4.3.2 Conventional Dry Detention Basins

General Application
Water Quality BMP

Description: A surface storage basin or facility designed to provide water quantity control through detention of stormwater runoff.

KEY CONSIDERATIONS

- Conventional dry detention basins provide control for overbank and extreme flood protection only. These basins are **not** intended to provide water quality treatment.
- Single basins are applicable for drainage areas up to 75 acres.
- Typically less costly than stormwater (wet) basins for equivalent flood storage, as less excavation is required.
- Must be used in conjunction with other BMPs that can adequately meet the minimum standard of 80% removal of TSS.
- Conventional dry detention basins can be used to provide recreational and other open space opportunities between storm runoff events when the basin bottom is dry.

MAINTENANCE REQUIREMENTS:

- Remove debris from inlet and outlet structures.
- Maintain side slopes and outlet structure.
- Monitor sediment accumulation and remove periodically.

STORMWATER MANAGEMENT APPLICABILITY

Stormwater Quality:	**No**
Channel Protection:	**Yes**
Detention/Retention:	**Yes**

Accepts hotspot runoff: *Yes, but two feet of separation distance required to water table when used in hotspot areas*

COST CONSIDERATIONS

Land Requirement:	**Med - High**
Capital Cost:	**Low**
Maintenance Burden:	**Low**

LAND USE APPLICABILITY

Residential/Subdivision Use:	**Yes**
High Density/Ultra Urban Use:	**No**
Commercial/Industrial Use:	**Yes**

POLLUTANT REMOVAL

Total Suspended Solids:	**10%**

4.3.2.1 General Description

Conventional dry detention basins are surface facilities intended to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts. These facilities temporarily detain stormwater runoff, releasing the flow over a period of time. They are designed to completely drain following a storm event and are normally dry between rain events.

Dry detention basins can be utilized to provide flood protection for the locally regulated peak discharge storm event. Such basins provide limited pollutant removal benefits and are **not** intended for water quality treatment. Because conventional dry detention-only facilities can not provide a significant degree of water quality treatment, they must be used in conjunction with other structural controls that provide treatment of the water quality volume (WQv). Chapter 3 provides more information on treatment trains.

4.3.2.2 Planning and Design Standards

The following standards shall be considered **minimum** design standards for the design of a dry detention basin. Dry detention basins that are not designed to these standards will not be approved. Consult with the local engineering department to determine if there are any variations to these criteria or additional standards that must be followed.

A. LOCATION AND SITING

- It is strongly recommended that dry detention basins be located where the topography allows for maximum runoff storage at minimum excavation or embankment construction costs. When locating a dry detention basin, the site designers should also consider the location and use of other land use features, such as planned open spaces and recreational areas, and should attempt to achieve a multi-use objective with the basin where this can be safely achieved.
- Detention basins shall not be located on unstable slopes or slopes greater than 15%.
- Flood protection controls for locally regulated peak discharges should be designed as final controls for on-site stormwater. Therefore, dry detention basins will typically be located downstream of structural stormwater BMPs that are designed to provide treatment of the water quality volume (WQv) and channel protection volume (CPv).
- A single dry detention basin shall not have a contributing drainage area greater than 75 acres unless specifically approved by the local municipality
- Dry detention basins shall not be located in a stream or any other navigable waters of the United States, including natural (i.e., not constructed) wetlands. Where an appeal or variance of this policy is desired, the property owner must obtain coverage under a Section 404 permit under the Clean Water Act and/or an Aquatic Resource Alteration Permit (ARAP) and provide proof of such coverage with the Water Quality Management Plan.
- Each conventional dry detention basin shall be placed in an easement that is recorded with the deed. The easement shall be defined at the outer edge of the safety bench, or a minimum of 15 feet from the normal water pool elevation (measured perpendicular from the pool elevation boundary) if a safety bench is not included in the basin design. The easement limit should be located no closer than as follows unless otherwise specified by the local jurisdiction:
  - From a public water system well – TDEC specified distance per designated category
  - From a private well – 50 feet; if the well is downgradient from a hotspot land use, as defined in this manual, then the minimum setback is 250 feet
  - From a septic system tank/leach field – 50 feet
- The minimum setback for habitable structures from the drainage easement shall be 15 feet. The first floor elevation (FFE) for any structure adjacent to the basin shall have an elevation no lower than 1 foot above the top of the berm.

- All utilities shall be located outside of the basin site.

B. GENERAL DESIGN

- A dry detention basin shall consist of the following elements, designed in accordance with the specifications provided in this section.
  (1) An outlet structure;
  (2) An emergency spillway;
  (3) Maintenance access; and,
  (4) Appropriate landscaping. (Consult landscaping standards/ordinances of the local jurisdiction for more specific information.)
- Dry detention basins shall be sized to attenuate peak discharges. Routing calculations must be used to demonstrate that the storage volume is adequate to meet the local jursidiction regulations.

C. PHYSICAL SPECIFICATIONS / GEOMETRY

- Vegetated embankments shall be less than 20 feet in height. Side slopes shall not exceed 3:1 (horizontal to vertical) on one side of the basin to facilitate access for maintenance and repair. The remainder of the basin shall have side slopes no steeper than 2:1 although 3:1 is preferred. Benching of the slope is required for embankments greater than 10 feet in height and having greater than a 3:1 side slope. Riprap-protected embankments shall be no steeper than 2:1. Geotechnical slope stability analysis is recommended for embankments greater than 10 feet in height and is mandatory for embankment slopes steeper than those given above. All embankments must be designed to State of Tennessee guidelines for dam safety.
- The maximum depth of the basin shall not exceed 10 feet, without prior approval of the jurisdiction.
- Areas above the normal high water elevations of the detention basin shall be sloped toward the basin to allow drainage and to prevent standing water. Careful finish grading is required to avoid creation of upland surface depressions that may retain runoff. The basin bottom shall be graded toward the outlet to prevent standing water. A low flow or pilot channel across the facility bottom from the inlet to the outlet (often constructed with riprap) is recommended to convey low flows and prevent standing water conditions.

D. INLET and OUTLET STRUCTURES

Inflow channels shall be stabilized with flared riprap aprons, or the equivalent. A sediment forebay shall be provided for dry detention basins that are located in a treatment train with off-line water quality treatment structural controls. The sediment forebay shall be sized to contain 0.1 inch per impervious acre (363 ft^3) of contributing drainage and shall be no more than 4 to 6 feet deep.

- The outlet structure shall be sized for peak discharge controls (based upon hydrologic routing calculations) and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure. Small outlets that will be subject to clogging or are difficult to maintain shall not be permitted. Seepage control or anti-seep collars shall be provided for all outlet pipes per the regulations of the local jurisdiction.
- Water shall not be discharged from a detention basin in an erosive manner. Riprap, plunge pads or pools, or other energy dissipators shall be placed at the outlet of the barrel to prevent scouring and erosion. If a basin outlet discharges immediately to a channel that carries dry weather flow, care should be taken to minimize disturbance along the downstream channel and streambanks, and to reestablish a forested riparian zone in the shortest possible distance (if the downstream area is located in a vegetated buffer).

E. EMERGENCY SPILLWAY

- An emergency spillway shall be included per regulations of the local jurisdiction.

F. MAINTENANCE ACCESS

- A maintenance right-of-way or easement having a minimum width of 20 feet shall be provided to the basin from a driveway, public or private road. The maintenance access easement shall have a maximum slope of no more than 15% and shall have a minimum unobstructed drive path having a width of 12 feet, appropriately stabilized to withstand maintenance equipment and vehicles.
- The maintenance access shall extend to the forebay (if included) and outlet works, and, to the extent feasible, be designed to allow vehicles to turn around.

G. SAFETY FEATURES

- A safety bench shall be provided for embankments greater than 10 feet in height and having greater than a 3:1 side slope. For large basins, the safety bench shall extend no less than 15 feet outward from the normal water edge to the toe of the basin side slope. The slope of the safety bench shall not exceed 6%.
- All embankments and spillways shall be designed to TDEC rules and regulations as applied to the Safe Dams Act of 1973, where applicable.
- The property owner may consider fencing the basin for the purpose of safety management.
- All outlet structures shall be designed so as not to permit access by children. The posting of warning signs is encouraged near the basin to prohibit swimming and fishing in the facility.

H. LANDSCAPING

- All areas of the basin shall be stabilized with vegetation to prevent the occurrence of erosion.
- Woody vegetation shall not be planted on the embankment or allowed to grow within 15 feet of the toe of the embankment and 25 feet from the principal spillway structure.
- Vegetated buffers, as defined and described in Chapter 6 of this manual, are not required for dry detention basins. However, it should be noted that vegetated buffers can be utilized for water quality treatment and can result in a volume reduction that reduces the WQv. The criteria for the vegetated buffer reduction are presented in Chapter 5 of this manual.

4.3.2.3 Design Procedures

In general, site designers should perform the following design procedures when designing a dry detention basin.

Step 1. Compute runoff control volumes.

Calculate pre- and post-development peak discharges and runoff volumes. Consult local regulations for peak discharge control (i.e., detention) requirements.

Step 2. Confirm design criteria and applicability.

Consider any special site-specific design conditions/criteria from subsection 4.3.2.2. Check with the local jurisdiction, TDEC, or other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply to the site.

Step 3. Determine basin location and preliminary geometry.

This step involves initially designing the grading of the basin (establishing contours) and determining the elevation-storage relationship for the basin. Include consideration of a safety bench, if used or required by the local jurisdiction.

Step 4. Calculate peak discharge release rates and water surface elevations for flood control (i.e., detention)

Set up a stage-storage-discharge relationship for the control structure for the peak discharge control storm orifices.

Step 5. Design embankment(s) and spillway(s)

Size emergency spillway per the regulations of the local jurisdiction.

Step 6. Investigate potential basin hazard classification

The design and construction of dry detention basins are required to follow the latest version of the TDEC Rules and Regulations Application to the Safe Dams Act of 1973.

Step 7. Design inlets, outlet structures, maintenance access, and safety features.

See subsection 4.3.2.2 for more details.

Step 8. Design vegetation

A vegetation scheme for the detention basin should be prepared to indicate how the basin bottom, side slopes and embankments will be stabilized and established with vegetation.

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4.3.2.4 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.2.4 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective operation of the detention basin as designed. It is the responsibility of the property owner to maintain all stormwater BMPs in accordance with the minimum design standards and other guidance provided in this manual. The local jurisdiction has the authority to impose additional maintenance requirements where deemed necessary.

This page provides guidance on maintenance activities that are typically required for detention basins, along with a suggested frequency for each activity. Individual basins may have more, or less, frequent maintenance needs, depending upon a variety of factors including the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain the basin in proper operating condition at all times.

Inspection Activities	**Suggested Schedule**
• After several storm events or an extreme storm event, inspect for: bank stability; signs of erosion; and damage to, or clogging of, the outlet structures and pilot channels.	As Needed
• Inspect for: trash and debris; clogging of the outlet structures and any pilot channels; excessive erosion; sediment accumulation in the basin and inlet/outlet structures; tree growth on dam or embankment; the presence of burrowing animals; standing water where there should be none; vigor and density of the grass turf on the basin side slopes and floor; differential settlement; cracking; leakage; and slope stability.	Semi-annually
• Inspect that the outlet structures, pipes, and downstream and pilot channels are free of debris and are operational. • Note signs of pollution, such as oil sheens, discolored water, or unpleasant odors. • Check for sediment accumulation in the facility. • Check for proper operation of control gates, valves or other mechanical devices.	Annually
Maintenance Activities	**Suggested Schedule**
• Clean and remove debris from inlet and outlet structures. • Mow side slopes (embankment) and maintenance access. Periodic mowing is only required along maintenance rights-of-way and the embankment.	Monthly or as needed
• Repair and revegetate eroded areas. • Remove vegetation that may hinder the operation of the basin. • Repair damage to the basin, outlet structures, embankments, control gates, valves, or other mechanical devices; repair undercut or eroded areas.	As Needed
• Monitor sediment accumulations, and remove sediment when the basin volume has become reduced significantly.	As Needed (typically every 20 to 50 years)

The property owner is encouraged to use the inspection checklist that is presented on the next page as a guide in the inspection and maintenance of conventional dry detention basins. Local authorities can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the dry ED basin. Questions regarding stormwater facility inspection and maintenance should be referred to the local engineering department.

INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
CONVENTIONAL DRY DETENTION BASIN INSPECTION CHECKLIST

Location: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone: _____

Date: _____ Time: _____ Site conditions:_____

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Embankment and Emergency Spillway		
Vegetation coverage adequate?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Metal pipes in good condition?		
Control valve operational?		
Basin drain valve operational?		
Outfall channels function, not eroding?		
Other (describe)?		
Basin Bottom		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

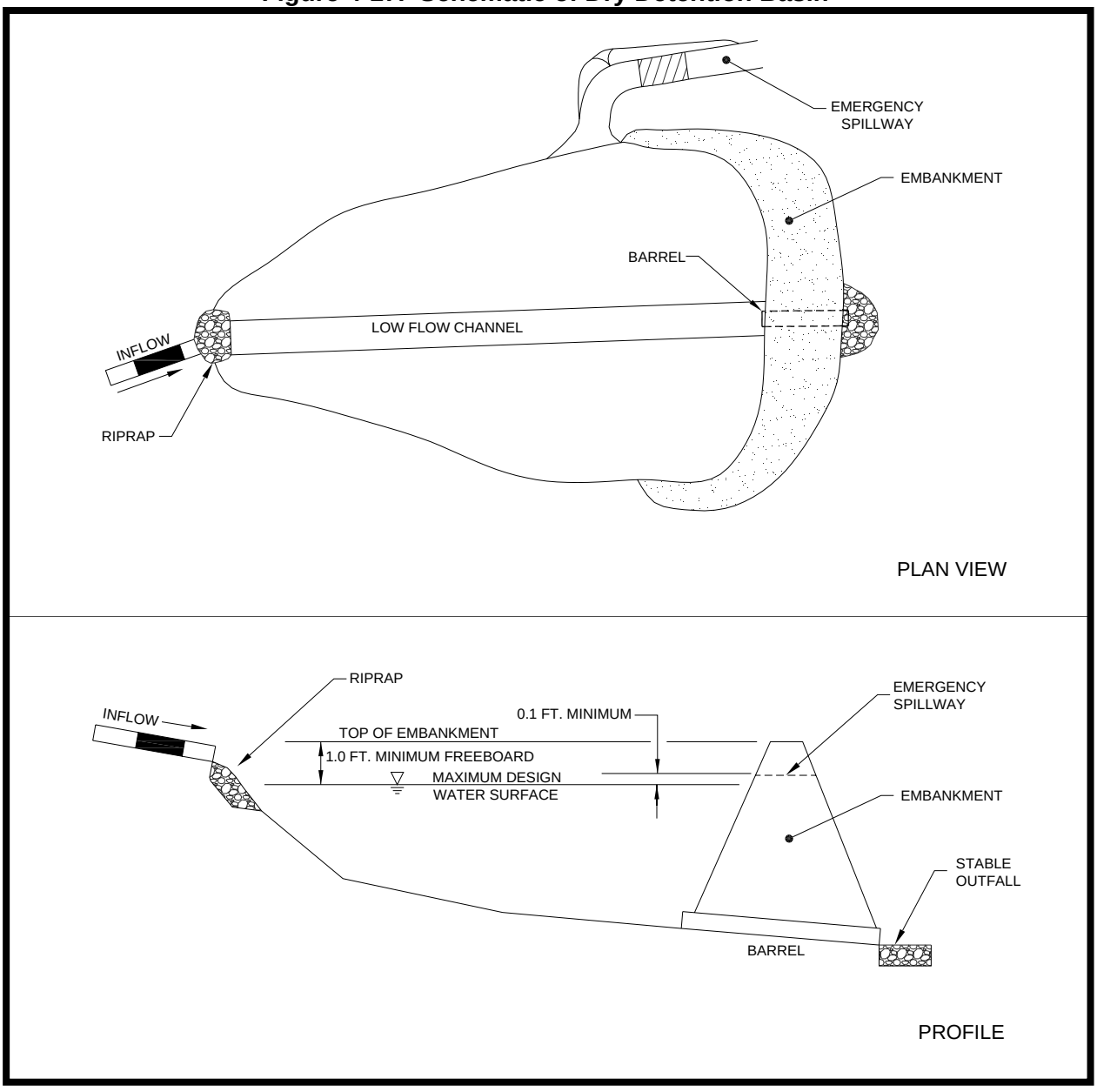
Corrective Action Needed	Due Date

Inspector Signature:_____ Inspector Name (printed)_____

4.3.2.5 Example Schematic

The example schematics for dry detention basins presented in Figure 4-17 can be used to assist in the design of such a BMP.

Figure 4-17. Schematic of Dry Detention Basin



4.3.2.6 Design Form

Use of the following design procedure forms when designing a conventional dry detention basin is recommended. Proper use and completion of the form may allow a faster review of the basin design by the local engineering department.

Design Procedure Form: Dry Detention Basins

PRELIMINARY HYDROLOGIC CALCULATIONS

1 Compute storage volume required for locally regulated storm events

storage = _____ acre-ft
storage = _____ acre-ft

DRY DETENTION BASIN DESIGN

2. Confirm design criteria and applicability.

See Section 4.3.2.2

3. Conduct grading design and determine storage available

Prepare an elevation-storage table and curve using the average area method for computing volumes.

Elevation MSL	Area ft^2	Ave. Area ft^2	Depth ft	Volume ft^3	Cumulative Volume ft^3

4. Calculate required local jurisdiction peak discharge release rates and WSELs

Set up a stage-storage-discharge relationship

Elevation	Storage	Low Flow	Riser			Barrel		Emergency	Total
		WQv-ED	CPv_ED	High Storage		Inlet	Pipe	Spillway	Storage
				Orif.	Weir				
MSL	acre-ft	H(ft) Q(cfs)	H(ft) Q(cfs)	H Q	H Q	H(ft) Q(cfs)	H(ft) Q(cfs)	H(ft) Q(cfs)	acre-ft

Check inlet condition
Check outlet conditions

Use culvert design guidance from local municipality

5. Size emergency spillway using the local municipality peak discharge and set top of embankment elevation and emergency spillway elevation based on $WSEL_{peak}$

$Q_{ES}=Qp_{peak}$ _____ cfs
$WSEL_{peak}=$ _____ ft
$El_{embank}=$ _____ ft
$El_{ES}=$ _____ ft

6. Investigate potential basin hazard classification

See TN Safe Dams Act of 1973

7. Design inlets, sediment forebays, outlet structures, maintenance access, and safety features

See Section 4.3.2.2

8. Design basin vegetation

4.3.2.7 References

Atlanta Regional Council (ARC). *Georgia Stormwater Management Manual Volume 2 Technical Handbook.* 2001.

City of Nashville, Tennessee. *Metropolitan Nashville and Davidson County Stormwater Management Manual, Volume 4 Best Management Practices.* 2006.

Knox County, Tennessee. *Knox County Stormwater Management Manual Volume 2, Technical Guidance*. 2006.

4.3.2.8 Suggested Reading

California Storm Water Quality Task Force. *California Storm Water Best Management Practice Handbooks.* 1993.

City of Austin, TX. *Water Quality Management.* Environmental Criteria Manual, Environmental and Conservation Services, 1988.

City of Sacramento, CA. *Guidance Manual for On-Site Stormwater Quality Control Measures.* Department of Utilities, 2000.

Merritt, F.S., Loftin, M.K., Ricketts, J.T. *Standard Handbook for Civil Engineers*. Fourth Edition McGraw-Hill, 1996.

Metropolitan Washington Council of Governments (MWCOG). *A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone.* March, 1992.