Greenville County Technical Specification for:

LID-04 VEGETATIVE SWALE

1.0 Vegetated Swales

1.1 Description

Vegetative Swales are designed and installed as an alternate to hard piping stormwater conveyance systems. Vegetative Swales improve water quality by providing partial pollutant removal as runoff is filtered by the vegetation and by the opportunity to infiltrate into the underlying soil layer. Vegetative Swales also reduce flow velocities in comparison to hard piping systems. Vegetative Swales are designed to generate a relatively slow flow velocity to facilitate water quality treatment for small, frequent storm events.

1.2 When and Where to Use

Vegetated Swales are commonly installed along roadway and sidewalk corridors, and within residential developments. In low lying areas, Vegetated Swales have the potential for standing water and should be located as applicable. Vegetative Swales require continual vegetative cover in order to provide adequate treatment of runoff. It is important to maximize water contact with the vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. Vegetative Swales are susceptible to erosion and channelization if a thick stand of permanent vegetation is not sustained. A thick permanent vegetative cover is essential for proper functioning and to prevent damage from erosion.

1.3 Application and Limitations

The suitability of a Vegetative Swale at a site depends on land use, size of the drainage area, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the Vegetated Swale system. Vegetative Swales are not designed to treat drainage areas greater than 5 acres. Large drainage areas may be divided into sub-watersheds and treated using multiple swales.

1.4 Design Requirements

Perform the design of Vegetated Swales for the following two design conditions:

- Stability/Permissible Velocity: This design process involves evaluating how the Vegetated Swale responds under low vegetation retardance conditions. This condition is defined when vegetation is cut low or lies down, producing a lower Manning's n value, lower flow depths, and higher flow velocities. The limiting factor for stability design is the permissible velocity of the flow in the Vegetated Swale.

- Capacity: This design process involves evaluating how the Vegetated Swale responds under high vegetation retardance conditions. This condition is defined when vegetation is not maintained or is very long and rigid, producing a higher Manning's n value, higher flow depths, lower flow velocities, and higher shear stresses. The limiting factor for capacity design is the cross sectional area of the Vegetated Swale and the design shear stress.

Table 1: Permissible Velocities

Permanent Cover	Permissible Velocity (ft./sec.) Without TRMS*					
	Erosion Resistant Soils % Slope			Easily Eroded Soils % Slope		
	0-5	5-10	> 10	0-5	5-10	> 10
Bermuda Grass	8	7	6	6	5	4
Bahia Centipede Grass Tall Fescue Kentucky Bluegrass	7	6	5	5	4	3
Grass-legume Mixture	5	4	NR	4	3	NR

*Allow velocities over 5 ft/sec only where good cover and maintenance will be provided. If poor vegetation exists due to shade, climate, soils or other factors, reduce the permissible velocity.

NR = Not Recommended

For maximum water quality performance, Vegetative Swales are recommended to be off-line structures. If a Vegetative Swale is designed to be an online structure, it must be able to safely convey the runoff the 10-year 24-hour storm event.

Design Vegetative Swales with the following hydraulic design requirements:

- Minimum channel slope of 0.5 percent.
- Maximum channel slope of 5%.
- Optimal surface channel slope ranging from 1% to 2%.
- Design a 2-foot minimum bottom width, with a level bottom.
- Design with a non-erosive peak runoff velocities and shear stresses for 10-year 24-hour storm event, and capable of conveying the 10-year 24-hour storm event without overtopping.
- Design with a minimum length of 100 feet.
- The depth of flow for the water quality not greater than 4 inches.
- Provide a forebay at all inlets.
- Side slopes no steeper than 3:1 (H:V).

1.5 Materials

1.5.1 Turf Reinforcement Matting (TRM)

Vegetative Swales require non-erosive peak runoff velocities and shear stresses. Ensure the channel dimensions are capable of providing non-erosive flow rates and shear stresses. If non-erosive flow rates and shear stresses are not achieved, select an appropriate Permanent Turf Reinforcement Matting designed to provide non-erosive conditions. Do not use Temporary Erosion Control Blankets (ECBs) as they will degrade over time and lose their effectiveness.

Table 2: Material Specifications

Material	Specification
Turf Reinforcement Matting (TRM)	Use a TRM meeting appropriate design velocities and shear stresses.

1.5.2 Forebay

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

1.5.3 Outlet Structures

Discharge stormwater runoff from Vegetative Swales to a storm drainage system on site, or discharge to a stable protected outlet point.

1.6 Construction Requirements

1.6.1 Site Preparation

Do not install Vegetative Swales when the contributing area is not completely stabilized or is periodically being disturbed.

1.6.2 Excavation

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

1.6.3 Surface

Install Vegetative Swales with a minimum bottom width of 2-feet where applicable to ensure an adequate filtration area. Install Vegetative Swale surface side slopes that are 3H:1V for ease of maintenance and for side inflow to remain as sheet flow. When site constraints are restrictive, the maximum surface side slopes are 2H:1V.

Install Vegetative Swales with an optimal surface channel slope ranging from 1% to 2%, forcing a slow and shallow flow. This aspect of Vegetative Swales allows particulates to settle out of the runoff and limits erosion.

Flow can enter Vegetative Swales 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.

1.6.4 Grass

Plant all Vegetative Swales grasses to applicable standards and specifications.

1.7 Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of Vegetative Swales. 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:

- Mow grass within swales at least twice during the growing season to maintain a maximum height of approximately 6 inches.
- Repair erosion, rills, and gullies.
- Remove accumulated sediment as necessary.
- Vegetative Swales may periodically require aeration of the channel bed in order to increase the permeability of the system.

Table 3: 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 permanent cover is not established.	Annual (semi-annually first year)
Inspect for clogging and correct the problem	Annual
Aeration of 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 vegetative swale.	As needed, after 25% of the original design volume has filled.

1.8 References

CASQA California Stormwater BMP Handook. TC-30 Vegetated Swale. Jan 2003.

NCDENR Stormwater BMP Manual, Chapter 14 Grass Swale, Chapter Revised 06-08-09