Extended Detention

Description: Constructed stormwater detention basin that has a permanent pool (or micropool). Runoff from each rain event is captured and treated primarily through settling and biological uptake mechanisms.

Advantages/Benefits:

- Can be designed as a multi-functional SCM
- Can be designed as an amenity within a development
- Wildlife habitat potential
- High community acceptance when integrated into a development

Disadvantages/Limitations:

- Potential for thermal impacts downstream
- Prohibited in karst terrain
- Community perceived concerns with mosquitoes and safety

Selection Criteria:

25% Runoff Reduction Credit

Land Use Considerations:

- X **Residential**
- X **Commercial**
- X **Industrial**

Maintenance:

- Remove debris from inlet and outlet structures
- Maintain side slopes/remove invasive vegetation
- Monitor sediment accumulation and remove periodically

M

Maintenance Burden

L = Low M = Moderate H = High

SECTION 1: DESCRIPTION

An Extended Detention (ED) Pond relies on 24 to 48-hour detention of stormwater runoff after each rain event. An under-sized outlet structure restricts stormwater flow, so it backs up and is stored within the basin. The temporary ponding enables particulate pollutants to settle out and reduces the maximum peak discharge to the downstream channel. ED ponds rely on gravitational settling as their primary pollutant removal mechanism. Consequently, they generally provide fair-to-good removal for particulate pollutants, but low or negligible removal for soluble pollutants. The use of ED alone generally results in a low overall runoff reduction. As a result, ED is normally combined with other practices to maximize runoff reduction.

SECTION 2: PERFORMANCE

Table 6.1. Runoff Volume Reduction Provided by ED Ponds	
Stormwater Function	**Specified Design**
Runoff Volume Reduction (RR)	25%

Sources: CSN (2008), CWP (2007)

SECTION 3: SCHEMATICS

See Appendix 6-A for schematics for use in sheet flow treatment design.

SECTION 4: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

The following feasibility issues need to be evaluated when ED ponds are considered as the final practice in a treatment train. Many of these issues will be influenced by the type of ED Pond being considered (refer to Design Applications at the end of this section).

Infiltration/Soils. Soil conditions do not constrain the use of ED ponds but can affect the design requirements. Hydrologic Soil Groups (HSG) should be determined from NRCS soil data. For more information on soil types go to: http://websoilsurvey.nrcs.usda.gov/app/. Alternative HSG classifications will be considered when supporting reports from a licensed soil scientist or geotechnical engineer are provided.

Available Space. A typical ED pond requires a footprint of 1% to 3% of its contributing drainage area, depending on the depth of the pond (i.e., the deeper the pond, the smaller footprint needed).

Accessibility. ED ponds require periodic maintenance and must be accessible to various types of equipment. A path of travel for equipment no less than twelve feet in width with a maximum slope of 3:1 must be provided for the ED pond. The path of travel shall be along no less than 50% of the perimeter of the ED pond and must be accessible by common equipment and vehicles at all times.

Elevation Considerations. The depth of an ED pond is usually determined by the amount of hydraulic head available at the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the ED pond discharges. Typically, a minimum of 6 to 10 feet of head is needed for an ED pond to function.

Subsurface Constraints. ED pond subgrade shall always be separated from the water table and bedrock. A separation distance of 2 feet is required between the bottom of the excavated ED pond and the seasonally high ground water table and/or bedrock.

Utilities. Public underground utilities and associated easements should not be located within the ED pond footprint. Local utility design guidance shall be consulted in order to determine clearances required between stormwater infrastructure and other dry and wet utility lines. Private utilities should not be located within the pond area when possible.

Contributing Drainage Area. A minimum contributing drainage area of 25 acres is recommended for ED ponds.

Micropool applications require a minimum of 10 acres unless water balance calculations support a permanent pool using a smaller drainage area.

Hotspot Land Uses. Runoff from hotspot land uses should not be treated with ED ponds without appropriate pretreatment and MWS staff approval. For additional information on stormwater hotspots, please consult GIP-01, **Section 7.3**.

Floodplains. ED ponds should be constructed outside the limits of the 100-year floodplain. Flood waters from the 100-year event or smaller should be prohibited from entering the ED pond outlet pipe or overflow system.

Setbacks. It is not recommended to place ED ponds immediately adjacent to structures. To avoid the risk of seepage, a licensed professional engineer should be consulted to determine the appropriate setbacks necessary to prevent extended detention pond infiltration from compromising structural foundations or pavement. At a minimum, ED ponds should be located a horizontal distance of 100 feet from any water supply well and 50 feet from septic systems.

Dam Safety. Tennessee Safe Dams Act may apply to ponds with storage volumes and embankment heights large enough to fall under the regulation for dam safety, as applicable. Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year storm and for instances of malfunction or clogging of primary outlet structure.

Applications. ED ponds can be used at commercial, institutional and residential sites in spaces that are traditionally pervious and landscaped. Extended Detention is normally combined with other stormwater treatment options where a portion of the runoff is directed to bioretention, infiltration, etc. that are within the overall footprint to enhance its performance and appearance. Variations include wet extended detention, micropool extended detention, and multiple pond system.

SECTION 5: DESIGN CRITERIA

5.1 Sizing of Extended Detention Practices

5.1.1 Stormwater Quality

While ED ponds can provide for flood protection, they will rarely provide adequate runoff volume reduction and pollutant removal to serve as a stand-alone compliance strategy. Upland runoff reduction practices can be used to satisfy most or all of the runoff reduction requirements at most sites. Upland runoff reduction practices will greatly reduce the size, footprint and cost of the downstream ED pond.

Runoff treatment (T_v) credit may be taken for the entire water volume below the permanent pool elevation of any micropools, forebays and wetland areas, as well as, the temporary extended detention above the normal pool. A minimum of 40% of the T_v must be designed into the permanent pool. The remaining 60% of the Tv will be contained in a live pool controlled by a low flow orifice. For orifices with diameters less than 3 inches, anti-clogging devices should be used. Low flow orifices can be sized using the following equation:

Equation 6.1. Area of Low Flow Orifice

$$a = \frac{2A(H - H_o)^{0.5}}{3600CT(2g)^{0.5}}$$

Where:

a	=	Area of orifice (ft^2)
A	=	Average surface area of the pond (ft^2)
C	=	Orifice coefficient, 0.66 for thin, 0.80 for materials thicker than orifice diameter
T	=	Drawdown time of pond (hrs), must be greater than 24 hours
g	=	Gravity (32.2 ft/sec^2)
H	=	Elevation when pond is full to storage height (ft)
Ho	=	Final elevation when pond is empty (ft)

5.1.2 Geometry

Side Slopes. Side slopes leading to the ED pond shall have a minimum gradient of 3H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

Long Flow Path. ED pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time, treatment pathways, and pond performance. In terms of flow path geometry, there are two design considerations:

- The overall flow path can be represented as the length-to-width ratio *OR* the flow path. These ratios must be at least 3L:1W. Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.7. In some cases – due to site geometry, storm sewer infrastructure, or other factors – some inlets may not be able to meet these ratios. However, the drainage area served by these "closer" inlets should constitute no more than 20% of the total contributing drainage area.

Vertical Extended Detention Limits. The maximum T_v ED water surface elevation may not extend more than 4 feet above the basin floor or normal pool elevation.

No Pilot Channels. Micropool ED ponds shall not have a low flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to promote the maximum infiltration possible.

Internal Slope. The maximum longitudinal slope through the pond should be approximately 2% to promote positive flow through the ED pond.

5.1.3 Stormwater Quantity

The outlets must then be sized for appropriate storm events. If the pond is additionally going to address peak flow attenuation, the downstream impacts must be considered for the 2-through 100-year events. Refer to **Volume 2 Chapter 8** for instruction on design of outlet orifices, spillways, and weirs.

5.2 Pretreatment

Sediment forebays are considered to be an integral design feature to maintain the longevity of ED ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. The total volume of all forebays should be at least 15% of the total Treatment Volume, exclusive.

Volumetric pretreatment practices, such as forebays, are sized based on a percentage of the required treatment volume of the GIP. The percentage requirement for the pretreatment practice is exclusive of the required treatment volume for the GIP. Exclusive, in this application, is defined as being separate from the required treatment volume of the GIP. The volume provided by pretreatment practices cannot be included in the calculation for overall treatment volume provided by the GIP.

SECTION 6: SPECIAL CASE DESIGN ADAPTATIONS

6.1 Karst Terrain

Karst is found in some areas of Metro Nashville. The presence of karst complicates both land development in general and stormwater design in particular. Designers should always conduct geotechnical investigations in karst terrain to assess this risk during the project planning stage. Because of the risk of sinkhole formation and groundwater contamination in karst regions, use of ED ponds is prohibited.

SECTION 7: CONSTRUCTION

7.1 Construction

Construction Stage Erosion and Sediment Controls. ED ponds should be fully protected by silt fence and construction fencing to prevent sedimentation. Sediment traps or basins may be located within the ED pond excavation limits during construction. The plan must also show the proper procedures for converting the temporary sediment control practice to an ED pond, including dewatering, cleanout and stabilization.

Excavation. The proposed site should be checked for existing utilities prior to any excavation.

7.2 ED Pond Installation

Construction should take place during appropriate weather conditions. The following is a typical construction sequence to properly install an ED pond. These steps may be modified to reflect different applications or expected site conditions:

Step 1. The designer and the installer should have a preconstruction meeting, checking the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed ED pond. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

Step 2. Ensure that the entire contributing drainage area has been stabilized prior to ED pond construction. Otherwise, use EPSC measures as outlined in Section 8.1.

Step 3. Excavation of the ED pond.

Step 5. Install all components per plans.

Step 6. Conduct the final construction inspection (see **Section 9**). Then log the GPS coordinates for each ED pond facility and submit them to MWS.

SECTION 8: AS-BUILT REQUIREMENTS

After the extended detention pond has been constructed, the owner/developer must have an as-built certification of the extended detention pond conducted by a registered Professional Engineer. The as-built certification verifies that the GIP was installed per the approved plan. The as-built requirements are found in SWMM Volume 1.

SECTION 9: MAINTENANCE

9.1 Maintenance Document

The requirements for the Maintenance Document are in Appendix C of Volume 1 of the Manual. They include the execution and recording of an Inspection and Maintenance Agreement or a Declaration of Restrictions and Covenants, and the development of a Long Term Maintenance Plan (LTMP) by the design engineer. The LTMP contains a description of the stormwater system components and information on the required inspection and maintenance activities. The property owner must submit annual inspection and maintenance reports to MWS.

9.2 Maintenance Inspections

Maintenance of ED ponds is driven by annual inspections that evaluate the condition and performance of the pond, including the following:

- Measure sediment accumulation levels in forebay.
- Monitor the growth of wetlands, trees and shrubs planted, and note the presence of any invasive plant species.
- Inspect the condition of stormwater inlets to the pond for material damage, erosion or undercutting.
- Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine embankment integrity.
- Inspect pond outfall channel for erosion, undercutting, rip-rap displacement, woody growth, etc.
- Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc.
- Inspect condition of all trash racks, reverse sloped pipes or flashboard risers for evidence of clogging, leakage, debris accumulation, etc.
- Inspect maintenance access to ensure it is free of woody vegetation, and check to see whether valves, manholes and

locks can be opened and operated.

- Inspect internal and external side slopes of the pond for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately.

9.3 Common Ongoing Maintenance Issues

ED ponds are prone to a high clogging risk at the ED low-flow orifice. This component of the pond's plumbing should be inspected at least twice a year after initial construction. The constantly changing water levels in ED ponds make it difficult to mow or manage vegetative growth. The bottom of ED ponds often become soggy, and water-loving trees such as willows may take over. The maintenance plan should clearly outline how vegetation in the pond will be managed or harvested in the future.

The maintenance plan should schedule a cleanup at least once a year to remove trash and floatables that tend to accumulate in the forebay, micropool, and on the bottom of ED ponds.

Frequent sediment removal from the forebay is essential to maintain the function and performance of an ED pond. Maintenance plans should schedule cleanouts every 5 to 7 years, or when inspections indicate that 50% of the forebay capacity has been filled. Sediments excavated from ED ponds are not usually considered toxic or hazardous, and can be safely disposed by either land application or land filling.

SECTION 10: COMMUNITY AND ENVIRONMENTAL CONCERNS

Extended Detention Ponds can generate the following community and environmental concerns that need to be addressed during design.

Aesthetics. ED ponds tend to accumulate sediment and trash, which residents are likely to perceive as unsightly and creating nuisance conditions. Fluctuating water levels in ED ponds also create a difficult landscaping environment. In general, designers should avoid designs that rely solely on *dry* ED ponds.

Existing Wetlands. ED ponds should never be constructed within existing *natural* wetlands, nor should they inundate or otherwise change the hydroperiod of existing wetlands.

Existing Forests. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during design and pond construction. Designers should also be aware that even modest changes in inundation frequency can kill upstream trees (Cappiella *et al.,* 2007).

Safety Risk. ED ponds are generally considered to be safer than other pond options, since they have few deep pools. Steep side-slopes and unfenced headwalls, however, can still create some safety risks. Gentle side slopes should be provided to avoid potentially dangerous drop-offs, especially where ED ponds are located near residential areas.

Mosquito Risk. The fluctuating water levels within ED ponds have potential to create conditions that lead to mosquito breeding. Mosquitoes tend to be more prevalent in irregularly flooded ponds than in ponds with a permanent pool (Santana *et al.*, 1994). Designers can minimize the risk by combining ED with a wet pond or wetland.

SECTION 11: REFERENCES

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Virginia Department of Conservation and Recreation (VADCR). 2011. *Virginia DCR Stormwater Design Specification No. 15, Extended Detention (ED) Pond, Version 1.9, March 1, 2011*. Division of Soil and Water Conservation. Richmond, VA.

APPENDIX 6-A
SCHEMATICS

Figure 6.1 portrays a typical schematic for an ED pond.

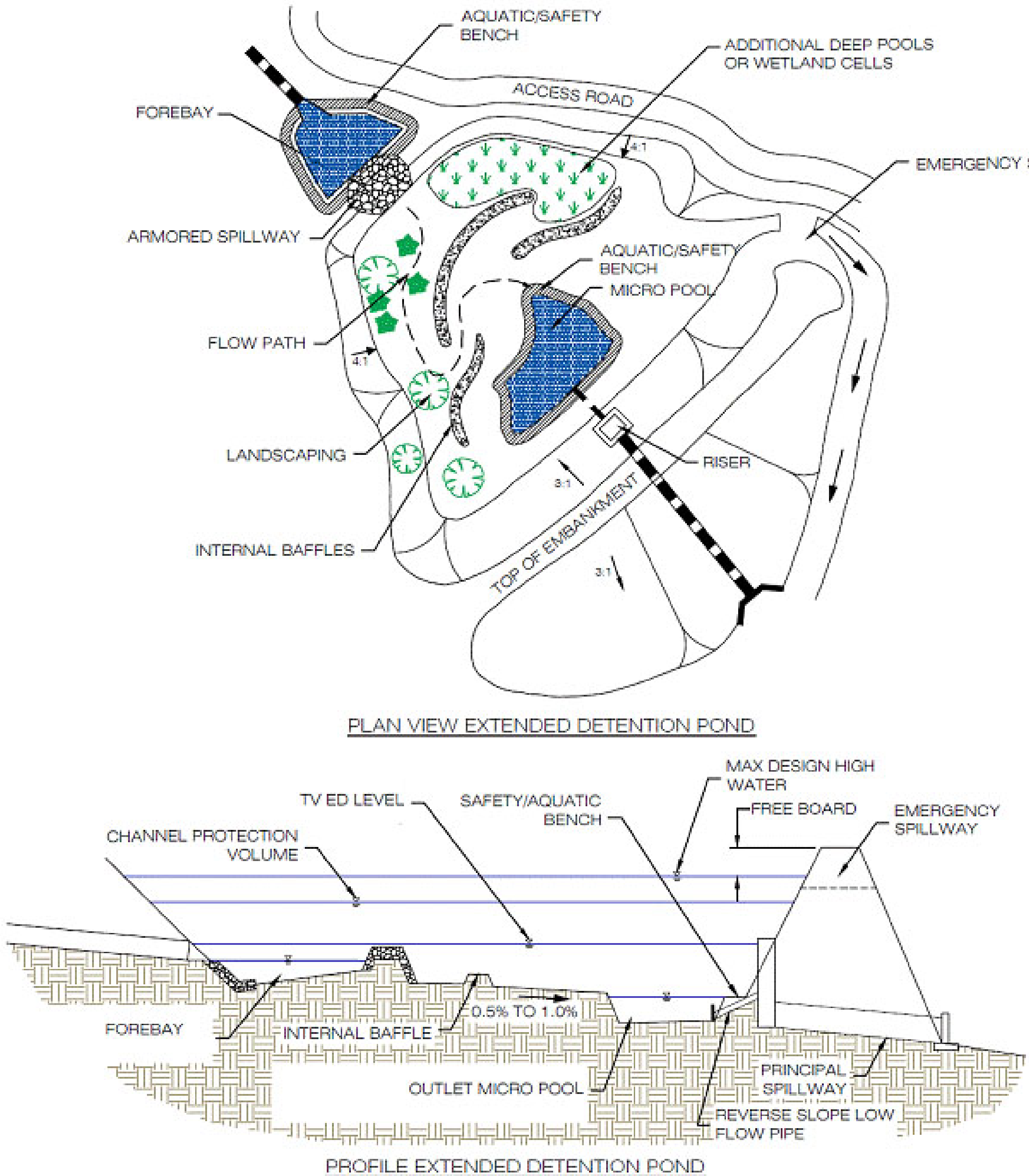

Figure 6.1. Typical Extended Detention Pond Details (source: VADCR, 2011)

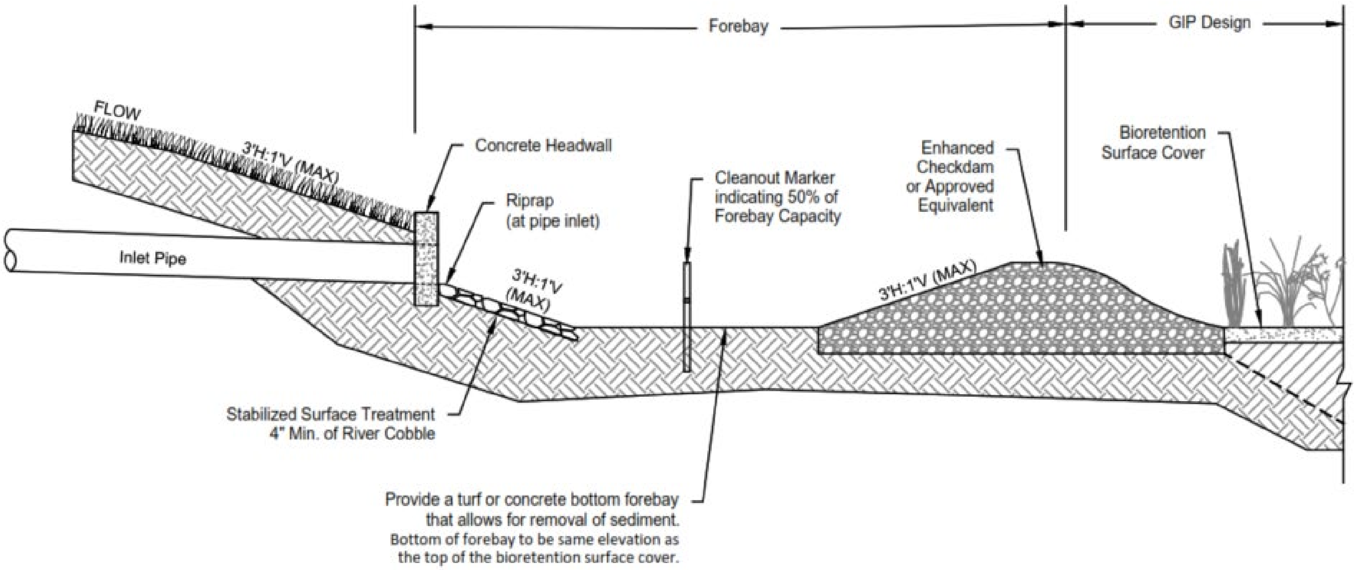

Figure 6.2. Forebay Detail

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