4.3.2 Conventional Dry Detention

General Application
Stormwater BMP

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

KEY CONSIDERATIONS

- Conventional detention ponds provide control for overbank and extreme flood protection only. These ponds are not intended to provide water quality treatment.
- Typically less costly than stormwater (wet) ponds for equivalent flood storage, as less excavation is required.
- Must be used in conjunction with other BMPs that can adequately meet Knox County's minimum standard of 80% removal of TSS.
- Dry detention basins can be used to provide recreational and other open space opportunities between storm runoff events when the pond 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 SUITABILITY

- ☐ **Water Quality**
- ☐ **Channel/Flood Protection**
- ☑ **Overbank Flood Protection**
- ☑ **Extreme Flood Protection**

Accepts runoff from SPAP land uses: *Yes*

FEASIBILITY CONSIDERATIONS

- **M-H** **Land Requirement**
- **L** **Capital Cost**
- **L** **Maintenance Burden**

Residential/Subdivision Use: *Yes*

High Density/Ultra-Urban: *No*

Drainage Area: *unlimited.*

4.3.2.1 General Description

Conventional dry detention ponds 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 ponds can be utilized to provide overbank flood protection (Qp_2, Qp_{10}, and Qp_{25}) and extreme flood protection for the 100-year storm event (Qp_{100}). Such ponds provide limited pollutant removal benefits and are not intended for water quality treatment. Because conventional 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). Volume 2, Chapter 2 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 pond. Detention ponds that are not designed to these standards will not be approved. The Director of Engineering and Public Works (the Director) shall have the authority to require additional design conditions if deemed necessary.

A. LOCATION AND SITING

- It is strongly recommended that dry detention ponds be located where the topography allows for maximum runoff storage at minimum excavation or embankment construction costs. When locating a 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 pond where this can be safely achieved.
- Detention ponds shall not be located on unstable slopes or slopes greater than 15%.
- Flood protection controls for peak discharge control (Qp_2, Qp_{10}, Qp_{25} and Qp_{100}) should be designed as final controls for on-site stormwater. Therefore, dry detention ponds 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).
- Detention ponds 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 Stormwater Management Plan.
- Each detention pond shall be placed in a water quality easement. The water quality 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 pond design. The easement limit should be located no closer than as follows unless otherwise specified by the Director:
  - 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 land use that must obtain a Special Pollution Abatement Permit, then the minimum 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 pond shall have an elevation no lower than 1 foot above the top of the berm.
- All utilities shall be located outside of the pond/basin site.

B. GENERAL DESIGN

- A dry detention pond 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.

- Dry detention basins shall be sized to attenuate peak discharges for the overbank flood (Qp_2, Qp_{10}, Qp_{25}) protection and/or extreme flood protection (Qp_{100}) design criteria (see Chapter 2). Routing calculations must be used to demonstrate that the storage volume is adequate. See Volume 2, Chapter 7 for procedures on the design of detention storage.

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 pond to facilitate access for maintenance and repair. The remainder of the pond 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.

- Areas above the normal high water elevations of the detention pond 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 pond 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.

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 ponds 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 Qp_2, Qp_{10}, Qp_{25} and Qp_{100} control (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. See Volume 2, Chapter 7 for more information on the design of outlet structures. The outlet barrel shall be of reinforced concrete.

- Seepage control or anti-seep collars shall be provided for all outlet pipes.

- Water shall not be discharged from a detention pond 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 pond 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 water quality buffer).

D. EMERGENCY SPILLWAY

- An emergency spillway shall be included in the stormwater pond design to safely pass Qp_{100}. The spillway prevents pond water levels from overtopping the embankment and causing structural damage. The emergency spillway shall be located so that downstream structures will not be impacted by spillway discharges.
- The emergency spillway shall be located a minimum 0.1 foot above the 100-year water surface elevation.
- A minimum of 1 foot of freeboard shall be provided, measured from the top of the water surface elevation for the extreme flood to the lowest point of the dam embankment, not counting the emergency spillway.

E. MAINTENANCE ACCESS

- A maintenance right-of-way or easement having a minimum width of 20 feet shall be provided to the pond 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.

F. 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 ponds, the safety bench shall extend no less than 15 feet outward from the normal water edge to the toe of the pond 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 pond for the purpose of safety management.
- All outlet structures shall be designed so as not to permit access by children. Knox County encourages the posting of warning signs near the pond to prohibit swimming and fishing in the facility.

G. LANDSCAPING

- All areas of the pond 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.
- Water quality buffers, as defined and described in Volume 2, Chapter 6 of this manual, are not required for dry detention ponds. However, it should be noted that vegetated buffers can be utilized for water quality treatment and can result in a volume credit that reduces the WQv. The criteria for the vegetated buffer credit are presented in Volume 2, Chapter 5 of this manual.

4.3.2.3 Design Procedures

In general, site designers should perform the following design procedures when designing a stormwater pond.

Step 1. Compute runoff control volumes.

Calculate Qp_2, Qp_{10}, Qp_{25} and Qp_{100}, in accordance with the guidance presented in Volume 2, Chapter 2.

Step 2. Confirm design criteria and applicability.

Consider any special site-specific design conditions/criteria from subsection 4.3.2.2. Check with

Knox County Engineering, 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 pond location and preliminary geometry.

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

Step 4. Calculate Qp_2, Qp_{10}, Qp_{25} and Qp_{100} release rates and water surface elevations.

Set up stage-storage-discharge relationships for the control structure for the 2, 10, 25 and 100-year storms.

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

Size emergency spillway, calculate the 100-year water surface elevation, set the top of the embankment elevation a minimum of 1 foot above the water surface elevation of the 100-year event, and analyze safe passage of the Qp_{100}. Set the emergency spillway elevation a minimum 0.1 foot above the 100-year water surface elevation. At final design, provide safe passage for the 100-year event.

Step 6. Investigate potential pond hazard classification.

The design and construction of stormwater management ponds 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 pond should be prepared to indicate how the pond 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 pond 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 Director has the authority to impose additional maintenance requirements where deemed necessary.

This page provides guidance on maintenance activities that are typically required for detention ponds, along with a suggested frequency for each activity. Individual ponds 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 pond 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 pond. • Repair damage to pond, 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 pond volume has become reduced significantly.	As Needed (typically every 20 to 50 years)

Knox County encourages the use of the inspection checklist that is presented on the next page to guide the property owner in the inspection and maintenance of dry detention ponds. The Director 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 detention pond. Questions regarding stormwater facility inspection and maintenance should be referred to the Knox County Department of Engineering and Public Works, Stormwater Management Division.

INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
CONVENTIONAL DRY DETENTION POND 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?		
Pipes in good condition?		
Slide gate operational?		
Pond drain valve operational?		
Outfall channels function, not eroding?		
Other (describe)?		
Pond 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:

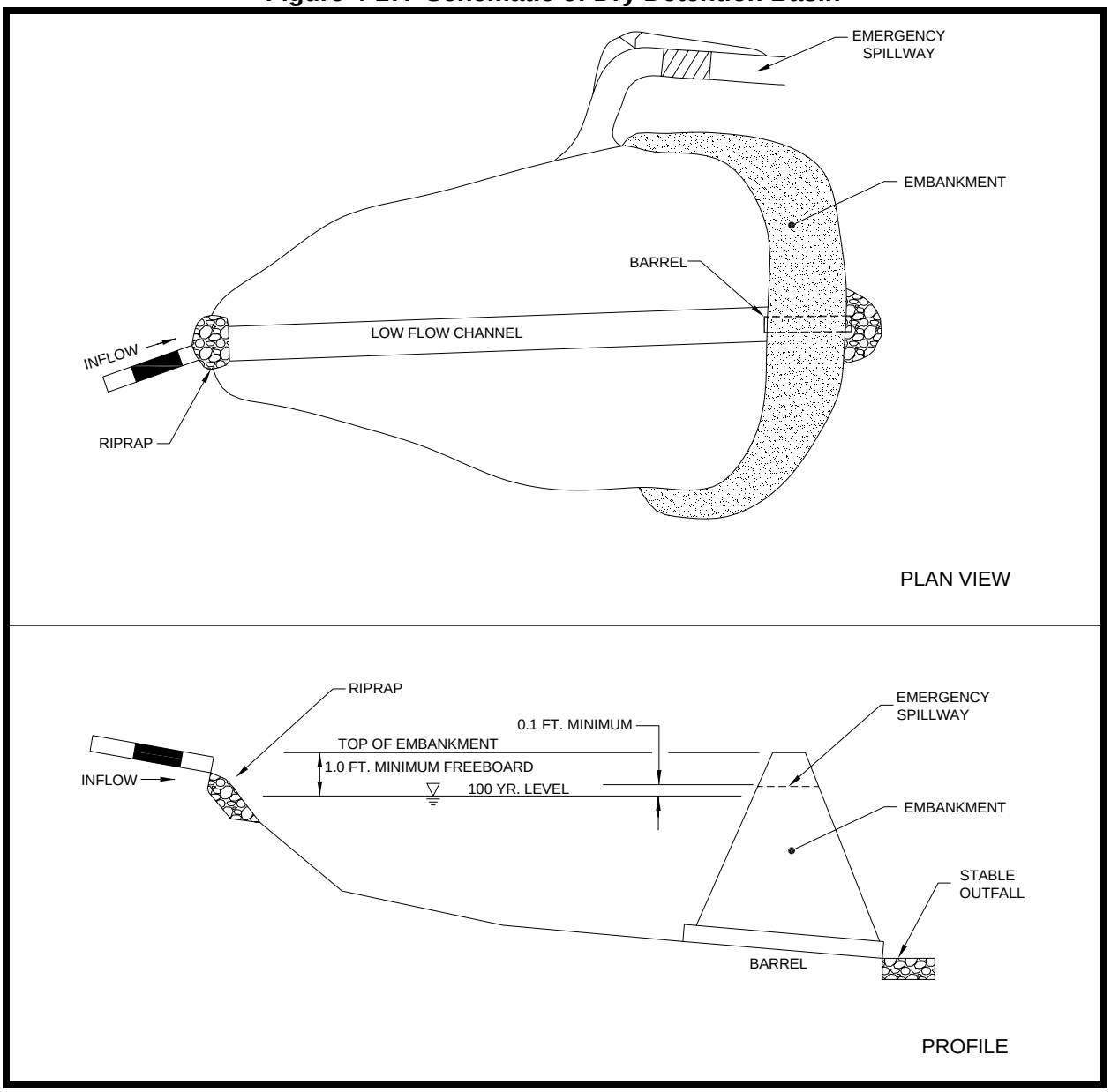
Corrective Action Needed	Due Date

Inspector Signature:_____ Inspector Name (printed)_____

4.3.2.5 Example Schematic

The example schematics for dry detention ponds 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

Knox County recommends the use of the following design procedure forms when designing a conventional dry detention pond. Proper use and completion of the form may allow a faster review of the Stormwater Management Plan by Knox County Engineering.

Design Procedure Form: Dry Detention Ponds

PRELIMINARY HYDROLOGIC CALCULATIONS

1 Estimate storage volume required for 2-year storm — 2-year storage = _____ acre-ft
Estimate storage volume required for 10-year storm — 10-year storage = _____ acre-ft
Estimate storage volume required for 25-year storm — 25-year storage = _____ acre-ft
Estimate storage volume required for 100-year storm — 100-year storage = _____ acre-ft

DRY DETENTION POND DESIGN

2. Confirm design criteria and applicability. — ***See subsection 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 Qp_2, Qp_{10}, Qp_{25} and Qp_{100} release rates and WSEL — 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

Calculate Qp_2 — Qp_2= _____ cfs
Calculate Qp_{10} — Qp_{10}= _____ cfs
Calculate Qp_{25} — Qp_{25}= _____ cfs
Calculate Qp_{100} — Qp_{100}= _____ cfs

Maximum head = — H= _____ ft
Use weir equation for slot length ($Q=CLH^{3/2}$) — L= _____ ft

Check inlet condition
Check outlet conditions — **Use culvert design guidance in Chapter 7**

5. Size emergency spillway using the Qp_{100} and set top of embankment elevation and emergency spillway elevation based on $WSEL_{100}$ — $Q_{ES}=Qp_{100}$ _____ cfs; $WSEL_{100}$= _____ ft; $El_{embank}=WSEL_{100}+1.0$ _____ ft; $El_{ES}=WSEL_{100}+.01$ feet _____ ft

6. Investigate potential pond 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 vegetation according to guidance in Chapter 6

9. Verify peak flow control

4.3.2.7 References

AMEC. *Metropolitan Nashville and Davidson County Stormwater Management Manual Volume 4 Best Management Practices.* 2006.

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

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.

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