WQ-2: WET DETENTION BASINS

1.0 Wet Detention Basins

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 ponds 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:

Wet Detention Basin. 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**.*

Wet Extended Basin. A wet extended basin is a wet basin with an Aquatic Bench where the water quality volume is split evenly 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. This basin has the potential to have greater pollutant removal efficiencies for Nitrogen and Phosphorus and may be required for nutrient impaired water bodies. The *optimum drainage area for a wet extended basin is **25 acres or more***.

Micropool Extended Basin. The micropool extended basin is a variation of the wet extended detention basin where only a "micropool" is maintained at the outlet to the pond. The outlet structure is designed to detain the water quality volume as extended detention 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** and the maximum drainage area is **25 acres**.*

1.2 Design

The design of a wet detention basin can be divided into three components of volume: forebay volume, permanent pool volume, and temporary water quality pool volume. Refer to Figures 1 and 2 are schematic and plan views of a properly oriented wet detention pond.

Figure 1: Schematic of a Wet Detention Basin

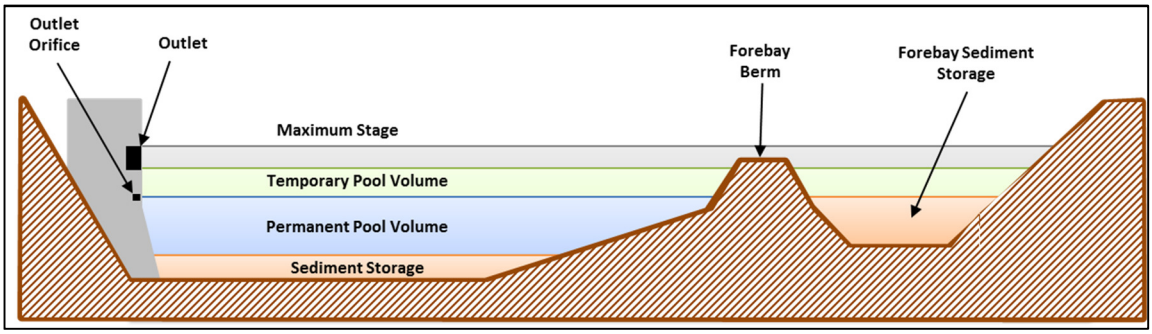
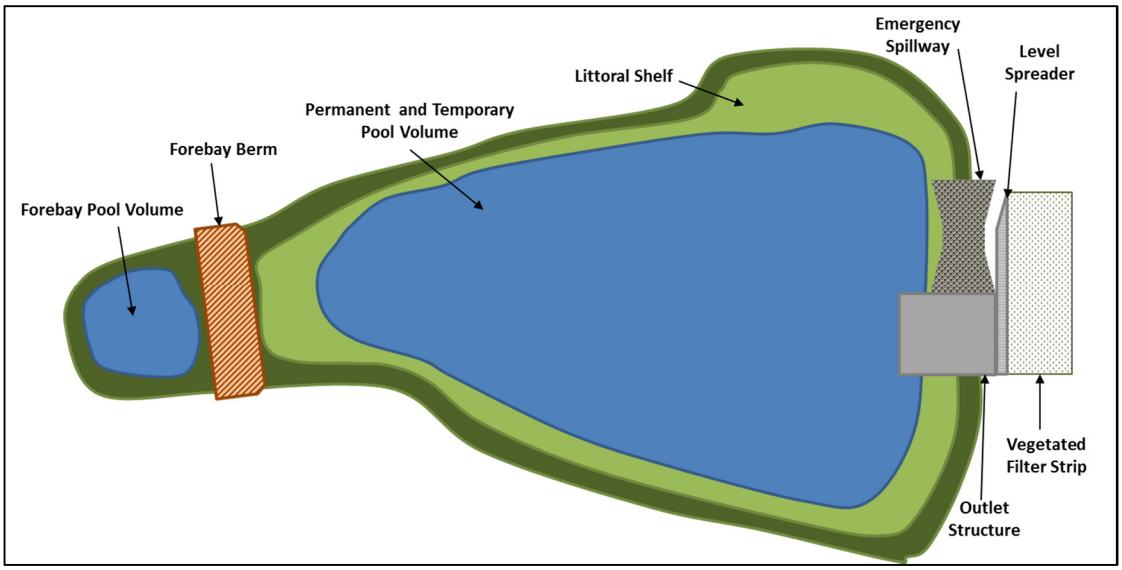


Figure 2: Plan View of a Wet Detention Basin



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 pond's flow length to flow width ratio, the basin may be design with baffles.

Optimizing the wet 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 will avoid the problem of dead storage or incoming runoff short circuiting through the pond. Optimum flow lengths will 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

A wet detention basin is designed to meet an 80% target TSS removal efficiency. This is accomplished by providing the following minimum Permanent Pool Volumes:

Wet Detention Basins, design the minimum permanent pool volume equal to **1-inch of runoff** from the drainage area.

Wet Extended Basins with Aquatic Bench, design the minimum permanent pool volume equal to **½-inch of runoff** from the drainage area.

Micropool Extended Basins, design the minimum permanent pool volume equal to **0.1-inch of runoff** from the drainage area.

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. Ensure the bottom of the basin is located at least 2 feet from the seasonally high water table.

1.2.3 Temporary Water Quality Pool Volume

The temporary water quality volume is **½-inch of runoff from the drainage area**. Each wet detention basin must be able to hold the water quality volume above the permanent pool and release this volume over a 24-hour period. This is achieved through an outlet orifice or other flow control device.

1.2.4 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 ponds 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:

- Trash boxes made of sturdy wire mesh that cover the low flow orifice.
- 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.
- ***Hoods or Reverse flow pipes are required for wet extended basins and micropool extended basins.***

1.2.5 Aquatic Vegetation

Aquatic vegetation plays an important role in pollutant removal in a wet extended basins and micropool extended basins. Vegetation enhances the appearance of wet extended basins and micropool extended basins and stabilizes side slopes.

1.2.5.1 Wet Extended Basin Aquatic Bench

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.

Do not plant woody vegetation on the embankment or within 100 feet of the toe of the embankment or 25 feet from the principal spillway structure.

Ensure a maintenance plan is established for maintaining the aquatic vegetation.

1.2.5.2 Micropool Extended Basin Aquatic Vegetation

To facilitate nutrient removal by emergent wetland vegetation, design a planted littoral shelf 5-10 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.

Plant the main extended detention area of micropool basins with 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.

The selection of the proper plant species and planting locations is an integral part in designing a successful micropool extended basin. Prepare a planting plan by a qualified landscape architect or wetland ecologist for the aquatic vegetation.

Do not plant woody vegetation on the embankment or within 100 feet of the toe of the embankment or 25 feet from the principal spillway structure.

Ensure a maintenance plan is established for maintaining the aquatic vegetation.

1.2.6 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

Design the Forebay volume (or combined volume of Forebays) equal to a minimum of 10% of the overall water quality treatment volume. Each Forebay is sized according to the corresponding outlet's 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 so approximately 75 percent of the required sediment storage volume is allocated to the Forebay.

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

1.2.7 Principal Spillway

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

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

If the underlying soil is Hydrologic Soil Group A, B, or C, perform an infiltration test on the wet detention basin bottom must. 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

1.5.1 Aquatic Vegetation Maintenance

Maintain a minimum cover of 85 percent cover of the emergent vegetation. Perform annual vegetation harvesting to increase the nutrient removal efficiencies. Perform harvesting in the summer so that there is

adequate regrowth before winter. Ensure minimal pond disturbance, especially to bottom sediments, during harvesting.

Aquatic shelves can become overgrown with invasive plants. The most common invasive plant is the Cattail (Typha species). Cattails crowd out other, more desirable plants. Other unwanted plant species include common reed (Phragmites species), various noxious floating aquatics (such as parrot feather, Myriophyllum aquaticum, and giant salvinia, Salvina spp.), and Asiatic dayflower (Murdannia keisak).. Noxious floating aquatics may require careful chemical or physical removal. If these exotic invasive species are present, contact the County Extension agent. The frequency of required invasive plant removal varies based on several factors including:

- the density at which the wetland is planted with desirable species,
- the time of year the wetland is planted, and
- the maturity of the wetland.

During the first year or two after establishment, remove invasives twice a year. As the desirable species begin to dominate, reduce the maintenance frequency to once a year.

1.5.2 General 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 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

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 evasive 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

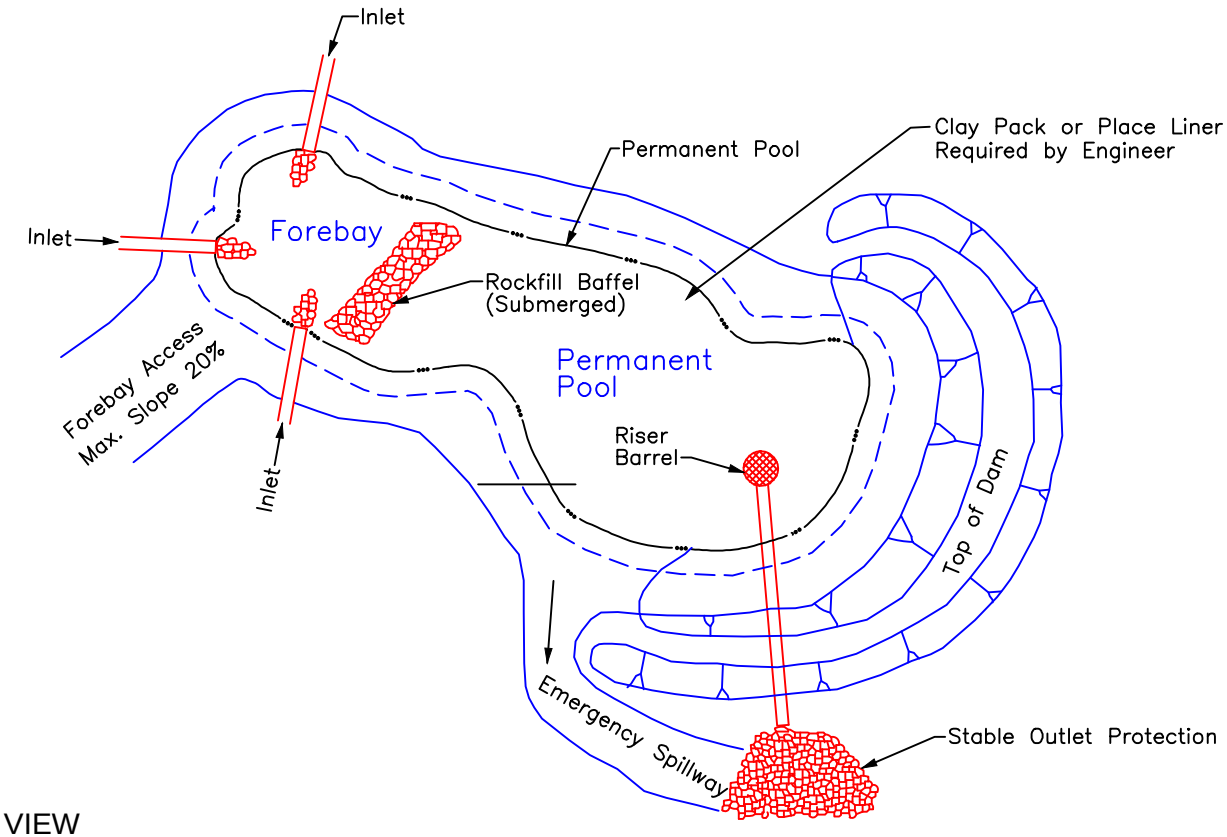
Component	Problem	Solution
Entire wet detention basin	Trash/debris is present.	Remove the trash/debris.
Perimeter	Areas of bare soil and/or erosion	Re-grade the area as necessary, plant vegetation, and water until established.
Inlet device: pipe or swale	Pipe is clogged.	Unclog the pipe. Dispose of sediment 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 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.

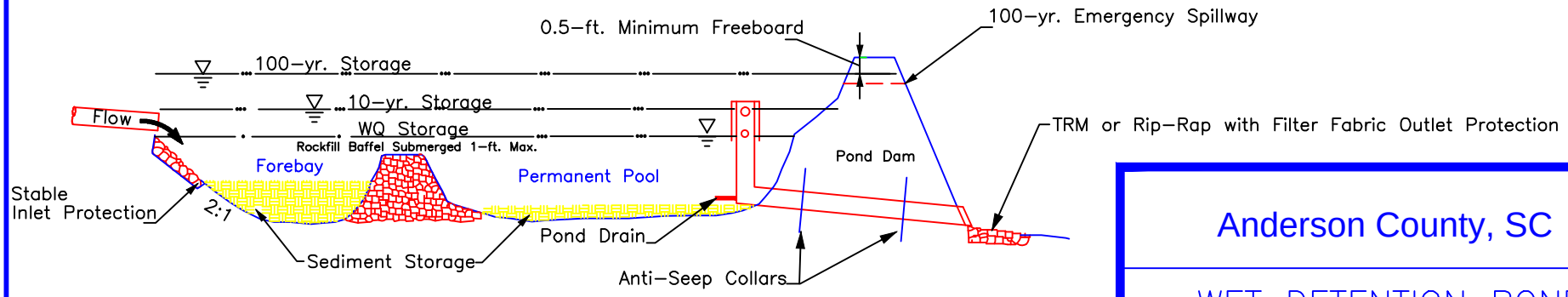
1.6 References

2010 Greenville County Storm Water Management Design Manual.

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



PLAN VIEW



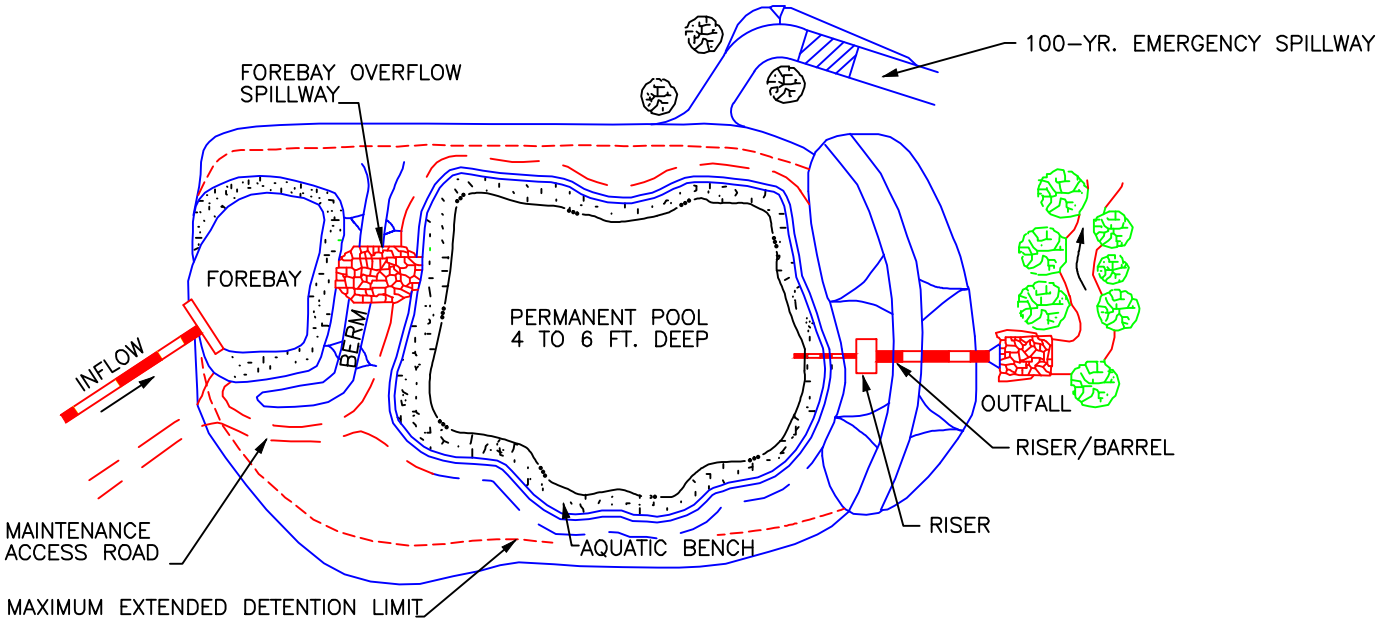
PROFILE

Anderson County, SC

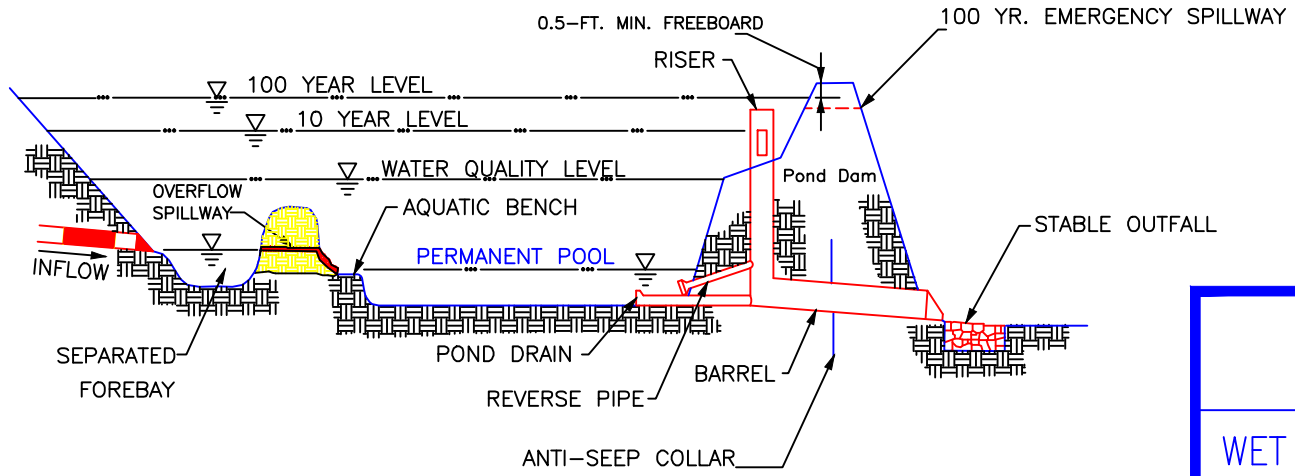
WET DETENTION POND

STANDARD DRAWING NO. WQ–1A

APPROVED BY: _____ JANUARY, 2013 DATE



PLAN VIEW



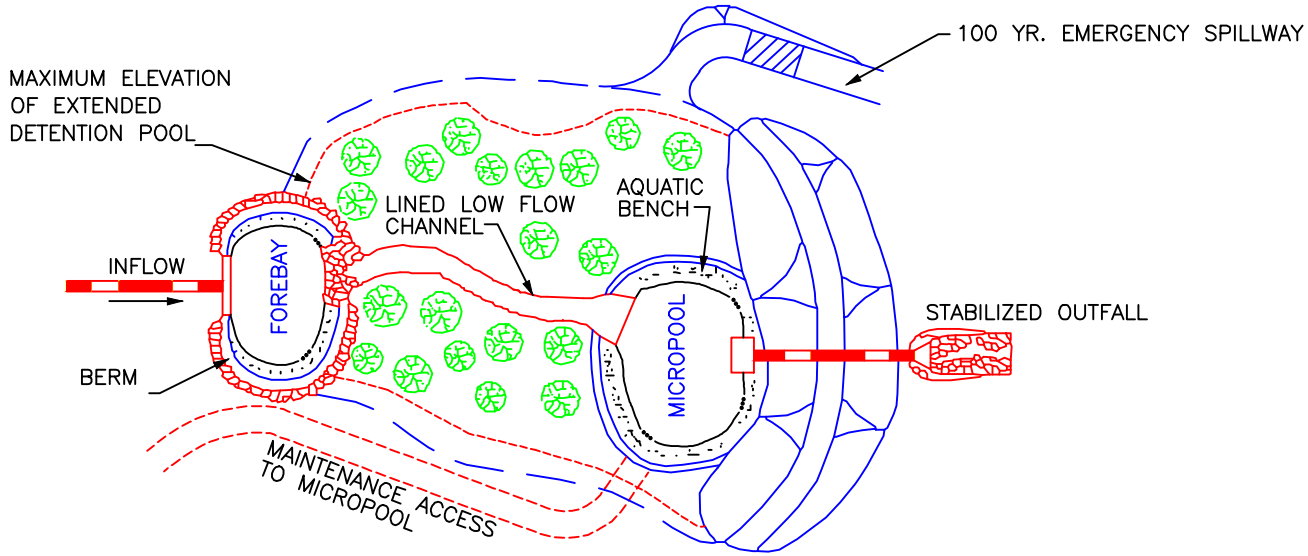
PROFILE

Anderson County, SC

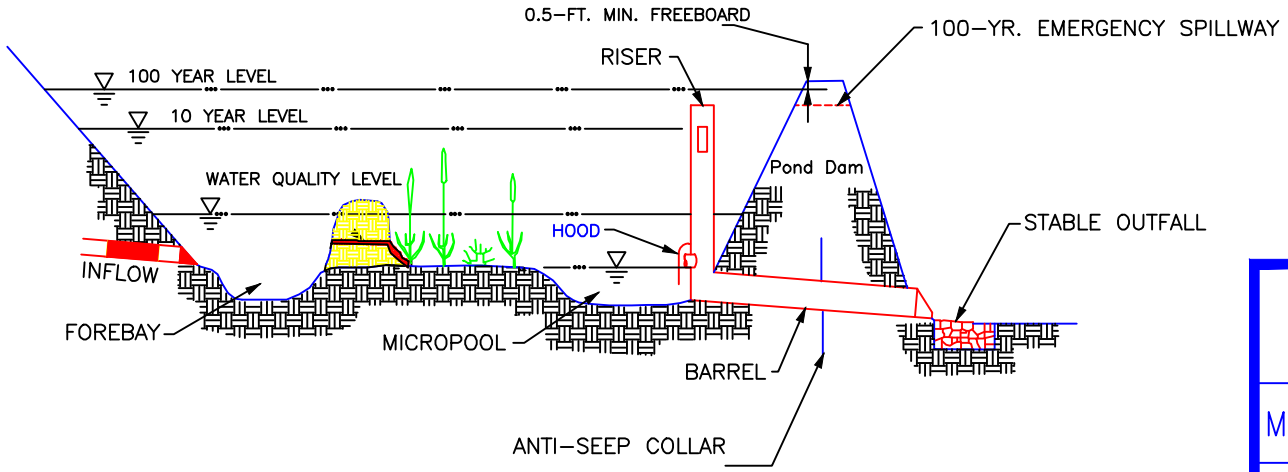
WET EXTENDED DETENTION POND

STANDARD DRAWING NO. WQ–01B

APPROVED BY: _____ JANUARY, 2013
DATE



PLAN VIEW



PROFILE

Anderson County, SC

MICROPOOL EXTENDED DETENTION POND

STANDARD DRAWING NO. WQ–1C

APPROVED BY: _____ JANUARY, 2013
DATE

WET DETENTION BASIN MAINTENANCE AND RESPONSIBILITY AGREEMENT

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

The wet detention basin system is defined as the dry detention basin, outlet structure, and pretreatment if provided.

Important maintenance procedures:

- Immediately after the wet detention basin is established, water the plants on the vegetated shelf and perimeter of the basin twice weekly if needed, until the plants become established (typically six weeks).
- Only fertilize the wet detention pond according the results of a soil analysis after the initial fertilization required to establish vegetation.
- Ensure a stable groundcover is maintained in the drainage area to reduce the sediment load.
- Minimize the flushing of sediment through the emergency drain to the maximum extent practical when draining the wet detention basin for maintenance or emergency activities.

After the wet detention basin 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.

Ensure the measuring device used to determine the deposited sediment elevation/depth gives an accurate depth reading and does not penetrate into accumulated sediments.

When the depth reads _____ feet in the main pond, remove the deposited sediment.

When the depth reads _____ feet in the forebay, remove the deposited sediment.

Perform recommended maintenance activities as follows:

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

Perform trouble shooting activities as follows:

BMP Component	Problem	Solution
Entire 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 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.