Informational Manual
Composting Facility Stormwater BMPs

North Carolina Department of Environment and Natural Resources

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Composting Facility Stormwater BMPs Informational Manual

Background

This Composting Facility Stormwater Best Management Practices (BMPs) informational manual was created to help composting facilities identify optimal BMPs to minimize and control the runoff on the composting sites. The increased runoff from impervious surfaces, such as compacted pads, roofs, and roads can erode stream channels, increase pollutant loading, cause downstream flooding, and prevent groundwater recharge. The runoff from composting activities has the potential to increase the nutrient loadings in nearby streams and degrade the water quality in all types of waters. Protecting these waters is crucial to protect fish and wildlife habitat, human health, and drinking water supplies. This manual provides a list of 16 BMPs that when in place can help decrease the runoff quantity and improve its quality.

This manual was developed in response to the 2009-2011 Compost Operation Stakeholder Advisory Group (COSAG). It contains 16 different BMPs with a description, purpose, design, operation and maintenance considerations for each on a one-page format. Each information sheet has been designed with the composting process in mind. Information for each has been extracted from the existing NCDENR Stormwater BMP Manual and North Carolina Erosion and Sediment Control Planning and Design Manual.

Introduction to Stormwater BMPs

The BMPs presented in this manual showcase a summary of the most common and proven techniques to minimize stormwater, erosion, and control sediment. Some are based on design locations (such as Site Configuration) and operations (Good Housekeeping), while others are permanent (such as Constructed Wetlands) or temporary physical structures (such as silt fences). This manual is not meant to be a design guide, but provide general information about different BMPs.

To identify the right series of BMPs for a composting facility, the designer must calculate the runoff volumes generated from different parts of the composting facility. It is recommended that the designer follows Chapter 3 Stormwater Calculations and then Chapter 4 Selecting the Right BMP of the NCDENR Stormwater BMP Manual (http://portal.ncdenr.org/web/lr/bmp-manual).

It is also important to know the different between what is considered stormwater and wastewater as per NC Division of Water Resources. The NPDES General Permit NCG240000 Fact Sheet outlines the differences and parameter requirements for different composting facilities. The factsheet can be found under the General Permits tab on the NPDES Stormwater Program Website (http://portal.ncdenr.org/web/lr/npdes-stormwater).

Acknowledgments
This manual was prepared with the help of many individuals from NCDENR, including but not limited to Ken Pickle, PE, and Annette Lucas, PE, from the Stormwater Permitting Program in the NC Division of Energy, Mineral, and Land Resources, and Jorge Montezuma, EIT, from the Recycling and Materials Management Section in the Division of Environmental Assistance and Customer Service. It also relies on two primary NC DENR manuals, the DENR Stormwater BMP Manual and the North Carolina Erosion and Sediment Control Planning and Design Manual, as well as other reports published by consultants and municipalities as outlined on the reference list section. Most of this material has been reworked extensively and is therefore difficult to reference precisely. Exact referencing has been attempted when possible, and those documents that have been utilized in general have been included in the reference list.

Disclaimer
To the best of their ability, the authors have insured that material presented in this manual is accurate and reliable. The design of engineered facilities, however, requires considerable judgment on the part of designer. It is the responsibility of the design professional to insure that techniques utilized are appropriate for a given situation. Therefore, neither the State of North Carolina, Department of Environment and Natural Resources, nor any author or other individual, group, business, etc., associated with production of this manual, accepts any responsibility for any loss, damage, or injury as a result of the use of this manual.

Reference List
Commercial Composting Water Quality Permit Development, Prepared for Oregon Department of Environmental Quality Land Quality and Water Quality Division by CH2MHill: http://portal.ncdenr.org/c/document_library/get_file?uuid=6c5d6037-e253-4507-8b2b-0dc0eb18098c&groupId=38361

Compost Technical Brief: Evaluation of Compost Facility Runoff Management and Beneficial End Use:
http://www.cwc.org/organics/org002fs.pdf

Evaluation and Prioritization of Compost Facility Runoff Management Methods (No. CM-00-2), E&A, Inc: http://www.cwc.org/organics/organic_htms/cm002rpt.htm

North Carolina State University Department of Biological and Agricultural Engineering:
http://www.bae.ncsu.edu/

Yard Waste Compost Facility Siting and Management Considerations, Minnesota Pollution Control Agency:
http://www.pca.state.mn.us/index.php/view-document.html?gid=5684

Summary Tables

Table 1. Stormwater BMPs Ability for Stormwater Quality Control

Stormwater BMPs	Peak Attenuation	TSS Removal Efficiency	TN Removal Efficiency	TP Removal Efficiency	Fecal Removal Ability	Potential to heat stormwater
Rainwater Harvesting	Possible	0%	0%	0%	Low	Med
Grassed Swale	No	0 - 35%	0 - 20%	0 - 20%	Low	Low
LV-VFS	Some	40%	30%	35%	Med	Low
Wet Pond	Yes	85%	25%	40%	Med	High
Dry Detention Basin	Yes	50%	10%	10%	Med	Med
BRC without IWS	Possible	85%	35%	45%	High	Med
BRC w/IWS (Coastal Plain/ Sand Hills)	Possible	85%	60%	60%	High	Med
BRC w/IWS (Piedmont/ Mountains)	Possible	85%	40%	45%	High	Med
Constructed Wetland	Yes	85%	40%	40%	Med	High
Sand Filter	Possible	85%	35%	45%	High	Med
Infiltration Devices	Yes	85%	30%	35%	High	Low

TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus; LV-VFS = Level Spreader & Vegetative Filter Strip; BRC = Bioretention Cell; IWS = Internal Water Storage. This table has been adapted from Table 4-1 BMP Ability for Stormwater Quality Control found in the NC DENR Stormwater BMP Manual.

Table 2. Possible Site Constraints for Stormwater BMPs

Stormwater BMPs	Size of Drainage Area	Space Required	Head Required	Works with Steep Slopes?	Works with Shallow Water Table?	Works with Shallow Depth to Bedrock?	Works with High Sediment Input?	Works with Poorly Drained Soils?
Rainwater Harvesting	Small	Varies	Low	✓	✓	✓	✓	✓
Grassed Swale	Small	Low	Med	✓	✓	✗	✗	✓
LV-VFS	Small	Med	Low	✗	✓	✓	✗	✓
Wet Pond	Medium - Large	High	High	✗	✓	✗	✓	✓
Dry Detention Basin	Small - Large	Med	High	✗	✗	✗	✓	✓
BRC without IWS	Small	High	Med	✓	✗	✗	✗	✓
BRC w/IWS	Small	High	Med	✓	✗	✗	✗	✗
Constructed Wetland	Small - Large	High	Med	✗	✓	✗	✓	✓
Sand Filter	Small	Low	Med	✓	✗	✗	✗	✓
Infiltration Devices	Small – Medium	High	Low	✗	✗	✗	✗	✗

This table has been adapted from Table 4-2 Possible Siting Constraints for BMPs found in the NC DENR Stormwater BMP Manual.

Table 3. Cost, Community, and Environmental Issues for Stormwater BMPs

Stormwater BMPs	Construction Costs	Maintenance Level	Safety Concerns	Community Acceptance	Wildlife Habitat
Rainwater Harvesting	Med	Med	✘	High	Low
Grassed Swale	Low	Low	✘	High	Low
LV-VFS	Low	Low	✘	High	Med
Wet Pond	Med	Med	✓	Med	Med
Dry Detention Basin	Low	Low – Med	✓	Med	Low
BRC	Med – High	Med – High	✘	Med – High	Med
Constructed Wetland	Med	Med	✓	Med	High
Sand Filter	High	High	✘	Med	Low
Infiltration Devices	Med – High	Med	✘	Med – High	Low

This table has been adapted from Table 4-3 Cost, Community and Environmental Issues for BMPs found in the NC DENR.

1. SITE CONFIGURATION

Description

The configuration of a site can help to manage discharges to surface waters by segregating, containing, or diverting stormwater in order to properly control and treat it.

The configuration of your site can greatly affect both the quantity and quality of stormwater runoff coming from the site. Relevant aspects of site design can include the land area, surface waters, wetlands, and topography. Ensure that on-site management capabilities are adequate for the amount of feedstocks and finished compost at the site. A good site configuration should include BMPs such as diversion, covering, and containment. Keep site operations organized, and monitor areas where pollutants could enter the stormwater. Use natural topography and graded slope to separate stormwater and process wastewater. Limit graded slopes and fills to an angle that can grow vegetation in order to control erosion and sedimentation.

Purpose

– To reduce the quantity of runoff that carries typical compost pollutants such as sediment, organic matter, and trace metals.
– To control and limit the opportunity for pollutants to enter the stormwater.

Design Considerations

- Select the right site from the start. Consider drainage details, topography, and separation from surface waters as part of the site selection criteria.
- Only manage the appropriate quantity of feedstocks and finished compost according to the size of the facility and the type of equipment available.
- Segregate stormwater and wastewater.
- Limit potential for material spillage from machinery.
- Maximize the amount of site vegetation.
- Place industrial activities away from surfaces waters, place physical barriers or flags on established setbacks.
- Ensure that the site is not in a 100-year flood plain.
- Ensure that the staging areas and access roads are adequate for the sizes of vehicles and equipment onsite; including emergency vehicle access.
- Consider reducing, reusing, and recycling all fluids generated from composting operations.
- Cover the composting processing areas and finished product to minimize runoff.
- Divert on-site runoff away from the active composting areas to prevent contamination.
- Divert off-site runon away from the site to prevent containing additional runoff volumes.

Operation and Maintenance Considerations

- Re-grade and repair the site as needed to maintain site configuration.
- Revise the site configuration and operating modes in response to new problems.

2. EXPOSURE REDUCTION

Description

Exposure reduction involves eliminating or minimizing the amount of the composting activity and materials that are exposed to precipitation. By doing so, the potential for pollutants being picked up and carried away by stormwater is removed or reduced. Roofs and covers can also prevent product from being lost that could be carried away by rain water.

Purpose

– Can reduce all target pollutants in composting activities such as suspended and dissolved solids, nutrients, pathogens, COD, and heavy metals.
– Allows for better moisture and temperature control of open-air composting methods (such as windrows).
– Minimizes precipitation coming into contact with potential pollutants.

Design Considerations

- Roof structures or other permanent or temporary type covers such as sheds and tarps can be used. However, large tarps may be extremely difficult to handle with manual labor, to the extent that reliable utilization is not possible. Automated cover systems are available
- Gutters and area grading should direct water away from covered areas so water does not run under the roof or cover.
- Younger windrows should be targeted first if roofs and covers can only be used in a limited number of areas.
- Roofs and covers are impervious areas and can increase runoff volumes; however if runoff does not come in contact with active composting material, it can be treated separately as stormwater instead of process wastewater.
- Has the greatest potential of any BMP to achieve pollutant control from a composting site.

Operation and Maintenance Considerations

- Roofs and covers should be repaired or replaced as needed.
- Fully enclosed structures should consider ventilation for human health concerns and for structural integrity of materials (such as metals) due to volatilization of chemicals into the air.

3. GOOD HOUSEKEEPING & OPERATIONS

Description

Good housekeeping and operations of other materials management practices can prevent or reduce pollutants from entering stormwater runoff as well as help maintain a clean and orderly work environment. Each site should evaluate the site operations in order to implement appropriate good housekeeping measures.

In extreme cases, modification of operational techniques and procedures can eliminate up to 90% of the runoff generated from a facility. Consider operational techniques to reduce stormwater volume and pollutant load such as maintaining the shape of the piles to facilitate aeration and reduce potential for runoff to have suspended solids. Operational techniques should be tailored to each site to effectively control runoff.

Purpose

- Reduction of stormwater runoff in contact with feedstocks, finished compost, and other materials.
- Reduction of stormwater volume and reduction of peak flow rates.

Reduction of contaminants levels in stormwater.

Design Considerations

- Develop and maintain a stormwater pollution prevent management plan and a good housekeeping program for the site.
- Consider changes in operation that can help reduce runoff, such as consolidating windrows into larger volume windrows, and extended aerated static piles.
- Develop a contingency plan outlining response procedures in case stormwater issues arise.
- Train employees on stormwater pollution prevention and stormwater BMPs maintenance.
- Insure that garbage and waste materials are picked up regularly and properly disposed of to prevent runoff contamination.
- Keep ground surfaces clean by sweeping, shoveling, or vacuuming to minimize amount of fines (suspended solids) in the stormwater runoff.
- Follow established procedures for loading, unloading, or transferring of feedstocks and composting materials.
- Eliminate potential exposures from stormwater to composting areas.

Operation and Maintenance Considerations

- Implement operating plan for the site.
- Routinely inspect stormwater outfalls for signs of pollutants such as deposited sediment.
- Maintain adequate heat in the piles to drive moisture off as vapor.
- Maintain the shape of the windrows.
- Measures should be in place to prevent cross-contaminate between feedstocks and post-PFRP* compost.
- Equipment should be routinely inspected to make sure it is in working order.

*PRFP stands for Process to Further Reduce Pathogens and this threshold is met after the composting process has reached a certain level of temperature-time thresholds for the compost mixture to be approved for use by regulatory bodies. Details can be found under NCDENR rules.

4. DIVERSIONS AND CONTAINMENT

Description

Diversion and containment structures can be utilized in a number of ways at composting facilities to prevent, control, and even treat various types of runoff. Structures commonly employed for these purposes include earthen or concrete berms, dikes, pads, curbing, gutters, swales, trenches, and catch basins. These practices are generally viewed as simple, low-cost measures that may be adapted to nearly any site configuration. Diversions and containment work most effectively when used in conjunction with other BMPs.

Site layout and topography dictate the best use of diversion and containment structures but conceptual design remains the same for all facilities: prevent or limit offsite run-on or onsite runoff, and intercept and direct high pollutant discharges to appropriate treatment measures. Successful implementation of diversion and containment practices has the potential to reduce site runoff volume and significantly improve water quality.

Purpose

- Diversion of stormwater and wastewater to appropriate measures for discharge or treatment.
- Prevent mixing of stormwater and wastewater, and prevent untreated discharges to surface waters.
- Eliminate, minimize, contain, or direct high pollutant load runoff.

Design Considerations

- For sloped sites near surface waters or their conveyances, consider terracing compost windrows parallel to the water body, diverting run-on upslope with berms, and containing runoff downslope using trenches draining to treatment areas.
- It is good engineering practice to design diversion and containment structures capable of handling peak flows from at least a 10-year storm.
- Earthen measures (such as berms, swales, trenches) should be engineered to resist erosive flow velocities.

Operation and Maintenance Considerations

- Concrete structures require minimal maintenance while earthen structures, particularly berms, may require periodic reworking and repair initially or following large storms.
- Cleanout of accumulated sediment in conveyances is occasionally necessary.
- All BMPs should be visually inspected on a regular basis.

For technical specifications and additional information see Chapter 6 Section III of the NCDENR E&SC Planning and Design Manual at http://portal.ncdenr.org/web/lr/publications#espubs.

5. VEGETATIVE COVER/STABILIZATION

Description

In order to control accelerated erosion and contaminants in runoff, natural vegetative growth or other material which renders the soil surface stable should be implemented on the site. A vegetative buffer should be maintained around surface waters, wetlands, and interior drainage features. Establish and maintain stabilization in areas especially vulnerable to damage from erosion and sedimentation.

Vegetation and plants increase pollutant removal by providing resistance to the flow of runoff and subsequently reducing runoff velocity. Plant roots stabilize the soil and remove pollutants that adhere to the sediment particles from runoff.

Purpose

– Can reduce particulate pollutants such as sediment, phosphorus, organic matter, and trace metals.
– Slows down water flow, and promotes water infiltration, and provides sediment filtration.

Design Considerations

- The angle of graded slopes and fills should be no greater than the angle that can be retained by vegetative cover; maximum recommended slope is 3:1.
- Include vegetation protection areas and retain pre-existing native vegetation.
- Material storage or heavy equipment should not be allowed in areas where vegetative cover is desired.
- Temporary ground cover may need to be utilized until permanent vegetation is established.

Operation and Maintenance Considerations

- Routine mowing and replanting of vegetative cover when necessary.
- Vegetation could require frequent landscape maintenance such as irrigation, mowing, trimming, removal of invasive species, and replanting when necessary.
- Recommended planting includes grasses that are short, drought-tolerant, and non-bunching.

For technical specifications and additional information see Chapter 6 Section II of the NCDENR E&SC Planning and Design Manual at http://portal.ncdenr.org/web/lr/publications#espubs.

6. RAINWATER HARVESTING SYSTEMS

Description

Rainwater harvesting is the practice of collecting, storing, and reusing stormwater onsite. Facilities requiring large volumes of water for windrow moisture control, dust control, or other uses may benefit from the reuse of stormwater for these purposes. Rainwater harvesting systems may be used to capture and store relatively clean rooftop runoff volumes and make available large volumes of water for regular use. Reducing the volume downstream can help limit the amount of stormwater pollutants carried through its downslope path.

Rainwater is usually drained from a roof to a cistern. Other methods of harvesting rainwater include diverting runoff to a pond where it can be stored and used as needed. This may be more appropriate where larger volumes of water are required only occasionally. Stormwater reuse has additional benefits in that it results in no discharge to receiving waters.

Purpose

- Reduces the generation of stormwater runoff and attenuates peak flows to the receiving water.
- Provides a convenient source of usable water onsite for various purposes.
- Reduces pollutant load from the site by an equivalent reduction in runoff volume.

Design Considerations

- Rainwater harvesting facilities should be sized based on their drainage area, target design storm and frequency, anticipated rate of stormwater reuse, and cost of installation.
- For full pollutant removal benefit, rainwater harvesting systems should have a year-round, dedicated use or should include a passive drawdown device so that they dewater between storm events (or a combination of the two).
- Pumps can be included in rainwater harvesting designs where an increase in water pressure is needed or to facilitate transfer of water to its reuse location.

Operation and Maintenance Considerations

- Maintenance is typically minimal and consists primarily of preventing clogging of gutters, drains, spouts, and other conveyances and routine maintenance of pumps (if any).
- Holding ponds used for reuse may require occasional sediment cleanout and periodic inspection to verify structural integrity, especially after any storm event.

For more information see Chapter 25 Rainwater Harvesting Systems in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

7. EROSION & SEDIMENT CONTROL

Description

Erosion and sediment control (E&SC) involves the prevention of surface soil erosion, and the capture and control of sediment generated from erosion.

There are numerous individual practices, measures, and devices that can be performed or installed to prevent erosion and to control sediment. E&SC measures are typically applied at work sites during construction when disturbing the ground, but are also used for sites such as composting facilities that are constantly working with materials and soils that can potentially erode or contribute to the generation of sediment.

Purpose

– Can reduce composting particulate pollutants such as sediment and organic matter.
– Can slow down water flow.
– Can reduce nutrients in the flow that are attached to the sediment captured.

Design Considerations

- Focus on erosion prevention first, and then sediment capture and control where erosion cannot be prevented.
- Preventative measures include, but are not limited to: minimizing the disturbed or exposed area, vegetation planting, slope stabilization, mulch, and riprap.
- Capture & control measures include, but are not limited to: sediment traps, flocculants (PAMS), sediment/silt fences, gravel weirs, gravel inlet protection, compost socks, and skimmer basins.
- Size is typically dependent on the size of the area draining to each type of measure.
- Most E&SC measures are temporary and require consistent maintenance, but in the case of composting facilities, they might be treated as permanent structures with constant maintenance.

Operation and Maintenance Considerations

- Maintenance of E&SC measures varies dependent of each measure, but primarily involves sediment removal or replacement of the device.
- Visual inspection of E&SC measures are typically performed after every rain event.

For technical specifications and more information see Chapter 6 Section VI and VII of the NCDENR E&SC Planning and Design Manual at http://portal.ncdenr.org/web/lr/publications#espubs.

8. GRASSED SWALE

Description

A water quality grassed swale is a shallow open-channel drainage way stabilized with grass or other herbaceous vegetation that is designed to filter pollutants. The vegetation and soils in the swale remove pollutants primarily via filtration, settling, and infiltration.

Grassed swales filter pollutants as stormwater runoff moves through the leaves and roots of the grass. By reducing flow depths and velocities and increasing the time the water is in the swale, grassed swales can help to reduce runoff rates.

Purpose

– Can reduce target composting activity particulate pollutants such as sediment and organic matter.
– Slows down water flow and promotes sedimentation and infiltration.
– Some nutrient reduction provided.

Design Considerations

- Adding check dams or depression storage promotes more infiltration and better pollutant removal.
- Must be designed to not erode during typical rain events.
- Side slopes should be no steeper than 3:1 (horizontal : vertical).
- Broad swales on flat slopes with dense vegetation are the most effective.
- Removal efficiencies are highest for sediment-bound pollutants.
- The longitudinal slope of the swale should be as flat as possible to minimize velocities and improve pollutant filtering.
- Typically used in conjunction with other, more effective BMPs.
- Design to maximum shear stress and velocity to allow for proper establishment of vegetation.

Operation and Maintenance Considerations

- Maintenance of a grassed swale involves periodic sediment removal, routine mowing, and replanting of vegetation when necessary.
- Eroded areas of a swale should be stabilized immediately to prevent an increase in sediment leaving the site.

For more information see Chapter 14 Grassed Swale in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

9. LEVEL SPREADER - VEGETATIVE FILTER STRIP SYSTEM

Description

A level spreader - vegetative filter strip (LS-VFS) consists of a level spreader in series with a vegetative filter strip. A LS-VFS is designed to diffuse stormwater over a level concrete lip in order to produce sheet flow over the VFS. The vegetation and soils in the VFS remove pollutants primarily via filtration and infiltration.

A LS-VFS is typically installed to provide diffuse flow per a buffer rule, to meet stormwater rule provisions, or to provide pollutant removal. Design requirements for the system vary based on the regulatory requirements and the type of ground cover in the VFS. A VFS is placed into one of four categories: protected riparian buffer, wooded stormwater setback/buffer, herbaceous stormwater setback/buffer, or engineered filter strip. The VFS is usually 30 feet in width except when the LS-VFS is used to meet stormwater rule requirements in SA waters, in which case the VFS must be a minimum of 50 feet in width.

Purpose

- Can reduce particulate pollutants such as sediment, organic matter, and trace metals.
- Slows down water flow and promotes infiltration.
- Meets diffuse flow requirements under the buffer and stormwater programs.

Design Considerations

- The LS must be constructed with a uniform slope of zero percent (or level).
- A LS-VFS does not have the capability for stormwater detention; however, it does provide some volume control for smaller storms via infiltration in the VFS, particularly in soils with higher infiltration rates.
- The length of the LS-VFS must be determined based on the flow rate that is directed to it.
- The LS must be straight or convex.
- When used to meet Stormwater Rule requirements, the VFS must have a longitudinal slope of less than 5 percent if for wooded vegetation and 8 percent if it is graded and grassed.
- This BMP is vulnerable to excess solids loading.

Operation and Maintenance Considerations

- Maintenance of an LS-VFS involves periodic sediment removal in the level spreader swale and routine mowing and replanting of VFS grass when necessary.
- Strips receiving excessive sediment may require periodic re-grading and re-seeding of their upslope edge because deposited sediment can kill grass and prevent the LS-VFS from achieving diffuse flow.

For more information see Chapter 8 Level Spreader - Vegetative Filter Strip System in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

10. WET DETENTION BASIN

Description

A wet detention basin, or commonly known as wet pond, is a permanent body of water with additional capacity that is used to temporarily store, treat, and slowly release runoff over a period of time. Wet ponds remove pollutants from runoff primarily by settlement of suspended particulates and possibly infiltration of a portion of the runoff into the ground, depending on the soil infiltration rate.

A wet pond will include a forebay at each inlet for pretreatment and to capture and remove particulate pollutants before entering the main pond. Further settling then occurs as flow travels through the main pond. An outlet structure regulates the pond's rate of discharge and is usually constructed to release the design runoff volume over a 2-5 day period. This way, the additional storage capacity is available for the next storm event.

Composting facilities that require makeup or irrigation water for operations may find additional benefit from wet ponds as a convenient, low-cost source of water.

Purpose

– Effectively reduces two primary composting pollutants: total suspended solids and nutrients.
– Can detain runoff and attenuate peak flows.

Design Considerations

- A wet pond should be sized based on the site design storm and drainage basin area.
- A densely planted vegetated shelf should be incorporated along the basin's perimeter as it discourages waterfowl (a source of pollutants) and prevents shoreline erosion.
- Permanent pool and temporary pool depths are usually $\geq$ 3′, and 1′ respectively, but may vary.

Operation and Maintenance Considerations

- Maintenance includes periodic removal of sediment from forebays and inspection of banks and outlet structure for integrity and function. Vegetation on the vegetated shelf and any sloping banks may require minimal maintenance occasionally.

For more information see Chapter 10 Wet Detention Basin in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

11. DRY EXTENDED DETENTION BASIN

Description

A dry extended detention basin, commonly known as detention basin, temporarily holds incoming stormwater, and slowly drains to the surface of the basin. The temporary holding of the water allows for solids to settle and reduces peak flow rates leaving a site.

Dry basins do not have a permanent pool of water, so they are typically dry between storm events. A low-flow outlet slowly releases the water that is temporarily detained over a period of days. They are typically more appropriate where water quality issues are secondary to managing the rate water leaves the site, since the overall pollutant removal efficiency of dry detention basins is low. Dry detention basins are not intended as infiltration or groundwater recharge measures.

Purpose

– Primarily slows down water flow for large and small areas.
– Can reduce target composting activity particulate pollutants such as sediment and suspended organic matter.

Design Considerations

- Water that is temporarily detained typically drains in 2 to 5 days.
- A forebay may be required if the design flow to the facility is over 10 acre-inches.
- A low flow channel can be included to help prevent developing a soggy bottom or standing water.
- Typically used in conjunction with other, more effective BMPs to reduce sediment and nutrients.
- Outlet design must ensure that trapped particulates are not simply flushed out by succeeding storms.

Operation and Maintenance Considerations

- Maintenance of a dry detention basin involves periodic sediment removal and routine mowing and replanting of grass when necessary.
- The outlet drain must be kept free of solids and debris to ensure proper function.

For more information see Chapter 17 Dry Extended Detention Basin in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

12. BIORETENTION

Description

Bioretention is the use of plants and soils for removal of pollutants from stormwater runoff primarily via adsorption, filtration, sedimentation, and biological decomposition. A bioretention cell is also sometimes referred to as a rain garden.

A bioretention cell consists of a shallow excavation filled with 2′ – 4′ of soil media mixture that is covered with various types of water-tolerant vegetation and mulch, or grass sod. The surface of the BMP is depressed in a bioretention cell to allow for temporary ponding of runoff that then filters through the soil media. Water exits the bioretention cell via exfiltration into the surrounding soil, flow out an underdrain pipe, and evapotranspiration from the vegetation. A bioretention cell can also provide landscaping and habitat enhancement benefits.

Purpose

– Reduce target composting activity pollutants such as suspended solids, nutrients, pathogens, and heavy metals.
– Slows down water flow and promotes infiltration.
– Attenuatethe temperature of runoff for waters that are temperature sensitive like trout streams.

Design Considerations

- The area draining to a bioretention cell must be stabilized to prevent clogging of the soil media.
- Some form of pretreatment to remove excess solids should be provided prior to runoff entering a bioretention cell to prevent clogging or failure. Pretreatment measures can be as simple as a vegetative swale or grass area.
- The temporary ponding depth of water is 9” – 12”; which drains within 12 hours.
- The size of a bioretention cell is determined by the amount of runoff draining to it; with any dimensions (width, length, or radius) being at least 10 feet to allow sufficient space for plants.
- The proper soil media and vegetation must be selected for bioretention to function effectively.
- The soil media is typically 2′ – 4′ deep.
- An Internal Water Storage (IWS) zone can be added to existing and new bioretention cells to increase Nitrogen removal, water infiltration to adjacent soils, and temperature reductions.

Operation and Maintenance Considerations

- Maintenance of bioretention involves periodic sediment removal, pruning of vegetation or mowing of grass, and refreshing of the mulch layer.
- Clogging of the soil media and failure can occur if the area draining to it is not stabilized, or if pretreatment is insufficient.

For more information see Chapter 12 Bioretention in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

13. CONSTRUCTED WETLAND

Description

A constructed wetland is a manmade wetland built to temporarily store, treat, and release runoff over a period of time, typically 2-5 days. Constructed wetlands are designed to mimic the functions of natural wetlands and use physical, chemical, and biological processes to remove pollutants. These systems can be highly effective at removing a wide range of compost pollutants such as suspended solids, BOD, N and P nutrients, fecal coliform/pathogens, and heavy metals. Additionally, constructed wetlands can also provide peak flow attenuation and some volume reduction as they act like a natural sponge and absorb water.


DWQ

Constructed wetlands are designed similarly to wet ponds but include shallow water, inundation zones, and deep pools. Grading the wetland in zones promotes the growth of wetland vegetation which enhances this BMP's effectiveness. Site areas that are frequently wet or contain pooled water after storm events are usually suitable for a constructed wetland as long as jurisdictional wetlands do not already exist.

Purpose

- Effectively reduces a wide range of common composting pollutants.
- Can detain runoff, attenuate peak flows and reduce runoff volume.
- Provides excellent habitat for many types of wildlife.

Design Considerations

- A constructed wetland should be sized based on its design storm; with a minimum runoff volume of 3,630 cubic feet.
- The elevation of the seasonally high water table and permanent pool elevation are critical to the long term success of a constructed wetland; ideally, these elevations coincide.
- Extended drawdown of the permanent pool can result in the loss of wetland vegetation and reduced function.
- This BMP is vulnerable to excess solids loading; a forebay for pretreatment is required and additional pretreatment measured should be added.

Operation and Maintenance Considerations

- Maintenance includes periodic removal of sediment from forebays or other pretreatment measures and inspection of banks and outlet structure for integrity and function.
- Vegetation requires close attention initially but once established only minor maintenance is required.

For more information see Chapter 9 Stormwater Wetlands in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

14. SAND FILTER

Description

A sand filter is a surface or subsurface device that routes water through a sedimentation chamber for pretreatment and then percolates stormwater through a sand media that filters out pollutants. Sand filters are capable of removing a wide variety of pollutant concentrations in stormwater via settling, filtering, and adsorption processes. Sand filters have been a proven technology for drinking water treatment for many years and have been demonstrated to be effective in removing common stormwater pollutants including TSS, BOD, fecal coliform, hydrocarbons, and metals. Since sand filters can be located underground, they can also be used in areas with limited surface space. A major concern is that sediment can quickly blind a sand filter and cause premature failure of the BMP.

Purpose

– Can reduce particulate pollutants such as sediment, organic matter, and trace metals. Highly effective at removing TSS, BOD and fecal coliform.
– Slows down water flow and may promote infiltration.

Design Considerations

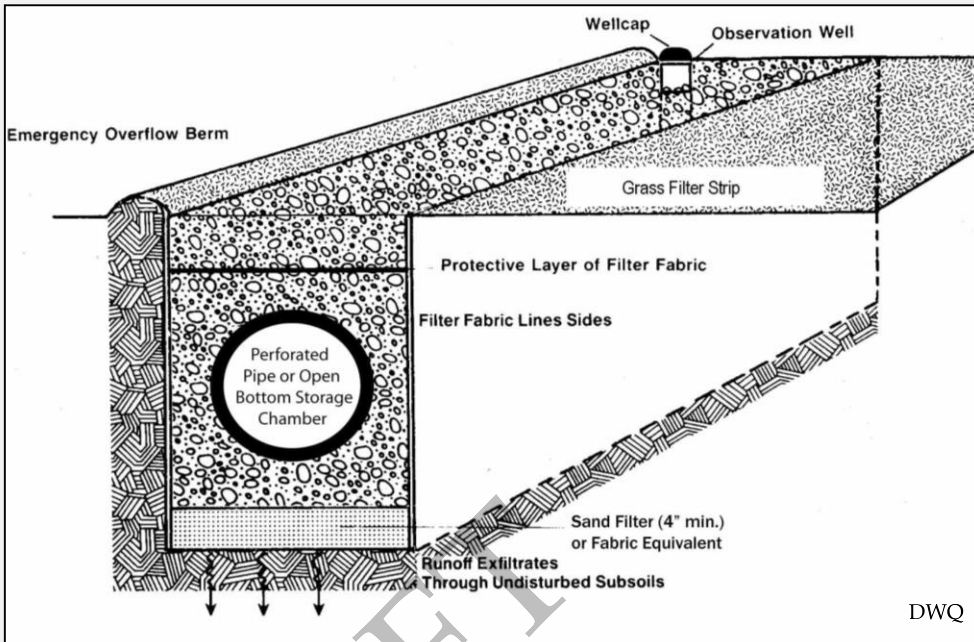
- Requires less space than other BMPs and can be placed underground where space is limited.
- Sand filters are most successful when they treat drainage areas with a large fraction of impervious surfaces.
- Sand filters typically employ underdrain systems to collect and discharge treated stormwater but may also be designed as infiltration type systems when located in soils with sufficient permeability or infiltration rates.
- A forebay or sedimentation chamber is required on all sand filters to protect the sand filter from clogging due to sediment, and to reduce the energy of the influent flow.
- The sand filter medium should be washed medium to coarse sand.

Operation and Maintenance Considerations

- Maintain as needed to remove visible surface sediment accumulation, trash, debris, and leaf litter to prevent the filter from clogging prematurely.
- The drainage area should be carefully managed to reduce the sediment load to the sand filter.
- The sedimentation chamber or forebay should be cleaned out whenever sediment depth exceeds six inches.
- Sand media should be skimmed yearly to remove the top layer, most likely to sature with sediment.
- The sand filter media should be replaced whenever it fails to function properly after maintenance.

For more information see Chapter 11 Sand Filter in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

15. INFILTRATION DEVICES



Description

Infiltration devices are normally dry except during storm events. Infiltration devices do not discharge during the design storm but instead contain and infiltrate the design flow into underlying soils and groundwater. Infiltration devices will typically overflow during storm events that exceed the design storm. Infiltration devices have good pollutant removal efficiencies and operate best in areas with well-draining permeable soils. Adequate pretreatment must be provided to prevent clogging. Infiltration is not appropriate for composting runoff classified as wastewater or stormwater containing a high pollutant load.

Purpose

– Capture and filter runoff by allowing it to naturally infiltrate back into the soil.
– Reduces runoff volume from site, recharges groundwater, and attenuates peak flows to receiving water.
– Particularly effective at removing sediment and other pollutants adsorbed to particulates.

Design Considerations

- Infiltration works best in relatively small drainage areas that are completely impervious or sufficiently stable so as to minimize the amount of sediment going to the BMP.
- Infiltration devices require permeable underlying soil generally found east of I-95 in North Carolina.
- Pretreatment devices for removing sediment and solids must be used to protect the basin or trench from clogging. Options for pretreatment may include forebays, filter strips, grassed swales with check dams and concrete sumps.

Operation and Maintenance Considerations

- Typical maintenance includes sediment removal from pretreatment devices and occasional observation of drawdown times to ensure that the basin or trench is infiltrating as designed.
- Infiltration devices are prone to fail relatively quickly compared to other types of BMPs if exposed to excessive sediment and not properly maintained.

For more information see Chapter 16 Infiltration Devices in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.

16. PROPRIETARY SYSTEMS

Description

A proprietary system is a manufactured device that treats stormwater before it is discharged to another BMP or to the receiving water. This is a broad category of BMPs with a variety of pollutant removal mechanisms and varying pollutant removal efficiencies.

Proprietary BMPs are usually classified into two major groups: separation devices and filtration devices. Separation devices can be further subdivided into two types: chambered and hydrodynamic. In chambered BMPs, runoff passes through several chambers where settling of sediment particles and flotation of hydrocarbons takes place. Hydrodynamic devices typically impart a swirling motion to the incoming flow that aids in settling of sediment particles. Filtration BMPs typically pass runoff through filter cartridges or filter media, thereby removing some fraction of the solid pollutants from the stormwater.

Purpose

– Can reduce particulate pollutants such as sediment, organic matter, and trace metals.

Design Considerations

- Individual proprietary systems are extremely variable in design details, design concepts, and pollutant removal mechanisms.
- Can be cheaper than traditional technologies for stormwater treatment.
- Typically requires less land surface than traditional technologies.
- May be engineered to target specific pollutants.
- Proprietary devices may be designed as stand-alone BMPs or, they may also be designed as part of a stormwater treatment and control train, in combination with other BMPs.

Operation and Maintenance Considerations

- Regular inspection, maintenance, and clean out of proprietary systems is required for best performance.
- Because of the reduced size compared to traditional technologies, maintenance actions may be more frequent.

For more information see Chapter 20 Proprietary Systems in the NCDENR Stormwater BMP Manual at http://portal.ncdenr.org/web/lr/bmp-manual.