WQ-02 WET DETENTION BASIN

1.0 Wet Detention Basin

1.1 Description

A Wet Detention Basin is intended to manage both the quantity and quality of stormwater runoff before discharging off-site. The minimum drainage area for Wet Detention Basins ranges from 10-25 acres, depending on the specific wet detention application.

Stormwater runoff enters a Wet 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 Wet Detention Basin, becoming part of a combined temporary and permanent storage. The temporary water quality storage volume drains from the Wet Detention Basin over a period of 24-hours. Permanent storage remains in the Wet Detention Basin, where natural processes facilitate both settling and nutrient reduction of the water contained within the Wet Detention Basin.

Wet Detention Basins are applicable where larger developments in a watershed substantially modify the hydrology and pollutant loading of a watershed. Because Wet Detention Basins are area-intensive, their use in drainage areas smaller than 10 acres is not recommended. Applicable sites include:

- Large single family developments,
- Industrial facilities, and
- Large commercial facilities.

Wet Detention Basins are capable of removing metals, suspended solids, nitrogen and phosphorous, and other nutrients. Wet Detention Basins may also be used for water quantity control. The tendency of Wet Detention Basins to attract waterfowl has the potential for higher fecal coliform counts and may not be applicable in watersheds with fecal impairments. Wet Detention Basins also have the potential to raise the temperature of a receiving stream, and may not be applicable in watersheds with biota susceptible to thermal pollution.

Wet Detention Basins are classified as being one of the following:

1. Wet Detention Basin.
2. Wet Extended Basin.
3. Micropool Extended Basin.

1.2 Design

The preferred method to size Wet Detention Basins is to trap 85% of TSS based on annual loadings (The Greenville County IDEAL Model or another model such as the USEPA overflow model may be used to design Wet Detention Basins to meet this criteria). In addition to the design requirements of this Specification, follow design requirements in Chapter 7 of the Greenville County Stormwater Management Design Manual.

An alternative to size Wet Detention Basins, as a default criteria, is to capture the first 1-inch of runoff from the impervious area of the site and discharge it over a 24-hour period.

The design of a Wet Detention Basin can be divided into three components of volume:

1. Forebay volume,
2. Permanent pool volume, and

3. Temporary water quality pool volume.

1.2.1 Flow Length

For maximum Wet 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 1.5L:1W. To increase the Wet Detention Basin's flow length to flow width ratio, the basin may be design with baffles.

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

Design Wet Detention Basins with a wedge-shaped (when practicable), with the widest cross sections occurring at the downstream end of the basin. Design the deepest pools at the downstream end of the basins to help facilitate cooler effluent water temperatures.

1.2.2 Permanent Pool Volume

The following are suggested permanent pool volumes to aid designers, but are not required. Pool volume should be sufficient for necessary water quantity and quality purposes:

Wet Detention Basins, Wet Detention Basins have a permanent (dead storage) pool of water. The water quality volume is stored above the permanent pool and released over 24-hours. *The optimum drainage area for a Wet Detention Basin is **25 acres or more**.*

Design the permanent pool volume equal to **1-inch of runoff** from the impervious area on site.

Wet Extended Basins with Aquatic Bench, A Wet Extended Basin has an aquatic bench where the water quality volume is split between the permanent pool and extended detention storage provided above the permanent pool. The water quality volume is stored above the permanent pool and released over 24-hours. The design has similar pollutant removal efficiencies as traditional wet basins, but consumes less space. *The optimum drainage area for a Wet Extended Basin is 25 acres or more.*

Design the permanent pool volume equal to **½-inch of runoff** from the impervious area on site.

Micropool Extended Basins, The micropool extended basin is a variation of the wet extended detention basin where only a small "micropool" is maintained at the outlet to the pond. The outlet structure is designed to detain the water quality volume for 24-hours. The micropool prevents re-suspension of previously settled sediments and prevents clogging of the low flow orifice. *The minimum drainage area for a micropool pond is 10 acres.*

Design the permanent pool volume equal to **0.1-inch of runoff** from the drainage area.

The following are requirements for permanent pools in Wet Detention Basins:

- Design the permanent pool with an optimal depth between 4 and 6 feet, with a minimum depth of 4 feet and a maximum depth of 12 feet. The depth of the permanent pool prevents particles that have settled to the Basin bottom from re-suspending when runoff enters the Basin.
- Ensure the bottom of the basin is located at least 2 feet from the seasonally high water table.
- Permanent pools may be difficult to maintain if the contributing watershed is less than 10 acres, and if the ratio of drainage area to wet pond surface area is less than 6:1.
- The minimum required watershed area depends on infiltration rates of the soil within the Wet Detention Basins.

1.2.3 Temporary Water Quality Pool Volume

The preferred method to size the Temporary Water Quality Pool Volume is to trap 85% of TSS based on annual loadings (The Greenville County IDEAL Model or another model such as the USEPA overflow model may be used to design Wet Detention Basins to meet this criteria).

1.2.4 Wet Extended Basin Aquatic Bench

Aquatic vegetation plays an important role in pollutant removal in a Wet Extended Basin. Vegetation enhances the appearance of the Wet Extended Basin and stabilizes side slopes. To facilitate nutrient removal by emergent wetland vegetation, design a planted littoral shelf 5-15 feet wide around the permanent pool where 6 to 18 inches of the permanent pool is maintained over the littoral shelf to promote the growth of emergent wetland vegetation. Plant a minimum of 3 types of indigenous emergent wetland species at a minimum density of 50 plants per 200 square feet. The selection of the proper plant species and planting locations is an integral part in designing a successful aquatic bench in the Wet Extended Basin. Prepare a planting plan by a qualified landscape architect or wetland ecologist for the aquatic bench. Recommended aquatic vegetation for the aquatic bench is provided below. Shallow water vegetation species are capable of surviving in depth of water ranging from 1 foot deep to the top of the permanent pool. These species are the primary emergent vegetation found in wet stormwater detention ponds and constructed vegetated wetlands.

Vegetation Common Name		
Alligator Flag	Lance -leaf Arrowhead	Swamp Hibiscus
Arrow Arum	Lizard's Tail	Swamp Lily
Caric Sedge	Louisiana Iris	Swamp Rose
Coastal Spikerush	Pickerelweed	Swamp Sunflower
Duck Potato	Pond Cyprus	Sweetflag
Flat Sedge	Rice Cutgrass	Switchgrass
Giant Bulrush	Soft Rush	Tickseed
Golden Canna	Softstem Bulrush	Three-square
Green Arum	Southern Blue-Flag Iris	Virginia Chain Fern
Jointed Spikerush	Smartweed	Wool Grass

Ensure vegetation near the basin meets requirements in ***Chapter 7, Section 7.2.3.4*** of the Stomwater Management Design Manual.

1.2.5 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 wet detention area, therefore allowing the main pond to maintain its original design volume

When sizing Wet 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 Wet Detention Basin and place forebays upstream of the main wet 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 Wet 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. The forebay berm may incorporate drain pipe or be constructed of riprap to facilitate equalization of the pond over time.

Design the top of the forebay barrier a maximum of 1-foot below the permanent pool elevation, and it may extend above the elevation of the permanent pool.

Design the forebay depth, as measured from the maximum water quality event surface level, between 4 and 6 feet. To minimize the re-suspension of settled particles, design the minimum permanent pool depth of water in the forebay 3-feet above the design sediment storage elevation.

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

1.2.6 Principal Spillway

Design the principal spillway to safely pass, at a minimum, 10-year and 25-year, 24-hour storm event. Design the principal spillway with a trash rack and anti-vortex device.

1.2.7 Low Flow Orifice

Use a low flow orifice to slowly release the water quality volume over a period of 24-hours or longer depending upon the design criteria for the water quality structure. Wet basins with slow release rates for water quality control require small outlet control structures. These structures are prone to becoming clogged. Ensure the low flow orifice is protected from clogging by designing appropriate trash guards. Acceptable trash guards include:

- Floating Skimmers
- Hoods that extend at least 6-inches below the permanent pool water surface elevation.
- Reverse flow pipes where the outlet structure inlet is located below the permanent pool water surface elevation.
- Trash boxes made of sturdy wire mesh.

1.2.8 Emergency Spillway

Design emergency spillways to safely pass the post development 100-year, 24-hour storm event without overtopping any dam structures. Design the 100-year water surface elevation a minimum of 1 foot below the top of the dam embankment

1.3 Other Design Requirements

Perform an infiltration test on the Wet Detention Basin bottom determined from site specific soil boring samples. If the infiltration rate exceeds 0.01in/hour, a liner or clay pack is required.

A level spreader may be installed at the Wet Detention Basin outlet structure to prevent destabilization of the receiving water body. The installation of a 30 foot wide filter strip beyond the level spreader is recommended.

1.4 Installation

Perform the follow for all Wet Detention Basin installations:

1. Route all channels and pipes conveying flow to the basin 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 so that the bottom is level front to back and side to side and prepare subsoil.
6. Apply and grade planting soil for wet extended aquatic bench.
7. Install forebay and erosion control at pond inlets/outlets
8. Seed, plant and mulch the embankments and the wet extended aquatic bench
9. Route flow from contributing watershed to the basin as shown in the engineering drawings.
10. Follow required maintenance guidelines.

1.5 Maintenance

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

Table 1: Summary of General 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 sediment accumulation in the basin and forebay	Annual
Inspect for operational inlet and outlet structures	Annual
Repair embankment, side slopes, undercut or eroded areas	Annual, or as needed
Perform wetland plant management and harvesting	Annual
Pesticide/ Nutrient management	Annual, or as Needed
Remove sediment from the forebay	Per design cycle (typical 5-10 year maintenance), after 50% of total forebay capacity is filled
Remove sediment accumulations the main permanent pool	Per design cycle, (typical 5-10 year maintenance) after 25% of permanent pool volume is filled

Table 2: Summary of Maintenance Requirements for Individual Features

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
Littoral Shelf	Survey the plant species, if monoculture developing, take appropriate action.	Annually
	Remove and replace dead or severely diseased vegetation.	Annually
	Removal of invasive vegetation.	Semi-Annual (every 6 months)
Permanent pool	Remove sediment when accumulated sediment reaches 20-25% volume or every 5-15 years.	As required
	Apply algaecide	When algal growth > 50% pond surface.
Forebay	Remove sediment when accumulated sediment reaches 25-50% volume	As required
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
Wet 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 on the embankment.	Ensure vegetation is in Accordance with Design Manual Section 7.2.4.3

	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.
	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

Wet Detention Pond Modeling in IDEAL		
What to Model as in IDEAL	Wet Detention Pond	
Similar BMPs	Retention or Irrigation Ponds	
	Extended Detention Wetland	
	Shallow Marsh Wetlands	
	Pond/Wetland System	
	Multiple Pond System	
	Wet Stormwater Detention/Extended Basins	
Specifications Needed for IDEAL	Soil texture and degree of saturation of the soil within 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

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