WQ-01 DRY DETENTION BASIN

1.0 Dry Detention Basin

1.1 Description

A Dry Detention Basin does not maintain a permanent pool and is intended to manage both the quantity and quality of stormwater runoff before discharging off-site. Stormwater runoff enters a Dry Detention Basin through one or more inlets that discharge into a Forebay that is designed to settle out larger sediment. The runoff then passes over a forebay berm and into the main Dry Detention Basin. From the main basin, runoff exits the basin through the principal spillway. In the case of extreme rainfall events, an emergency spillway is included in the design in order to safely pass high flow rates.

1.2 Design

In addition to the design requirements of this Specification, follow all design requirements in Chapter 7 of the Greenville County Stormwater Management Design Manual.

1.2.1 Converting Sediment Basins to Dry Detention Basins (Multipurpose Basins)

Sediment basins that are used during construction can be converted into permanent Dry Detention Basins when the construction phase ends. If used during construction as a sediment basin, completely clean out the basin, remove deposited sediment, re-grade the contours as needed, make necessary modifications to the emergency spillway, and vegetate with permanent vegetation in accordance with ***Chapter 7, Section 7.2.3.4*** of the Stormwater Management Design Manual.

1.2.2 Site Selection

Ensure the seasonally high groundwater table is at least 2 feet below the bottom of the basin. Less separation distance makes the dry extended detention basin vulnerable to developing ephemeral pools of standing water during wet-weather periods. If the 2-foot minimum separation distance cannot be met, consider the design of a stormwater wetland or wet detention basin.

1.2.3 Safety

Follow the safety design criteria such as those outlined by the USDA Soil Conservation Service (previously the Natural Resources Conservation Service), U.S. Army Corps of Engineers, and the Safe Dams Act. A dam is defined as being an artificial barrier that impounds water to a depth of 15- feet or greater and has a maximum storage volume of 10-acre-feet or greater; therefore, impoundment depths greater than 15-feet are subject to the requirements of the Safe Dams Act unless the facility is excavated. Several exemptions are allowed from the Safe Dams Act and any questions concerning specific design application should be addressed by SCDHEC.

Incorporate all possible safety precautions such as signs and fencing for permanent dry basins that are readily accessible to populated areas. Ensure the inside pond slopes are no steeper than 3H:1V where applicable. A safety fence or vegetative barrier is required where the interior side slopes are steeper than 3H:1V or when the impoundment is a wall greater than 24 inches in height. If the wall is adjacent to a walkway or street a railing may be required instead of a fence.

1.2.4 Basin Geometry

The volume of a Dry Detention Basin is driven exclusively by the volume of stormwater that is required to be captured. Once that volume is calculated, the dimensional aspect of the basin is mostly site driven. Utilize the following dimensional and layout requirements:

- The maximum depth is 10 feet without requiring a Geotechnical slope stability analysis.
- The Dry Basin bottom has an optimal slope of 2%.
- Ensure there are no depressions in a dry detention facility where water might pocket after the water level has receded.
- Dry detention systems and swales are designed to drain within three (3) days.
- Maximum WSE for the 25-year storm event is below the emergency spillway with a minimum 0.5-ft of freeboard between maximum WSE for the 25-year storm and the emergency spillway.
- The minimum flow length to width ratio is 2:1, but 3:1 is recommended. The basin width preferably expands as it approaches the outlet.
- Side slopes of the basin are no steeper than 3H:1V if stabilized by vegetation.
- Direct the discharge from the basin to a stable channel or outlet.

In addition to detention volume, the design must provide for sediment storage equal to 25 percent of detention volume. Provide additional sediment storage if the upstream drainage basin will contribute high sediment loads over several years.

Minimize flow short-circuiting as it causes turbulence and eddies in the flow, and can interfere with the function of the basin outlet system. The most direct way of minimizing short-circuiting is to maximize the distance between the riser and the inlet(s). Provide larger length to width ratios if sedimentation of particulates during low flows is desirable. Irregularly shaped basins appear more natural. If a relatively long, narrow facility is not suitable at a given site, baffles constructed from gabions or other materials can be placed in the basin to lengthen the flow length.

1.2.5 Flow Length

For maximum Dry Detention Basin water quality benefits, the optimal ratio of flow length to flow width is 3L:1W. Due to site constraints, the minimum allowable design ratio of flow length to flow width is 2L:1W. To increase the basin flow length to flow width ratio, the basin may be design with baffles.

Optimizing the dry basin flow shape and flow distance through the basin promotes better water quality treatment. Settling is the primary pollutant removal mechanism sought when addressing flow length as a water quality design feature. Dry Detention Basins designed with optimum flow lengths avoid the problem of dead storage or incoming runoff short circuiting through the basin. Optimum flow lengths decrease the turbulence within the basin and minimize the re-suspension of deposited sediments.

Design Dry Detention Basins with a wedge-shaped (when practicable), with the widest cross sections occurring at the downstream end of the basin.

1.2.6 Dry Basin Bottom Requirements

Grade the Dry Detention Basin bottom towards the outlet structure to prevent standing water conditions and stabilize to prevent scour. A minimum 2 percent bottom slope is recommended for both cross slope and longitudinal slope. If the 2% grade cannot be obtained an acceptable alternative is to install an under drain. Install the under drain in the following manner:

- The under drain is one of the last items installed to eliminate any sediment build-up causing the under drain to not function properly.
- Install a non-woven geotextile fabric in the excavated trench first.
- Install a perforated drain pipe covered with washed stone.
- Wrap both the stone and perforated drain pipe with the non-woven geotextile and backfill with sandy porous material.

1.2.7 Low Flow Channel

Low flow channels may be used for dry basins in areas with low permeable soils. Install a low flow channel to prevent standing water conditions when the pond bottom may be subject to non-storm flow from groundwater, footing drainage, storm sewer acting as under drain and sump discharge. Stabilize the low flow channel using Class B riprap with an underlying filter fabric, a TRM, or concrete. The upstream side of the low flow channel starts downstream of the forebay and extends to the outlet structure. Low flow channels are not recommended for basins with highly permeable soils.

1.2.8 Basin Dewatering

Use a low flow orifice or dewatering device to slowly release the water quality volume over a period of 24-72 hours depending upon the design criteria for the water quality structure. Dry basins with slow release rates for water quality control require a small orifice at the bottom of the outlet control structure with a minimum size of 2-inches. These structures are prone to becoming clogged. Ensure the low flow orifice is protected from clogging by designing appropriate trash guards. Acceptable low flow or dewatering methods include orifices with trash boxes made of sturdy wire mesh or Floating Skimmers.

1.2.9 Forebay

The function of the forebay is to trap the majority of the coarse fractions of the suspended solids in the runoff before it enters the main dry detention area.

When sizing Dry Detention Basins to capture 85% of TSS based on annual loading, the Forebay will include approximately 75 percent of the required sediment storage volume based on a minimum cleanout cycle of 5 years.

When designing the basin to capture the first inch of runoff from impervious areas (water quality treatment volume), the forebay volume (or combined volume of forebays) is equal to a minimum of 10% of the overall water quality treatment volume. Each Forebay is sized according to the outlets contribution to the basin. Provide a forebay for all inlets to a Dry Detention Basin and place forebays upstream of the main dry detention area. A forebay is not required for an outlet that contributes less than 10% of the total drainage area or to the basin.

Design forebay side slopes to be 2H:1V or flatter.

The forebay is separated from the larger Dry Detention Basin area by berms, barriers, or baffles that may be constructed of earth, stones, riprap, gabions, or geotextiles. The berm, barrier, or baffles act as a trap for coarse sediments and minimize their movement into the main detention basin.

Design the Forebay in a manner that it is accessible for easy cleanout because it will eventually fill in with coarse particles. Design the access to the Forebay with a maximum slope of 15-20 percent extending from the top of the embankment to the toe.

1.2.10 Principal Spillway

Design the principal spillway to safely pass, at a minimum, the 10-year, and 25-year 24-hour storm event. Design the principal spillway with a trash rack to control clogging by debris and to provide safety to the public. Ensure the riser is installed with anti-floatation measures to prevent the riser floating. Ensure location of spillway is in accordance with ***Chapter 7, Section 7.2.3.4*** of the Stomwater Management Design Manual.

1.2.11 Emergency Spillway

Design emergency spillways to safely pass the post development 100-year, 24-hour storm event without overtopping any dam structures. The maximum WSE for the 100-year, 24-hour storm event is below the top of dam with 1 foot freeboard between WSE and the top of dam. Ensure location of spillway is in accordance with ***Chapter 7, Section 7.2.3.4*** of the Stormwater Management Design Manual.

1.3 Installation

Perform the following for Dry Detention Basin installation requirements:

1. Route all channels and pipes conveying flow to the basin will away from the basin area until the basin is complete and stabilized.
2. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter, and stockpile or dispose of it properly. Remove all unused fill material to the designated disposal area.
3. Ensure that fill material for the embankment is free of roots, woody vegetation, organic matter, and other objectionable material. Place the fill in lifts not to exceed 9 inches, and machine compact it. Over fill the embankment 6 inches to allow for settlement.
4. Install inlet and outlet control structures. Ensure principal spillway and emergency spillway installed to proper elevations as specified in the engineering drawings.
5. Grade the basin with a slope of 2% towards the outlet structure to ensure basin dewatering.
6. Install forebay and erosion control at basin inlets/outlets.
7. Stabilize all berms and embankment in accordance with Greenville County Technical Specification EC-03 Seeding/Stabilization and ensure planted vegetation meets requirements in ***Chapter 7, Section 7.2.3.4*** of the Stormwater Management Design Manual.
8. Route flow from contributing watershed to the Dry Detention Basin as shown in the engineering drawings.
9. Follow required maintenance guidelines.

1.4 Maintenance

Proper maintenance ensures the continued functionality of the Dry Detention Basin. Tables 1, 2 and 3 outline the various maintenance requirements after the installation of a Dry Detention Basin.

Table 1: Summary of Maintenance Requirements

Required Maintenance	Frequency
Clean and remove debris from inlet and outlet structures.	After large storm events
Mow side slopes	As needed
Removal of invasive vegetation	Semi-annual
Inspect for damage to outlet control structure	Annual
Inspect for operational inlet and outlet structures	Annual
Repair embankment, side slopes, undercut or eroded areas	Annual, or as needed
Remove sediment from the forebay	Per design cycle (Minimum 5 year maintenance), after 50% of total forebay capacity is filled
Remove sediment accumulations the main permanent pool	Per design cycle, (Minimum 5 year maintenance) after 25% of permanent pool volume is filled

Table 2: Summary of Maintenance Requirements

BMP Component	Maintenance	Frequency
Basin banks	Pruning and weeding.	As required
	Remove trash and debris.	As required
	Repair eroded areas, replant grass. If recurring problem, consider sodding.	Semi-Annual (every 6 months)
	Inspect trees and shrubs to evaluate their health.	Annually
Outlet structure	Clean out outlet of all debris	Semi-Annually (every 6 months)
	Check if bank needs stabilization downstream of outlet.	Semi-Annually (every 6 months)

Table 3: Summary of Trouble Shooting Activities

BMP Component	Problem	Solution
Entire detention basin	Trash/debris is present.	Remove the trash/debris.
Perimeter	Areas of bare soil and/or erosion	Re-grade the area as necessary, plant vegetation, and water until established.
Inlet device: pipe or swale	Pipe is clogged.	Unclog the pipe. Dispose of sediment properly.
	Pipe is cracked or damaged.	Replace the pipe.
	Erosion is occurring	Re-grade as necessary to smooth and provide additional erosion protection as needed such as erosion control blankets and turf reinforcement matting to prevent future erosion problems.
Forebay	Sediment has accumulated and reduced the depth to 50% of the original design depth.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a proper location.
	Erosion has occurred or riprap is displaced.	Provide additional erosion protection such as turf reinforcement matting or riprap if needed to prevent future erosion problems.
	Weeds are present.	Remove the weeds, preferably by hand. If pesticides are used, wipe them on the plants rather than spraying.
Main treatment area	Sediment has accumulated to a depth greater than the original design sediment storage depth.	Search for source of sediment and remedy the problem if possible. Remove sediment and dispose of properly. Re-vegetate disturbed areas immediately with sod (preferred) or seed protected with erosion blankets.
	Pruning is needed to maintain optimal plant health.	Prune according to best professional practices
	Plants are dead, diseased or dying.	Determine the source of the problem: soils, hydrology, disease, etc. Remedy the problem and replace plants. Provide a one-time fertilizer application to establish the ground cover if a soil test indicates it is necessary.
	Weeds and noxious plants are growing in the main treatment area.	Remove the plants by hand or by wiping them with pesticide (do not spray).

Embankment	Shrubs or trees have started to grow on the embankment.	Remove shrubs or trees immediately.
	Grass cover is unhealthy or eroding.	Restore the health of the grass cover – consult a professional if necessary.
	Signs of seepage on the downstream face.	Consult a professional.
	Evidence of muskrat or beaver activity is present.	Use traps to remove muskrats and consult a professional to remove beavers.
	An annual inspection shows that the embankment needs repair.	Make all needed repairs.
Outlet structure	Clogging has occurred.	Clean out the outlet device. Dispose of the sediment off-site.
	The outlet device is damaged	Repair or replace the outlet device.

1.6 IDEAL Modeling

The County's preferred method of demonstrating compliance with its water quality standard is to use the IDEAL model. To facilitate use of this model, the table below shows how to represent this BMP and BMPs similar to this one in the IDEAL model. It lists the parameters needed to successfully run the model and the parameters that affect the trapping efficiency of the BMP.

Table 4: IDEAL Modeling Guide

Dry Detention Pond Modeling in IDEAL		
What to Model as in IDEAL	Dry Detention Pond	
Similar BMPs	Micropool Extended Detention Pond	
	Dry Detention/Extended Basin	
	Underground Detention Facility	
Specifications Needed for IDEAL	Soil texture and degree of saturation of the soil underlying the pond	
	At least 3 area measurements at varying stages of the pond	
	Type, shape, and size of the emergency spillway if applicable	
	Riser type, shape, and dimensions	
	Number of orifices with corresponding inverts and sizes	
	Size, slope, Manning's roughness coefficient, entrance loss coefficient, and invert height of the barrel	
	Direct loading of bacteria that will be entering the pond	
Parameters that Drive Performance	Feature	How Value Affects Sediment Trapping Efficiency (TE)
	Underlying Soil Texture	Soils with higher infiltration capabilities increase TE
	Surface Area	Increasing surface area increases TE
	Bottom Area	Increasing bottom area increases infiltration and TE

1.7 References

Knox County Tennessee Stormwater Management Manual. 4.3.3 Dry Extended Detention Ponds, Chapter 4 Vol. 2.

NCDENR Stormwater BMP Manual, Chapter 10 Wet Detention Basin, Chapter Revised 06-16-09

Virginia Department of Conservation and Recreation. Extended – Detention Basin & Enhanced Extended Detention, Basin Chapter 3