is to identify and inspect the storm water best management practices (BMPs) based on their functions.

The fact sheets are used to educate the inspectors and property owners about the types of the BMP, their functions, components, benefits, and limitations. Based on the fact sheets, a BMP identification and inspection process can be performed.

In order to fulfill the purpose, this section presents a list of fact sheets for selected BMPs discussed in this Manual. Table 1 shows the list of the BMPs:

Table 1 Category and Sub-categories of Best Management Practices (BMP)

I. Filtering	II. Hydrodynamic Structure	III. Infiltration	IV. SWMM Pond	V. Wetland	VI. Others
Attenuation Swale/Dry Swale	Bay Saver	Dry Well	Dry Pond	Shallow Marsh	Other
Bioretention	Oil Grit Separator/ Water Quality Inlet	Infiltration Basin	Extended Detention Structure Dry	Artificial Wetlands	Gabion
Filter Strips	Stormceptor	Infiltration Trench	Extended Detention Structure Wet		Level Spreader
Landscape	Underground Storage		Wet Pond		Flow Splitter
Sand Filters					
Grass Swale					
Vegetated Buffer					

FILTERING DEVICE
Dry Swale

Figure 2 Dry Swale
(Source: Stormwater BMPs, East Baton Rouge Parish.)

General Description

The dry swale (or bio-swale) consists of an open channel that has been modified to enhance its water quality treatment capability by adding a filtering medium consisting of a soil bed with an underdrain system (CRC, 1996). The dry swale system is sized to accept the entire Water Quality Volume (WQv) and allow it to be filtered through the treatment medium and/or infiltrate through the bottom of the swale. The dry swale system is designed to drain down between storm events within about one day. Figure 3 shows the schematics of dry swale.

Dry swales are made up of an open conveyance channel with a filter bed of prepared soil that overlays an underdrain system. Flow is conveyed into the main channel of the swale where it is filtered by the soil bed. Runoff is then collected and passes into a perforated pipe and gravel underdrain system to the outlet.

Benefits

1. Preferred system for residential application.
2. Appropriate for infiltration purposes.
3. Mitigate runoff from impervious surfaces.
4. Remove sediment and pollutants to improve water quality.
5. Good option for small area retrofits – replacing existing drainage ditches.
6. Good retrofit opportunities for residential or institutional areas of low to moderate density.

Limitations

1. Not appropriate for large drainage areas.
2. Not practical in areas with steep topography or wet or poorly drained soils.
3. They require relatively large amounts of land.
4. They are generally not effective when flow volumes and/or velocities are high and may erode.
5. Possible re-suspension of sediment.

Inspection/Maintenance Consideration

Annual inspection should be performed to detect any erosion problems. Inspect regularly and after each major storm. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sedimentation	• *Accumulation of sediment*	• *Clean the sediment.*
Vegetation	• *Overgrown*	• *Mow the grass to maintain 4 to 6 inch height.*
Rip rap location/condition	• *Unstable and missing rocks*	• *Repair and/or add rocks if needed*
Underdrain pipe	• *Clogged* • *Damaged*	• *Clean the underdrain pipe* • *Repair or replace if needed*
Filter fabric	• *Damaged*	• *Repair or replace if needed*
Ponding	• *Standing water after 72 hours of rainfall*	• *Clear the swale of any build up of material or grade the swale as needed.*

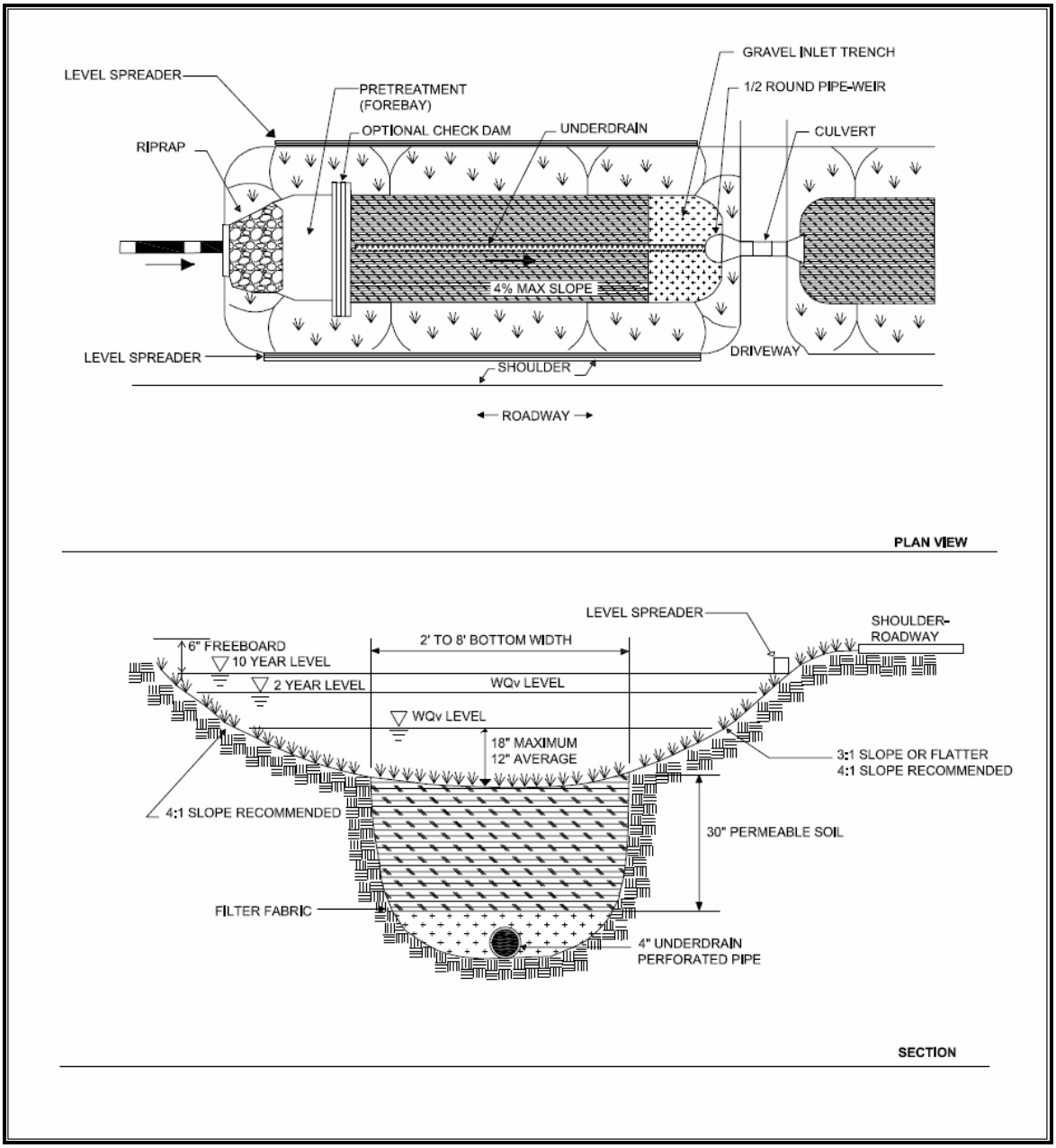


Figure 3 Schematic of Dry Swale Components
(Source: Stormwater BMPs, East Baton Rouge Parish)

FILTERING DEVICE
Bio-Retention

Figure 4 Bioretention

General Description

Bioretention BMPs can be thought of as modified infiltration basins that treat stormwater through absorption, filtration, volitization, ion exchange, and microbial decomposition. Bioretention systems are often also referred to as bioretention filters, bioretention areas, bioretention facilities, bioretention cells, or rain gardens. This facility is used to remove a wide range of pollutants, such as suspended solids, nutrients, metals, hydrocarbons, and bacteria from stormwater runoff. Figure 5 shows a typical Bioretention system. Through the use of specific plants, trees, and shrubs, a bioretention BMP is designed to mimic the ecosystem of an upland forest floor. There are six basic components of a bioretention BMP:

1. Grass Buffer Strip – Designed to filter out particulates and reduce runoff velocity
2. Sand Bed – Further reduces velocity by capturing a portion of the runoff. In addition, provides aeration to the plant bed and enhances exfiltration.
3. Ponding Area – Collects and stores runoff prior to infiltration
4. Organic/Mulch Layer – Provides some filtering of runoff, protects the soil surface from erosion, and encourages development of beneficial microorganisms.
5. Planting Soil – Provides nourishment for plant life. Clay particles within the soil adsorb pollutants.
6. Plants – Provides uptake of harmful pollutants.

Benefits

1. Easily incorporated into new development
2. Suitable for high impervious area
3. Appropriate for small drainage areas
4. High community acceptance.

Limitations

1. Sediment-loaded runoff can clog the soils in the system
2. Not suitable for steep slopes (>20 percent)
3. Extensive landscaping specific soil matrix required.

Inspection/Maintenance Consideration

Regular inspection and maintenance is critical to the effective operation of bioretention facilities as designed. It is the responsibility of the property owner to inspect and maintain the facility as per the minimum requirement provided by the county.

Frequent inspection (once a month and within 24 hours after very storm greater than 1.0 inches) is required to ensure the effectiveness of the bioretention facilities. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	*Trash/debris is present*	*Remove trash/debris*
The perimeter of the facility	• *Bare soil and/or erosive gullies have formed*	• *Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established.*
The inflow: pipe, swale, riprap	• *Clogged pipe,* • *damaged or cracked pipe,* • *erosion is occurring in the swale*	• *Unclog the pipe. Remove the sediment.* • *If the pipe is cracked or damaged, replace the pipe.* • *If the erosion is occurring in the swale, provide erosion control device such as turf matting or riprap to avoid further erosion.*
Bioretention Vegetation	• *Plants are over grown.* • *Plants are dead, diseased or dying.*	• *Prune the plans if overgrown.* • *Replace the plant and provide a one-time fertilizer application to establish the ground cover.*
Bioretention: soils and mulch	• *Soils and mulch are clogged with sediment.* • *Indicates presence of heavy metals in the soil media.* • *Mulch is breaking down*	• *Remove and replace the top layers or the entire media as needed.* • *Toxic soil shall be removed, disposed of properly and replaced with new planting media.* • *Remove and replace the mulch layer if needed. Replace with triple shredded hard wood mulch at a maximum of three inches.*
Underdrain pipe	*Clogged*	*Washout the underdrain*
The drop inlet	• *Clogged* • *The drop inlet is damaged*	• *Cleanout the drop inlet. Dispose of the sediment off-site.* • *Repair or replace the drop inlet.*

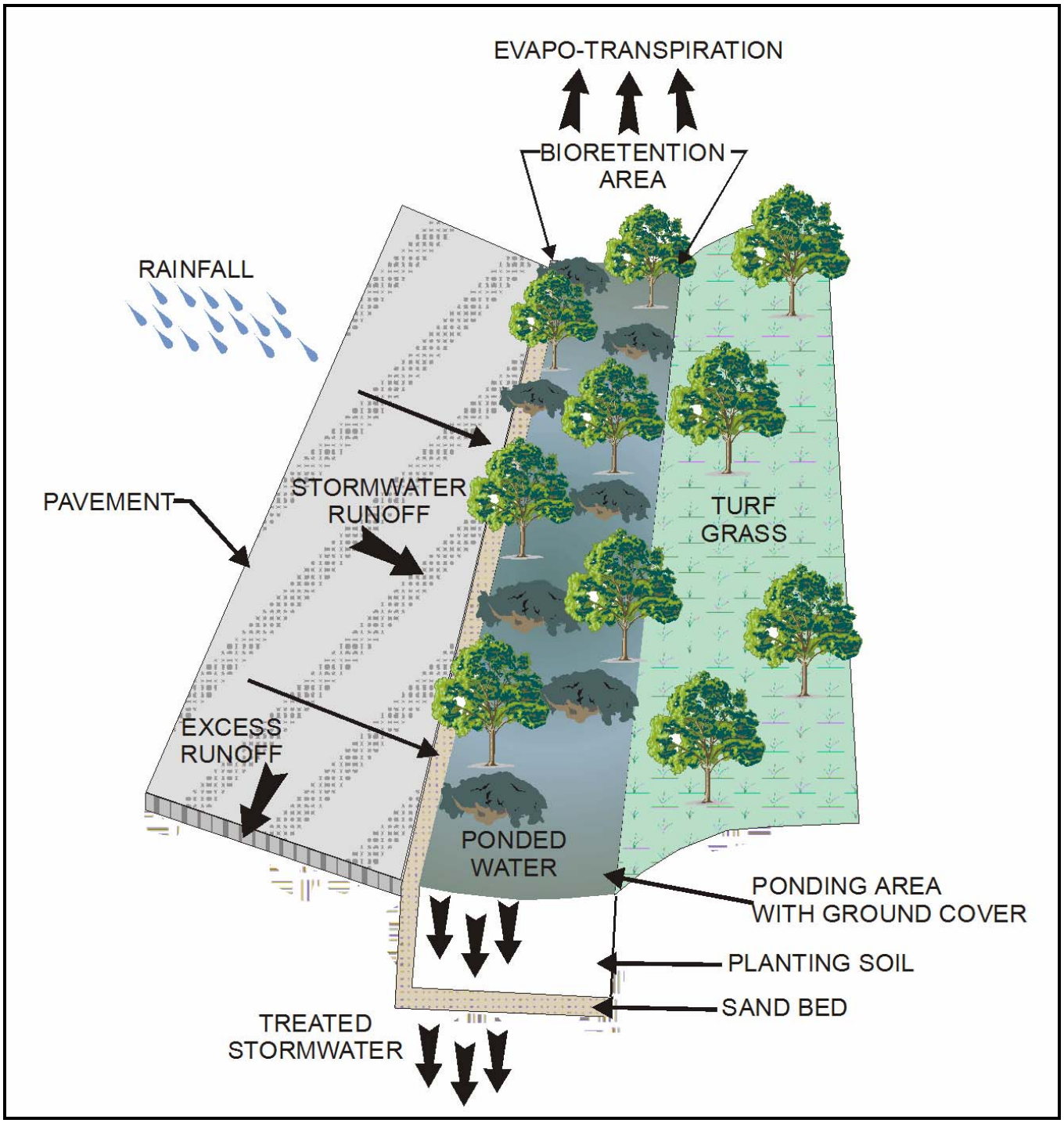


Figure 5 Schematic of Bioretention

(*Source: Bioretention System for Stormwater Management, Ten Town Great Swamp Watershed Committee)*

FILTERING DEVICE
Filter Strip

Figure 6 Filter Strip
(Source: LID Systems, Trinkaus Engineering)

General Description

A filter strip is an area of vegetation established for the purpose of removing sediment, and other pollutants from runoff and waste water. Filter strips also aid with reducing the flow rate of runoff and allow runoff to infiltrate into the soil to recharge the groundwater supply.

Filter strips are gently sloping, densely vegetated areas used to treat stormwater runoff, acting as a buffer between impervious areas and storm sewer systems or streams.

Filter strips can be designed to collect and convey filtered runoff to other types of BMPs, such as vegetated swales, infiltration basins and natural buffer areas. A schematic of filter strip is shown in figure-7.

Benefits

1. Filters contaminants from runoff prior to its discharge to the storm sewer system.
2. Reduces peak velocity and volume of stormwater runoff delivered to storm sewer system or stream.
3. Provides some recharge to groundwater supply.
4. Can be used to treat runoff along residential streets, stream corridors, and small parking lots.
5. Provides an ideal habitat for wildlife, depending on vegetation selected.
6. Inexpensive to install and maintain.
7. Enhances aesthetics of local landscape.
8. Area can be used for snow storage during winter.
9. Applicable to all types of sites (residential/commercial/industrial).

Limitations

1. Filter strip is difficult to maintain sheet flow.
2. Not suitable for arid regions.
3. Not appropriate for ultra urban areas where little pervious surface exist.
4. Not suitable for large drainage areas.
5. Not suitable for soil with high clay content.
6. If improperly designed, filter strips can become a mosquito breeding ground.

Inspection/Maintenance Consideration

Inspections shall be made on a quarterly basis for the first two years following installation, and then on a biannual basis thereafter. Inspections shall also be made after every storm event greater than 1in. during the establishment period. Keeping vegetation healthy in filter strip requires routine inspection and maintenance, which include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning.

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Vegetation	• *Overgrown vegetation*	• *Mow grass to maintain 3" to 4" height.*
Ponding	• *Pools of standing water*	• *Clear the standing water or regrade the soil along the slope.*
Erosion	• *Rills and gullies observed along the strip.*	• *Rills and gullies may be filled with topsoil, stabilized with erosion control matting, and either seeded or sodded, as desired.*
Pea gravel diaphragm	• *Clogged and sedimentation*	• *Clean out the diaphragm and remove built-up sediment.*
Check dams	• *Cracks, rots, or structural damage observed.*	• *Repair the crack or any damage on the check dams.*
Inlets or sediment sump	• *Clogged*	• *Inlets and sediment sumps that drain to filter strip should be cleaned as needed.*

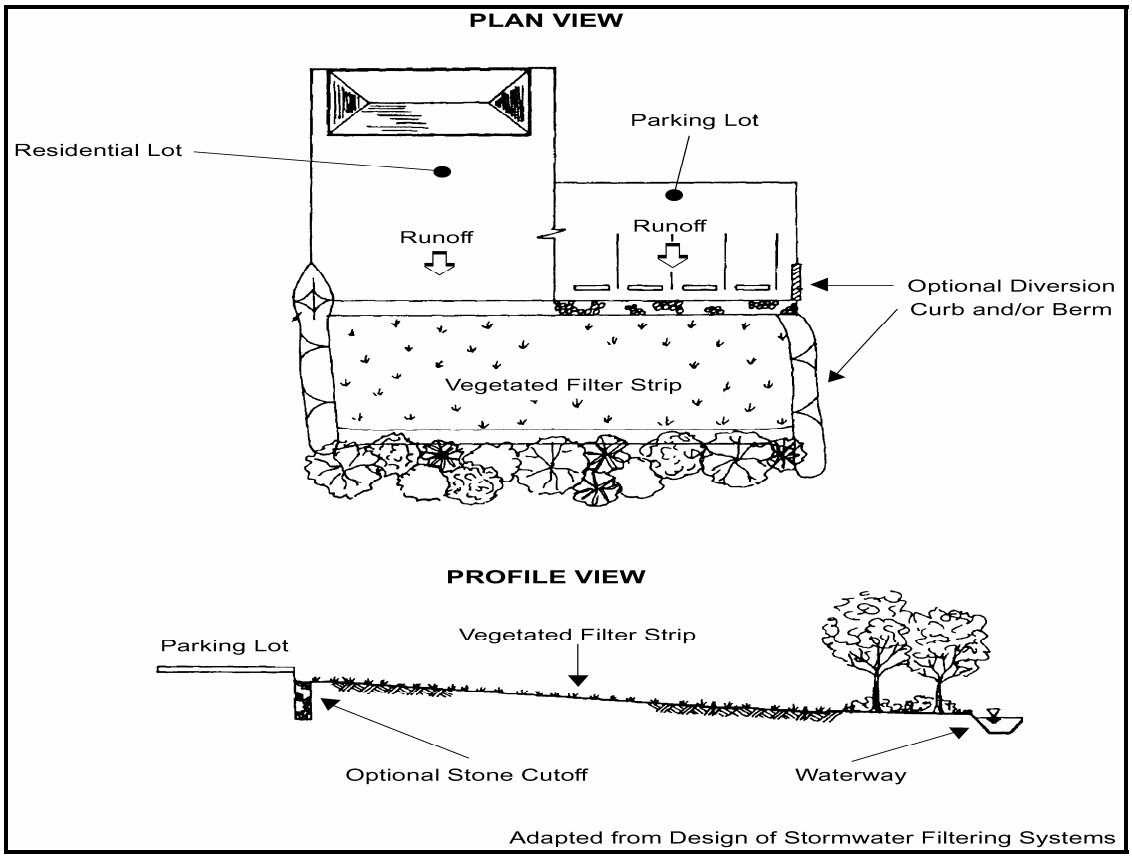


Figure 7 Schematic of Filter Strip Components
(Source: New Jersey Stormwater Best Management Practice Manual)

FILTERING DEVICE
Landscape – Rain Garden

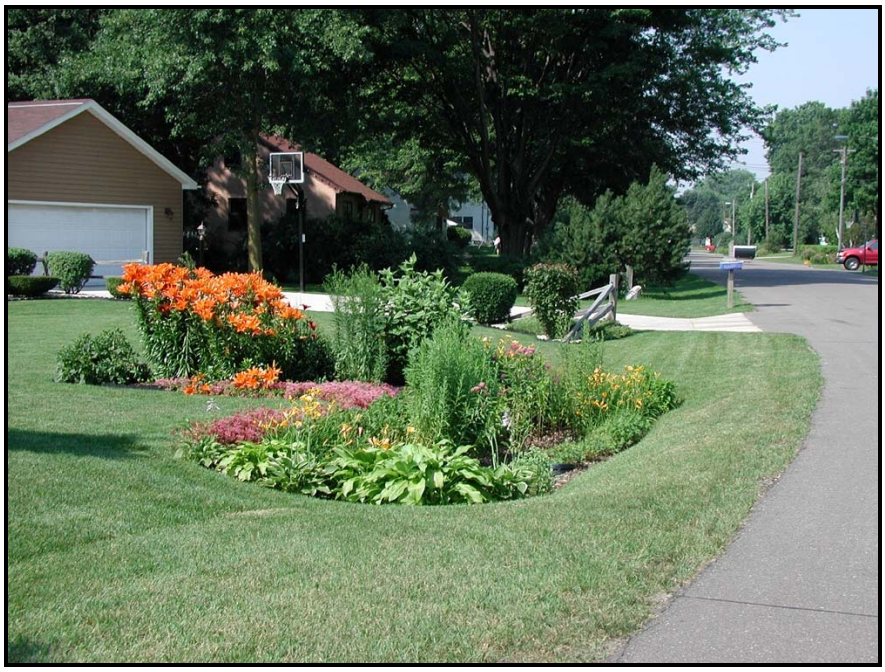


Figure 8 Rain Garden
(Source: Beltrami Soil & Water Conservation District, MN)

General Description

Rain gardens are just what it sounds like – gardens that soak up rain water, mainly from roof, but also from your driveway and lawn. It utilizes bioretention techniques to accomplish water quality improvement and water quantity reduction. These are planted areas that use native plants and other perennials that don not mind having wet feet. They are built in depressions which capture and filter storm water runoff from impervious areas such as downspouts, driveways, and flooding slopes, etc.

Rain gardens offer a functional and attractive option to the "pipe and pond" approach to storm water management. Because they provide an attractive landscaped garden as well as storm water retention, rain gardens are particularly useful in small urban spaces A schematic of rain garden is shown in figure-9.

Benefits

1. Increasing the amount of water filtering into the ground, this recharges groundwater and helps reduce the amount of pollutants washing off to lakes and streams.
2. Provide valuable wildlife habitat.
3. Enhancing the beauty of yard and neighborhood.
4. Help protect communities from flooding and drainage problems.
5. Reducing the need for costly municipal stormwater treatment structures.
6. Useful even where little space is available.

Limitations

1. Rain gardens will not remove permanent stands of water (pool or pond) in a yard. However, water gardens can be designed to incorporate such a feature.
2. Do not locate rain gardens over septic systems or near wells.

Inspection/Maintenance Consideration

Inspections shall be made annually for sediment buildup, erosion, and vegetative conditions. Inspections shall also be made after every storm event greater than 1in. during the establishment period. Keeping vegetation healthy in filter strip requires routine inspection and maintenance, which include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning.

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Ponding	• *Pools of standing water*	• *Clear the standing water or regrade the soil along the slope.*
Erosion	• *Rills and gullies observed along the strip.*	• *Rills and gullies may be filled with topsoil, stabilized with erosion control matting, and either seeded or sodded, as desired.*
Bioretention: soils and mulch	• *Soils and mulch are clogged with sediment.* • *Indicates presence of heavy metals in the soil media.* • *Mulch is breaking down*	• *Remove and replace the top layers or the entire media as needed.* • *Toxic soil shall be removed, disposed of properly and replaced with new planting media.* • *Remove and replace the mulch layer if needed. Replace with triple shredded hard wood mulch at a maximum of three inches.*

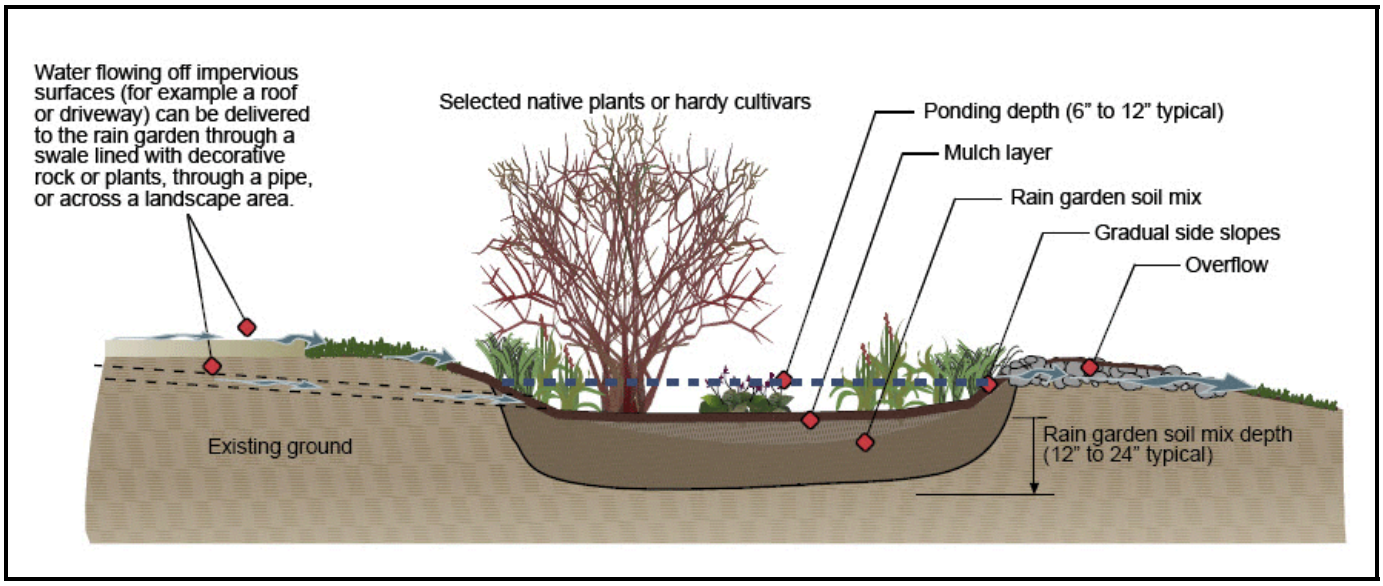


Figure 9 Schematic of Rain Garden
(Source: Anatomy of Rain Garden, KOIN local6.com)

FILTERING DEVICE
Sand Filter

Figure 10 Sand Filters
(Source: East Baton Rouge Parish-Stormwater BMPs)

General Description

Sand filters also known as filtration basins, filter systems, or media filtration facilities, surface sand filters consist of a pretreatment basin, water storage reservoir, flow spreader, sand and underdrain piping. A sand filter is a flow-through system designed to improve water quality from impervious drainage areas by slowly filtering runoff through sand. It consists of one or more filtration and sedimentation chambers to treat runoff. It removes pollutants through straining and sedimentation. Treated effluent is discharged to the existing stormwater collection system. Both underground and surface sand filters have the same functions.

Sand filters are proposed to address intensely developed urban areas where the drainage areas are highly impervious. It can be used on small urban areas where space is limited and where the soils or groundwater concerns would not support an infiltration device.

There are two basic components of a sand filter design: pretreatment basin and sand filter. They are both important features of design and can not be ignored. The pretreatment basin reduces the amount of sediment reaching the sand filter and helps to ensure that the stormwater reaches the sand filter as a sheet flow. The sand filter traps the sediment and pollutants and provides a media for microbial removal of bacteria.

There are three basic sand filtration BMP types: (1) underground sand filter, (2) perimeter sand filter, and (3) surface sand filter. The underground BMP is ideal to treat stormwater in the ultra urban environment where land costs are high. The perimeter sand filter and surface sand filter are good to treat parking lot runoff. A Sand filter schematic shown in figure-11.

Benefits

1. Applicable in small drainage areas of 1 to 10 acres.
2. Appropriate for intensely urban developed areas and with steep slopes.
3. May require less space than other treatment control BMPs.
4. Good retrofit capability.
5. Provide high removal efficiencies for TSS.

Limitations

1. Sand filters are ineffective in removing dissolved pollutants except by adsorption.
2. May not be effective in controlling peak discharges.
3. Expensive.
4. If anoxic conditions develop in the sand filter due to poor drainage, phosphorous levels can increase as water passes through the sand filter.
5. Not applicable in areas of high water table.

Inspection/Maintenance Consideration

Inspections shall be made on a quarterly basis and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Adjacent pavement (if applicable)	• *Sediment is present on the pavement surface*	• *Sweep or vacuum the sediment as soon as possible.*
Perimeter of the sand filter	• *Areas of bare soil and/or erosive gullies have formed.* • *Vegetation is too short or too long*	• *Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established.* • *Maintain vegetation at a height of approximate six inches.*
Flow diversion structure	• *Structure is clogged* • *Structure damaged.*	• *Clean out the conveyance and dispose of any sediment off-site.* • *Repair or replace the structure as needed.*
Pretreatment area	• *Accumulation of sediment greater than six inches.* • *Erosion has occurred* • *Weeds are present*	• *Search the source for the sediment and remedy the problem if possible. Remove the sediment and dispose where it will not impact to streams or BMP.* • *Provide additional erosion protection such as reinforced turf matting or riprap as needed.* • *Remove the weeds.*
Filter bed and underdrain collection system	• *Ponding occurs for more than 24 hours after a storm.*	• *Check to see if the collector system clogged and flush if needed. If water still ponds, remove the top few inches of filter bed media and replace. If water still ponds, then consult an expert.*
Outfall spillway and pipe	• *Shrubs or trees on the embankment.* • *Outflow pipe is clogged.* • *Outflow pipe is damaged.*	• *Remove shrubs and trees immediately.* • *Clean out the pipe. Provide additional erosion protection such as reinforced turf matting or riprap as needed* • *Repair or replace the pipe.*

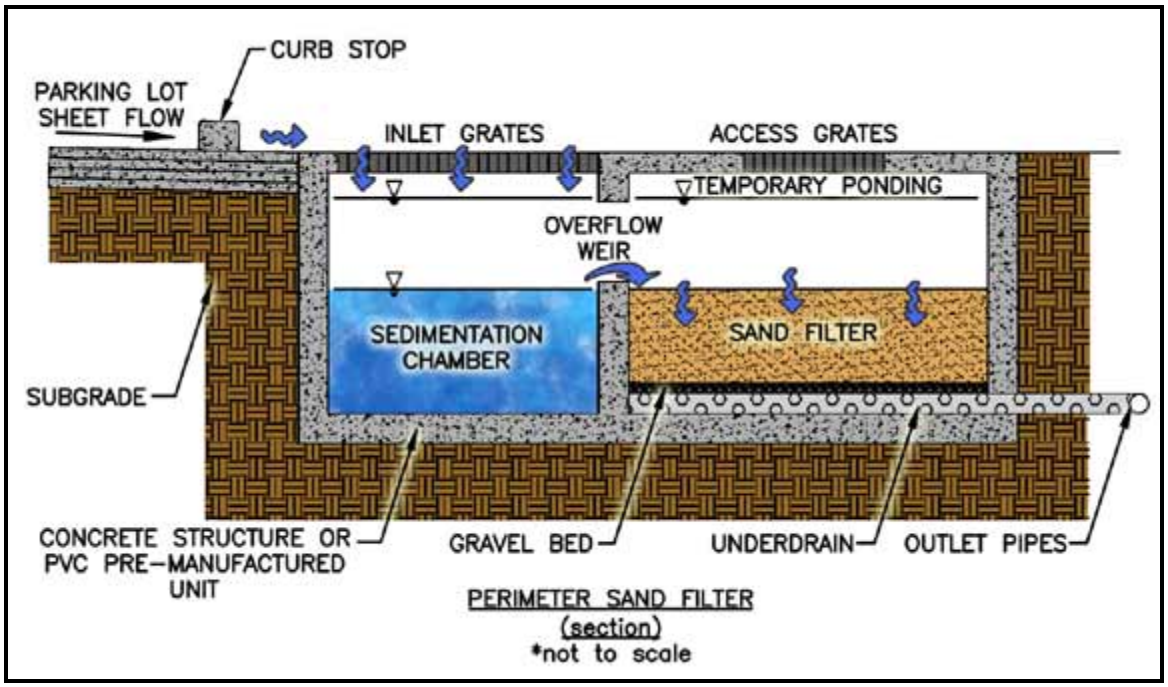


Figure 11Schematic of Sand Filter Components

(Source: http://www.abbey-associates.com/splash-splash/stormwaterBMP_NEW.htm)

FILTERING DEVICE
Grass Swale

Figure 12 Grass Swale
(Source: Lake Superior Duluth streams.org)

General Description

A grass swale, also known as a grassed channel, is a linear vegetated ditch used to treat and reduce flow velocities of stormwater runoff. They are applicable nearly everywhere and effective at receiving runoff from highways and residential areas, due to their linear nature.

Grass swales differ from the enhanced dry swale design in that they do not have an engineered filter media to enhance pollutant removal capabilities, and therefore have a lower pollutant removal rate than a dry or wet swale. A Grass swale can partially infiltrate runoff from storm events in areas with pervious soils.

Two primary considerations for designing of grass swales are channel capacity and minimization of erosion. When properly designed to accommodate a predetermined storm event volume, a grassed swale results in a significant improvement over the traditional drainage ditch in both slowing and cleaning of water. A typical model is shown on figure 13.

Benefits

1. Trap sediments and other pollutants.
2. Reduces runoff and promotes infiltration, which in turn, controls peak discharges.
3. Good option for retrofitting small areas, especially in terms of replacing drainage ditches.
4. May provide groundwater recharge, if design and soils allow for increased infiltration.

Limitations

1. Individual swale can only treat a small area.
2. May not be appropriate for sites with many driveway culverts or extensive sidewalk systems.
3. Require more maintenance than curb and gutter systems.
4. Limited to small areas (< 5 acres); cannot be used on steep slopes (> 6 percent).

Inspection/Maintenance Consideration

Inspection needs to be performed quarterly and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sediment	• *Accumulation of sediment in trench.*	• *Clean out the sediment.*
Swale	• *Erosion is occurring in the swale*	• *Regrade the swale if necessary to smooth it over and provide erosion control devices such as reinforced turf matting or riprap.*
Vegetation	• *Overgrown*	• *Mow and trim vegetation around the facility.*
Ponding	• *Standing water at the swale.*	• *Remove the trash or sediment. If ponding still occurs regrade the swale.*

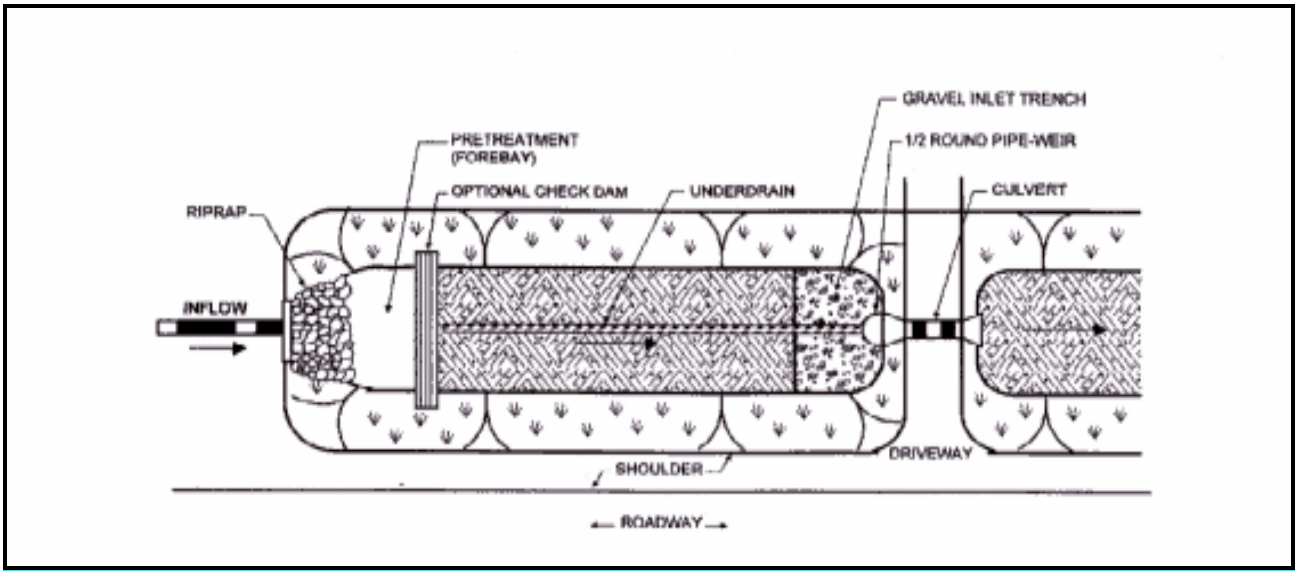


Figure 13 Schematic of Grass Swale Components

(Source: Center for Watershed Protection)

FILTERING DEVICE
Vegetated Buffer

Figure 14 Vegetated Buffer
(Source: http://www.aztecnm.com/publicworks/stormwater/bmps.htm)

General Description
Vegetated buffers are an effective stream protection measure for erosion and sediment loss. They protect streams by limiting erosion in the areas immediately adjacent to the stream and filtering sediment. Their function is to slow runoff velocities, allowing sediment and other pollutants to settle. Vegetated buffers were originally used for agricultural treatment practice and have more recently evolved into an urban practice. Vegetated buffers act as filters to intercept and adsorb nutrients, sediment and other pollutants carried in stormwater runoff. A Schematic of vegetated buffer is shown in figure-15.

Benefits
1. Reduces overland flow of water helping to prevent siltation of shoreline areas.
2. Dampen noise levels from watercraft and neighborhood traffic.
3. Divert chilling winds and provide shade. Groundcovers protect the bare soil as well as deflect heat.
4. Buffers are attractive, long-lived, easily maintained, and can be created at low costs.

Limitations
1. Not suitable for large drainage areas.
2. Minimal detention provided.
3. Large areas are required to construct the vegetated buffer.
4. Thick vegetative cover required.

Inspection/Maintenance Consideration
Inspect the vegetated buffer at least four times in a year and after large storm events exceeding 1.0 inch. Keeping vegetation healthy in vegetated buffers requires routine inspection and maintenance, which include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning.

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Vegetation	• *Overgrown vegetation* • *Sediment Accumulation*	• *Mowing or replanting periodically to ensure their effectiveness.* • *Remove accumulated sediment deposits. When finished, buffer strip should be level from side to side and drain freely towards outlet.*
Inlet and Outlet	• *Clogged with excessive sediment*	• *Clean out the sediment from the inlet and outlet area.*
Erosion/Scouring	• *Eroded or scoured buffer strip bottom due to flow channelizations, or higher flows*	• *For small bare areas over seed the buffer strip bottom. For large bare areas re-grade and re-seed the buffer strip bottom.*

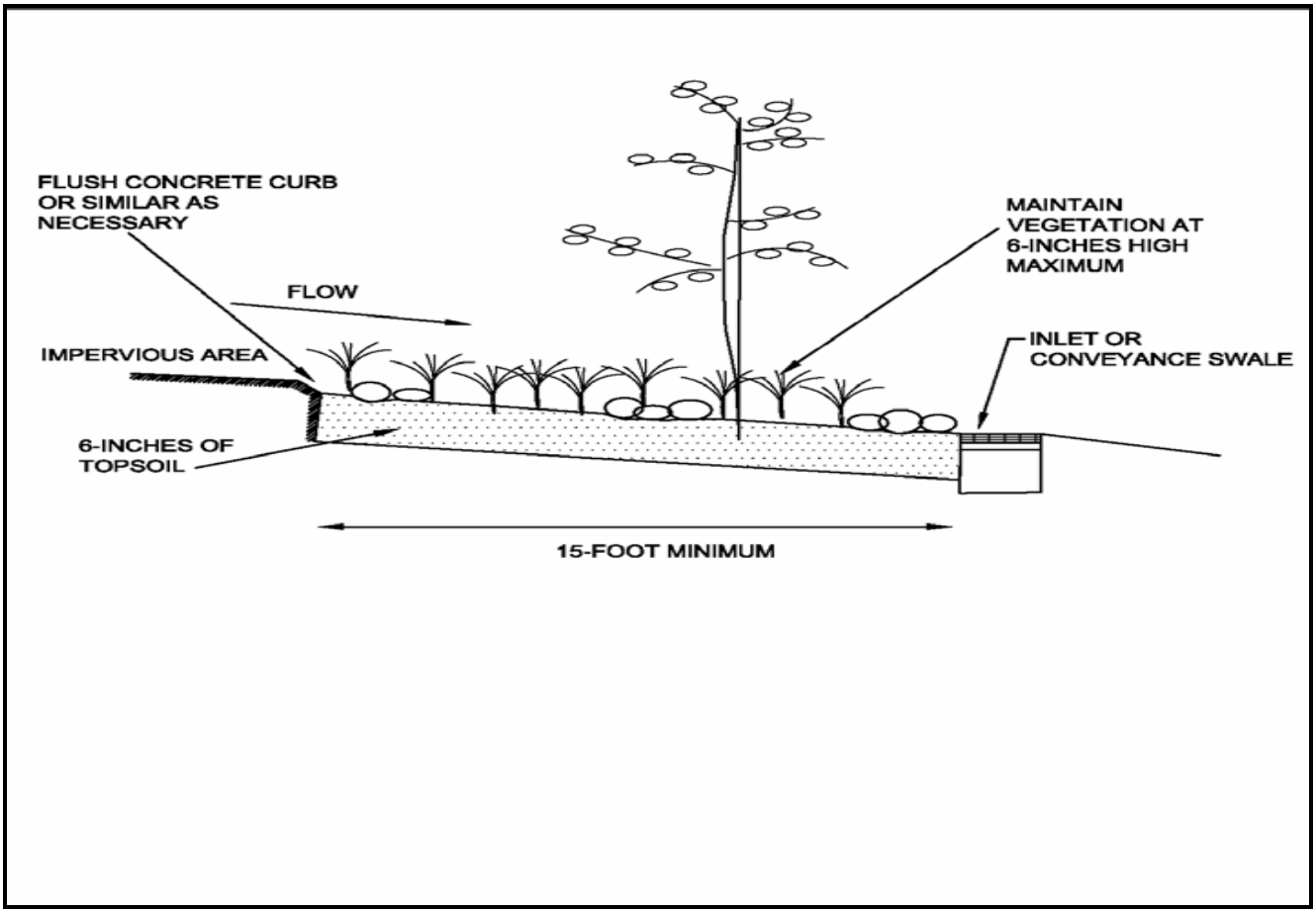


Figure 15 Schematic of Vegetated Buffer
(Source: Stormwater Technical Guidance, Alameda Countywide Clean Water Program)

FILTERING DEVICE
Porous Pavement

Figure 16 Porous Pavement
(Source: A-Bonoestro, Inc.) *(Source: B-Pervious Concrete)* *(Source: C-Treehugger, Inc.)*

General Description

Porous pavement is a permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil. This porous surface replaces traditional pavement, allowing parking lot runoff to infiltrate directly into the soil and receive water quality treatment. There are several pavement options, including porous asphalt, pervious concrete, and grass pavers. Porous asphalt and pervious concrete appear the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous grid systems with open areas designed to allow grass to grow within the void areas. Other alternative paving surfaces can help reduce the runoff from paved areas but do not incorporate the stone trench for temporary storage below the pavement. While porous pavement has the potential to be a highly effective treatment practice, maintenance has been a concern in past applications of the practice.

When operating properly, porous pavements are as effective at removing pollutants from stormwater as other infiltration devices. Also like other infiltration BMPs, porous pavements are not designed to sustain a high removal rate for suspended sediment. While initial removal rates for suspended sediment are very high, the removal process causes clogging of the pavement and subsequently reduces its infiltration capacity. As the infiltration capacity decreases, so does the capture and treatment of runoff pollutants. Careful attention to maintenance is necessary to reduce the potential for clogging. In addition, all adjacent areas should be stabilized to prevent sediment from washing onto the pavement surface to prevent premature clogging. Figure 17 shows the schematic of porous pavement.

Benefits

1. Porous pavements have the potential to be an effective ultra-urban BMP.
2. Less need for curbing storm sewers.
3. Improved road safety because of better skid resistance.
4. Recharge to local aquifers.

Limitations

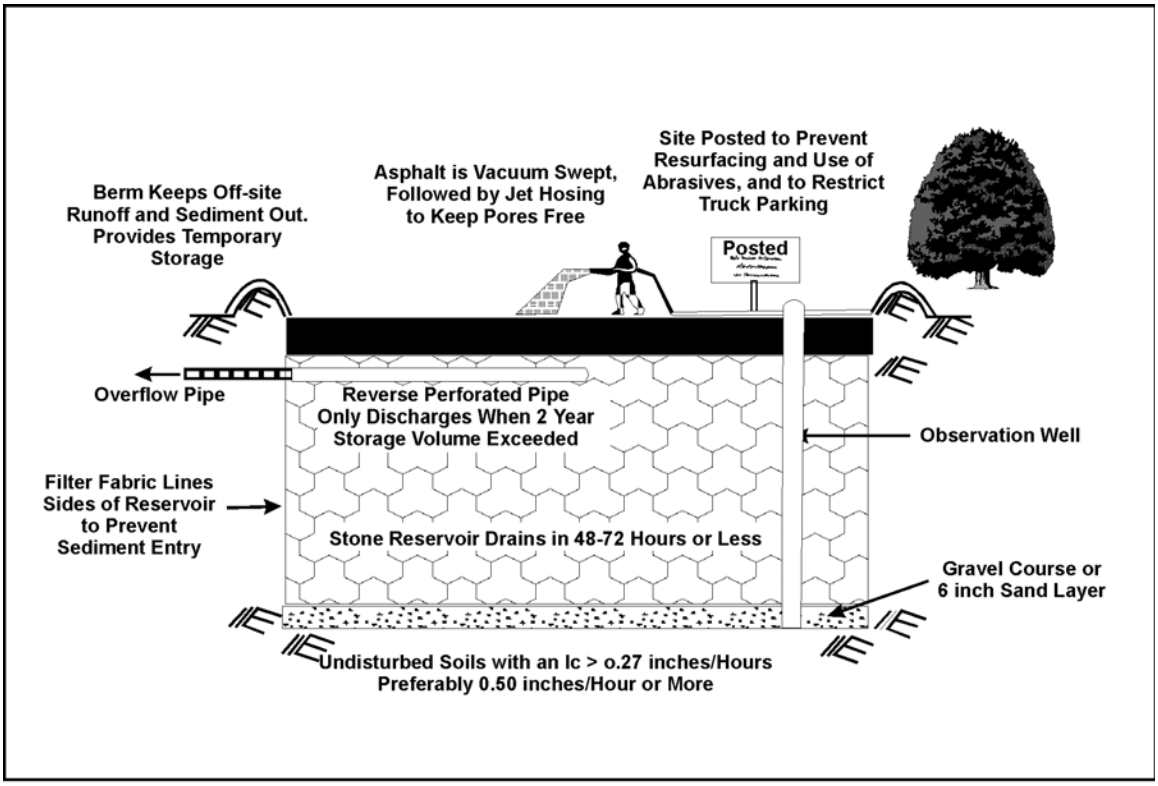
1. Not appropriate high removal rate of Total Suspended Solids (TSS).
2. Porous pavement has a high rate of failure.
3. Porous pavement has a tendency to become clogged if improperly installed or maintained.

4. Anaerobic conditions may develop in underlying soils if the soils are unable to dry out between storm events. This may hinder microbial decomposition.
5. Porous pavement creates risk for groundwater contamination, depending on soil conditions and aquifer susceptibility.

Inspection/Maintenance Consideration

Inspections shall be made on a quarterly basis and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Adjacent pavement (if applicable)	• *Sediment is present on the pavement surface*	• *Sweep or vacuum the sediment as soon as possible.*
Paved Surface	• *Surface deterioration or spalling* • *Water does not infiltrate between storms.* • *Ponding occurs for more than 24 hours after storm.*	• *Repair or replace the surface as needed.* • *Need to dewater after every storm.* • *Check to see if the collector system clogged and flush if needed.*
Outfall spillway and pipe	• *Outflow pipe is clogged.* • *Outflow pipe is damaged.*	• *Clean out the pipe.* • *Repair or replace the pipe.*



Source: Reference 3.

Figure 17 Schematic of Porous Pavement Components

(Source: Strom Water Technology fact Sheet Porous Pavement, EPA)

HYDRODYNAMIC STRUCTURE
Bay Savers™

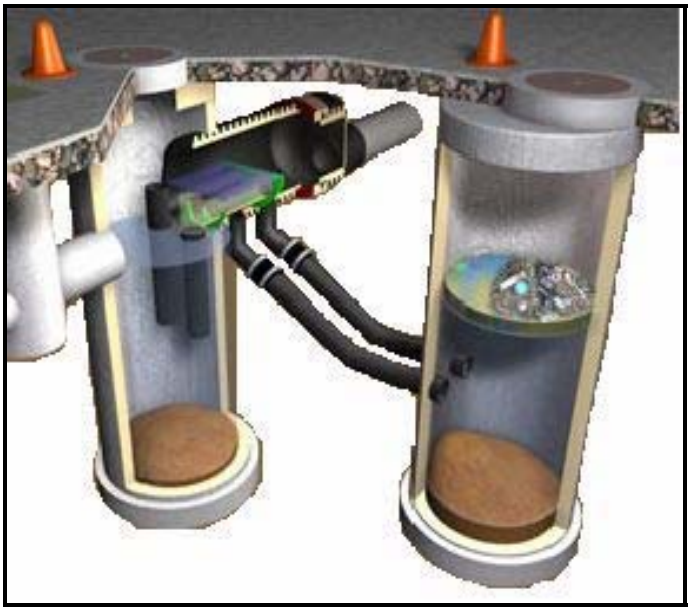


Figure 18 Bay Savers
(Source: www.baysaver.com)

General Description
The Bay Saver system splits water between two different manholes for optimal removal efficiency, responding to changes in the influent flow rate. The two manholes trap the pollutants and allow removal by routine maintenance. Low flows are diverted to the offline tank. High flow passes through the primary tank.

The Bay Saver removes the pollutants from the stormwater runoff through one of the two mechanisms: sedimentation or flotation. Sedimentation is the gravity-driven process and allows the solids to settle down. Flotation works the same way as sedimentation, but in the opposite direction. Floatable pollutants like free oils and debris rise to the surface and are trapped in the storage manhole. It consists of three main components: the Bay Saver unit, the primary manhole, and the storage manhole. A typical model is shown on figure 19.

Benefits
1. Easy maintenance.
2. Unobstructed access for pollutant inspection and removal.
3. Affordable and easy to install.
4. Minimal head requirement.
5. Small footprint.

Limitations
1. It appears some floating litter may accumulate in the primary tank and discharge during high flows.
2. Proprietary device.

Inspection/Maintenance Consideration
Inspections shall be made every six months and within 24 hours after every storm event greater than 1.0 inches to clean the oil and sediment accumulation. The system needs to be cleaned typically, every 12 to 36 months depending on site conditions or when the sediment has accumulated to within one foot of the bottom of the connecting pipes. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sediment	• *Accumulation of sediment on the manhole floor.*	• *Clean out the manhole floor using vacuum truck.*
Storm drain inlet pipes	• *Clogged.* • *Loose connection.*	• *Clean out the drain lines.* • *Tighten the connection (watertight).*
Strom drain outlet pipes	• *Clogged.* • *Loose connection.*	• *Clean out the drain lines.* • *Tighten the connection (watertight).*
Manholes	• *Clogged* • *Manhole cover damage*	• *Clean out the manholes.* • *Replace the manhole covers.*

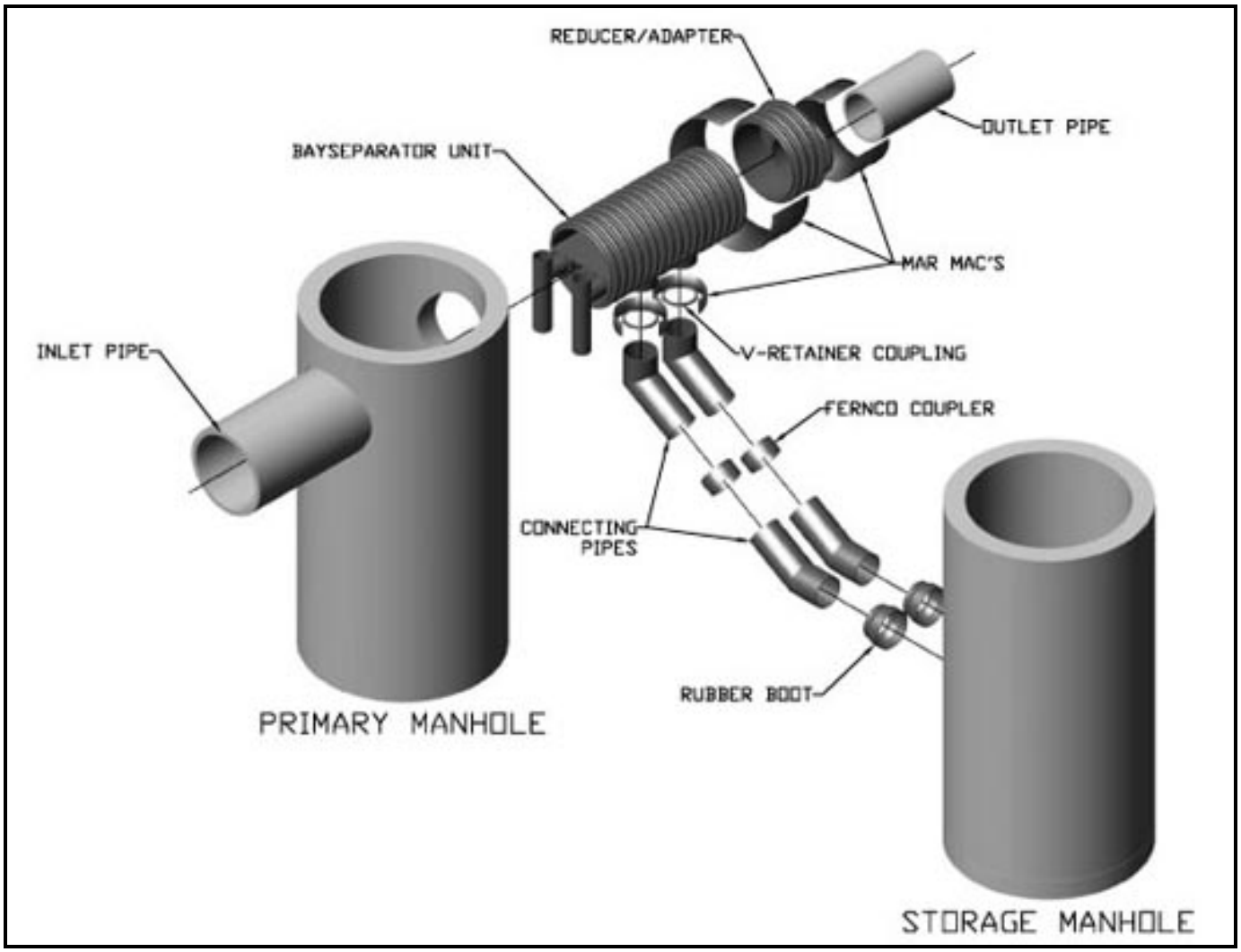


Figure 19 Schematic of Bay Saver Components
(Source: www.baysaver.com)

HYDRODYNAMIC STRUCTURE
Oil-Grit Separator

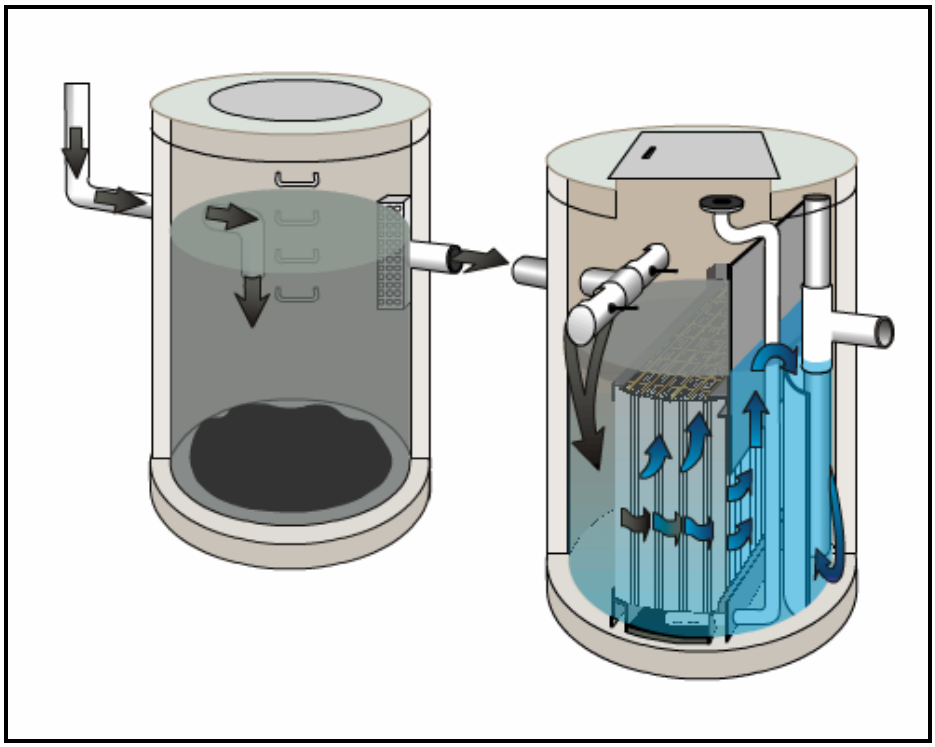


Figure 20 Oil-Grit Separators
(Source: Tremayne Stanton-Kennedy)

General Description

Oil and grit separators (OGS) are structures consisting of three or four chambers that remove sediment, screen debris, and separate oil from stormwater. These structures are also known as oil and water separators or water quality inlets. Their major environmental benefit comes in the form of improved downstream water quality as part of a treatment train.

In the case of a conventional OGS unit, the first chamber, termed the grit chamber, is designed to settle sediment and large particulate matter; the access from the first chamber to the second chamber is covered with a trash rack, which operates as a screen to prevent debris from passing through to the second chamber. The second chamber, termed the oil chamber, is designed to trap and separate free surface oils and grease from the stormwater runoff. The third chamber houses the stormwater outlet pipe that discharges the overflow to the storm drain system.

Oil and grit separators are particularly well suited to capture particulates and hydrocarbons from small, highly impervious areas such as residential townhouse/apartment parking lots, loading/parking areas at commercial facilities, and gas stations. Two basic types of oil and grit separators are available: the three chamber OGS; and the manhole OGS. A typical model is shown on figure 21.

Benefits

1. Ideal for small urban lots, where large or above-ground BMPs are not feasible.
2. Can be effective as a pretreatment device for runoff before entering other BMPs.
3. Very accessible for maintenance activities.
4. Life-span of most separators is high with proper maintenance
5. Easy installation.

Limitations

1. Area draining to separator should contain no more than 1 acre of impervious area.
2. Conventional OGS have demonstrated poor pollutant removal.
3. OGS store only a fraction of a two year storm design volume.
4. Requires frequent maintenance.
5. Cannot remove dissolved or emulsified substances.

Inspection/Maintenance Consideration

Inspections shall be made every six months and within 24 hours after every storm event greater than 1.0 inches to clean the oil/grit separator in order to maintain their pollutant removal capabilities. Failure to clean them out on a regular basis can result in mixing of floating hydrocarbons into the water column and resuspension and loss of previously trapped material. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Grit Chamber and Separator	• *Clogged* • *Leaves or excessive mud/sand.* • *Oil present in the grit or water chamber*	• *Clean out the chamber*
Wash Rack	• *Pollutants poured directly into the wash rack* • *Clogged* • *Damaged*	• *Fix the problem.* • *Clean out the wash rack.* • *Repair or replace if needed.*
Drain lines	• *Clogged.* • *Damaged.*	• *Clean out the drain lines.* • *Repair or replace the drain lines.*
Effluent shutoff valve	• *Operational for closure during cleaning.*	• *If not, repair or replace the valve.*
Hydrants/hoses	• *Leaking*	• *Repair or replace the hydrants/hoses.*
Stormdrain inlet	• *Clogged*	• *Clean out the inlet.*

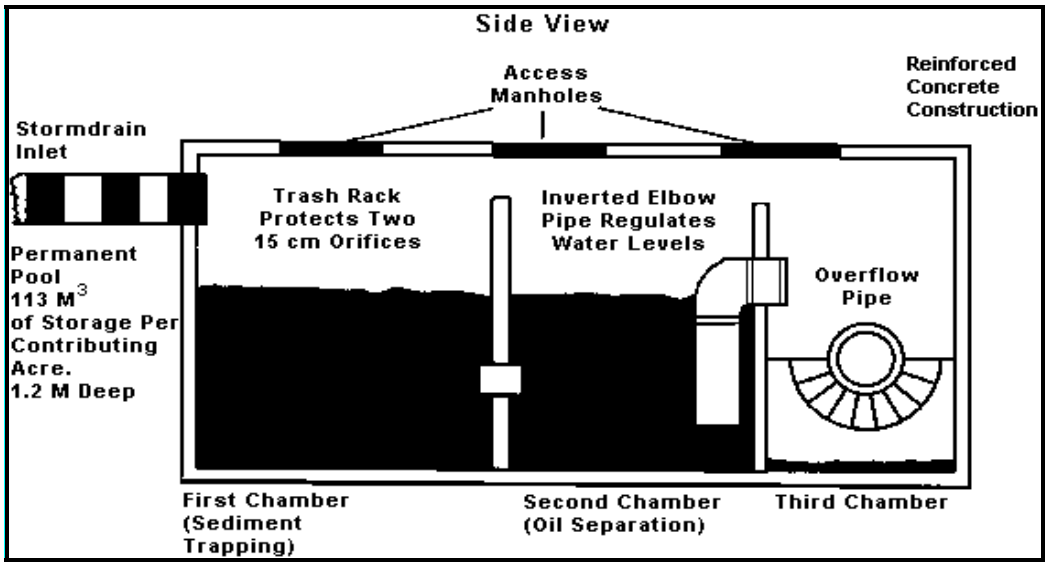


Figure 21 Schematic of Oil-Grit Separator Components

(Source: Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring, US FHWA)

HYDRODYNAMIC STRUCTURE
Stormceptor™

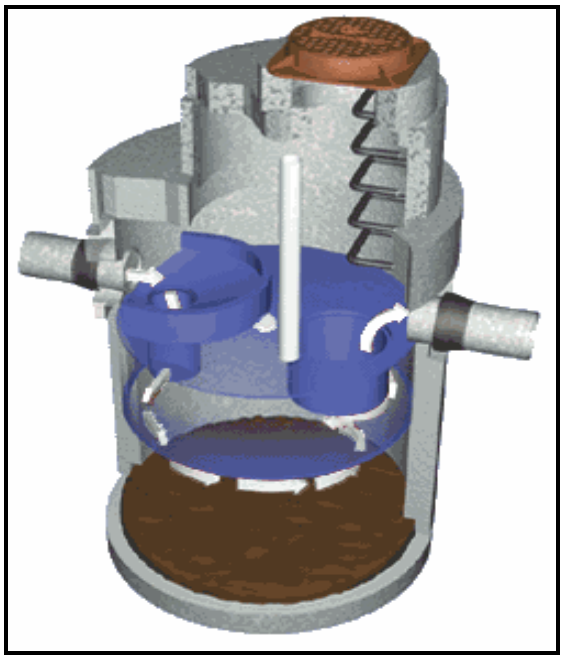


Figure 22 Stormceptor
(Source: Treatment of BMP Technology Report, California Department of Transportation)

General Description
The Stormceptor System is a water quality device used to remove total suspended solids (TSS) and total petroleum hydrocarbons (TPH) from stormwater run-off, preventing hazardous spills and non-point source pollution from entering downstream lakes and rivers. A Stormceptor takes the place of a conventional manhole or inlet structure within a storm drain system.

The unit is divided into two chambers a treatment and a flow bypass chamber. During typical storm events, runoff is directed by the inflow weir through a drop pipe into the lower treatment chamber where sediment, oil, and grease are separated from the flow by gravity. The bypass chamber is designed to convey excess stormwater, which overtops the inflow weir, through the system without treatment.

The Stormceptor is primarily used for treatment of stormwater runoff from impervious surfaces. It can be ideally used in ultra-urban settings since each is composed of a precast structure that is installed beneath the ground and can either be retrofitted to an existing storm drain system or replace a proposed access hole in a storm drain system. The structures are designed to capture and treat a portion of the flow that enters into the storm drain system; however, the volume of runoff treated is limited to the available volume in the lower chamber structure. Because of this, a Stormceptor might treat less than a typical water quality treatment volume and should be placed at the beginning of the storm drain line for maximum treatment efficiency. A typical model is shown on figure 23.

Benefits
1. Small footprint, all underground, and no addition Right-of-Way or easement requirement.
2. Low head requirement.
3. Capable of removing up to 80 percent of the total sediment load when properly applied as a source control for small drainage areas
4. A Stormceptor is proven effective at removing over 98 percent of free oil from storm water runoff and is an excellent spill control device.

5. A Stormceptor slows incoming stormwater to create a non-turbulent treatment environment, allowing free oils and debris to rise, and sediment to settle.
6. Maintenance is quick, easy and inexpensive with a standard vacuum truck.

Limitations

2. Scour may limit effectiveness.
3. Systems require regular maintenance to minimize the potential for washout of the accumulated sediments.

Inspection/Maintenance Consideration

Inspections shall be made every six months and within 24 hours after every storm event greater than 1.0 inches to clean the oil and sediment accumulation. The inspection frequency in subsequent years is based on observations made during the first year. Failure to clean them allowing a gradual build up of oil and sediment, will diminish this BMP efficiency, harming the environment. Inspections are easily carried out above ground from any standard surface access cover through a visual inspection of the orifice and drop tee components. A sludge judge and oil dip-stick is all that are needed for sediment and oil depth measurements. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Vent pipe	• *Clogged*	• *Clean out the vent pipe.*
Separation tank	• *Accumulation of sediment and oil.*	• *Clean out the tank using vacuum truck.*
Storm drain inlet pipes	• *Clogged.* • *Damaged.*	• *Clean out the drain lines.* • *Repair or replace the drain lines.*
Strom drain outlet pipes	• *Clogged.* • *Damaged.*	• *Clean out the drain lines.* • *Repair or replace the drain lines.*
Stormdrain inlet	• *Clogged*	• *Clean out the inlet.*

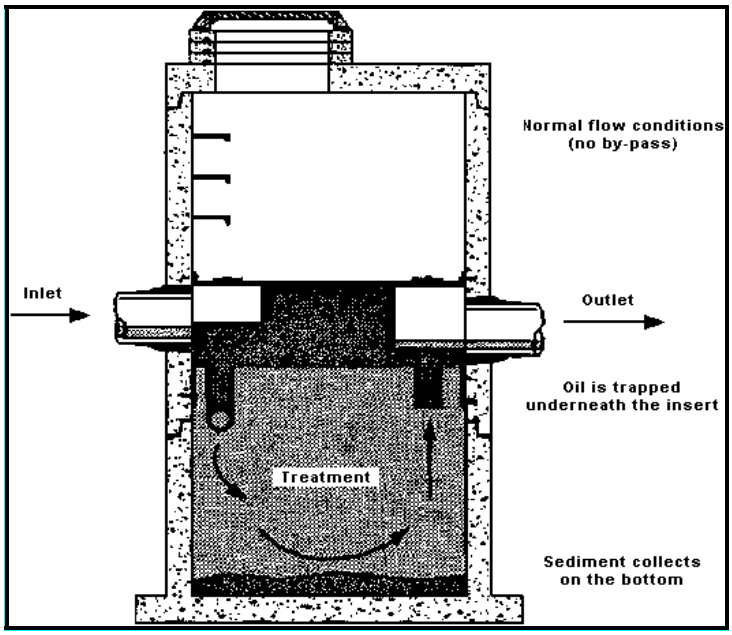


Figure 23 Schematic of Stormceptor Components

(Source: Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring, US FHWA)

HYDRODYNAMIC STRUCTURE
Underground Storage

Figure 24 Underground Storage
(Source: Lake Superior Duluth Streams--Stormwater)

General Description

Underground stormwater storage systems capture and store runoff in larger pipes or other subsurface structures. Stormwater enters the system through a riser pipe connected to a catch basin or curb inlet and flows into a series of chambers or compartments for storage. Captured runoff is retained throughout the storm event, and can be released directly into surface waters through an outlet pipe. Some systems are designed to exfiltrate the runoff into surrounding soils, where it helps to recharge the groundwater table.

Underground stormwater storage systems can be successful part to a development's overall stormwater management plan, when coupled in-line with other stormwater BMPs, but provide minimal water quality benefits. This facility most often used in conjunction with other surface stormwater BMPs

Underground storage systems can be constructed from concrete, steel, or plastic materials. Each material has advantages and disadvantages. A typical model is shown on figure 25.

Benefits

1. Underground storage systems capture and store runoff.
2. Low head requirement.
3. A good option for high density or urban areas with limited available space, unusual shapes, or where land is expensive.
4. Insulation from freezing.
5. Aesthetically pleasing to public in that such systems are out-of-sight and thus out-of-mind.
6. Increased level of public safety over open ponds and other surface stormwater BMPs.

Limitations

1. Underground storage provides little or no water quality improvement.
2. Requires extensive and costly excavation
3. High materials cost compared to other surface stormwater BMPs
4. Maintenance costs are more expensive than other surface stormwater BMPs..

Inspection/Maintenance Consideration

Inspections shall be made every six months and within 24 hours after every storm event greater than 1.0 inches to clean the oil and sediment accumulation. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Stormwater inlet pipes	• *Sedimentation.* • *Damaged.*	• *Clean out the drain lines.* • *Repair or replace the drain lines.*
Stormwater outlet pipes	• *Sedimentation.* • *Damaged.*	• *Clean out the drain lines.* • *Repair or replace the drain lines.*
Structural components	• *Damaged* • *Leaks*	• *Repair or replace the damaged structure*

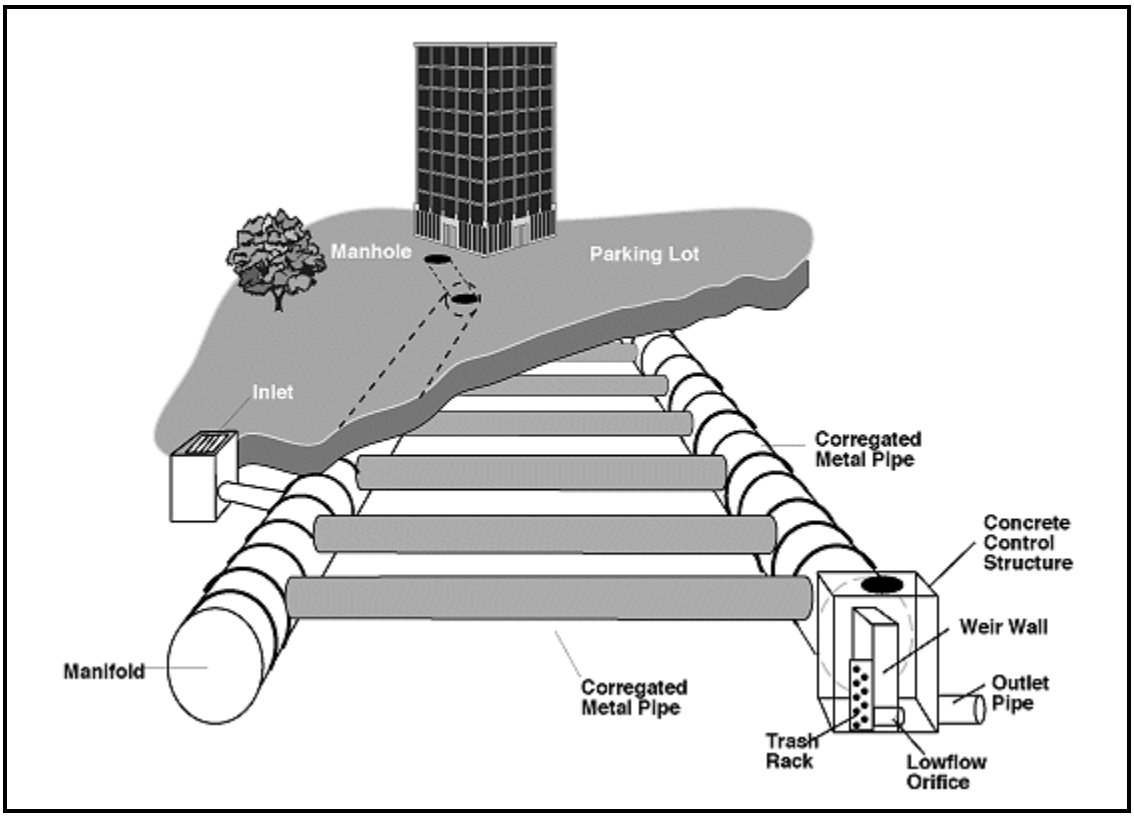


Figure 25 Schematic of Underground Storage System
(Source: Lake Superior Duluth Streams--Stormwater)

INFILTRATION
Dry Well

Figure 26 Dry Well
(Source: Maine Department of Environmental Protection)

General Description
A dry well (seepage pit) typically consists of a pit filled with large aggregate such as gravel or stone. Alternately, it may consist of a perforated drum placed in a pit surrounded with stone. A Dry well captures and infiltrates water from roof downspouts or paved areas. The surface layer of the dry well is typically at or above the existing grade. It may be covered by grass or another surface. Figure 27 shows the schematics of a dry well.

Benefits
1. Suitable for steeper slopes
2. Appropriate for treating runoff from residential driveways or rooftop downspouts.
3. Improved water quality, reduce runoff volume and rate.
4. Increased groundwater recharge.
5. Visually unobtrusive.

Limitations
1. Not suitable for soil with limited permeability.
2. Not suitable for treating runoff from large impervious surfaces such as parking lots.

Inspection/Maintenance Consideration
Inspect the dry well for debris accumulation. Inspect the dry well at least four times a year, as well as after large storm events exceeding 1.0 inch.

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Gutters	• *Clogged with sediment and trash*	• *Clean out gutters and ensure proper connections to facilitate the effectiveness of the dry well.*
Filter fabric surround the dry well	• *Clogged with leaves and trash*	• *Replace the filter fabric as necessary.*
Observation well cap	• *Missing or damaged*	• *Install a new well cap if missing. Replace the damaged cap with a new cap.*

BMP Element	Inspection	Maintenance
Intermediate sump box	• *Clogged*	• *Clean out the sump box if clogged. Otherwise cleanout once per year.*
Underdrain pipe	• *Clogged*	• *Washout the underdrain*
Perforated pipe	• *Exceeding drain down time (max time 72 hours).*	• *Drain the dry well via pumping and clean out perforated piping, if included.*

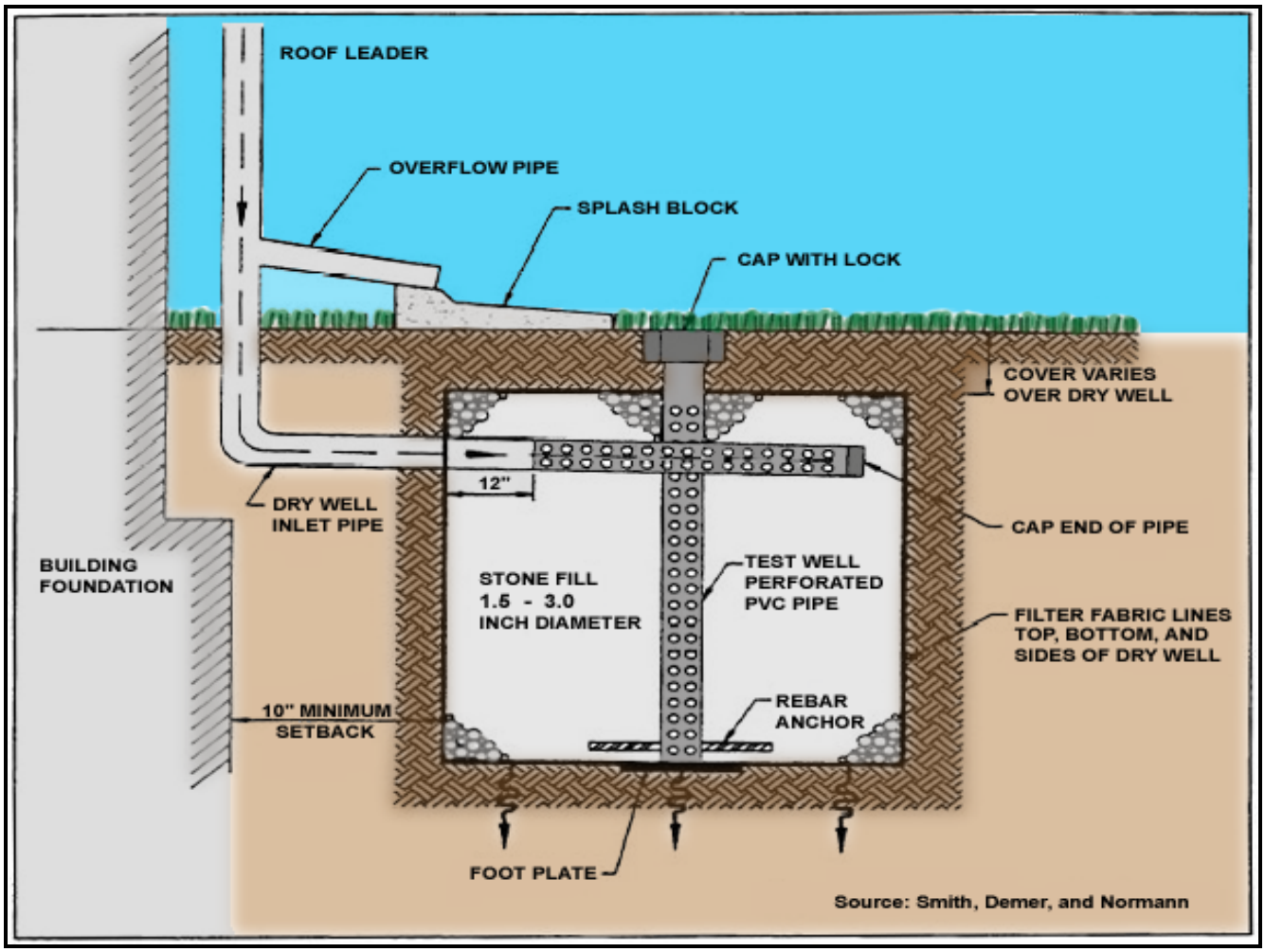


Figure 27 Schematic of Dry Well
(Source: Smith, Demer, and Normann)

INFILTRATION
Infiltration Basin

Figure 28 Infiltration Basin
(Source: Alternative Stormwater Best Management Practice, City of Lincoln, Nebraska)

General Description

An Infiltration basin is a surface pond which captures first-flush stormwater and treats it by allowing it to percolate into the ground and through permeable soils. As the stormwater percolates into the ground, physical, chemical, and biological processes occur which remove both sediments and soluble pollutants. Infiltration basins are believed to have high pollutant removal efficiency, and can also help recharge the groundwater, thus restoring low flows to stream systems. Infiltration basins typically serve drainage areas from 2 to 20 ha (5 to 50 ac).

Infiltration basins effectively remove soluble and particulate pollutants. This provides the majority of treatment by processes related to soil infiltration includes: sorption, precipitation, trapping, filtering, and bacterial degradation. Potential locations include residential lots, commercial areas, parking lots, highways median strips, and adjacent to road shoulders. Basin most suitable for permeable soils (sand and gravel), and where the water table and bed rock are situated below the bottom of the basin.

Vegetation is a key to success of the infiltration basin. Deep-rooting vegetation will enhance infiltration of water while also providing erosion resistance. Another key element of the infiltration basin is having enough area to maintain a shallow pool that will infiltrate within 72 hours or less. A typical model is shown on figure 29.

Benefits

1. Infiltration basins help preserve the natural water balance of a site.
2. Applicable for large and small development.
3. Provides 100 percent reduction in the load discharged to surface waters.
4. Can help to maintain baseflow of nearby streams.
5. Reduce local flooding.
6. Reduces peak flow rate and energy of stormwater discharges, therefore limiting downstream erosion and scouring.

Limitations

1. It can be problematic at many sites because of stringent soil requirements.
2. Short life span, due to the clogging of the basin resulting from settling of the sediments in the bottom of the basin.
3. Frequent maintenance required to maintain the infiltration capacity of the basin.
4. May not be appropriate for industrial sites or locations where spills may occur.
5. Not appropriate for fill sites or steep slopes.
6. Require ample space for installation.

Inspection/Maintenance Consideration

Infiltration basins should be inspected following major storms, especially in the first few months after construction. If stormwater remains in the system beyond the design drawdown time (typically 72 to 96 hours), either the infiltration capacity was overestimated or maintenance is needed. Inspection needs to be performed quarterly and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sediment	• *Accumulation of sediment in trench.*	• *Clean out the sediment.*
Inlet/Outlet	• *Clogged.* • *Eroded*	• *Clean out the inlet/outlet.* • *Avoid erosion by placing some riprap or rock.*
Inlet-pipe or swale/Outlet-pipe	• *Clogged due to sediment, trash, and leaves.* • *Damaged.* • *Erosion is occurring in the swale*	• *Clean out the pipes.* • *Repair or replace the well if needed.* • *Regrade the swale if necessary to smooth it over and provide erosion control devices such as reinforced turf matting or riprap.*
The forebays	• *Sediment has accumulated.* • *Erosion has occurred or riprap is displaced.* • *Weeds are present*	• *Search for the source of the sediment and remedy the problem if needed. Remove sediment and dispose of it in a location where it will not cause impact to streams or the BMP.* • *Provide additional erosion protection such as reinforced turf matting or riprap if needed to prevent further erosion.* • *Remove the weeds.*
The main treatment area	• *Sediment* • *Ponding more than 5 days after storm event.*	• *Same as for forebays.* • *Replace the top few inches of filter media and see if this corrects the ponding problem. If so, revegetate immediately. If not, consult an appropriate expert.*
Vegetation	• *Overgrown*	• *Mow and trim vegetation around the facility.*
Embankment	• *Vegetation (shrubs and tree) have started to grow on the embankment.* • *Erosion or gully*	• *Remove the shrubs and trees immediately.* • *Provide additional erosion protection such as reinforced turf matting or riprap if needed to prevent further erosion.*

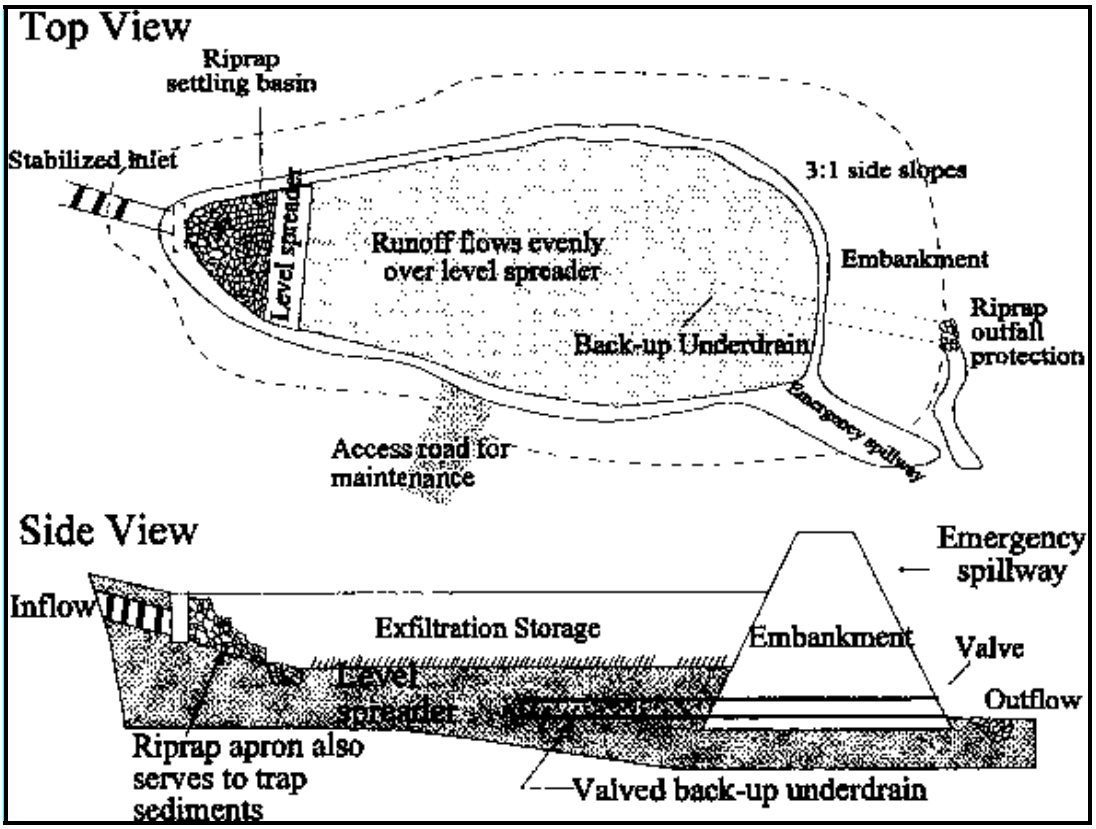


Figure 29 Schematic of Infiltration Basin Components

(Source: Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring, USFHWA)

INFILTRATION
Infiltration Trench

Figure 30 Infiltration Trench
(Source: Center for Watershed Protection, CWRA)

General Description

An infiltration trench is basically an excavated trench that has been lined with filter fabric and backfilled with stone to form an underground basin. Runoff is diverted into the trench and either exfiltrates into the soil, or enters a perforated pipe underdrain and is routed to an outflow facility. The depth of an infiltration trench generally ranges between 3 and 8 ft (Schueler 1987) and may change when site-specific factors are considered. Infiltration trenches are very adaptable BMPs, and the availability of many practical configurations make it ideal for small (less than 4 ha [10 ac]) urban drainage areas, such as ultra-urban sites. They are most effective and have a longer life cycle when some type of pretreatment is included in their design. Pretreatment may include techniques such as vegetated filter strips or grassed swales.

An Infiltration trench effectively removes soluble and particulate pollutants. This provides the majority of treatment by processes related to soil infiltration including sorption, precipitation, trapping, filtering, and bacterial degradation. Potential locations include residential lots, commercial areas, parking lots, highway median strips, and adjacent to road shoulders. Trenches most suitable for permeable soils (sand and gravel), and where the water table and bed rock are situated below the bottom of the trench.

Three basic trench types are used and each type can be built above or below ground. The three types of trench are as follows: *complete trench, partial trench, and water quality exfiltration system.* The complete trench only has exits through the stone into the soil by exfiltration. All runoff which enters a complete trench is exfiltrated from the trench. The partial trench has a perforated underdrain in case there are concerns about underlying soils, downstream seepage, or clogging at the filter fabric-soil interface. This can have a perforated pipe near the top of the trench instead of an underdrain, to ensure that flows in excess of the low flows will exfiltrate. The water quality exfiltration system is volumetrically designed to handle and exfiltrate only the first flush volume. This treats a smaller volume and is focused solely upon water quality. A typical model is shown on figure 31.

Benefits

1. Ground water recharge.
2. Can be utilized where space is limited, due to their narrow dimensions.
3. Reduces the volume of runoff from a drainage area.
4. Reduces downstream flooding and protect Stream bank integrity.

Limitations

1. Difficult to keep sediment out of the structure during construction.
2. Regular maintenance needed to function properly.
3. If it gets severely clogged, it must be replaced.
4. Not suitable for slope greater than 20 percent.
5. Infiltration structures are difficult to apply in slowly permeable soils or in fill areas.

Inspection/Maintenance Consideration

Inspections shall be made frequently and within 24 hours after every storm event greater than 1.0 inches to clean the trash and sediment accumulation. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sediment	• *Accumulation of sediment in trench.*	• *Clean out the sediment.*
Inlet/Outlet	• *Clogged.* • *Eroded*	• *Clean out the inlet/outlet.* • *Avoid erosion by placing some riprap or rock.*
Observation well	• *Clogged due to sediment, trash, and leaves.* • *Damaged.*	• *Clean out the observation well.* • *Repair or replace the well if needed.*
Filter fabric	• *Accumulation of sediment*	• *Remove sediment. If needed replace the filter fabric to restore infiltration trench to design condition.*
Overflow spillway	• *Clogged with sediment or debris.* • *Eroded*	• *Remove and disposed the trash and sediment properly so that there is no clogging or blockage.* • *Place some riprap or rock to avoid erosion if needed.*
Observation well cap	• *Missing or damage*	• *Replace if needed.*
Vegetation	• *Overgrown*	• *Mow and trim vegetation around the trench.*
Ponding	• *Standing water at the surface or in the trench*	• *Check the clogging or blockage due to sediment or trash. If exist, then remove the clogging, improve grade from head to foot of infiltration trench, replace filter fabric and stone aggregate.*

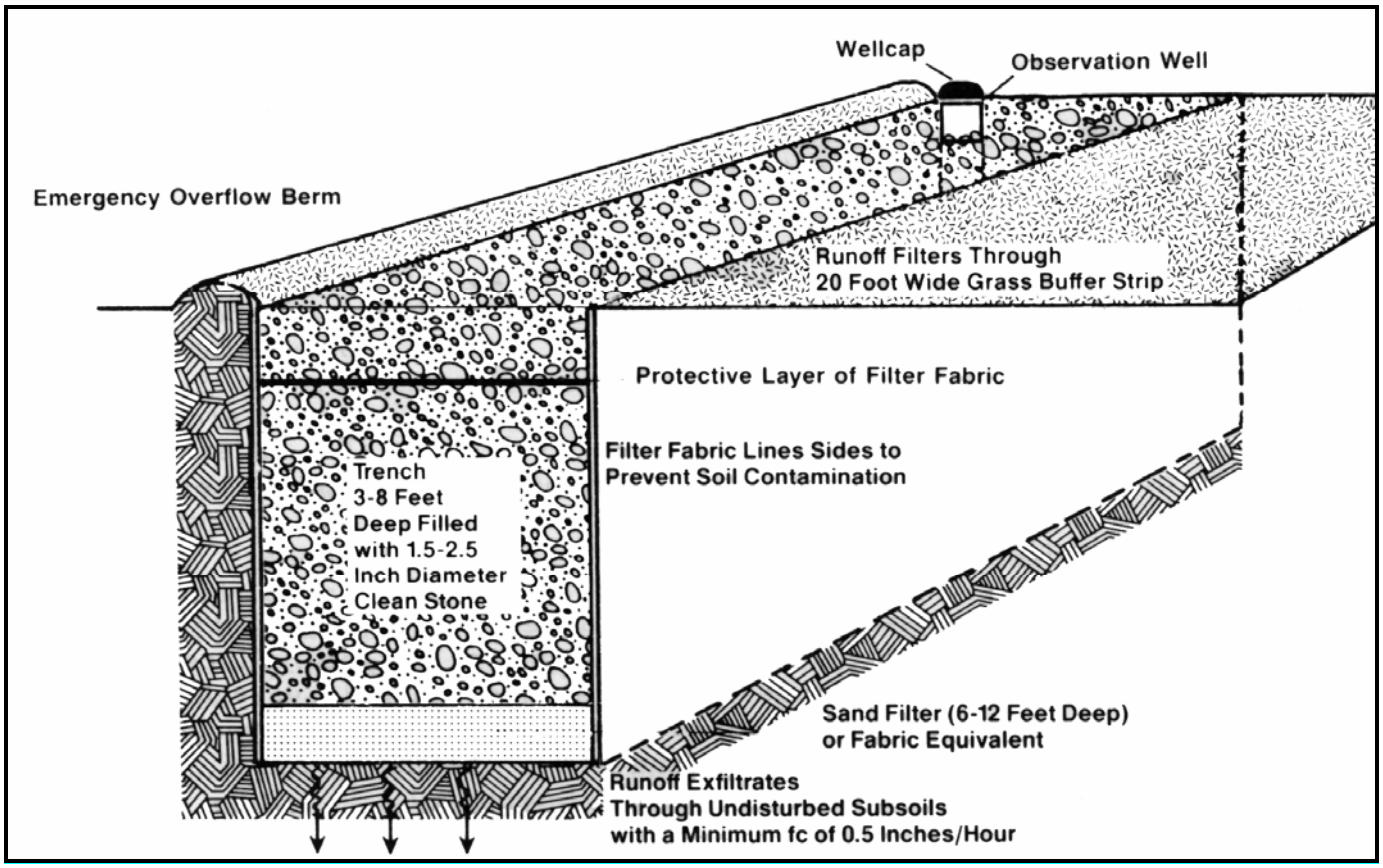


Figure 31 Schematic of Infiltration Trench Components
(Source: Minnesota Urban Small Sites BMP Manual)

SWM POND
Dry Pond

Figure 32 Dry Pond
(Source: Fairfax County, VA)

General Description

Dry ponds, also called "detention ponds" are designed to retain stormwater temporarily and drain within two to three days after the rain stops. Water is impounded to allow many of the pollutants to settle to the bottom. The impounded water is discharged through an outlet that provides for prolonged release. Most dry ponds do not contain a permanent pool of water, and no water will remain if it is functioning properly. Some dry ponds, however, incorporate a shallow marsh or wetlands to improve pollutant removal. These facilities are known as extended detention ponds.

Dry ponds can provide limited pollutant removal or settling of particulate matter, but a large portion of this material can be resuspended by future runoff events. Therefore, dry ponds are mostly used to reduce peak runoff of stormwater to receiving streams to limit downstream flooding and to provide some degree of channel protection.

Dry ponds should be implemented for drainage areas greater than 10 acres. This area requirement is purely a function of outlet sizing to ensure that the outlet does not become clogged. A typical model is shown on figure 33.

Benefits

1. Can perform well in cold climates.
2. Can limit downstream scour and loss of aquatic habitat by reducing the peak flow rate and energy of stormwater discharges to receiving streams.
3. Can be used as recreational areas (ex. athletic fields) if designed properly.

Limitations

1. Generally not appropriate for drainage areas less than 10 acres.
2. Provided only marginal removal of pollutants.
3. Potential for clogging outlets.
4. Poorly maintained basins can create nuisance odors, weed growth and accumulation of trash.

Inspection/Maintenance Consideration

Inspection needs to be performed quarterly and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Invasive vegetation*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the invasive vegetation.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant the grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant the grass on the bare area to avoid erosion.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Principal spillway pipe	• *Principal spillway is blocked.* • *Principal spillway join is leaking.* • *Sections of the pipe have settled to a point where the integrity of the dam may be threatened.*	• *Clean the principal spillway.* • *Repair the pipe. Replace if needed.* • *Replace the section of the pipe if needed.*
Riser	• *Low flow orifice is blocked.* • *Riser is filled with trash, sediment, rock etc.* • *Trash rack is damaged.* • *Riser damaged/deteriorated.*	• *Removed the trash or sediment from the low flow orifice.* • *Clean the riser and the riser trash rack if needed.* • *Repair or replace the trash rack if needed.* • *Repair or replace the riser if needed.*
Ponding	• *Standing water.* • *Eroded areas (rills, channels, etc.) were noted on the pond side slopes.*	• *Search for the clogging or any damage causing ponding. If not, regrade the ground for the proper drainage.* • *Repair and stabilize the area.*

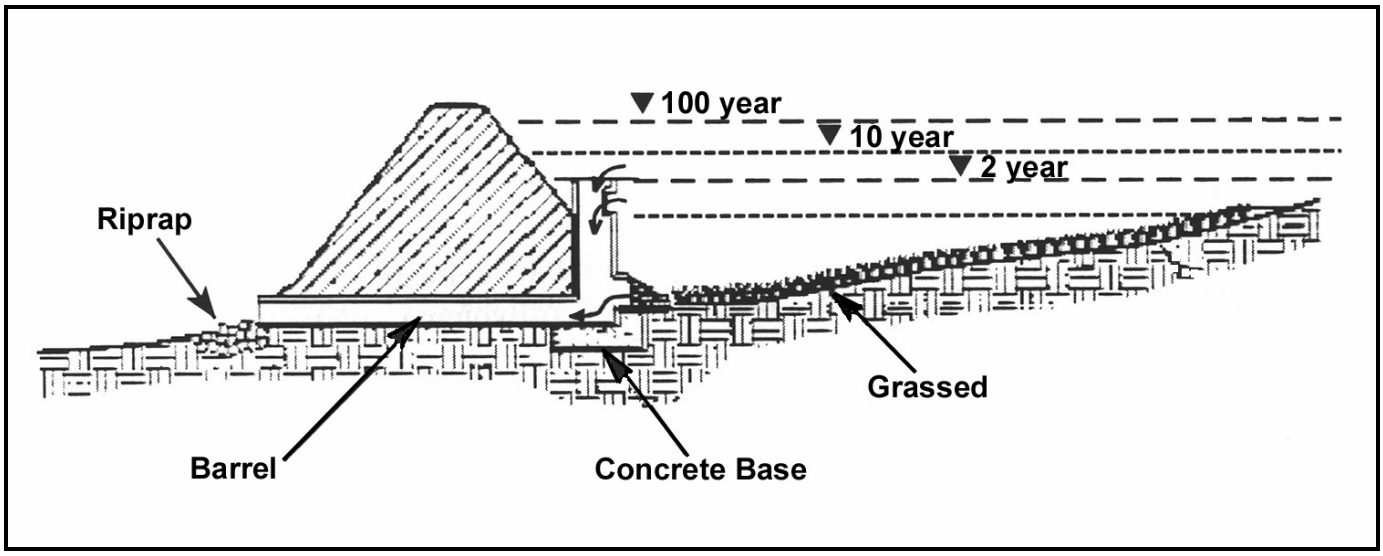


Figure 33 Schematic of Dry Pond Components
(Source: Minnesota Urban Small Sites BMP Manual)

SWM POND
Extended Detention Structure Dry

Figure 34 Extended Detention Structure Dry
(Source: Georgia Stormwater Management Manual)

General Description

Dry extended detention ponds are surface facilities intended to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts. These facilities temporarily detain the storm water runoff from a water quality design storm for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. However, they are often designed with small pools at the inlet and outlet of the basin.

In addition, dry extended detention ponds provide flood control by including additional temporary storage for peak flows above the dead storage. Extended detention ponds are also capable of managing smaller floods that contribute to channel erosion problems and occur more frequently than the annual or 2-year flood. A typical model is shown on figure 35.

Benefits

1. Moderate removal of urban pollutants.
2. Appropriate for water quality treatment and flood control.

Limitations

1. Potential for thermal impact/downstream warming.
2. Dam height restriction for high relief areas.
3. Pond drainage problem may occur for low relief terrain.

Inspection/Maintenance Consideration

Inspection needs to be performed quarterly and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Weeds are present*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the weeds.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant the grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant the grass on the bare area to avoid erosion.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Ponding	• *Standing water.* • *Eroded areas (rills, channels, etc.) were noted on the pond side slopes.*	• *Search for the clogging or any damage causing ponding. If not, regrade the ground for the proper drainage.* • *Repair and stabilize the area.*

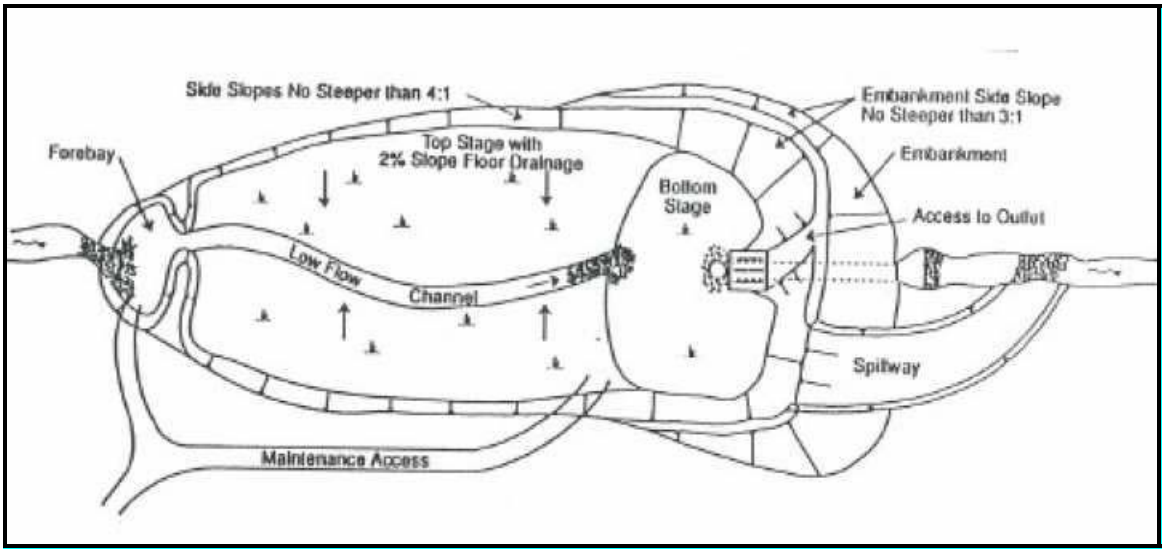


Figure 35 Schematic of Dry Extended Detention Pond Components
(Source: Weber County Engineering Department)

SWM POND
Extended Detention Structure Wet

Figure 36 Extended Detention Structure Wet
(Source: NCDENR Stormwater BMP Manual)

General Description

A wet extended detention pond combines the pollutant removal effectiveness of a permanent pool of water with the flow reduction of an extended storage volume. Ponds treat incoming stormwater runoff by settling and biological uptake. The primary removal mechanism is settling as stormwater runoff resides in this pool, but pollutant uptake, particularly of nutrients, also occurs to some degree through biological activity in the pond. Wet ponds are among the most widely used stormwater practices.

Wet extended detention ponds are typically used for residential subdivision, low-density commercial sites, but are not recommended for high-density residential and heavy urbanized areas. This may limit other uses of the facility, such as enhancing natural habitat. The fluctuating water elevations in the extended detention part of the facility will alternately flood and dry out the soils, making it more difficult to establish plants

A wet extended detention pond should be implemented for drainage areas greater than 25 acres. A typical model is shown on figure 37.

Benefits

1. Moderate to high removal of urban pollutants.
2. High rate of community acceptance. Wet basin can provide substantial aesthetic/recreational value and wildlife and wetlands habitat.
3. Widespread application with sufficient capture volume can provide additional control of channel erosion and enlargement.

Limitations

1. Generally not appropriate for drainage areas less than 25 acres.
2. Mosquito and midge breeding is likely to occur in ponds.
3. Cannot be placed on steep unstable slopes.
4. Potential for thermal impacts downstream from warmer discharge.

Inspection/Maintenance Consideration

Inspection needs to be performed once a month and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Weeds are present*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the weeds.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant the grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant the grass on the bare area to avoid erosion.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Riser	• *Low flow orifice is blocked.* • *Riser is filled with trash, sediment, rock etc.* • *Trash rack is damaged.* • *Riser damaged/deteriorated.*	• *Remove the trash or sediment from the low flow orifice.* • *Clean the riser and the riser trash rack if needed.* • *Repair or replace the trash rack if needed.* • *Repair or replace the riser if needed.*
Ponding	• *Standing water.* • *Eroded areas (rills, channels, etc.) were noted on the pond side slopes.*	• *Search for the clogging or any damage causing ponding. If not, regrade the ground for the proper drainage.* • *Repair and stabilize the area.*

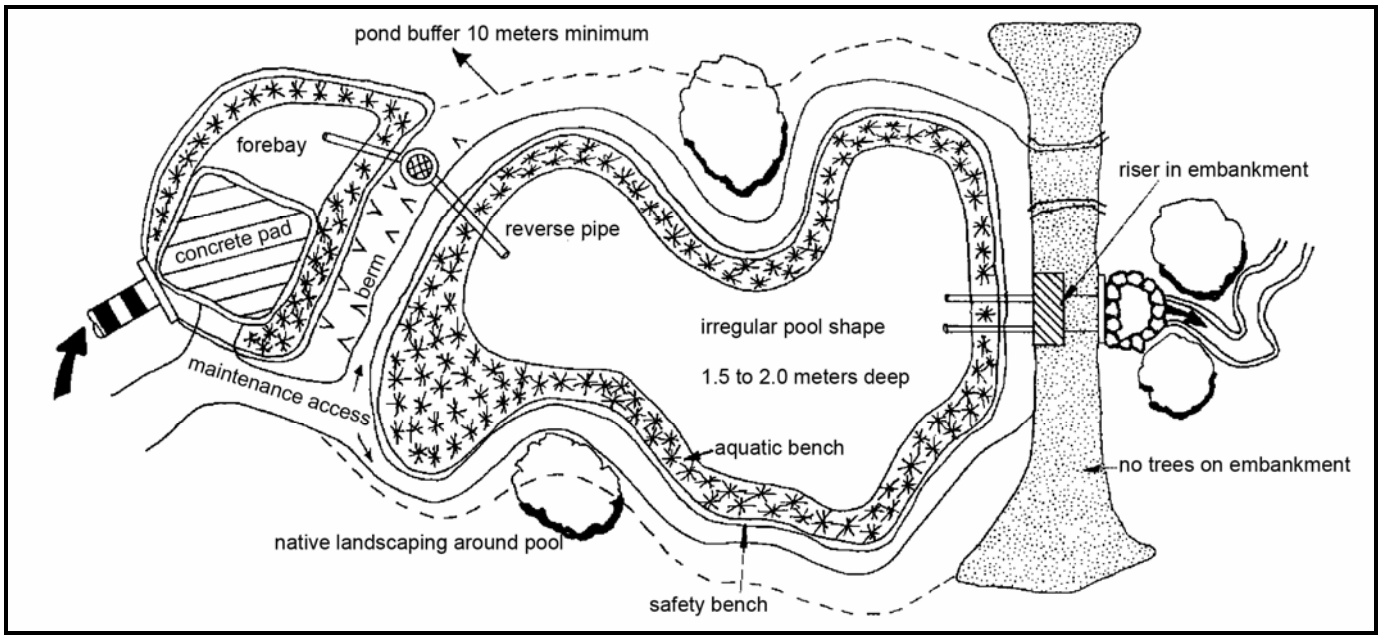


Figure 37 Schematic of Wet Extended Detention Pond Components
(Source: Charles River Watershed Association)

SWM POND
Wet Pond

Figure 38 Wet Ponds
(Source: Stormwater Engineering Group, Cooperative Extension, NCSU)

General Description

A wet pond is a stormwater management facility, which includes: a) permanent pool of water for enhancing water quality and b) additional capacity above the permanent pool for detaining stormwater runoff.

Wet ponds fill with stormwater and release most of it over a period of a few days, slowly returning the pond to its normal depth. Wet ponds treat incoming stormwater runoff by settling and algal uptake. The primary removal mechanism is settling while stormwater runoff resides in the pool. Nutrient uptake also occurs through biological activity in the pond.

Wet ponds require an adequate source of inflow to maintain the permanent water surface. Due to the potential to discharge warm water, wet ponds should be used with caution near temperature sensitive water bodies. Properly designed and maintained Wet ponds generally do not support significant mosquito populations (O'Meara). A typical model is shown on figure 39.

Benefits

1. Algal uptake/settling increase nutrient removal.
2. Reduces soil erosion.
3. Appropriate for use in areas with higher potential pollutant loads.
4. Wet ponds are among the most cost-effective and widely used stormwater practices.

Limitations

1. Wet ponds may cause some community concerns regarding safety.
2. Limited applicability in highly urbanized settings and in arid climates.
3. If improperly located, wet pond construction may cause loss of wetlands or forest.
4. In cold water streams, wet ponds are not a feasible option due to the potential for stream warming.

Inspection/Maintenance Consideration

Inspection needs to be performed quarterly and within 24 hours after every storm event greater than 1.0 inches. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Weeds are present*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the weeds.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant the grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant the grass on the bare area to avoid erosion.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Ponding	• *Standing water.* • *Eroded areas (rills, channels, etc.) were noted on the pond side slopes.*	• *Search for the clogging or any damage causing ponding. If not, regrade the ground for the proper drainage.* • *Repair and stabilize the area.*

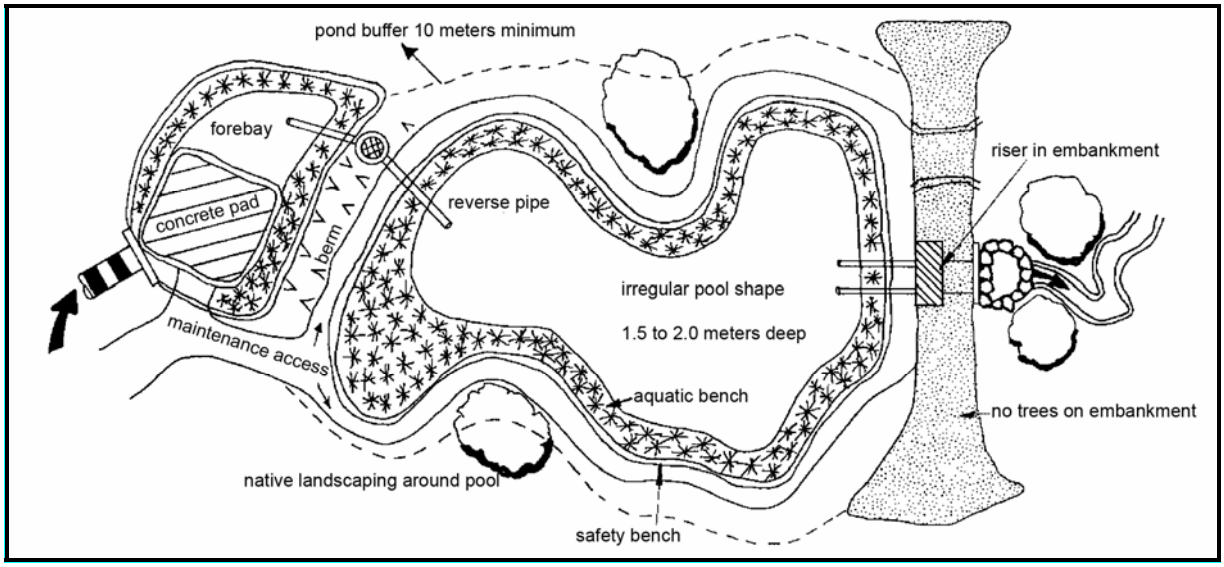


Figure 39 Schematic of Wet Pond Components
(Source: Charles River Watershed Association, CRWA)

WETLAND
Artificial Wetland

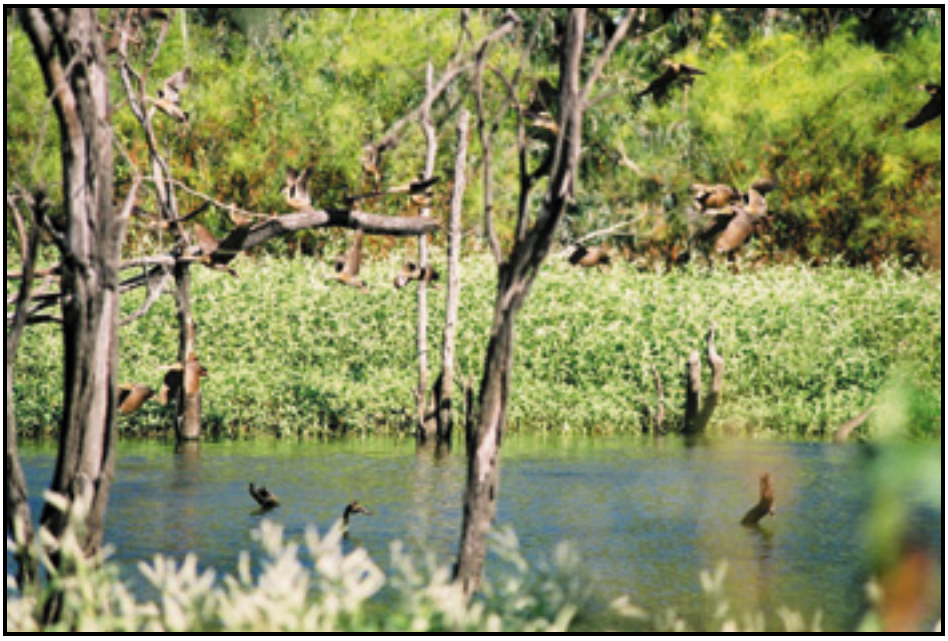


Figure 40 Artificial Wetland
(Source: http://www.greenmountpress.com.au/cottongrower/issues/233mjcot02/233reeves.htm)

General Description

Artificial wetlands are constructed shallow marsh systems planted with emergent vegetation that are designed to treat stormwater runoff. While they are one of the best BMPs for pollutant removal, artificial wetlands can also lower the peak rates and even reduce runoff volume. Adequate space and source of inflow are required to maintain the permanent water surface.

Wetland and marsh systems can have additional stormwater features that help to attenuate peak storm flows. Figure 41 is an example of a constructed wetland.

Benefits

1. Reduces stormwater runoff
2. Reduces peak discharges runoff volume.
3. Relatively low maintenance cost.
4. Soluble nutrients are assimilated by growing vegetation.
5. Aesthetic enhancement and valuable addition to community green space.

Limitations

1. Need baseflow or supplemental water to maintain water level.
2. Not appropriate for steep unstable slopes or densely developed areas.
3. Need larger areas than other BMPs.
4. May attract and breed mosquitoes.
5. Potential for nutrient release in winter.
6. Hydraulic capacity may be reduced with plant overgrowth.

Inspection/Maintenance Consideration

Inspection needs to be performed twice a year, before and after the rainy season, after large storm events, rapid ice breakup or more frequently if needed. If needed, consult wetland ecologist for vegetation installation. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Weeds are present*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the weeds.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Mosquitoes	• *Breed or Mosquitoes*	• *Control as necessary*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant grass on the bare area to avoid erosion.*

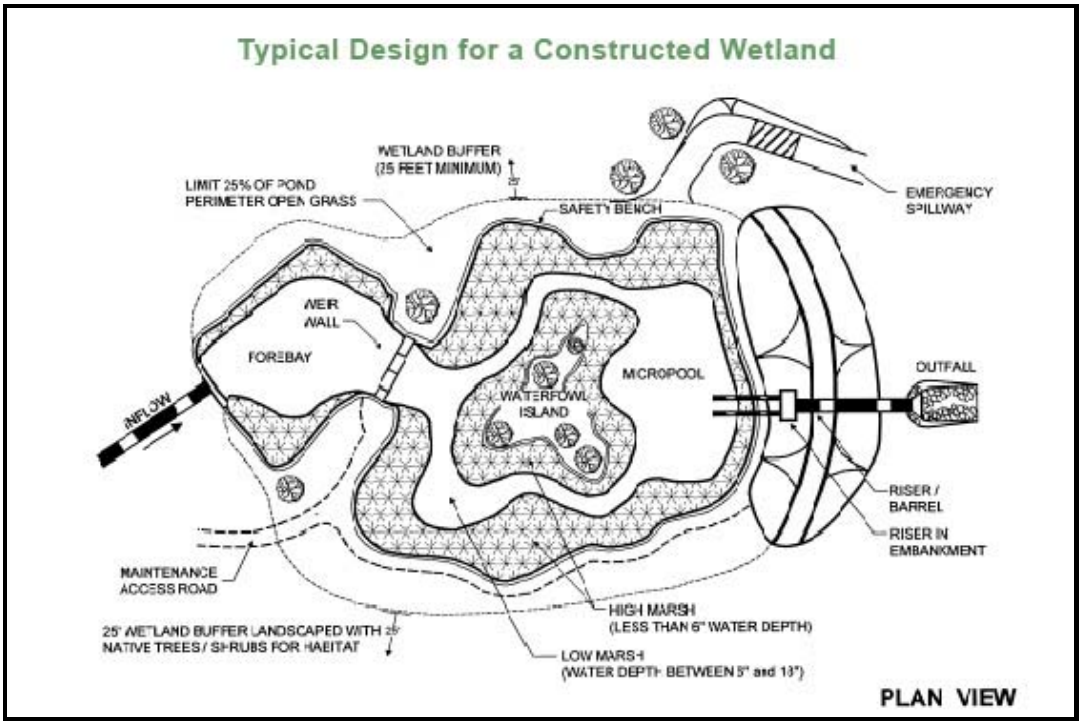


Figure 41 Schematic of Constructed Wetland Components
(Source: Maryland Stormwater Manual, MDE)

WETLAND
Shallow Marsh

Figure 42 Shallow Marsh
(Source: Department of Natural Resources, Minnesota)

General Description

In the shallow marsh design, most of the wetland volume is in the relatively shallow high marsh or low marsh depths. The only deep portions of the shallow wetland design are the forebay at the inlet to the wetland, and the micropool at the outlet. One disadvantage to this design is that, since the pool is very shallow, a large amount of land is typically needed to store the water quality volume, i.e., the volume of runoff to be treated in the wetland.

These systems can often have great habitat value. The fringe wetlands and deep water habitats provide shelter and breeding places for many species. Properly sited wetland systems can also be scenic assets along a highway corridor. Shallow marshes are designed with sinuous pathways to increase retention time and contact area.

Wetland and marsh systems can have additional stormwater features that help to attenuate peak storm flows. Figure 43 is an example of a shallow marsh system.

Benefits

1. Settlement of particulate pollutants.
2. Flood attenuation.
3. Reduces peak discharges.
4. Relatively low maintenance cost.
5. Improvement in downstream water quality.
6. Aesthetic enhancement and valuable addition to community green space.

Limitations

1. Relatively high construction cost compared to other BMPs.
2. May be difficult to maintain vegetation under a variety of flow conditions.
3. Need larger areas than other BMPs.
4. Release of nutrients in the fall.
5. Until vegetation is well established, pollutant removal efficiencies may be lower than anticipated.

Inspection/Maintenance Consideration

Inspection needs to be performed twice a year at least for the first three years after construction and annually thereafter. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Forebays	• *Accumulation of sediment.* • *Side slope erosion.* • *Weeds are present*	• *Clean out the sediment.* • *Provide erosion control devices such as reinforced turf matting or riprap.* • *Remove the weeds.*
Inflow point	• *Erosion/undercutting.* • *Inflow pipe clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the pipe. If needed repair or replace the pipe.*
Embankment	• *Overgrown vegetation.* • *Erosion and/or loss of dam material.* • *Animal burrows.* • *Fractures.* • *Signs of seepage on downstream face.*	• *Mow and trim vegetation around the facility.* • *Plant grass on the bare area to avoid erosion.* • *Burrow holes should be filled.* • *Repair the fractures on the dam.* • *Repair the seepage.*
Emergency Spillway(ES)	• *Overgrown vegetation.* • *Trees noted on the ES.* • *Erosion.*	• *Mow and trim vegetation.* • *Remove the trees.* • *Plant the grass on the bare area to avoid erosion.*
Outfall	• *Erosion/undercutting.* • *Outflow structure clogged or damaged.*	• *Provide erosion control devices such as reinforced turf matting or riprap.* • *Clean the structure. If needed repair or replace the pipe.*
Ponding	• *Standing water.* • *Eroded areas (rills, channels, etc.) were noted on the pond side slopes.*	• *Search for the clogging or any damage causing ponding. If not, regrade the ground for the proper drainage.* • *Repair and stabilize the area.*

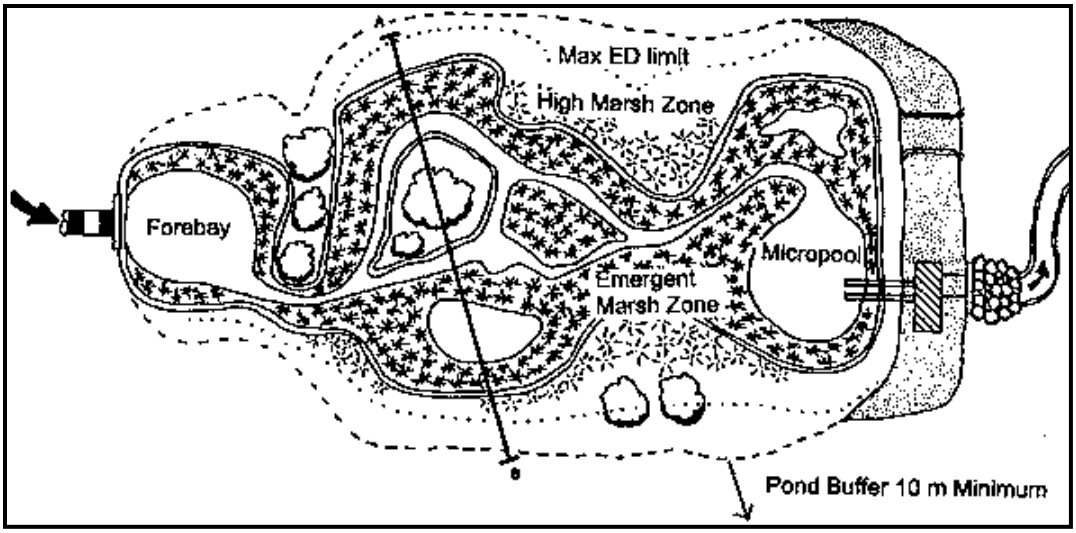


Figure 43 Schematic of Shallow Marsh Components
(Source: Federal Highway Department, USDOT)

OTHER
Check Dam

Figure 44 Check Dam
(Source: NPDES, DOT, New castle County, Delaware)

General Description

Check dams (*In-Stream/Channel Energy Dissipaters*) are generally used in concentrated-flow areas, such as vegetated ditches and swales. They can consist of stones, sandbags, or gravel and are most commonly used in the bottom of the channels that will be stabilized at a later date. Although check dams also collect sediment and hence act as filters, their primary purpose is to reduce erosive velocities.

Check dams tend to pond water. Under low-flow conditions, water ponds behind the structure and then dissipates slowly via infiltration or evaporation. Under high-flows conditions, water flows over and/or through the structure.

Check dams provide relatively good removal of coarse and medium size sediment from runoff. Figure 45 is an example of a check dams.

Benefits

1. Relatively inexpensive and easy to construct.
2. Effective at reducing erosion and sediment transport off site..
3. Relatively low maintenance cost.
4. Soluble nutrients are assimilated by growing vegetation.

Limitations

1. Require periodic repair and sediment removal upstream of check dams.
2. Removal of temporary check dams can be difficult.
3. Not appropriate to use in live streams or in channels with extended base flows.
4. Not appropriate in channels for drainage areas greater than 10 acres.

Inspection/Maintenance Consideration

Inspect the check dams regularly and after every runoff producing storm. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Sediments	• *Accumulation of sediment.*	• *Clean out the sediment.*
Inflow point	• *Erosion/undercutting.*	• *Provide erosion control devices such as reinforced turf matting or riprap.*
Erosion	• *Banks are severely eroded.*	• *Stabilize the banks. Replace the rocks or add rocks if needed.*
Vegetation	• *Overgrown vegetation*	• *Mow or trim the vegetation.*
Ponding	• *Standing water*	• *Drain the water and remove the clogged material between the rocks or logs.*
Sandbags	• *Sandbag fabric shows sign of deterioration*	• *Remove and replace the sand bags.*

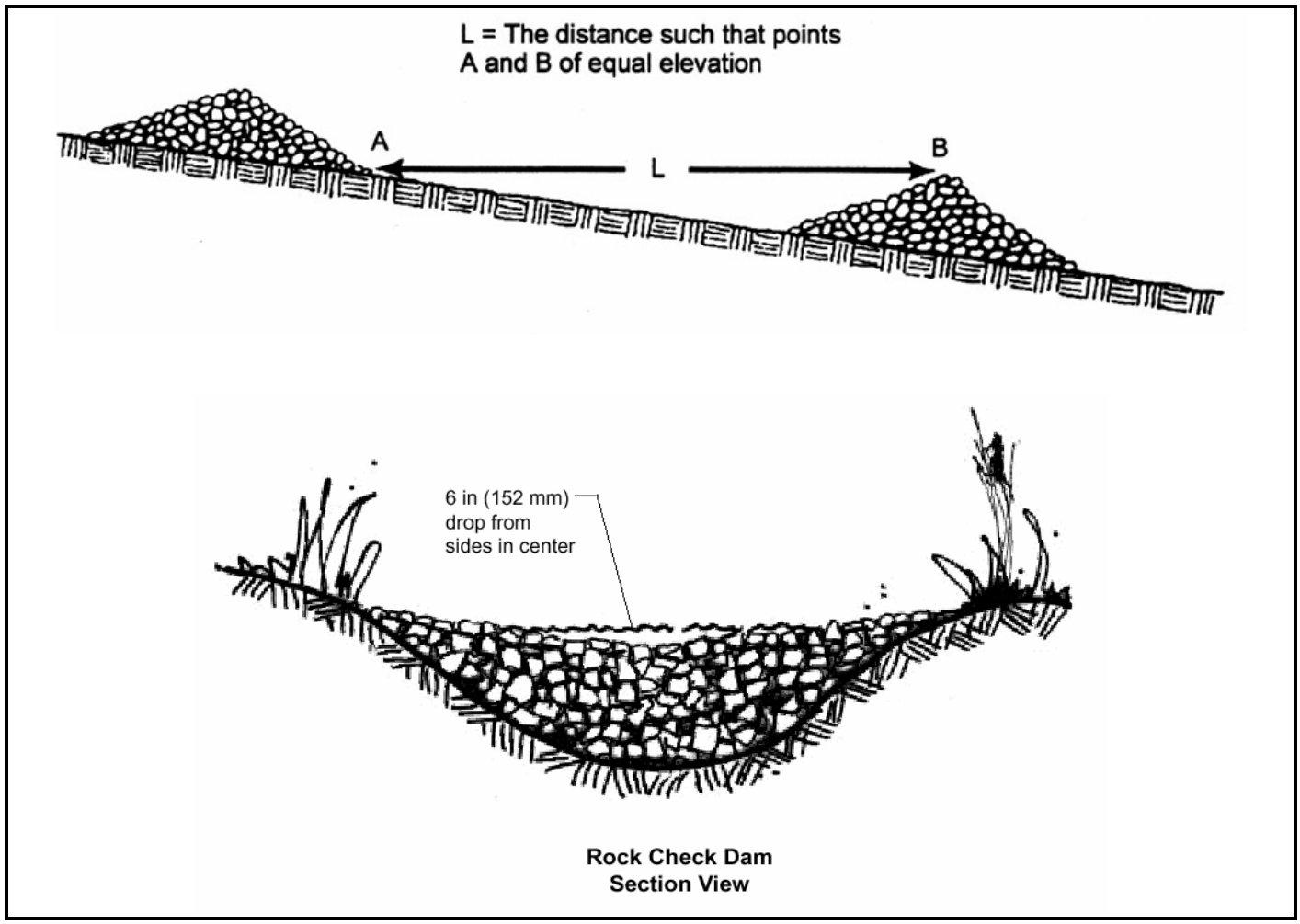


Figure 45 Schematic of Check Dam Components

(Source:http://www.empr.gov.bc.ca/Mining/MineralStatistics/MineralSectors/ConstructionAggregates/ReportsandPublications/Documents/Check%20Dam.pdf)

OTHER
Gabion

Figure 46 Gabion
(Source: Best Management Practices, redwood-Cottonwood River Control Area (RCRCA))

General Description

A gabion is a rectangular basket made of heavily galvanized wire mesh filled with small to medium size rock. Gabions are laced together and installed at the base of a bank to form a structural toe or sidewall. Vegetation may be incorporated by placing live branches between each layer of rock filled baskets. These branches take root inside the gabions and in the soil behind the structures. Their roots eventually consolidate the structure and bind it to the slope.

Gabions are used to stop undercutting and/or scouring at the base of steep slopes, they are attractive when plants are growing between them, and they can be used to create a steeper, more stable side slope than can be built with riprap. The habitat provided by gabion deflectors is at least as good as natural habitat, and the undercuts formed under gabions as they twist or settle provide good cover.

Benefits

1. Gabions are flexible.
2. They are durable because they support plant growth, which develops a living coating for the wire mesh and stones.
3. Relatively low maintenance cost.
4. Construction is simple and requires no skilled labor.
5. Since gabions are porous, no costly drainage provisions are required

Limitations

1. Expensive to construct.
2. Repair cost is high.
3. Not appropriate to use in concrete channels where rusting can cause premature failure of the cage.

Inspection/Maintenance Consideration

Periodic inspections should be performed for signs of undercutting or excessive erosion at transition areas. Inspect regularly and after each major storm. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Wire of cages	• *Rusting and wear*	• *Repair or replace the wire mesh.*
Sedimentation	• *Accumulation of sediment*	• *Clean the sediment*
Vegetation	• *Overgrown*	• *Mow or trim if needed.*

OTHER

Level Spreader

Figure 47Level Spreader
(Source: Stormwater Engineering Group, NCSU Cooperative Extension)

General Description

Used as an outlet for dikes, diversions, or other concentrated runoff which is slightly depressed allowing water to collect and then disperse uniformly over the surrounding vegetated area. A level spreader is a low cost method to convert a small volume of concentrated runoff to sheet flow and release it onto an area stabilized by existing vegetation. Although a level spreader by itself is not considered a pollutant reduction device, it improves the efficiency of other facilities, such as vegetated swales, filter strips, or infiltration devices, which are dependent on sheet flow to operate properly. There are two applications for level spreaders:

- Inflow level spreaders to evenly distribute flow entering into a structural best management practice.
- Outflow level spreaders, which can stand alone to distribute runoff from an impervious surface or used in conjunction with a structural best management practice.

Level spreaders can take many forms including vegetated filter strips, concrete sills (or lips) curbs, concrete troughs; a plastic tile cut in half, rock check dams, and treated lumber. Figure 48 shows the schematics of level spreader.

Benefits

1. Level spreaders may promote infiltration and improve water quality.
2. It can remove pollutants from runoff by filtration, infiltration, adsorption, absorption, decomposition, and volatilization.
3. Widely used BMP due to ease of installation and availability of materials.
4. Low cost and simple to construct.

Limitations

1. Drainage area limited to 5.0 acres.
2. Regular maintenance is essential to ensure sheet flow discharge.
3. Maximum slope is 1.0%.
4. Cannot handle large quantities of sediment-laden stormwater.

Inspection/Maintenance Consideration

Periodic inspections should be performed to detect any damage. Inspect regularly and after each major storm. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Swale and the level lip	• *Swale is clogged* • *Level lip is cracked, settled, undercut, eroded or damaged* • *Erosion around the end of level spreader*	• *Remove the sediment and dispose it off-site.* • *Make any necessary repair or replace if damage is too large for repair.* • *Repair or replace the lip.*
Sedimentation	• *Accumulation of sediment*	• *Clean the sediment and dredge the level.*
Vegetation	• *Overgrown* • *Trees or shrubs have begun to grow on the swale of just downslope of the level lip.*	• *Periodic mowing required.* • *Remove the trees or shrubs.*

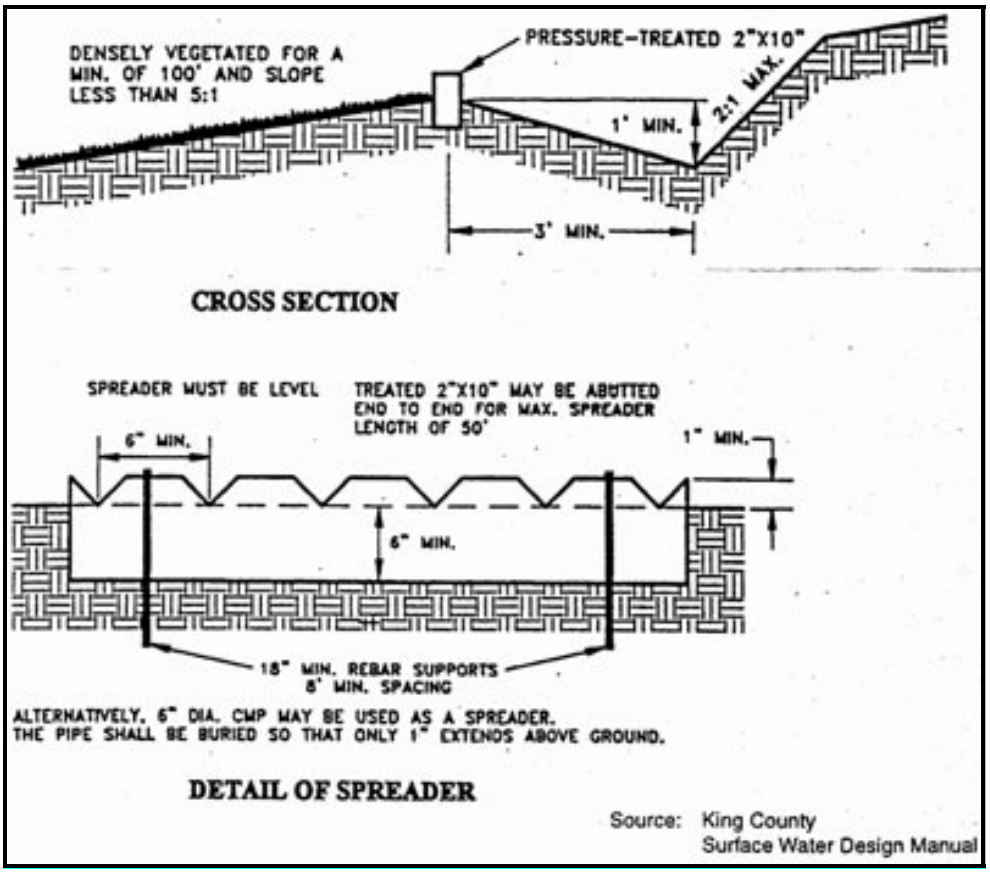


Figure 48 Schematic of Level Spreader Components

(Source: Design Principles for Parking Lots, Tennessee Valley Authority Economic Development)

OTHER
Flow Splitter

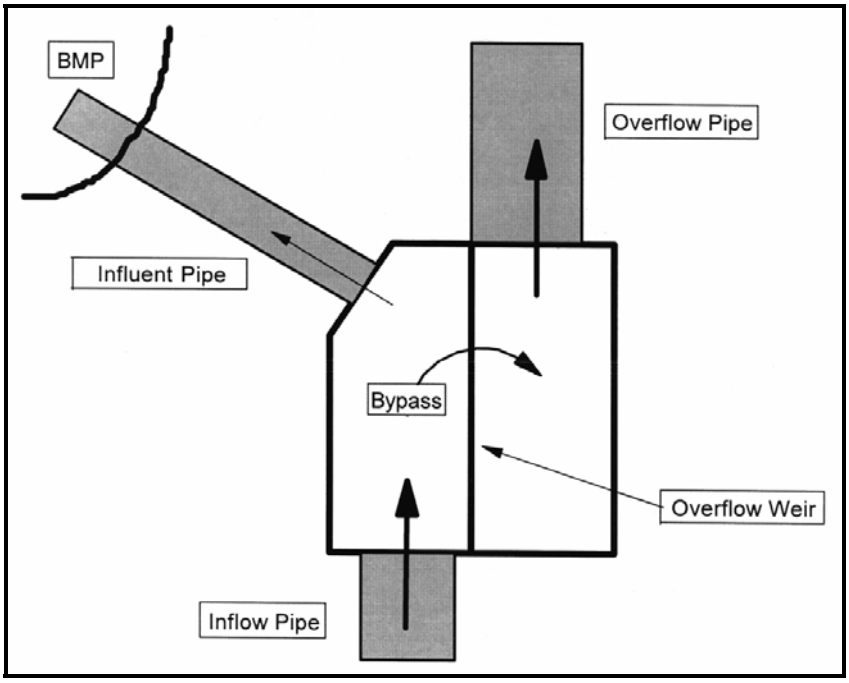


Figure 49 Flow Splitter
(Source: Metropolitan Council/Barr Engineering Co.)

General Description

A flow splitter is an engineered structure used to divide flow into two or more parts, and divert these parts to different places. The design of a flow splitter uses specifically designed structures, pipes, orifices, and weirs set at specific elevations to control the direction of flow.

Flow splitters are used to direct the first fraction of runoff (commonly called the "first flush") into an end-of-pipe BMP facility, while bypassing excess flows from larger events around the facility into a bypass pipe or channel. The bypass typically enters a detention pond or the downstream receiving drainage system, depending on flow control requirements. Figure 50 shows the schematics of a flow splitter.

Off-line BMP systems that require flow-splitter consideration include:

1. Bioretention cells
2. Dry well
3. Infiltration trench
4. Wet ponds

Benefits

1. Limit the flow into a BMP facility to the design volume, enhancing their longevity by reducing volumetric rate of treatment, erosion, slope, and vegetation damage.
2. Reduces chances of resuspension of sediments in the BMP.
3. Reduces dilution effect in the BMP.

Limitations

1. A flow splitter has the potential to cause flow reversal. Flow reversal is the flow of water out of a BMP facility back through the flow splitter structure.
2. To achieve the desired bypass rate, a flow splitter minimizes the depth of bypass.

3. Maximize the elevation difference between the water level in the facility and the flow splitter to minimize the potential for reversal flow.

Inspection/Maintenance Consideration

Periodic inspections should be performed to detect any damage. Inspect regularly and after each major storm. Inspection activities shall be performed as follows:

BMP Element	Inspection	Maintenance
Entire facility	• *Trash/debris is present*	• *Remove trash/debris*
Structural condition	• *Concrete structure cracked*	• *Repair the cracked or replace if needed.*
Sedimentation	• *Accumulation of sediment*	• *Clean the sediment.*
Vegetation	• *Overgrown on way to off-line BMP*	• *Periodic mowing requires for proper conveyance.*
Rip rap location/condition	• *Unstable and missing rocks*	• *Repair and/or add rocks if needed*

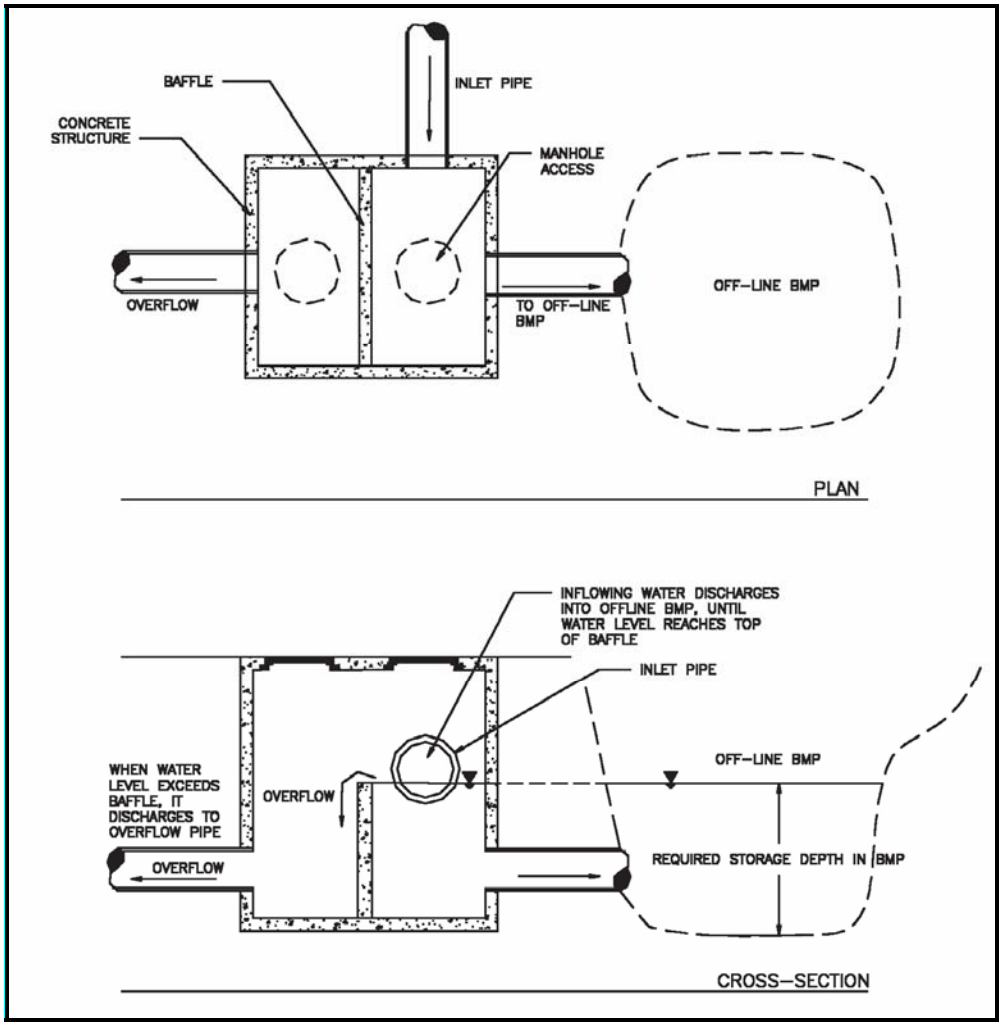


Figure 50 Schematic of Flow Splitter Components

(Source: Massachusetts Nonpoint Source Pollution Management)

3.6 BMP Photographs Naming

Photographs should be taken of each BMP facility. The photos should be comprehensive to reflect the inspection results and include pertinent information relating to the BMPs performance. For ponds, the riser and embankment must be included, along with the impoundments, inlets, and outlets where possible. The photos should be described on the inspection form with a proper number and description.

The most efficient and convenient digital photo format is JPEG (jpg). Every field photo must have the structure or BMP number, descriptor, and date imbedded in the image. Photographs should be named, starting with BMP facility identification number, followed by a description of the photograph subject, and then the date. Table 3.3 below shows the photo naming convention.

Table 2 Standard Photograph Naming Convention

Subject	Naming Standard
Riser	1234-001_RISER_04302009_1.jpg
Outfall	1234-001_OUT_04302009_1.jpg
Observation Well	1234-001_OB_04302009_1.jpg
Inflow	1234-001_INF_04302009_1.jpg 1234-001_INF_04302009_2.jpg
Emergency Spillway	1234-001_04302009_1.jpg
Embankment	1234-001_EMBK_04302009_1.jpg
Overall	1234-001_OVERALL_04302009_1.jpg
Erosion	1234-001_ERO_04302009_1.jpg
Low Flow Orifice	1234-001_LOWFLOW_04302009_1.jpg
Control Structure	1234-001_CS_04302009_1.jpg
Weir	1234-001_WEIR_04302009_1.jpg
Fence	1234-001_FENCE_04302009_1.jpg
Riprap	1234-001_RR_04302009_1.jpg
Evidence Blocked	1234-001_BLOCK_04302009_1.jpg
Vegetation	1234-001_VEG_04302009_1.jpg
Forebays	1234-001_FOREBAY_04302009_1.jpg
Trash and Debris	1234-001_TRASH_04302009_1.jpg
Sedimentation	1234-001_SED_04302009_1.jpg

Figure 51 shows an example of the naming convention.

Figure 51 Example of BMP Inspection Digital Photo

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APPENDIX A

INSPECTION RATING CRITERIA
AND
INSPECTION RATING FORM

BMP Inspection Rating Criteria

This includes recommended procedures to conduct visual inspections of public BMP facilities for the purposes of rating their operational readiness based on the following categories ***Sustainability, Environmental Quality***, and ***Safety.*** A system of rating values is applied to determine condition, maintenance and repair prioritization. BMP inspection parameters have been grouped into three categories:

- **Environmental Quality** – This category focuses on the environmental conditions and includes water quality treatment, stormwater management performance, flood control, habitat conditions, quality management, and functionality of the facility.
- **Sustainability** – This category focuses on the structural and overall condition of the facility with respect to the evaluation of the site features necessary to ensure longevity.
- **Safety** – This category focuses on the safety of private owners, the public, field inspectors, and maintenance personnel.

All BMPs inspection parameters are scored on a scale of 1 to 5. The scoring defines the relative condition of each parameter shown on the field inspection form. The objective is to provide a consistent framework for performing the rating of each parameter. In general, the rating reflects the following:

1 – Operating as Designed, No Issues Observed
2 – Operational, Minor Issues Exist
3 – Operational, Moderate Issues Exist
4 – Performance is Compromised, Major Problems Exist
5 – Non-Functional

If the BMP design does not need the rating of a specific parameter, the rating is recorded as "0 – Not Scored".
If the BMP design needs to be rated for a specific parameter but could not be inspected, the rating is recorded as "NR – Not Rated".

Environmental Quality*:* The following parameters focus on environmental benefits and functions of the BMP such as water quality treatment, stormwater management, wildlife/aquatic habitat. This also includes the facility's negative impact on the surrounding environments such as erosion and litter.

- **Debris –** This rates the overall condition of the BMP related to physical conditions such as woody/leaf, garbage, and sedimentation that can possibly block the outlet structure.

  Rating Value:

  1. No woody/leafy debris, garbage, and/or sediment accumulations at the facility and/or outlet structure.
  2. Minor accumulations of woody/leafy debris, garbage, and/or sediment at the facility and/or outlet structure. Blocking 0 - 25% of the outlet structure.

3. Moderate accumulations of woody/leafy debris, garbage, and/or sediment at the facility and/or outlet structure. Blocking 26 - 50% of the outlet structure potentially could cause problems during future storm events. Maintenance needs to be scheduled.
4. Major accumulations of woody/leafy debris, garbage, and/or sediment at the outlet structure. Blocking 51 - 75% of the outlet structure potentially could cause problems during future storm events. Maintenance needs to be performed immediately.
5. Huge accumulations of woody/leaf, garbage, and/or sediments at the outlet structure. Blocking 76 - 100% of the outlet structure could cause the outlet structure and the structural integrity of the facility to be compromised. Maintenance needs to be performed immediately.

- **Point of Discharge Impact –** This rates the overall condition of the BMP at discharge points, including sheet flows, into the facility that may damage the performance of the BMP. For example, scour within the BMP as a result of unstable discharge points.

  Rating Value:

  1. There are no problems as a result of discharge channels, pipe conveyances, or sheet flow. Facility is operating as designed and no maintenance is required.
  2. Minor issues, such as sedimentation or basin scour, as a result of the discharge channels, pipe conveyances, or sheet flow. Facility is operating as designed and no maintenance is required, but condition should be monitored.
  3. Moderate issues, such as sedimentation or basin scour, causing problems with the performance of the facility. Maintenance should be performed.
  4. Major evidence shows that BMP performance is compromised. Maintenance should be performed.
  5. Evidence shows that BMP performance has failed. Maintenance should be performed immediately.

- **Inflow Stability –** This rates the condition of conveyance features that flow into a BMP, including evidence of instabilities around the periphery of the BMP as a result of sheet flow. Any evidence of erosion or down-cutting of the channel should be evaluated.

  Rating Value:

  1. Channels or conveyance pipes are functioning as designed. No maintenance is required.
  2. Minor erosion or deficiencies observed within channels or conveyance pipes. No maintenance is required, but condition should be monitored.
  3. Moderate evidence of erosion or deficiencies observed around the channels or conveyance pipes. Active of erosion discharging sediment into the BMP facility. Maintenance should be performed.
  4. Major evidence of erosion shows that BMP performance is being compromised. Erosion is actively affecting BMP function and could impact the structural integrity of the embankment. Maintenance should be performed.

5. Channels or conveyance pipes have failed. This causes the failure of the embankment or failure is expected during the next storm event. Maintenance should be performed immediately.

- **BMP Vegetation –** This parameter needs to be evaluated for BMPs that have specific plants defined for stormwater treatment. The inspection rating for the vegetation should be based on the worst parameter. For example, the vegetation covers 80% of the treatment area, but 60% of the species are invasive. In this case, the rating for this parameter would be 4 due to the large percentage of invasive species. This parameter considers only the site area performing stormwater treatment. Embankment and site vegetation can be scored with different parameters. This parameter cannot be adequately accessed during winters.

  Several BMPs require plants to perform treatment and plants are essential for the success of the facility. These are the following BMPs:

  - ❖ Bio-retention
  - ❖ Stormwater wetlands
  - ❖ Wet swales
  - ❖ Submerged benches at stormwater ponds

  Rating Value:

  1. Greater than 80% of the treatment area has vegetative cover and less than 10% of the species is invasive. The plants are predominately in good health.
  2. Between 60 - 80% of the treatment area has vegetative cover and 10 - 30% of the species is invasive. There are few species showing evidence of poor health.
  3. Between 40 - 60% of the treatment area has vegetative cover. Invasive species with 31 - 50% becoming predominant over native species.
  4. Treatment area has 20 - 40% vegetative cover. The majority of species are invasive with 51-70% invasive present. About 20 - 40% of the plants appear to be poor health or showing the signs of stress.
  5. Less than 20% of the treatment area has vegetative cover and greater than 70% of the treatment area has invasive species. The majority of the plants are in poor health indicating the presence of toxic or systemic chemical.

- **Permanent Pool –** This rates the condition of BMPs with permanent standing water that is designed for water quality treatment. This parameter is used to identify the loss of permanent pool volume or loss of water required to maintain the pool, and may indicate the need for dredging. The BMPs that qualify for this parameter are: ponds, stormwater wetlands, and wet swales.

  The focus is on standing water and is evaluated by comparing the maximum observed water depth of the permanent pool against the design depth. This can be measured at the deepest point of the impoundment area and in most cases this may be in the middle of the pool area. An alternate location (e.g., riser) can be used to perform the observed water depth

measurement. The BMP features such as forebays or plunge pools are not considered for the depth measurement.

The inspector should focus on the presence of excessive sedimentation filling in the forebays or delta-like deposits at the in-flow point(s) of the pool area. Inspection should also be performed where there is evidence of irregular water sources, such as fluctuating shoreline and/or invasive vegetation along the fringe of water edge. This situation arises due to the installation of impervious liners or low-flow devices.

Rating Value:

0. No permanent pool designed for this facility.
1. Water depth corresponds to the design plan, and there is no evidence of an irregular water source.
2. Water depth is greater than 75% of the design depth, and/or there is minor evidence of an irregular water source.
3. Water depth is 50 - 75% of the design depth, and/or there is moderate evidence of an irregular water source.
4. Water depth is 25 - 50% of the design depth, and/or there is significant evidence of an irregular water source.
5. Water depth is less than 25% of the design depth, and/or there is major evidence of an irregular water source.

- **Pretreatment –** This rates the facility relating to pretreatment (such as forebays or filter strip) of stormwater before entering the main treatment area. The capacity to trap incoming sediment in the forebays or other pretreatment areas is a major criterion to rate this parameter. Inspectors should consider evidence of adequate freeboard to capture and retain sediment.

Rating Value:

0. Pretreatment does not exist.
1. Pretreatment is absent of woody/leafy vegetation, debris, garbage, or sediment accumulations and there is adequate freeboard.
2. Minor accumulations of woody/leafy vegetation, debris, garbage, or sediment comprising <25% of the volume, and/or there is a minor freeboard deficiency.
3. Moderate accumulations of woody/leafy vegetation, debris, garbage, and/or sediment comprising 26 - 50% of the volume, and/or there is a moderate freeboard deficiency. Maintenance needs to be scheduled.
4. Major accumulations of woody/leafy vegetation, debris, garbage, and/or sediment comprising 51 - 75% of the volume, and/or there is a significant freeboard deficiency. Maintenance needs to be performed immediately

5. Pretreatment has failed and has major accumulations of woody/leafy vegetation, debris, garbage, sediment comprising >75% of the volume, and/or there is a major freeboard deficiency. Maintenance needs to be performed immediately.

- **Water Depth –** This measures the depth of standing water in the facility. It is measured to the nearest tenth of a foot.

  This is the depth of the standing water within the observation well for infiltration and filtering devices. During field inspection, the water level is measured from the top of the observation well to the surface of water. Ponding water depth is calculated by subtracting the water level in the observation well from the observation well depth. The field should be left blank for devices that do not have observation wells.

  Sustainability Quality: The following parameters focus on evaluation criteria, that are relevant to all BMPs and those that are specific to structural elements of embankments, berms, or structural outlets. These parameters are identified in Maryland Pond 378 Regulations and this manual uses the regulations as a guide.

- **Mowability –** This rates the ability to mow the areas requiring routine mowing and their slope (4:1 steepness or flatter) consideration for performing the mowing. This helps in minimizing the growth of woody vegetation on the embankment. The embankment should be kept clear about 15 feet along the toe of embankment on both the upstream and downstream sides, with a 25 feet wide strip around the outfall structure, along the access road, the emergency spillway opening, the bottom and sides of the filtering devices, dry swales, and infiltration basin (if vegetated).

  Rating Value:

  0. Facility does not need routine mowing.
  1. Mowing areas are adequately flat and accessible by tractor type mowing equipment.
  2. All the structural components of the facility (embankments, spillway, outfall, and access road) are flat enough to perform routine mowing by tractor type mowers, but other components within the facility requiring routine mowing are too steep to mow with tractor type equipment.
  3. The structural components of the facility (embankments, spillway, outfall, and access road) are getting too steep to perform mowing with tractor type mowers allowing only partial area mowing without using hand equipment.
  4. The structural components of the facility (embankments, spillway, outfall, and access road) are too steep to perform mowing with tractor type mowers requiring hand equipment to clear these areas. This may require hand trimming with mechanized trimmers to perform the mowing.
  5. The structural components of the facility (embankments, spillway, outfall, and access road) are too steep to perform mowing with tractor type mowers or hand mowers. This requires the use of hand trimmers, boom arms attached to large equipment, or other specialized equipment.

- **Access –** This rates the existence and overall condition of access roads to and around the BMP. Five criteria are used to rate this parameter: Unobstructed, Pull-Off, Turnaround, 10-feet Minimum Width and Stabilized and Maximum Steepness of 6.6:1 (15%).

  Unobstructed: The facility should be accessible by car from a public roadway or privately owned parking lot without obstructions such as traffic barriers or overgrown vegetation. County roads, city roads, and park roads are considered public roads. If the traffic barrier, overgrown vegetation, or other features block the access, this criterion has not been met.

  Pull-Off: This criterion needs to provide an area for trailers and other heavy equipment to be parked without blocking access to the facility or blocking traffic on the roadway with respect to maintenance purposes. A pull-off can be a roadway shoulder if it is 12-feet wide or a parking lot in the case of a privately owned BMP.

  Turnaround: The facility should have an area at the top or entrance of the access way for a large dump truck to turn around and back down into the facility.

  10-feet Minimum Width: For maintenance access areas, a 10-feet minimum width is necessary to allow equipment to enter. All the structural components (access roads, outfall structures, embankment, forebays or pretreatment, and spillway) should have a proper width to allow maintenance access.

  Stabilized and Maximum Steepness of 6.6:1 (15%): The facility should have a stabilized access area for maintenance with a maximum steepness of 6.6:1.

Rating of the parameters based on all of the five criteria such s if all the 5 criteria met the rating would be 1.

Criteria Met	Rating
5	1
4	2
3	3
1,2	4
0	5

- **Conveyance Structure Stability –** This rates the stability of conveyance through and out of the facility. This parameter considers erosion, ground cover, and control features (gabion, check dams, earthen dams). The conveyance systems should be stable and have adequate vegetative/grass cover and be free from erosion. BMPs with underdrain systems may also be considered.

  Rating Value:

  1. Overall conveyance is stable.
  2. Conveyance through and out of the facility has minor erosion, but ground cover is stable.

3. Conveyance through and out of the facility has evidence of minor erosion and loss of ground cover, but structure is not damaged.
4. Conveyance through and out of the facility has evidence of major erosion and minimal ground cover, and the condition of the structure is worsening.
5. Conveyance through and out of the facility has failed and is not performing as designed. Berms and dams have failed due to severe erosion. Immediate attention is required.

- **Downstream Condition –** This rates the overall downstream channel condition. The downstream channel should be stable and show no signs of erosion.

  Rating Value:

  1. Downstream channel is stable and has no sign of erosion.
  2. Minor erosion at the downstream channel. Channel is stable and has no headcut.
  3. Major erosion at the downstream channel. The width of the existing channel is greater than designed and a headcut has formed. There is minor loss of vegetation and channel is unstable.
  4. Major erosion at the downstream channel. Channel is unstable due to the loss of vegetation and a major headcut is observed.
  5. Downstream channel has completely eroded. Major loss of vegetation on the banks and headcut has formed. Immediate attention is required.

- **Site Vegetation –** This rates the overall condition of vegetation management, other than routine mowing. Vegetation management includes: tree trimming, thinning of trees, and shrub removal. Overgrown vegetation along the embankment, fence, access roads, and gate affects the rating of this parameter. The embankment, embankment toe, and 25-feet area around the riser/weir structure is scored later under upstream and downstream embankment cover parameters.

  Rating Value:

  1. Entire site is well managed, free from overgrown vegetation and dead trees, and all pond features are easily accessible. Access road is free from unwanted vegetation. No vegetation management is required other than routine mowing.
  2. Unwanted vegetation covers 0 - 25% of the entire site. All features are easily accessible and no vegetation management is needed other than routine mowing.
  3. Unwanted vegetation covers 26 - 50% of the entire site and makes it difficult to access and inspect the pond features. Vegetation management is recommended.
  4. Unwanted vegetation covers 51 - 75% of the entire site, making it difficult to access and inspect pond features. Inflow and outflow structures are not accessible. Proper vegetation management is required to inspect the facility.

5. Unwanted vegetation covers 76 - 100% of the entire site. It is impossible to access the facility for the inspection. Access gate is not accessible due to overgrown vegetation. Vegetation management is urgent and inspection could not be performed.

- **Upstream Embankment Cover –** This rates the overall vegetation condition of the upstream gradient of the embankment, within 15-feet of the embankment toe, and the percent coverage of herbaceous cover. The existence of woody vegetation on the dam embankment can cause an embankment failure. Additionally, the 25-feet area around the riser/weir should be kept free from woody vegetation.

  Rating Value:

  1. Dense vegetation with 100% herbaceous covers on the upstream embankment. There is no evidence of woody vegetation.
  2. Moderately vegetated with 76 - 100% herbaceous cover on the upstream embankment. Evidence of minor woody vegetation less than 0.5 inch in diameter on the dam embankment.
  3. Moderately vegetated with 51 - 75% herbaceous cover on the upstream embankment. Evidence of moderate woody vegetation, ranging in size from 0.5 to 1.5 inches in diameter on the dam embankment.
  4. Minor vegetation with 26 - 50% herbaceous cover on the upstream embankment. Evidence of major woody vegetation greater than 1.5 inches in diameter on the dam embankment. Maintenance needs to be performed immediately.
  5. Evidence of minor vegetation with 0 - 25% herbaceous cover on the upstream embankment. Heavy woody vegetation greater than 1.5 inches diameter has compromised the structural integrity of the embankment and emergency spillway. Maintenance needs to be performed immediately.

- **Upstream Embankment Erosion –** This rates the overall condition of the stability of the upstream embankment related to erosion. Inspector should rate this parameter based on the vegetative cover and problems due to settlement, scouring, horizontal or longitudinal cracking, or sloughing (a depressed or hollow area, filled with deep mud).

  Rating Value:

  1. No evidence of erosion, sloughing, settlement, or slides is observed on the embankment. Embankment appears stable.
  2. Minor evidence of erosion and settlement with no sign of soil loss, sloughing, or small sized horizontal/vertical slope cracks on the embankment. Embankment appears stable.
  3. Moderate evidence of erosion or sloughing, in addition to minor evidence of settlement, soil loss, and medium sized horizontal/vertical slope cracks. Embankment appears stable, but maintenance is required.
  4. Major evidence of erosion, settlement, soil loss, and large sized horizontal/vertical slope cracks. The structural integrity of the embankment may be compromised due to the moderate evidence of sloughing. Maintenance needs to be performed immediately.

5. Major evidence of erosion with major soil loss, settlement, or large sized horizontal/vertical slope cracks. The structural integrity of the embankment has been compromised due to the significant evidence of sloughing. Maintenance needs to be performed immediately.

- **Upstream Embankment Toe –** This rates the stability of the upstream embankment within 15 feet of the upstream toe of the embankment. Inspectors should consider the holes or any void areas created due to embankment settlement or proof of rodents such as muskrats and groundhogs, which can burrow through the embankment and create piping problem. Inspectors should also examine the holes for evidence of water entering the area.
  Rating Value:

  1. No evidence of holes or void areas. Upstream embankment toe is stable.
  2. Minor evidence of holes or void areas due to embankment settlement. Upstream embankment toe is stable.
  3. Moderate evidence of embankment settlement and/or presence of burrow holes. Upstream embankment toe appears stable, but maintenance is required.
  4. Major embankment settlement and evidence of water entering into burrow holes. Upstream embankment toe is unstable. Maintenance needs to be performed immediately.
  5. The structural integrity has been compromised due to embankment settlement and/or significant evidence of water entering into burrow holes. Maintenance needs to be performed immediately.

- **Downstream Embankment Cover –** This rates the overall vegetation condition of the downstream gradient of the embankment, within 15-feet of the embankment toe, and the percent coverage. The existence of woody vegetation on the dam embankment can cause an embankment failure.

  Rating Value:

  1. Dense vegetation with 100% herbaceous covers on the downstream embankment. There is no evidence of woody vegetation.
  2. Moderately vegetated with 76 - 100% herbaceous cover on the downstream embankment. Evidence of minor woody vegetation less than 0.5 inch in diameter on the dam embankment.
  3. Moderately vegetated with 51 - 75% herbaceous cover on the downstream embankment. Evidence of moderate woody vegetation, ranging in size from 0.5 to 1.5 inches in diameter on the dam embankment.
  4. Minor vegetation with 26 - 50% herbaceous cover on the downstream embankment. Evidence of major woody vegetation greater than 1.5 inches in diameter on the dam embankment. Maintenance needs to be performed immediately.
  5. Evidence of minor vegetation with 0 - 25% herbaceous cover on the downstream embankment. Heavy woody vegetation greater than 1.5 inches diameter has

compromised the structural integrity of the embankment and emergency spillway. Maintenance needs to be performed immediately.

- **Downstream Embankment Erosion –** This rates the overall condition of the stability of the downstream embankment related to erosion. Inspector should rate this parameter based on the vegetative cover and problems due to settlement, scouring, horizontal or longitudinal cracking, or sloughing (a depressed or hollow area, filled with deep mud).

  Rating Value:

  1. No evidence of erosion, sloughing, settlement, or slides is observed on the embankment. Embankment appears stable.
  2. Minor evidence of erosion and settlement with no sign of soil loss, sloughing, or small sized horizontal/vertical slope cracks on the embankment. Embankment appears stable.
  3. Moderate evidence of erosion or sloughing, in addition to minor evidence of settlement, soil loss, and medium sized horizontal/vertical slope cracks. Embankment appears stable, but maintenance is required.
  4. Major evidence of erosion, settlement, soil loss, and large-sized horizontal/vertical slope cracks. The structural integrity of the embankment may be compromised due to the moderate evidence of sloughing. Maintenance needs to be performed immediately.
  5. Major evidence of erosion with major soil loss, settlement, or large-sized horizontal/vertical slope cracks. The structural integrity of the embankment has been compromised due to the significant evidence of sloughing. Maintenance needs to be performed immediately.

- **Downstream Embankment Toe –** This rates the stability of the downstream embankment within 15 feet of the downstream toe of the embankment. Inspectors should consider the holes or any void areas created due to embankment settlement or proof of rodents such as muskrats and groundhogs, which can burrow through the embankment and create piping problem. Inspectors should also examine the holes for evidence of water entering the area.

  Rating Value:

  1. No evidence of holes or void areas. Downstream embankment toe is stable.
  2. Minor evidence of holes or void areas due to embankment settlement. Downstream embankment toe is stable.
  3. Moderate evidence of embankment settlement and/or presence of burrow holes. Downstream embankment toe appears stable, but maintenance is required.
  4. Major embankment settlement and evidence of water entering into burrow holes. Downstream embankment toe is unstable. Maintenance needs to be performed immediately.
  5. The structural integrity has been compromised due to embankment settlement and/or significant evidence of water entering into burrow holes. Maintenance needs to be performed immediately.

- **Pond Safety Bench –** This rates the flat area above the permanent pool and surrounding stormwater pond design to provide a separation to adjacent slopes.

  Rating Value:

  1. No safety bench exists.
  2. Safety bench is stable, flat, and extends outward from the normal water edge to the toe of the pond side slope.
  3. Safety bench is stable with a moderate change in the side slope and extends outward from the normal water edge to the toe of the pond.
  4. Safety bench is unstable with a major change in the side slope and extends outward from the normal edge to the toe of the pond. Maintenance needs to be performed immediately.
  5. Safety bench is eroded and unstable. The maximum slope of the safety bench exceeds 6%. Maintenance needs to be performed immediately.

- **Downstream Embankment Seepage –** This rates the overall condition of the downstream embankment related to water seepage. Inspectors should consider saturated soil conditions, direct discharge, surface erosion, accumulation of sediment at the embankment toe, slides or sloughing, vertical or horizontal settlement, and any change in vegetative cover while performing inspection.

  Rating Value:

  1. Downstream embankment is stable with no evidence of water seepage.
  2. Downstream embankment is stable with minor evidence of saturated soil at the toe. No evidence of direct discharge or erosion observed.
  3. Moderate evidence of saturated soil at the toe of the downstream embankment. Need to inspect and monitor the condition annually.
  4. The structural integrity may be compromised due to the significant evidence of saturated soil, direct discharge, and surface erosion at the embankment. Maintenance needs to be performed immediately.
  5. The structural integrity has been compromised due to the presence of concentrated discharge and surface erosion at the embankment. Maintenance needs to be performed immediately.

- **Emergency Spillway –** This rates the stability and the weir opening of the emergency spillway and focuses on erosion of sides and bottom. Prior to inspection, the inspector should be aware of the storm event used to establish the emergency spillway use frequency. The emergency spillway will only be used to pass the high storm event flow if the facility is functioning as designed. The emergency spillway's crest invert should be 1.0-foot below the top of the settled embankment. The weir opening should be free of debris and woody vegetation. For the facility where the riser design uses a mixture of principal/emergency spillway, the rating should be 0.

Rating Value:

0. No emergency spillway.
1. Emergency spillway is stabilized and functioning properly. Emergency spillways cross-section and openings are free from debris and woody vegetation.
2. Minor erosion of the sides and channel, but the emergency spillway is stabilized. Emergency spillways cross-section and openings have minor accumulation of debris and woody vegetation.
3. Moderate erosion of the sides and channel, but the top invert of the emergency spillway remains stable. Maintenance needs to be scheduled. Emergency spillways cross-section and openings have moderate accumulation of debris and woody vegetation.
4. Evidence of major erosion of the sides and channel. Riprap may have relocated to the toe or gabions are damaged. The structural integrity of the embankment may have been compromised due to the presence of sediment from the active erosion of the crest invert. Maintenance needs to be performed immediately. Emergency spillway's cross-section and openings have major accumulation of debris and woody vegetation.
5. Significant erosion observed on the sides, channel, and crest of the emergency spillway. The structural integrity of the embankment has been compromised due to the presence of sediment from the active erosion of the crest invert. Emergency spillways cross-section and openings are blocked due to the accumulation of debris and woody vegetation. Maintenance needs to be performed immediately.

- **Orifice Opening –** This rates the opening of the low flow orifice to allow the proper drainage of the BMP. Inspectors should evaluate the presence of woody vegetation, debris, garbage, and sediment blocking the opening of the orifice.

Rating Value:

0. No low flow orifice exists.
1. No evidence of woody/leafy vegetation and garbage debris at the opening of the orifice.
2. Less than 25% of the orifice opening is blocked by woody/leafy vegetation and garbage.
3. Approximately 25 - 50% of the orifice opening is blocked by woody/leafy vegetation and garbage debris. Maintenance should be scheduled.
4. Approximately 51 - 75% of the orifice opening is blocked by woody/leafy and garbage. Maintenance should be performed immediately.
5. Greater than 75% of the orifice opening is blocked by woody/leafy vegetation and garbage. The structural integrity of the embankment has been compromised due to the reduced storage volume and other problems related to the blockage. Maintenance should be performed immediately.

- **Orifice Trash Rack –** This rates the structural condition of the trash rack on the low flow orifice. Inspection should be performed in and around the orifice to examine the presence of woody vegetation debris, garbage, and sediment.

If there is no riser structure present and only a pipe with an end-section exists, an evaluation scoring of "0" is recorded.

Rating Value:

0. No trash rack on the low flow orifice exists.
1. No evidence of woody/leafy vegetation and garbage debris. Trash rack is safe and functioning properly.
2. Less then <25% of the orifice trash rack is blocked by woody/leafy vegetation and garbage. Trash rack has minor damage, but is functioning properly.
3. Approximately 26 - 50% of the orifice trash rack is blocked by woody/leafy vegetation and garbage debris. Trash rack has moderate damage and is only partially functioning. Maintenance should be scheduled.
4. Approximately 51 - 75% of the orifice trash rack is blocked by woody/leafy vegetation and garbage. Trash rack has major damage and its efficiency is compromised. Maintenance should be performed immediately.
5. Greater than 75% of the orifice trash rack is blocked by woody/leafy vegetation and garbage. Trash rack is damaged and compromised. The structural integrity has been compromised due to the ponding, which causes the reduced pond storage volume. Maintenance should be performed immediately.

- **Riser Opening –** This rates the opening of the riser structure and weir to allow for proper flow through the spillway. Inspector should evaluate the presence of woody vegetation, debris, garbage, and sediment in and around the opening of the orifice.

  Riser opening parameters should be recorded as "0" if the riser structure is a combination principal/emergency. If there is no riser structure present and only a pipe with an end-section exists, then only the riser opening parameter should be evaluated and scored. In the comments section, no riser structure should be documented.

  Rating Value:

  0. No riser opening exists.
  1. Riser opening is free of any woody/leafy vegetation, sedimentation, and garbage debris.
  2. Less than 25% of the riser opening is blocked with woody/leafy vegetation, debris, garbage, and sedimentation.
  3. Approximately 26 - 50% of the riser opening is blocked with woody/leafy vegetation, sedimentation, and garbage debris. Maintenance should be scheduled.
  4. Approximately 51 - 75% of the riser opening is blocked with woody/leafy vegetation, sedimentation, and garbage. Maintenance should be performed immediately.
  5. Greater than 75% of the riser opening is blocked with woody/leafy vegetation, sedimentation, and garbage. The structural integrity of the embankment has been compromised due to the blockage and storage volume has been reduced. Maintenance should be performed immediately.

- **Riser Trash Rack –** This rates the structural condition of the trash rack on the riser structure. Inspectors should evaluate any damage to the trash rack, presence of woody/leafy vegetation, garbage, debris, and sedimentation in and around the riser trash rack.

  Rating Value:

  0. No trash rack on the riser or only a pipe with an end-section exists.
  1. Riser trash rack is free of any woody/leafy vegetation and garbage debris. Trash rack is undamaged and functioning properly.
  2. Less than 25% of the riser trash rack is blocked and covered with woody/leafy vegetation and garbage. Trash rack has minor damage, but is functioning properly.
  3. Approximately 26 - 50% of the riser trash rack is blocked and covered with woody/leafy vegetation and garbage debris. Trash rack has moderate damage and is only partially functioning. Maintenance should be scheduled.
  4. Approximately 51 - 75% of the riser trash rack is blocked and covered with woody/leafy vegetation and garbage. Trash rack has major damage and efficiency is compromised. Maintenance should be performed immediately.
  5. Greater than 75% of the riser trash rack is blocked and covered with woody/leafy and garbage. Trash rack is damaged and efficiency is compromised. The structural integrity of the embankment has been compromised due to the blockage, ponding is occurring, and storage volume is reduced. Maintenance should be performed immediately.

- **Riser Sediment –** This rates the amount of sediment accumulated inside the riser structure that could deteriorate the riser performance. Inspector should evaluate the accumulation of woody/leafy vegetation, garbage, debris, and/or riprap condition.

  Rating Value:

  0. No riser structure exists.
  1. No evidence of woody/leafy vegetation, debris, garbage, and/or sediment accumulations.
  2. Minor accumulations of woody/leafy vegetation, debris, garbage, and/or sediment blocking <25% of the outlet structure.
  3. Moderate accumulations of woody/leafy vegetation, debris, garbage, and/or sediment. Approximately 26 - 50% of the outlet structure is blocked and/or the amount of debris potentially could cause problems during future precipitation events. Maintenance needs to be scheduled.
  4. Major accumulations of woody/leafy vegetation, debris, garbage, and/or sediment. Approximately 51 - 75% of the outlet structure is blocked and/or the amount of debris potentially could cause problems during future precipitation events. Maintenance needs to be performed immediately.

5. Major accumulations of woody/leafy vegetation, debris, garbage, and/or sediment. Greater than 75% of the outlet structure is blocked and the structural integrity of the facility has been compromised. Maintenance needs to be performed immediately.

- **Riser Structure –** This rates the overall structural integrity of the riser weir or outlet structure. Inspectors should evaluate any cracks, bad joints, or flaws in construction undermining, erosion, and/or leaning of the riser structure.

Rating Value:

0. No riser structure exists.
1. No evidence of cracks, spalling, bad joints, erosion, and/or leaning of the structure. Riser structure is stable.
2. Minor evidence of cracks and spalling, but is functional and appears to be in satisfactory condition.
3. Moderate evidence of cracks, spalling, and joint problems, but is functional and appears to be in satisfactory condition. Maintenance should be scheduled.
4. Major evidence of cracks, spalling, and joint problems, and/or leaning. Riser structure is not functioning as designed and appears to be in unsatisfactory condition. Condition may potentially compromise other parameters of the BMP. Maintenance needs to be performed immediately.
5. Major evidence of cracks, spalling, and joint problems, and/or leaning. The structural integrity of the riser structure has been compromised. Maintenance needs to be performed immediately.

- **Principal Spillway –** This rates the overall condition of the principal spillway (pipe / barrel). Inspectors should evaluate any blockages, joint problems, sedimentation, irregularities in the flow line, and structural integrity of the pipe.

Rating Value:

1. No evidence of woody/leafy vegetation, sedimentation, garbage, and debris observed around the pipe. Flow is unobstructed. All structural components of the principal spillway (pipe shapes, joints, and material conditions) are appears to be in satisfactory condition.
2. Less than 25% of the pipe is blocked with woody/leafy vegetation, sedimentation, and garbage. Flow is partially controlled. All structural components of the principal spillway (pipe shapes, joints, and material conditions) are appears to be in satisfactory condition. Minor defects are observed and may include minor changes in shape, dents, and/or slight gaps in joints.
3. Approximately 26 - 50% of the pipe is blocked with woody/leafy vegetation, sedimentation, garbage, and debris. Flow is controlled. All structural components of the principal spillway (pipe shapes, joints, and material conditions) are appears to be in satisfactory condition. Moderate defects are present and may include moderate changes in shape (top or side deflection), bolts or rivets under stress at the seams or

joints may have gaps with minor soil exposure, pipe bottom may have moderate to major evidence of corrosion or abrasion, and/or minor flow line grade changes. Maintenance should be scheduled.

4. Approximately 51 -75% of the pipe is blocked with woody/leafy vegetation, sedimentation, and garbage. Flow is significantly blocked. All structural components of the principal spillway (pipe shapes, joints, and material conditions) are appears to be in unsatisfactory condition. Major defects are observed and may include major changes in shape (side or top deflection), stress fractured bolts or rivets at seams or joints have moderate gaps with minor voids and major soil exposure, culvert bottom has major evidence of corrosion or abrasion, and/or moderate flow line grade changes. Maintenance should be performed immediately.

5. Greater than 75% of the pipe is blocked with woody/leafy vegetation, sedimentation, and garbage, causing the flow to be completely blocked. All structural components of the principal spillway (pipe shapes, joints, and material conditions) are appears to be in critical condition throughout the full length of the pipe. Indicators may include major changes in shape (side or top deflection), stress fractured bolts or rivets at the seams or joints have major gaps with major voids, major soil deposition within the pipe, pipe bottom is completely deteriorated, and/or major flow line grade changes. The structural integrity of the BMP has been compromised. Maintenance should be performed immediately.

- **Outfall Spillway –** This rates the overall condition of outfall of the principal spillway and areas within 25 feet of the principal spillway structure. Inspectors should evaluate channel erosion, side slopes, transitions to natural stream areas, sedimentation, and debris blockage.

Rating Value:

1. No evidence of stream erosion at the outfall. Dense vegetation and riprap provides the stability to the channel invert and slopes. Outfall is free of any woody/leafy debris, sedimentation, and garbage debris.

2. Minor evidence of stream erosion. Dense vegetation and riprap provides the stability to the channel invert and slopes. Less than 25% of the outfall is blocked with woody/leafy vegetation, sedimentation, and garbage.

3. Moderate evidence of stream erosion. Channel invert and slopes are moderately steep with less vegetative cover and slight erosion. Minor areas of riprap material are moving downstream. Approximately 26 - 50% of the outfall is blocked with woody/leafy vegetation, sedimentation, and garbage.

4. Major evidence of stream erosion. Channel invert and slopes are slightly wider than deep. Slopes are steep with no vegetation and minor sloughing actively occurring within stream channel. Major areas of riprap material are being washed out and relocated downstream. Approximately 51 - 75% of the outfall is blocked with woody/leafy vegetation, sedimentation, and garbage. Maintenance should be performed immediately.

5. Outfall has active stream erosion and the channel invert and slopes are as deep as they are wide. Slopes are steep with no vegetation and major bank sloughing actively occurring within stream channel. Major areas of riprap material are being washed out

and relocated downstream. Greater than 75% of the outfall is blocked with woody/leafy vegetation, sedimentation, and garbage. Maintenance should be performed immediately.

Safety: This parameter focuses on safety issues, primarily on prohibiting public access to the site.

- **Fencing –** This rates the condition of the fencing regarding the placement and structural integrity. Placement conditions evaluate whether the fences are affecting the functioning of the facility (such as blocking spillway openings, suspending fence fabrics over weir openings, and blocking channels). Structural condition considers the physical condition of the fence components, construction, and installation, as well as any security breaches that may be evident.

  Rating Value:

  0. No fencing.
  1. Fence is stable and does not block the facility functioning. No maintenance is required.
  2. Minor wear was observed on the fences but no security violations have occurred. Minor placement issues cause insignificant interference with functioning of the facility, but this obstruction is considerable during large storm events. No maintenance is required.
  3. Damage found but fencing is still upright and no security violations have occurred. Minor evidence of blockage or interference (such as accumulated trash/debris against fence fabric) affects the functioning of the facility. The condition and placement of the fence should be monitored and maintenance or relocation may be needed in the future.
  4. Existing openings in fencing that are less than 1-foot, which may allow animals to enter into the facility, but no evidence of human access is evident. The fence is impairing facility functioning (e.g., evidence of accumulated debris/trash against the fence is an obvious blockage). A fence repair/relocation should be performed.
  5. Fence is completely damaged and serious violations have occurred. Evidence of the human access to the site was noticed. A fence repair is required.

BMP Overall Rating – The overall rating for the BMP facility depends on all of the above individual parameters related to *Environmental Quality* and *Sustainability. Safety* does not affect the overall rating of the facility. The rating classes can be used by Prince George's County in planning inspection intervals, maintenance schedules, repair or replacement of BMPs, and to identify BMPs at-risk for failure. Table below summarizes the overall rating classes and provides a brief description. Calculating a mathematical average of the individual rating should not be performed to tally the component ratings, because the importance of certain ratings versus others could tend to skew the results. For instance, a pond could be in perfect condition in all aspects, except for a 20-foot embankment that is showing signs of failure. This should precipitate a general rating of E due to the safety concerns and immediate hazard.

The inspectors must spend the time to assess the overall condition of each BMP, taking into account all of the components. This should be completed before leaving the site.

BMP Inspection Rating Classes

(*Source: Maryland State Highway Administration-NPDES Program, 2007)*

Rating Class	Description
A	The BMP is functioning as designed with no problem conditions identified. No signs of impending deterioration. This facility needs multi-year inspection.
B	Minor problems are observed; however, BMP is functioning as designed with no critical parameters with problem conditions. This facility needs multi-year inspection. However, depending on problem condition may require annual inspection.
C	Moderate problems are observed; however, BMP is functioning as designed with no critical parameters with problem conditions. BMP performance is being compromised. Bi-annual inspection may be required. Structural defects may require repair and/or restoration. Maintenance of the BMP should be scheduled.
D	Major problems are observed, and facility is not functioning as designed, with several critical parameters with problem conditions. Conditions associated with the facility have compromised the BMP performance. BMP facility shows signs of impending deterioration with potential for failure. Maintenance should be performed immediately.
E	Severe problems are observed, and facility is not functioning as designed, with several critical parameters with problem conditions. Conditions associated with the facility have compromised the BMP performance. BMP facility shows signs of impending deterioration and/or failure. Maintenance should be performed immediately.
NR	Not rated due to insufficient inspection or BMP could not be accessed.

Corrective Action – This section allows for a response to comments made during previous inspection cycles.

Overall Comments - This section allows for any additional comments, such as site-specific conditions, and maintenance requests additional information associated with the BMP.

BMP Corrective Action

The BMP Corrective Action items allow the inspector to identify action items they recommended to be performed on a BMP. Table below includes codes identifying the required actions identified during the BMP inspections. Action codes are required if the inspectors identify any facility that needs subsequent inspections, maintenance or repair.

Summary of Corrective Action Items

Action Type Code	Action Code	Action Description	Unit	Quantity Estimate
Earthwork (EW)				
EW	BE	Rebuilt Embankment to Provide Required Freeboard		
EW	BN	Repair Pond Safety Bench	LF	
EW	CO	Construct Emergency Spillway	LS	
EW	CS	Clear Sediment	SF	
EW	RB	Repair Banks or Side Slopes	LF	
Action Type Code	**Action Code**	**Action Description**	**Unit**	**Quantity Estimate**
Remove Material (RM)				
RM	TD	Remove Trash and Debris	LS	
RM	DT	Remove Downed Trees	Ea	
RM	HW	Remove Hazardous Waste	LS	
RM	RO	Remove Oil Sheen	LS	
Structural Construction and Repair (SC)				
SC	OB	Repair or Replace Observation Well	Ea	
SC	WC	Repair or Replace Well Cap	Ea	
SC	OC	Construct Orifice Opening	LS	
SC	RW	Repair Weir Opening	LS	
SC	FC	Repair Cracks	LS	
SC	RP	Repair or Replace Pipe	LF	
SC	OS	Repair or Replace Outfall Structure/Stabilization	LS	
SC	RC	Replace CMP Riser with Concrete	Ea	
SC	TR	Install Trash Rack	Ea	
SC	UD	Repair or Replace Under-drains	LF	
SC	RV	Repair or Replace Valve	Ea	
Stabilization (ST)				
ST	ER	Repair Erosion	LF	
ST	RR	Replace Rip-Rap	LF	
ST	SC	Repair Seepage	LF	
ST	UC	Repair Undercutting	LF	
ST	SS	Stabilized Saturated Areas	SF	
Vegetation Material (VM)				
VM	CT	Cut/Remove Trees	Ea	
VM	GC	Planting – Ground Cover	SF	
VM	MH	Mulch – Shredded Hardwood	SF	
VM	MS	Mulch – Straw or Wood Cellulose Fiber	SF	
VM	OV	Remove Overgrown Vegetation	LS	

Ea = Each LF = Linear Feet LS = Lump Sum SF = Square Feet

BMP Inventory Detail

Owner Name: ----------

Street Address: ----------

Date of Inspection *(YYYYMMDD)*: ---------- Time of Inspection: ----------

Inspector Names: ----------

Field	Domain	Value	Comment	Description
ALL BMPS				
BMP ID	XXX-ZZZ		XXX-ZZZ	6-digit number followed by 3 digit Site ID (XXX) and 3-digit unique BMP No. (ZZZ)
Permit #				Obtained from County Database for each facility
Category				Category of BMP *(Pond, Wetland, Infiltration Trench, Filtering Device, Open Channel System)*
Sub-Category				Description of the facility category
ALL PONDS AND BMPs WITH EMBANKMENTS				
Fence Material				Fence material
Dam Height	(Feet)			Height of spillway embankment
Downstream Structure	XXX-ZZZ.001			Unique ID for downstream structure of the BMP
ALL INFILTRATION TRENCHS				
Observation Well	(Y/N)			Observation well exists?
Observation Well Cap	(Y/N)			Observation well cap exists?
Observation Well Depth	(Feet)			Well depth
Trench Width	(Feet)			Infiltration trench width
Trench Length	(Feet)			Infiltration trench length
ALL SAND FILTERS AND BIORETENTION FACILITIES				
Underdrain Pipe	(Y/N)			Underdrain collection 6" pipe
Underdrain Pipe Depth	(Feet)			Underdrain collection 6" pipe depth
ALL BMPs				
Status	(Under Construction, Built)			Present status of the BMP
In-Stream BMP	(Y/N)			BMP constructed in U.S. Waters
Comment – Overall				Overall BMP Comments
Inspector (s)	ABC, DEF			Initials of Inspector (s)

Additional Comments:

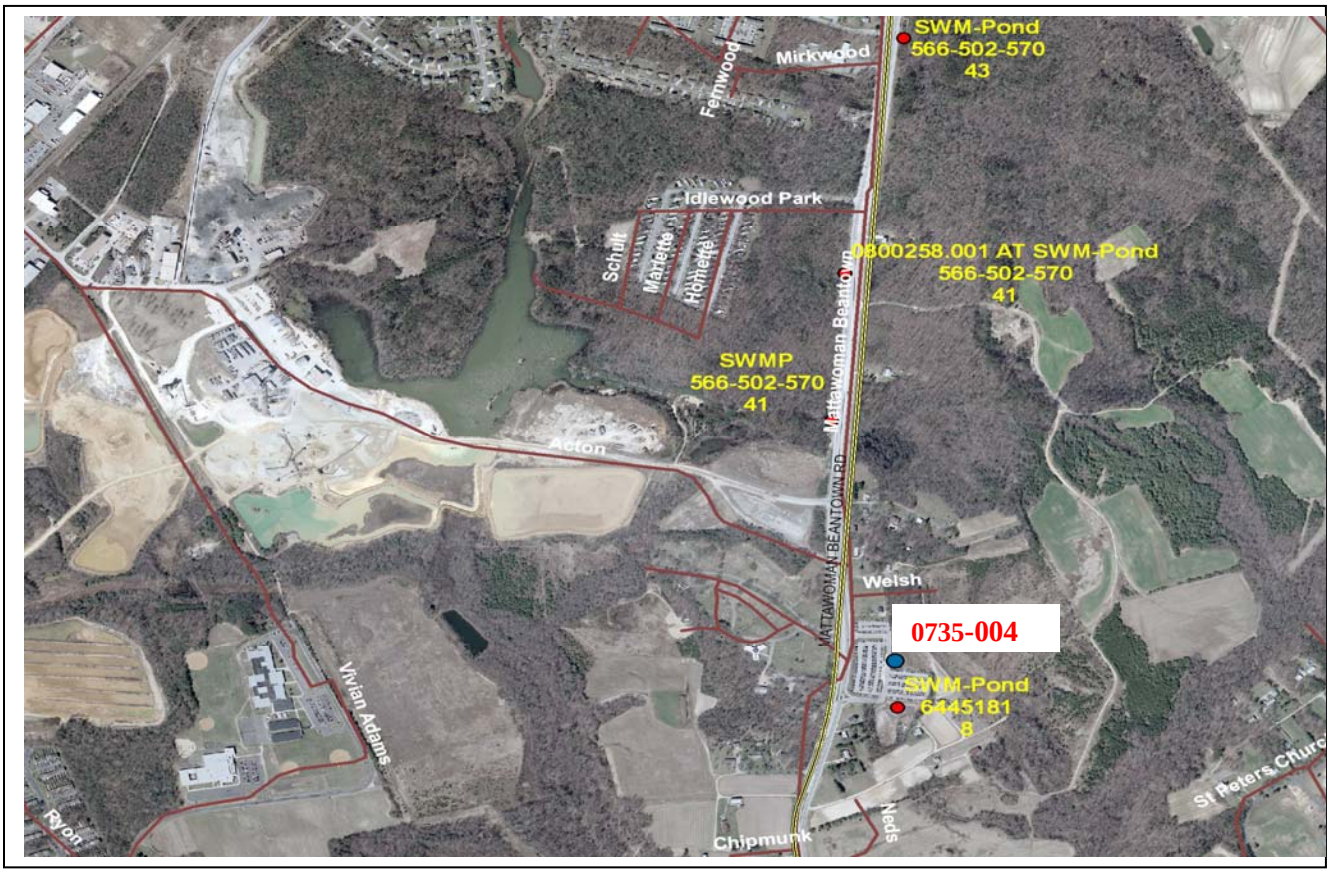
BMP Inspection Details

Field	Domain	Condition	Comment	Description
ALL BMPs				
Debris	1 – 5			Unwanted debris in /near facility
Point of Discharge Impact	1 – 5			Impact of the discharges into a BMP and their adverse effects that impair the performance of the BMP
In-Flow Stability	1 – 5			Rates the condition of conveyance features flow into that BMP.
Water Depth	Feet			Depth of standing water
Mowability	1 – 5			Ability to mow designated areas
Site Vegetation	1 – 5			Unwanted vegetation impacting overall site
Access	1 – 5			Access to and around the BMP relating to overall condition
Conveyance Structure Stability	1 – 5			Stability of conveyance through and out of BMP
ALL BMPs EXCEPT INFILTRATION TRENCH				
BMP Vegetation	1 – 5			Vegetation condition specific to water quality as part of BMP design
Pretreatment	1 – 5			Overall condition of any pretreatment device
Fences	1 – 5			Fencing around BMP related to overall condition
ALL PONDS AND BMPs WITH EMBANKMENTS				
Permanent Pool	1 – 5			Condition of BMPs with permanent standing water
Downstream Condition	1 – 5			Overall downstream condition
Embankment – Upstream Cover	1 – 5			Vegetation cover condition related to upstream embankment
Embankment – Upstream Erosion	1 – 5			Erosion condition related to upstream embankment
Embankment – Upstream Toe	1 – 5			Toe condition related to upstream embankment
Embankment – Downstream Cover	1 – 5			Vegetation cover condition related to downstream embankment
Embankment – Downstream Erosion	1 – 5			Erosion condition related to downstream embankment
Embankment – Downstream Toe	1 – 5			Toe condition related to downstream embankment
Embankment – Downstream Seepage	1 – 5			Seepage condition related to the downstream condition
Safety Bench	1 – 5			Scores the flat area surrounding or just below the permanent pool
Emergency Spillway	1 – 5			Emergency spillway condition
Orifice Open	1 – 5			Low-flow orifice opening
Orifice Trash	1 – 5			Low-flow orifice trash rack
Riser Open	1 – 5			Riser opening
Riser Trash Rack	1 – 5			Riser trash rack opening
Riser Sediment	1 – 5			Riser inside related to debris and sediment
Riser Structure	1 – 5			Riser structure related to cracks, joints
Principal Spillway	1 – 5			Principal spillway from riser
Outfall Spillway	1 - 5			Outfall to the principal spillway
ALL BMPs				
Rating	**A - E**			**Overall inspection rating**
Corrective Action	*See Action Item Table (Table 3.2)*			County response required
Comment Overall				Overall inspection comments

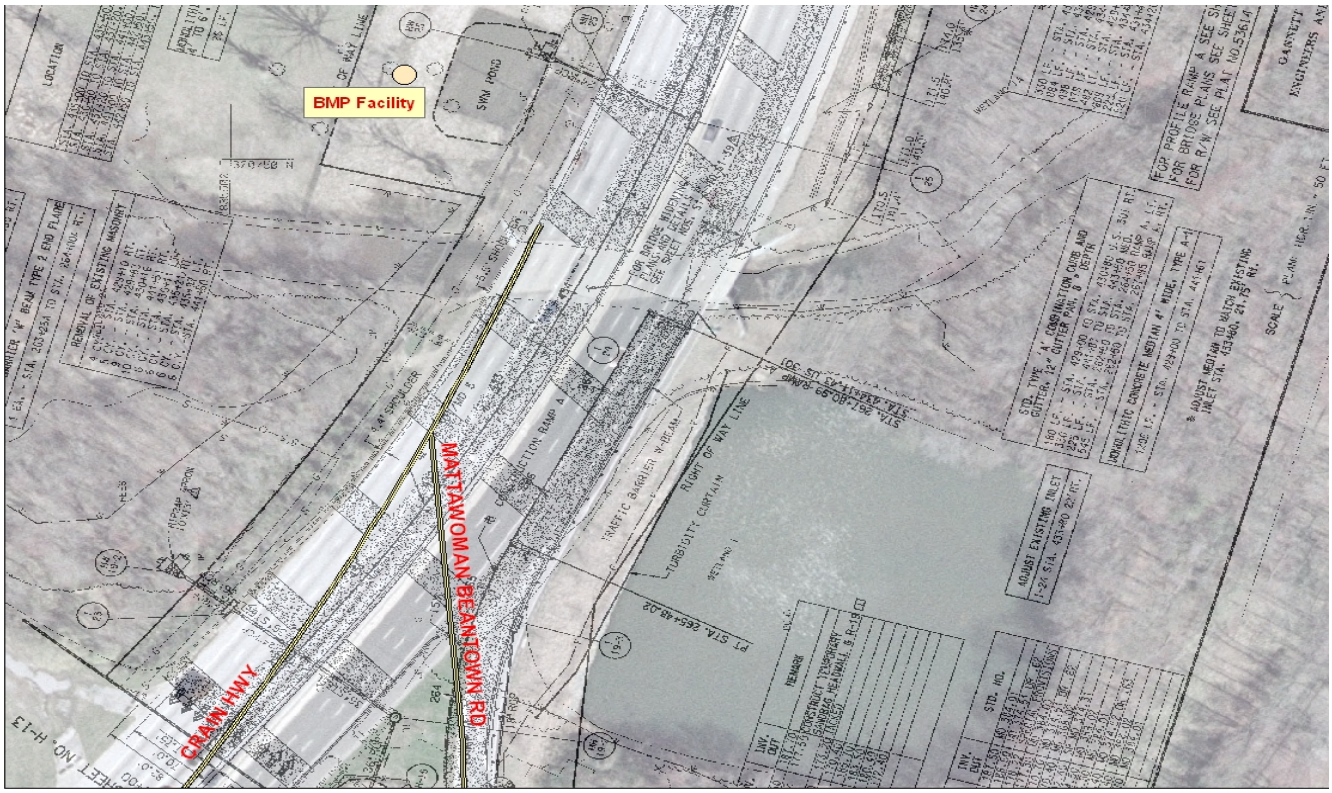
Photo #	Photo Description

APPENDIX B

Examples of Field Maps



BMP Location Map with Aerial Image at the background



BMP Location Map with Design Plan and Aerial Image at the background

APPENDIX C

Pictures of Standard BMP Features

Risers

BMP 0735-004
11/28/2006
Riser

BMP 0735-004
11/28/2006
Riser

BMP 0735-004
11/28/2006
Riser Low Flow

BMP 0735-004
11/28/2006
Riser

Weirs

BMP 0735-004
Weir

BMP 0735-004
Weir and Well

BMP 0735-004
11/28/2006
Weir

Forebays

BMP 0735-004
11/28/2006
Algae Growth

BMP 0735-004
11/28/2006
Forebay

Embankments

BMP 0735-004
11/28/2006
Embankment

BMP 0735-004
11/28/2006
Embankment Erosion

BMP 0735-004
11/28/2006
Embankment Looking Downstream

BMP 0735-004
11/28/2006
Embankment

Emergency Spillway

BMP 0735-004
11/28/2006

BMP 0735-004
11/28/2006

Inflows

BMP 0735-004
11/28/2006

BMP 0735-004
11/28/2006
Debris and Trash

BMP 0735-004
11/28/2006

BMP 0735-004
11/28/2006

Outfalls

BMP 0735-004
11/28/2006
Outfall

BMP 0735-006

Observation Wells


BMP 0735-004
11/28/2006
Observation Well


BMP 0735-004
11/28/2006
Observation Well


BMP 0735-004
11/28/2006
Observation Well

BMP 0735-004