17. Dry Extended Detention Basin

Description

A dry extended detention basin temporarily stores incoming stormwater, trapping suspended pollutants, and reducing the peak discharge from the site.

Regulatory Credits		Feasibility Considerations	
Pollutant Removal			
50%	Total Suspended Solids	Med	Land Requirement
10%	Total Nitrogen	Small	Cost of Construction
10%	Total Phosphorus	Small-Med	Maintenance Burden
Water Quantity		Small-Large	Treatable Basin Size
yes	Peak Attenuation	Med	Possible Site Constraints
yes	Volume Capture	Med	Community Acceptance

Advantages

- Can effectively control peak runoff discharge rates from both small and large drainage areas.
- Moderately effective at removing suspended solids and particulate matter.
- May allow for recreational and other open-space uses between storms.
- Presents fewer hazards to the public than wet basins because of the absence of a permanent pool of water.

Disadvantages

- Poor or nonexistent maintenance of dry extended detention basins is common problem throughout the state.
- Limited effectiveness in removing dissolved substances.
- Tends to develop a soggy bottom or standing water, which hinders facility maintenance and the growth of effective vegetative cover, as well as becoming a perceived eyesore.
- Debris can accumulate and not only be an eyesore, but also clog the outlets and cause overflows during large rainfall events.
- Can attract children and become a safety hazard. Fencing is typically considered unsightly.

Major Design Elements

Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.	
1	Sizing shall take into account all runoff at ultimate build-out including off-site drainage.
2	Vegetated side slopes shall be no steeper than 3:1.
3	BMP shall be located in a recorded drainage easement with a recorded access easement to a public ROW.
4	If the BMP is used for sedimentation and erosion control during construction, it must be cleaned out and returned to the design state.
5	For pollutant removal credit, the applicable design storm must be held for a period of no less than 2 but no more than 5 days.
6	BMP shall have an additional 25% storage volume for sediment deposition.
Required by DWQ policy. These are based on available research, and represent what DWQ considers necessary to achieve the stated removal efficiencies.	
7	Seasonally high groundwater table must be at least 2 feet below the bottom of the basin.
8	The energy of the influent flow must be controlled.
9	The maximum depth shall be 10 feet.
10	Freeboard shall be a minimum of 1 foot above the maximum stage of the basin.
11	A minimum legnth to width ratio of 3:1 is recommended. A minimum length to width ratio of 1.5:1 is required.
12	A sediment depth indicator must be provided.
13	Basin design must include a drain.
14	A forebay is required if the design volume is over 10 acre-inches.

17.1. General Characteristics and Purpose

As the name of this BMP implies, these basins are typically dry between storm events. A low-flow outlet slowly releases water retained over a period of days. This BMP can be applied in residential, industrial, and commercial developments where sufficient space is available. The primary purpose of dry extended detention basins is to attenuate and delay stormwater runoff peaks. They are appropriate where water quality issues are secondary to managing peak runoff, since the overall pollutant removal efficiency of dry extended detention basins is low. Dry extended detention basins are not intended as infiltration or groundwater recharge measures. See Figure 17-1 for an example of a dry detention basin located in a commercial/industrial development.

Figure 17-1
Dry Extended Detention Basin with Shallow Marsh

17.2. Meeting Regulatory Requirements

A listing of the major design requirements is provided on the first page of this section. At a minimum, any dry extended detention basin must meet the major design requirements indicated as being from the North Carolina Administrative Code. To receive the pollutant removal rates listed in the front of this Section, the dry extended detention basin must meet all of the major design requirements listed in the beginning of this Section.

Pollutant Removal Calculations
The pollutant removal calculations for dry extended detention basins are as described in Section 3.4, and use the pollutant removal rates shown at the beginning of this Section. Construction of a dry extended detention basin also passively lowers nutrient loading since it is counted as pervious surface when calculating nutrient loading.

Volume Control Calculations
A dry extended detention basin can be designed with enough storage to provide active volume control (calculations for which are provided in Section 3.4). All dry extended detention basins provide some passive volume control capabilities by providing pervious surface and therefore reducing the total runoff volume to be controlled. The design specifics for volume and/or peak flow control will vary according to the area where the applicable regulations for the area where the project will be located.

17.3. Design

17.3.1. Converting Sediment and Erosion Control Devices

Sediment basins that are used during construction can be converted into dry extended detention basins after the construction is completed. If used during construction as a sediment basin, the basin must be completely cleaned out, graded, and vegetated within 14 days of completion of construction.

17.3.2. Siting Issues

The seasonally high groundwater table must be 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, the design of a stormwater wetland or wet detention basin should be considered.

17.3.3. Contributing Drainage Basin

Dry extended detention basins can be utilized on very large sites, but often reach limitations around 25 acres or more. The most common limitation is the bottom of the basin approaching groundwater.

17.3.4. Pretreatment and Inflow

A forebay is required at the inlet of a dry extended detention basin to trap incoming sediment if the design flow to the facility is over 10 acre-inches. The forebay must contain ponded water and be designed as described in Section 5.0 Common Design Elements. A forebay is recommended on all other dry detention basins. With heavy, coarse sediment confined to the forebay area, maintenance is made simpler and less costly and the life of the BMP is extended.

To prevent resuspension of trapped sediment and scour during high flows, the energy of the influent flow must be controlled. This can be in the form of a forebay as mentioned above, a plunge pool, rip-rap, or other energy-dissipating and erosion control measures.

17.3.5. Length, Width, Depth and Geometry

The volume of a dry extended 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. Below are some dimensional and layout requirements:

- The maximum depth shall be 10 feet.

- A minimum of 1 foot of freeboard shall be provided between the design flow pool elevation and the emergency overflow invert.
- The minimum flow length to width ratio shall be 1.5:1, but 3:1 is recommended. The basin width should preferably expand as it approaches the outlet.
- Side slopes of the basin shall be no steeper than 3H:1V if stabilized by vegetation.
- In addition to detention volume, design must provide for sediment storage equal to 25 percent of detention volume. If it is known that the upstream drainage basin will contribute high sediment loads (e.g. construction) over several years, then additional sediment storage should be provided.

By causing turbulence and eddies in the flow, flow short-circuiting can interfere with the function of the basin outlet system and should therefore be minimized. The most direct way of minimizing short-circuiting is to maximize the distance between the riser and the inlet. Larger length to width ratios should be used 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 flowpath.

A sinuous low-flow channel should be constructed through the basin to transport dry-weather flows and minor storm flows. Preferably, the channel would be grass-lined and sloped at approximately 2 percent to promote drainage of the basin between storms. The entire bottom of the basin should drain toward the low-flow channel.

17.3.6. Sediment Accumulation

A sediment depth indicator must be provided in the dry extended detention basin, and the forebay if there is one. Sediment will accumulate more quickly in the main detention basin if there is no forebay and also if the upstream drainage basin is not properly stabilized. Sediment shall be removed from the dry extended basin (and forebay if applicable) when the sediment depth indicator shows that the sediment has accumulated to the design sediment accumulation depth of the basin.

17.3.7. Plant and Landscape Requirements

When choosing vegetation for a dry extended detention basin, consideration must be given to the wildflowers or grasses specified because of the frequent inundations, warm and cold seasons, as well as salt, and oil loading. Additionally, the plants should not be fertilized except for a one-time application after seeding. Mowing should be minimal. It has been found that a wet meadow mix or Bermudagrass typically performs well in those locations with the climate able to support it.

The dry extended detention basin must be stabilized within 14 days after the end of construction. The stabilization might be the final vegetation or a temporary stabilization measure until the vegetation becomes established.

17.3.8. Outlet Design

In addition to meeting specific hydraulic requirements for runoff detention and peak attenuation, outlets also must be functionally simple and easy to maintain. Below are design requirements and guidelines for dry extended detention basin outlets:

- Basin design should include a small permanent pool near the outlet orifice to reduce clogging and keep floating debris away from the outlet.
- Basin design must include a drain that will completely empty the basin for clean out.
- Durable materials such as reinforced concrete or plastic are preferable to corrugated metal in most instances.
- The riser should be placed in or at the face of the embankment to make maintenance easier and prevent flotation problems.
- Erosion protection measures should be used at the basin discharge point.
- To prevent piping and internal erosion problems around the spillway/outlet conduit through an embankment system, a filter diaphragm and drainage system is recommended.

17.4. Maintenance

17.4.1. Common Maintenance Issues

The facility should be inspected annually to verify that the facility is operating as designed and to schedule any required maintenance. If possible, inspections should occur during wet weather to verify that the facility is maintaining desirable retention times. In addition to regularly scheduled inspections, maintenance personnel should note deficiencies during any visits. One important purpose of inspections is to ascertain the operational condition and safety of the facility, particularly the condition of embankments, outlet structures, and other safety-related features. Other general objectives are to prevent clogging of the outlets, development of standing water, and growth of weeds and noxious plants.

Maintaining turf grass on the tops of berms and on the exterior slopes of embankments is advisable to facilitate access to the facility and inspection of the embankment, as well as stability of the slopes. The frequency of mowing may need to be greater if the facility is in an area of high visibility. However, if possible, the facility should be managed as an upland meadow with cold season grasses maintained no shorter than 4 inches and warm season grasses maintained no shorter than 3 inches. Cutting grass shorter than the minimum lengths can cause areas of the turf to die off or can require a much higher level of maintenance.

When the sediment depth indicator shows that the sediment has filled the design storage volume, the accumulated sediment, mud, sand, and debris must be cleaned out with earth-moving equipment and disposed of properly. If the facility supports open-space uses during dry weather, the removal may have to take place frequently. Once

these materials are removed, the disturbed areas should be stabilized and revegetated immediately, otherwise sediment will move to downstream areas. Freshly seeded areas should be protected with an erosion mat that has been securely staked in place to prevent flotation. In many cases, sodding offers the best approach to stabilization after removal of sediment and debris.

17.4.2. Sample Operation and Maintenance Provisions

Important maintenance procedures:

- The drainage area will be managed to reduce the sediment load to the dry extended detention basin.
- Immediately after the dry extended detention basin is established, the vegetation will be watered twice weekly if needed until the plants become established (commonly six weeks).
- No portion of the dry extended detention pond will be fertilized after the first initial fertilization that is required to establish the vegetation.
- I will maintain the vegetation in and around the basin at a height of approximately six inches.
- Once a year, a dam safety expert will inspect the embankment.

After the dry extended detention basin is established, it will be inspected **once a quarter and within 24 hours after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County)**. Records of operation and maintenance will be kept in a known set location and will be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.

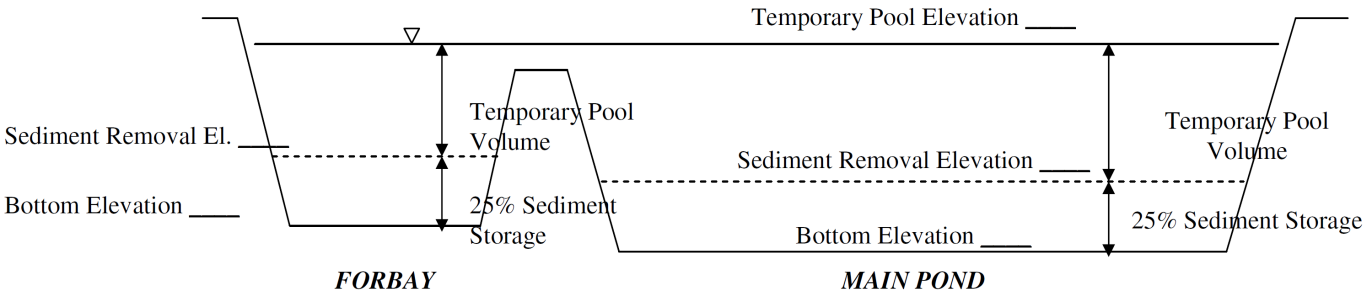
Table 17-1
Sample Operation and Maintenance Provisions for Dry Detention Basins

BMP element:	Potential problem:	How to remediate the problem:
The entire BMP	Trash/debris is present.	Remove the trash/debris.
The perimeter of the dry extended detention basin	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
The inlet device: pipe or swale	The pipe is clogged (if applicable).	Unclog the pipe. Dispose of the sediment off-site.
	The pipe is cracked or otherwise damaged (if applicable).	Replace the pipe.
	Erosion is occurring in the swale (if applicable).	Regrade the swale if necessary to smooth it over and provide erosion control devices such as reinforced turf matting or riprap to avoid future problems with erosion.
The forebay	Sediment has accumulated and reduced the depth to 75% of the original design depth (see diagram below).	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP.
	Erosion has occurred or riprap is displaced.	Provide additional erosion protection such as reinforced turf 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.

Table 17-1, continued
Sample Operation and Maintenance Provisions for Dry Detention Basins

BMP element:	Potential problem:	How to remediate the problem:
The main treatment area	Sediment has accumulated and reduced the depth to 75% of the original design depth (see diagram below).	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP. Revegetate disturbed areas immediately with sod (preferred) or seed protected with securely staked erosion mat.
	Water is standing more than 5 days after a storm event.	Check outlet structure for clogging. If it is a design issue, consult an appropriate professional.
	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).
The 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 by an appropriate professional shows that the embankment needs repair.	Make all needed repairs.
The outlet device	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.
The receiving water	Erosion or other signs of damage have occurred at the outlet.	Contact the NC Division of Water Quality 401 Oversight Unit at 919-733-1786.

Figure 17-4
Profile of a Dry Detention Basin



September 28, 2007 Changes:

1. Major Design Elements:
    a. Reformatted to include numbered requirements.
    b. Added, "For pollutant removal credit, the applicable design storm must be held for a period of no less than 2 but no more than 5 days," per 15A NCAC 02H .1008(e)(2).
    c. Added, "If the BMP is used for sedimentation and erosion control during construction, it must be cleaned out and returned to the design state."
2. 17.2: Added, "The design specifics for volume and/or peak flow control will vary according to the area where the applicable regulations for the area where the project will be located."
3. Figure 17-4: Corrected the labeling of the temporary pool.

April 25, 2008 Changes:

1. Major Design Elements:
    a. Corrected, "design flow" to "design volume". It now reads, "A forebay is required if the design volume is over 10 acre-inches."

June 1, 2009 Changes:

1. Major Design Elements:
    a. Added that 3:1 L:W is recommended.