Greenville County Technical Specification for:

WQ-08 ENHANCED DRY SWALE

1.0 Enhanced Dry Swale

1.1 Description

An Enhanced Dry Swale is a shallow open-channel drainage way stabilized with turf grass or other vegetation used to convey stormwater runoff and filter pollutants. Use Enhanced Dry Swales in medians and drainage conveyance swales or ditches as an enhancement to vegetated swales. Enhanced Dry Swales are useful along roads that have driveway entrances crossing the swale. Enhanced Dry Swales may be used as a stand-alone practice or in series with other stormwater management practices as part of a treatment train. The maximum contributing drainage area for Enhanced Dry Swales is 5 acres.

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

1.2 Design

The required method to design an individual Enhanced Dry Swale or to design an Enhanced Dry Swale as part of a treatment train with other water quality BMPs is to use the Greenville County IDEAL Model to demonstrate overall site compliance with applicable County water quality standards. See County Design Manual for site-specific applicable water quality standards.

Typical Enhanced Dry Swales have a bottom width between 2 and 8 feet, a maximum ponding depth of 1.5 feet, and minimum filter media depth of 2 feet. In order to allow for proper pollutant removal, design for the ponded runoff above the Enhanced Dry Swale 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 swale surface within 48 hours. Design the underdrain system to safely pass the peak draw down flow rate of the filter media.

1.3 Materials

Enhanced Dry Swales 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 Enhanced Dry Swale flow path to promote settling and infiltration.

1.3.1 Underdrain System

Place an underdrain system beneath the filter media for **all** Enhanced Dry Swales as many of the native soils found in Greenville County do not allow for adequate infiltration. The perforated underdrain drain pipe must be connected to a stormwater conveyance system or discharge to a stabilized outlet that daylights (emerges from the ground and is open to the air).

In extreme situations where an underdrain is not feasible due to unique site constraints, infiltration rate must be a minimum 0.5 inches per hour, verified by site specific soil samples at the elevation of the bottom of the Enhanced Dry Swale where infiltration will occur.

Provide an underdrain system that consists of a continuous closed joint perforated plastic pipe underdrain with a minimum 4-inch diameter, a 6-inch minimum gravel filter layer, non-woven geotextile filter fabric to wrap the perforated pipe and separate the gravel layer from the native soils and the filter media, and minimum 4-inch diameter non-perforated PVC outlet pipe.

Underdrain systems will be made of materials specified in Table 1.

Table 1: Underdrain Material Specifications

Material	Specification
Aggregate	Use coarse Aggregate No. 57 or No. 5 consisting of crushed slag or gravel.
Pipe Underdrains	Use PVC perforated pipe (AASHTO M 252) underdrains with a minimum diameter of 4 inches.
Outlet Pipe	Use non-perforated PVC pipe with a minimum diameter of 4 inches.
Non-woven Geotextile Fabric	Use Class 2 Type C non-woven geotextile fabric.

1.3.2 Filter Media

The filter media provides a medium for physical filtration for the stormwater runoff with enough organic matter content to support growth and provide water and nutrients for plant life.

The filter media for Enhanced Dry Swales is a permeable layer that is a minimum of 2 feet deep. Provide a filter media with a minimum infiltration rate of 1 inch per hour (optimal range is 1 to 6 inches per hour). The filter media is to be furnished, and on-site soils are not acceptable. The filter media shall be a uniform mix of sand and organic material meeting the following criteria.

Sand

- 75% to 85% composition by weight
- Medium to coarse washed sand
- Washed river sand and concrete/masonry sand are acceptable
- Do not use lime stone screenings

Organic Material

- 15% to 25% composition by weight
- Compost material that is well decomposed, stable, and weed free
- Derived from leaves, yard debris, wood waste, food waste, or other organic materials
- Does not include manure or biosolids
- Do not use manure-based mushroom compost
- US Composting Council Seal of Testing Assurance (STA) compost is preferred

Acidity/Alkalinity (pH)

- Between 5.2 and 8.0 with an optimal range of 6.0 to 7.5
- Tested prior to installation with documentation to be provided to County
- Utilizing Clemson Extension Agricultural Service Laboratory is recommended. For more information, visit their website at https://www.clemson.edu/public/regulatory/ag-srvc-lab/soil-testing/index.html.

Should the filter media pH fall outside of the acceptable range, modify with pelletized lime (to raise pH) or iron sulfate plus sulfur (to lower pH). Uniformly mix lime or iron sulfate into the filter media prior to use in Enhanced Dry Swales.

The Engineer will submit the source and makeup of the filter media and the pH test results to the County prior to the start of construction of Enhanced Dry Swales. Do not add material to a stockpile of filter media once a stockpile has been sampled. Allow sufficient time for filter media preparation and testing. It is recommended that the Engineer or Contractor consult the County regarding the list of landscape suppliers with the acceptable material that are capable of providing pre-mixed filter media in order to reduce testing and mobilization time and construction delays.

Use a filter media that is uniform, free of stones, stumps, roots or other similar objects larger than 2 inches excluding mulch. Do not mix or dump materials or substances within Enhanced Dry Swales that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.

A filter media that fails to meet the minimum requirements must be amended or replaced.

1.3.3 Forebay

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

1.3.4 Outlet Structures

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

1.3.5 Overflows

For maximum performance, Enhanced Dry Swales are recommended to be off-line structures. If an Enhanced Dry Swale 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 Enhanced Dry Swales on sites where the contributing area is not completely stabilized or is periodically being disturbed.

Separate Enhanced Dry Swales from the water table to ensure groundwater does not enter the facility leading to groundwater contamination or Enhanced Dry Swale failure. Ensure a vertical distance of 2 feet

between the bottom of Enhanced Dry Swales and the seasonally high ground water table, to be verified by a geotechnical report if requested by the County.

1.4.2 Excavation

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

1.4.3 Underdrain System

Prior to placing the underdrain system, alleviated compaction on the bottom of the Enhanced Dry Swale 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 Engineer. 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 non-woven geotextile fabric.

Place a layer of No. 5 or No. 57 Aggregate a minimum of 2 inches deep on top of the non-woven filter fabric. Place the pipe underdrains on top of the underlying aggregate layer. Lay the underdrain pipe at a minimum 0.5% longitudinal slope. The perforated underdrain drain pipe may be connected to a stormwater conveyance system or stabilized outlet.

Place No. 5 or No. 57 Aggregate around the pipe underdrain system to a minimum depth of 6 inches. Place a Class 2, Type C non-woven 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

Install a permeable non-woven geotextile filter fabric between the filter media and the underlying on-site soils. Place and grade the filter media using low ground-contact pressure equipment or excavators and/or backhoes operating on the ground adjacent to the Enhanced Dry Swale. Do not use heavy equipment within the perimeter of the Enhanced Dry Swale 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 Enhanced Dry Swale 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.

The Engineer will provide documentation from the supplier to verify the makeup of the pre-mixed filter media to the County.

1.4.5 Enhanced Dry Swale Surface

Install Enhanced Dry Swales 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 Enhanced Dry Swale surface side slopes that are 4H:1V for ease of maintenance and for side inflow to remain as sheet flow. The maximum Enhanced Dry Swale surface side slopes are 2H:1V.

Install Enhanced Dry Swales with a minimal surface channel slope ranging from 1% to 2%, forcing a slow and shallow flow. This aspect of the Enhanced Dry Swale 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 Enhanced Dry Swale 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 Enhanced Dry Swale through a pretreatment forebay or it may enter along the sides of the swale as sheet flow produced by stone diaphragms or level spreaders (see WQ-13 Level Spreader) along the top of the bank.

1.4.6 Plantings

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

1.5 Inspection and Maintenance

Regular inspection and maintenance are critical to the effective operation of Enhanced Dry 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:

- 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.

Required maintenance activities and their frequencies are listed in Table 2.

Table 2: Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height and remove clippings.	As needed (frequent/seasonally)
Test filter media for nutrient/fertilizer requirements.	Annual
Nutrient management per soil test results.	As needed
Pesticide management.	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)
Test filter media for pH.	Annual
Apply pelletized lime if pH < 5.2.	As needed
Add iron sulfate + sulfur if pH > 8.0.	As needed
Inspect for clogging and correct the problem	Annual
Roto-till or cultivate the surface of the bed when the Enhanced Dry Swale does not draw down in 48 hours.	As needed
Remove sediment build-up within the bottom of the Enhanced Dry Swale.	As needed, after 25% of the original design volume has filled.

1.6 IDEAL Modeling

The County's required method of demonstrating compliance with its water quality standards is to use the Greenville County IDEAL model. To facilitate use of this model, Table 3 and Table 4 show how to represent this BMP and BMPs similar to this one in the IDEAL model. They list the parameters needed to successfully run the model and the parameters that affect the sediment trapping efficiency of the BMP.

For the Enhanced Dry Swale, IDEAL's Enhanced Bioswale BMP will not precisely match the above specifications because the Enhanced Bioswale in IDEAL does not include an underdrain or engineered filter media. If an underdrain or engineered filter media are not being used in the design, then the designer should use Table 3 to model as an Enhanced Bioswale. However, if it is desired that the engineered media and underdrain be represented in IDEAL, a Bioretention Cell will be more appropriate, and the designer should use Table 4 to model as a Bioretention Cell.

Table 3: IDEAL Modeling Guide- Enhanced Bioswale

Enhanced Dry Swale Modeling in IDEAL as Enhanced Bioswale		
What to Model as in IDEAL	Enhanced Bioswale- Does not include media or underdrain.	
Similar BMPs	Enhanced Grass Swales	
	Enhanced Dry/Wet Swales	
Specifications Needed for IDEAL	Type, dimensions, slopes, and % peak flow for routing of the channel	
	Soil texture and degree of saturation of the soil	
	Check dam height, rock diameter, and longitudinal spacing of dams	
	Direct loading of bacteria that will be entering the swale	
Parameters that Drive Performance	Feature	How Value Affects Sediment Trapping Efficiency (TE)
	Underlying Soil Texture	Soils with higher infiltration capabilities increase TE
	Channel Slope	Most of the time, increasing slope decreases TE
	Channel Length	Increasing length increases TE
	Trapezoidal Side Slope	Flatter side slope increases TE
	Dam Spacing	Increasing dam spacing decreases TE

Table 4: IDEAL Modeling Guide- Bioretention Cell

Enhanced Dry Swale Modeling in IDEAL as Bioretention Cell		
What to Model as in IDEAL	Bioretention Cell- Includes filter media and underdrain system.	
Similar BMPs	Stormwater Alley	
	Green Roofs	
	Planter Box	
	Rain Gardens	
	Natural Infiltration Area/Basin	
	Bioretention Area/Swale/Basin	
Specifications Needed for IDEAL	Cell area and number of layers within the cell	
	If applicable, underdrain details such as: - Subgrade infiltration soil texture and degree of saturation - Underdrain orifice diameter	
	Type of media and depth of each layer of the cell	
	Shape and dimensions of the riser	
	Dimensions, slope, Manning's roughness coefficient, and entrance loss coefficient of the barrel	
	Type, shape, and dimensions of the emergency spillway if present	
	Direct loading of bacteria that will be entering the cell	
Parameters that Drive Performance	Feature	How Value Affects Sediment Trapping Efficiency (TE)
	Underlying Soil Texture	Soils with higher infiltration capabilities increase TE
	Area	Increasing area increases TE
	Amount of Clay in Media	More clay increases TE but decreases infiltration rate