WQ-06: BIOSWALES

1.0 Bioswales

1.1 Description

A Bioswale is a shallow open-channel drainage way stabilized with turf grass or other vegetation used to covey runoff and filter pollutants. Use Bioswales in medians and drainage conveyance swales or ditches as an enhancement to vegetated swales. Bioswales are useful along roads that have driveway entrances crossing the swale. The maximum contributing drainage area for Bioswales is five (5) acres.

Bioswales capture, treat, and release the stormwater quality runoff volume. Bioswales are different from normal drainage swales in that they have structures implemented to enhance detention and stormwater pollutant removal. Bioswales are used primarily for stormwater quality and have a limited ability to provide stormwater runoff volume control. Bioswales are vegetated channels that include a filter media that overlays an underdrain system. Bioswales are sized to allow the entire water quality storage volume to filter or infiltrate through the swale bottom. Because Bioswales are sensitive to fine sediments, do not install them on sites where the contributing area is not completely stabilized or is periodically being disturbed.

Table 1: Average Pollutant Capability

Property	Value	Property	Value
Total Suspended Solids	70%-80%	Hydrocarbons	65%
Total Phosphorus	35%-50%	Lead	60%-70%
Pathogens/Bacteria	10%-60%	Copper	15%-45%
Total Nitrogen	40%-60%	Zinc	40%-65%

1.2 Design

Design Bioswales to treat the water quality volume of runoff from the entire drainage basin. Calculate the surface area of the Bioswale by dividing the water quality volume by the ponding depth (18 inches). Typical Bioswales have a minimum bottom width between 2- and 8-feet and minimum filter media depth of 2 feet. In order to allow for proper pollutant removal, design for the ponded runoff above the Bioswale surface to drain in a maximum of 12 hours. Design for runoff within the filter media to drain to a depth of 2-feet below the Bioretention area surface within 48 hours. Design the underdrain system to safely pass the peak draw down flow rate of the filter media.

1.3 Materials

Bioswales consist of an underdrain system, filter media, plantings/vegetation and a pre-treatment forebay.

Place berms, check dams, weirs, and other structures perpendicular to the Bioswale flow path to promote settling and infiltration.

1.3.1 Underdrain System

Use a minimum 4-inch diameter perforated PVC pipe in a 6-inch layer of No. 57 Aggregate gravel or equivalent filter material as the underdrain system. Place a permeable nonwoven geotextile filter fabric between the gravel and the overlaying permeable filter media.

Table 2: Material Specifications

Material	Specification
No. 57 Aggregate	Use course aggregate No. 57 consisting of crushed slag or gravel.
Pipe Underdrains	Use perforated pipe underdrains with a minimum diameter of 4-inches.
Non-Woven Geotextile Fabric	Use Type C non-woven geotextile fabric.
Turf Reinforcement Matting (TRM)	Use a TRM that conforms with the current *SCDOT Rolled Erosion Control Products (RECP) Specification* for Turf Reinforcement Matting (TRM) description, materials, and construction requirements.

1.3.2 Filter Media

The filter media for Bioswales consists of a permeable layer that is a minimum of 2.0-feet deep. Provide a filter media with a minimum infiltration rate of 1.0 in/hour and a maximum rate of 6 in/hr. The filter media provides a medium for physical filtration for the stormwater runoff with enough organic matter content to support provide water and nutrients for plant life.

The USDA textural classification of the filter media is Loamy Sand or Sandy Loam. The filter media is furnished, and on-site soils are not acceptable.

Test the filter media to meet the following criteria:

Table 3: Filter Media Material Specifications

Item	Percent of Total Planting Mix by Weight	ASTM Sieve Size	Percent Passing by Weight
Sand* Clean, Washed, Well Graded, No Organic Material *Aggregate No . FA-10* *ASTM C-33 Concrete Sand* *AASHTO M-6* *AASHTO M-43, No. 9 or No. 10*	80% Max	3/8 in.	100
		No. 4	95-100
		No. 8	80-100
		No. 16	50-85
		No. 30	25-60
		No. 50	10-30
		No. 100	2-10
		No. 200	0-3
Screened Topsoil *Loamy Sand or Sandy Loam* *ASTM D5268* *(imported or manufactured topsoil)* *Max 5% clay content*	15% Max.	2 in.	100
		1 in.	95- 100
		No. 4	75-100
		No. 10	60-100
		No. 200	10-50
		0.002 mm	0-5
Organic Matter in the form of Compost, Leaf Compost, Peat Moss or Pinebark Nursery Mix**	5% Min	3/8 in.	85-100
		No. 8	50-80
		No. 30	0-40

Do not use lime stone screenings.
****** Potting grade pine bark with no particles larger than ½ inches.***

Submit the source of the filter media and test results to the ENGINEER prior to the start of construction of Bioswales. Do not add material to a stockpile of filter media once a stockpile has been sampled. Allow sufficient time for testing. Utilize a filter media from a certified source or laboratory to reduce mobilization time and construction delays.

Use a filter media that is uniform, free of stones, stumps, roots or other similar objects larger than two inches excluding mulch. Do not mix or dump materials or substances within Bioswales that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.

1.3.3 Forebay

Provide pretreatment of runoff to Bioswales with a forebay. Forebays are typically provided by constructing a check dam at the inlet to the Bioswale. Protect forebay inlets to reduce erosive forces of the runoff. The preferable protective material is a Turf Reinforcement Mat (TRM).

1.3.4 Outlet Structures

Discharge water from the underdrain system of Bioswales to a storm drainage system on site, or discharge to a stable protected outlet point.

1.3.5 Overflows

For maximum performance, Bioswales are recommended to be off-line structures. If a Bioswale is designed to be an online structure, the overflow structure must be able to safely pass runoff for the 10-year 24-hour storm event.

1.3.6 Plantings

Use plantings that conform to the standards of the current edition of *American Standard for Nursery Stock* as approved by the American Standards Institute, Inc.

Use plant materials that have normal, well developed stems or branches and a vigorous root system. Only use plantings that are healthy, free from physical defects, plant diseases, and insect pests.

Use plant species that are tolerant to wide fluctuations in soil moisture content. Use plantings capable of tolerating saturated soil conditions for the length of time anticipated for the water quality volume, as well as anticipated runoff constituents.

Use turfgrass species with a thick dense cover, slow growing, applicable to the expected moisture conditions (dry or wet), do not require frequent mowing, and have low nutrient requirements. The preferred method of establishing turf grass is sodding. Use temporary erosion control blankets to provide temporary cover when establishing turf grass by seeding.

1.4 Construction Requirements

1.4.1 Site Preparation

Do not install Bioswales on sites where the contributing area is not completely stabilized or is periodically being disturbed.

Separate Bioswales from the water table to ensure groundwater does not enter the facility leading to groundwater contamination or Bioswale failure. Ensure a vertical distance of 2 feet between the bottom of Bioswales and the seasonally high ground water table.

1.4.2 Excavation

Ensure excavation minimizes the compaction of the bottom of Bioswales. Operate excavators and backhoes on the ground adjacent to Bioswales or use low ground-contact pressure equipment. Do not operate heavy equipment on the bottom of Bioswales.

1.4.3 Underdrain System

Prior to placing the underdrain system, alleviated compaction on the bottom of the Bioswale by using a primary tilling operation such as a chisel plow, ripper, or subsoiler to a depth of 12 inches. Substitute methods must be approved by the RCE. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment.

Remove any ponded water from the bottom of the excavated area. Line the excavated area with a Class 2, Type C nonwoven geotextile fabric.

Place a layer of No. 57 Aggregate a minimum of 2-inches deep on top of the nonwoven filter fabric. Place the pipe underdrains on top of the underlying aggregate layer. Lay the underdrain pipe at a minimum 0.5 percent longitudinal slope. The perforated underdrain drain pipe may be connected to a stormwater conveyance system or stabilized outlet.

Place No. 57 Aggregate around the pipe underdrain system to a minimum depth of 6-inches. Place a Class 2, Type C nonwoven geotextile fabric between the boundary of the gravel and the filter media to prohibit the filter media from filtering down to the perforated pipe underdrain.

1.4.4 Filter Media

Place and grade the filter media using low ground-contact pressure equipment or excavators and/or backhoes operating on the ground adjacent to the Bioswale. Do not use heavy equipment within the perimeter of the Bioswale before, during, or after the placement of the filter media. Place the filter media in vertical layers with a thickness of 12 inches. Compact the filter media by saturating the entire Bioswale after each lift of filter media is placed until water flows from the underdrain system. Apply water for saturation by spraying or sprinkling. Perform saturation of each lift in the presence of the ENGINEER. Do not use equipment to compact the filter media. Use an appropriate sediment control BMP to treat any sediment-laden water discharged from the underdrain during the settling process.

Test the installed filter media to determine the actual infiltration rate after placement. Ensure the infiltration rate is within the range of 1 to 6 inches per hour.

1.4.5 Bioswale Surface

Install Bioswales with a bottom width ranging between 2- and 8-feet where applicable to ensure an adequate filtration area. Where the site allows, increase the filtration area by using wider channels, giving consideration to prevent uncontrolled sub-channel formation. Install Bioswale surface side slopes that are 4H:1V for ease of maintenance and for side inflow to remain as sheet flow. The maximum Bioswale surface side slopes are 2H:1V.

Install Bioswales with a minimal surface channel slope ranging from 1% to 2%, forcing a slow and shallow flow. This aspect of the Bioswale allows particulates to settle out of the runoff and limits erosion. Place flow control structures (berms, check dams, weirs, and other structures) perpendicular to the Bioswale flow path to promote settling and infiltration. Space flow controls structures a minimum of 50-feet and install energy dissipation techniques on the downstream side of these structures.

Flow can enter the Bioswale through a pretreatment forebay or it may enter along the sides of the swale as sheet flow produced by level spreader trenches along the top of the bank.

1.4.6 Plantings

Plant all Bioswale grasses, native grasses, perennials, shrubs, and other plant materials specified to applicable landscaping standards.

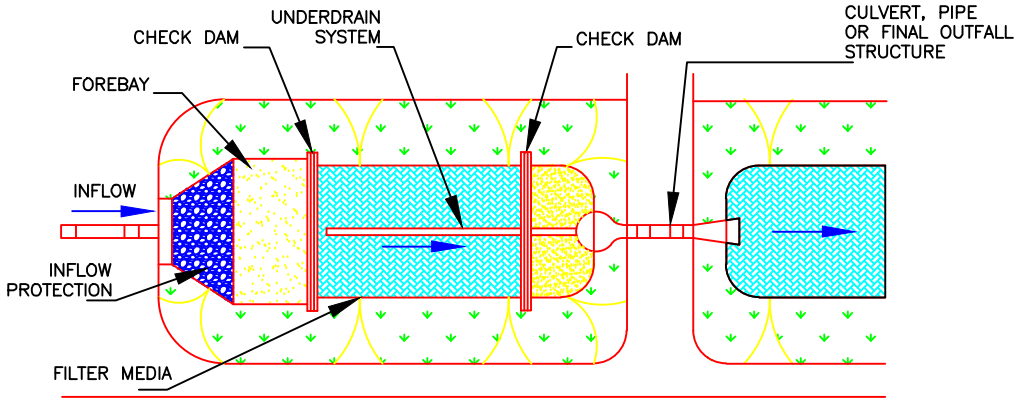
1.5 Inspection and Maintenance of Bioswales

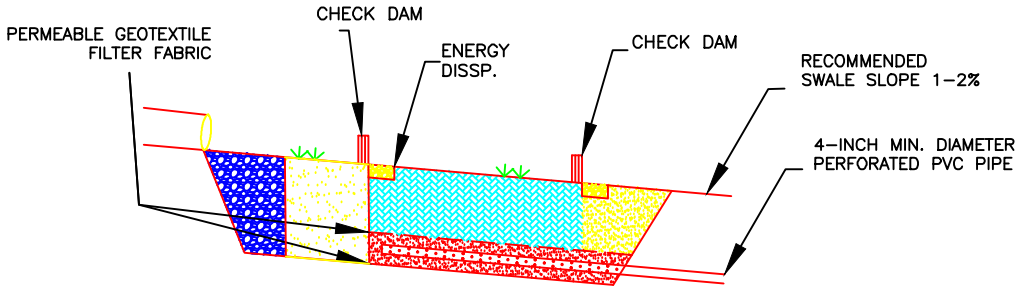
Regular inspection and maintenance is critical to the effective operation of Bioswales. Maintenance responsibility is vested with a responsible authority by means of an enforceable maintenance agreement that is executed as a condition of plan approval. Typical maintenance responsibilities include:

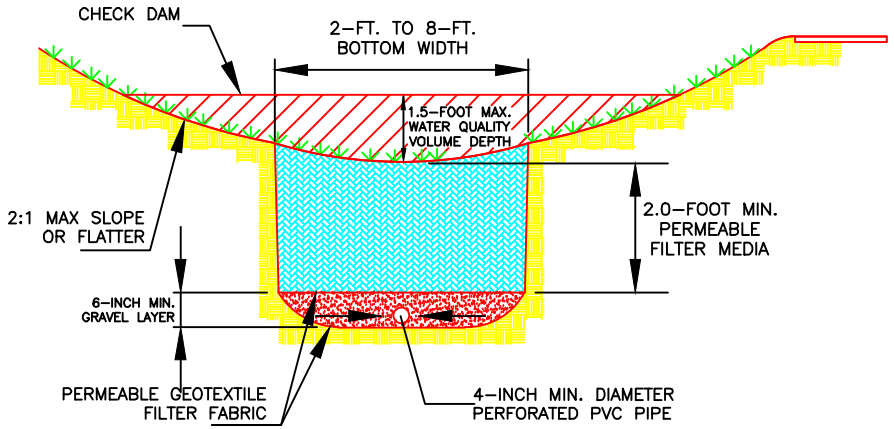
- Keep a record of the average de-watering time of the infiltration trench to determine if maintenance is required.
- Perform light core aeration as required to ensure adequate filtration when the surface of the filter bed becomes clogged with fine sediments over.
- Perform mowing to maintain storage volume and to maintain appearance periodically as needed.
- Remove trash and debris periodically as needed.

Table 4: Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height and remove clippings.	As needed (frequent/seasonally)
Nutrient and pesticide management.	Annual, or as needed
Inspect side slopes for erosion and repair	Annual, or as needed
Inspect channel bottom for erosion and repair	Annual, or as needed
Remove trash and debris accumulated in forebay	Annual
Inspect vegetation. Plant an alternative grass species if original cover is not established.	Annual (semi-annually first year)
Inspect for clogging and correct the problem	Annual
Roto-till or cultivate the surface of the bed when the Bioswale does not draw down in 48 hours.	As needed
Remove sediment build-up within the bottom of the Bioswale.	As needed, after 25% of the original design volume has filled.







Anderson County, SC

BIOSWALE

STANDARD DRAWING NO. WQ–06

APPROVED BY: _____ January 2012
DATE

BIOSWALE MAINTENANCE AND RESPONSIBILITY AGREEMENT

The Permanent *Stormwater System Maintenance and Responsibility Agreement* requires adequate maintenance for stormwater management/Best Management Practices (BMP) facilities including Bioswales. Document Bioswale deficiencies during **annual** inspections. Complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a Bioswale.

Important Maintenance Procedures:

- Manage the drainage area of the Bioswale to reduce the sediment load.
- After fertilizer is used to establish grass in the Bioswale, only apply fertilizer according to the results of a soil test.
- Ensure the grass cover in the Bioswale is dense and healthy. Re-sod or re-seed if necessary to ensure a dense stand of grass.

After the Bioswale is established, perform inspections once a quarter and after every storm event greater than 1.0 inch for the first year, and annually thereafter. Keep operation and maintenance records in a known location and make them available upon request.

Perform recommended maintenance activities as follows:

Required Maintenance	Frequency
Periodic pruning and weeding.	As needed
Remove trash and debris.	As needed
Inspect inflow points for clogging. Remove any sediment.	Every 6-months
Repair eroded areas. Re-seed or sod as necessary.	Every 6-months
Remove and replace dead or severely diseased vegetation.	Every 6-months
Removal of evasive vegetation.	Every 6-months
Nutrient and pesticide management.	Annual, or as needed

Perform trouble shooting activities as follows:

Field Condition	Common Solutions
Trash/ Debris is present	Remove trash/ debris
Sediment covers the grass at the bottom of the swale	Remove sediment manually if possible, and dispose of properly. Re-sod if necessary.
Areas of bare soil and/ or erosive gullies have formed	Re-grade the soil if necessary to remove the gully, then re-sod (or plant with other appropriate species) and water until established
Grass maintenance and weed control	Periodic mowing and weed control, watering during drought conditions, re-seeding of bare areas.
Nuisance vegetation is choking out desirable species	Remove vegetation by hand if possible. If pesticide is used, do not allow it to get into the receiving water (stream, pond, etc.).
Erosion or other signs of damage have occurred at the outlet	Re-grade if necessary to smooth it over and provide erosion prevention devices such as reinforced turf matting or riprap to avoid future problems with erosion.