Wet Ponds

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

Variations: Wet extended detention, micropool extended detention, multiple pond system.

Components:
- Permanent pool – prevents resuspension of solids
- Live storage above permanent pool – sized for a percentage of water quality volume and flow attenuation. Percentage depends on type of wet pond chosen
- Forebay – settles out larger sediments in an area where sediment removal will be easier
- Spillway system – spillway system(s) provides outlet for stormwater runoff when large storm events occur and maintains the permanent pool

Advantages/Benefits:
- Moderate to high pollutant removal
- Can be designed as a multi-functional BMP
- C ost effective
- 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
- May require additional permitting through TDEC for ARAP or Safe Dams
- Community perceived concerns with mosquitoes and safety

Design considerations:
- Minimum contributing drainage area of 25 acres; 10 acres for micropool extended detention (Unless water balance calculations show support of permanent pool by a smaller drainage area)
- Sediment forebay or equivalent pretreatment must be provided
- Minimum length to width ratio = 3:1
- Maximum depth of permanent pool = 8'
- 3:1 side slopes or flatter around pond perimeter

Selection Criteria:

✓ **Water Quality 80 % TSS Removal**

✓ **Quantity Control**

Land Use Considerations:

✓ **Residential**

✓ **Commercial**

✓ **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

General Description

Stormwater ponds are constructed stormwater basins that can be designed to serve multiple functions, including stormwater quality treatment, peak flow attenuation, and wildlife habitat creation. Stormwater quality treatment is achieved in the storage provided both within the permanent pool and the live pool volume, depending on the type of wet pond design. The permanent pool (or micropool for micropool extended detention design) provides the majority of the volume used for settling particulates. A well-designed and landscaped pond can be an aesthetic feature when planned and located properly.

Figure 1.1 illustrates a typical wet pond, showing the components found in the pond variations, described in the next section. Figures 1.2, 1.3, and 1.4 are schematics for wet pond variations that are allowed in Metro.

Stormwater wet ponds must be designed by a licensed professional engineer.

Components

Sediment forebay. The forebay is a pretreatment BMP that allows heavier sediments to settle out before they reach the permanent pool. Often, the floor of the forebay is concrete or other hardened surface so that periodic sediment removal is easier. The forebay treatment area can provide for a portion of the required water quality treatment volume for a site.

Permanent pool. The permanent pool, or dead storage, provides the mechanism for settling out solids from stormwater runoff, as well as providing the setting for biological uptake of some pollutants. As new stormwater runoff enters the permanent pool, stormwater stored in the permanent pool is replaced. A micropool is a type of permanent pool

Live storage. The storage area provided above the permanent pool is used to capture and slowly release the first flush volume. In some pond variations, such as the wet extended detention pond, the water quality treatment volume is split between the permanent pool and the live storage area. Larger storm events can also be treated for peak flow attenuation within the live storage volume.

Spillway systems. Spillway systems are typically made up of emergency spillways and primary spillway systems, designed as channels, riser and barrel structures, or a combination of the two. Spillway systems for wet ponds typically have multiple outlets to control different design storms. The spillway system must also include an emergency drain to allow complete draining of the pond within 24 hours.

Design Variations

The following design variations are allowed as stormwater quality treatment BMPs in Metro:

Design Variations (continued)

Wet pond. Stormwater wet ponds are built with a permanent pool, or dead storage, equal to the water quality volume. Stormwater runoff displaces the water already in the pool. Temporary storage is provided above the permanent pool elevation for attenuation of larger storm events.

Wet extended detention (ED) pond. In a wet extended detention (ED) pond, the water quality volume is split evenly between the permanent pool and extended detention (ED) storage provided above the permanent pool. During storm events, water is detained above the permanent pool elevation for 24-48 hours. This design provides the same pollutant reduction but consumes less space.

Micropool extended detention pond. Variation of the ED pond, where a micropool is maintained below the outlet of the pond. The micropool volume is calculated as 0.1 inch per impervious acre or 20% of the water quality volume (WQ_v), whichever is greater. The remainder of the required water quality volume is stored above the micropool in the live pool storage. The micropool prevents resuspension of solids and prevents clogging of low flow orifices. The live pool storage above the micropool is also used for the attenuation of larger storm events. The water quality volume stored in the live pool area must be detained for 24 hours. This pond most resembles the "dry pond" design. The difference in this style pond and the wet ED pond is the storage location of the water quality volume (WQ_v).

Multiple pond systems. Multiple ponds in series, that provide longer flow paths and two or more storage cells for water quality and quantity treatment. Pollutant reduction of ponds in series provides more than 80% TSS removal (see Volume 4, Section 6 Introduction, section 6.2 for guidance on pollutant removal reductions for BMPs in series).

Site and Design Considerations

The following design and site considerations must be incorporated into the BMP plan:

General design

1. A licensed professional engineer must design all types of wet ponds.
2. Ponds must not be constructed in or located on a stream.
3. All components of a stormwater wet pond, including access, must be located in a drainage easement.
4. Access to the forebay, permanent pool and spillways must be considered in the planning and design. Permanent access must be provided from a public road and maintained throughout the life of the structure.
5. A minimum drainage area of 25 acres is needed for wet ponds and wet ED ponds to maintain the permanent pool. The minimum drainage area for micropool ED ponds is 10 acres. A smaller drainage area may be acceptable with an adequate water balance (refer to PTP-02 *Constructed Wetlands*

Site and Design Considerations (continued)

Design Procedures Step #2 for water balance calculations) and an anti-clogging pond outlet.

6. The space required to construct a wet pond is approximately 2-3% of the tributary drainage area.
7. Stormwater ponds should be located to provide for maximum runoff storage at a minimal construction cost.
8. Stormwater ponds should not be located on slopes that are equal to or greater than 15%.

Pretreatment

9. All stormwater ponds must incorporate a sediment forebay or pretreatment device at the point or points of inflow. The purpose of the pretreatment is to settle out heavier solids in an area that is easier to clean out than the permanent pool.
10. The forebay must consist of a separate cell from the permanent pool, separated by an acceptable barrier.
    a. For maintenance purposes in larger ponds, the bottom of the forebay should be hardened (e.g., concrete lined) to make sediment removal easier and width of the forebay should accommodate a small piece of equipment, such as a Bobcat.
    b. The forebay must be sized to contain 0.1 inches per impervious acre contributing drainage and should be a minimum of 4-6 feet deep. The forebay storage volume counts toward the total WQ_v requirement and may be subtracted from the WQ_v for subsequent calculations.
    c. A fixed vertical sediment depth marker must be installed in the forebay to visually indicate sediment depth over time.
    d. Exit velocities from the forebay must be non-erosive.
11. Although forebays are preferred for pretreatment because they require less maintenance, other acceptable pretreatment devices include baffle boxes or stormwater quality inlets.

Permanent Pool

12. The maximum depth of the permanent pool is 8 feet. The objective is to avoid thermal stratification that could result in odor problems associated with anaerobic conditions.
13. In general, stormwater pond designs will be unique for each site. However, the following should be observed to meet the pollutant removal goals:
    a. Permanent pool:
        - Standard wet ponds: 100% of the water quality treatment volume (1.0 WQ_v).
        - Wet ED pond: 50% of the water quality treatment volume (0.5 WQ_v), the other 50% is accounted for in the live pool volume.
        - Micropool pond: Approximately 0.1 inch per impervious acre or 20% of the water quality treatment volume (0.1 IA) or (0.2 WQ_v), whichever is greater.

Site and Design Considerations (continued)

b. Short-circuiting of the pond should be avoided by designing stormwater ponds with a length to width ratio of 3:1 or greater. Baffles, pond shaping, or islands can be added to the permanent pool area to create a longer flow path.
c. Side slopes of the pond should not exceed 3H:1V, or additional safety precautions must be provided, and should terminate on a safety bench (see Figure 1.5). The safety bench requirement may be waived if the side slopes are 4H:1V or flatter.

14. The perimeter of all pool areas that are 6 feet or deeper must be surrounded by two benches: a safety bench and an aquatic bench. The safety bench extends at least 15 feet outward from the permanent pool water edge to the toe of the pond slope. The maximum slope of the safety bench is 6%. The aquatic bench should extend inward from the permanent pool edge a minimum of 15 feet and should have a maximum depth of 18 inches below the permanent pool surface elevation.
15. Bedrock must be considered in the Nashville area because excavation may be required for a permanent pool. If there is highly fractured bedrock or karst topography, then the feasibility of a wet pond should be carefully considered because it may not hold water and the additional water flow and/or weight could intensify karst activity.
16. To maintain a permanent pool, excessive losses through infiltration must be avoided. Depending on the soils, infiltration losses can be minimized through compaction, the addition of a clay liner or an artificial liner.

Live Pool

17. Live pool volumes are dependent upon the need for storm attenuation. Hydrograph routing must be completed for the 2- through 100-year events to determine the required volume and to demonstrate that post-construction flow rates are equal to or smaller than pre-construction rates for each event. Wet ED ponds and micropool ED ponds require that a percentage of the WQ_v be treated in the live-pool volume. This volume can also be included as volume required for storm attenuation.

Outlet Structures

18. Flow control from a stormwater pond is typically accomplished with the use of a concrete or corrugated metal riser and barrel. The riser should be located within the stormwater pond embankment for maintenance access, safety, floatation prevention, and aesthetics. See Figures 1.6 through 1.8 for typical pond outlet structures.
19. To control different storm events, outlets at varying elevations on the riser pipe should be used. The number of orifices varies and is usually a function of the pond design parameters. Additional information for outlet design is provided in Volume 2, Chapter 8.

Site and Design Considerations (continued)

For example, a wet pond riser configuration is typically comprised of multiple small storm outlets (usually orifices) and the 25- and 100- year outlets (often slots or weirs).

20. Water quality outlet designs require additional outlet configurations, separate from the storm attenuation/flood control outlet. For wet ponds, the water quality volume is fully contained in the permanent pool, no additional orifice sizing is necessary for this volume. For larger volumes, orifice sizing guidance is included in the Design Procedures and Figures 1.8 and 1.9. As runoff from a water quality event enters the wet pond, it simply displaces that same volume through a smaller storm event orifice. Thus an off-line wet pond providing *only* water quality treatment can use a simple overflow weir as the outlet structure. On-line wet ponds may or may not require multi-stage riser configurations, depending on the need for storm attenuation. In the case of wet ED ponds and micropool ED ponds, there is an additional outlet (usually an orifice) that is sized to pass the extended detention water quality volume on top of the permanent pool. Flow will first pass through this orifice, which is sized to release the water quality ED volume in 24-48 hours. The preferred design is a reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool to prevent floatables from clogging the pipe and to avoid discharging warmer water at the surface of the pond. The next outlet is sized for the release of other smaller storm events (2- or 10-yr). The primary outlet (often an orifice) invert is located at the maximum elevation associated with the extended detention water quality volume and is sized through routing to release flow at or below the pre-100-yr levels.

    The following types of orifices that may be encountered in a typical pond design are as follows:
    1. Pond drain (to allow maintenance and construction)
    2. Permanent pool orifice (to control volume and allow drawdown)
    3. WQ_v orifice (for ED and MicroPool to control live pool elevation)
    4. Outlets at required flow attenuation levels to control peaks.

    Alternative hydraulic control methods to an orifice can be used and include the use of a broad-crested rectangular, V-notch, or proportional weir, or an outlet pipe protected by a hood that extends at least 12 inches below the permanent pool.
21. The water quality outlet (if designed for a wet ED or micropool ED pond) must be fitted with adjustable gate valves or other mechanism that can be used to adjust detention time.
22. Higher flows pass through openings or slots protected by trash racks further up the riser.
23. Anti-seep collars must be installed on the outlet barrel and an anti-vortex device must be incorporated into the outlet barrel. An energy dissipater must be installed at the stormwater pond pipe outlet to prevent scour at the outlet.

Site and Design Considerations (Continued)

24. Stormwater ponds must have a bottom drain with an adjustable valve that can completely drain the pond within 24 hours. The pond drain should be sized one pipe size larger than the calculated design diameter. The drain valve is typically a handwheel activated knife or gate valve. Valve controls must be located inside of the riser at a point where they will not likely be inundated and can be operated in a safe manner.
25. Access to the riser must be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls.

Outlet Design Considerations

26. Proper hydraulic design of the outlet is critical to achieving good performance of the stormwater pond. The two most common outlet problems that occur are: 1) the capacity of the outlet is too great resulting in partial filling of the basin and less than the intended drawdown time and 2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, two alternative outlet types are recommended for use: 1) Notched weir and 2) perforated riser. The notched weir will not clog as easily, and is therefore preferred. Details for designing outlets/orifices are found in the Design Procedures Step # 6 and in Volume 2, Chapter 8.

Emergency spillway

27. An emergency spillway must be included in the stormwater pond design to safely pass large storm events. The spillway prevents overtopping of the embankment in large storm events and causing structural damage. The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
28. A minimum of 1 foot of freeboard must be provided, measured from the top of the water surface elevation for the 100-year storm event to the lowest point on the top of berm. The emergency spillway crest elevation will be slightly below the 100-year storm elevation, determined by the amount of flow calculated over the weir to match post- to pre-conditions.

Landscaping

29. Aquatic vegetation can play an important role in pollutant removal in a stormwater pond. In addition, vegetation can enhance the appearance of the pond, stabilize the side slopes and serve as wildlife habitat. Therefore, wetland plants are encouraged in a pond design, along with the aquatic bench (fringe wetlands), the safety bench and side slopes, and within shallow areas of the pool itself. The best elevations for establishing wetland plants, either by transplantation or volunteer colonization, are within 6 inches (plus or minus) of the permanent pool elevation. Information about wetland plants can be found at TVA's Native Plant Selector that can be found at: http://www.tva.gov/river/landandshore/stabilization/plantsearch.htm.
30. Woody vegetation must not be planted on the embankment or allowed to grow within 15 feet of the toe of the embankment and within 25 feet from the principle spillway.

Site and Design Considerations (Continued)

31. Fish such as *Gambusia affinis* can be stocked for mosquito control if necessary.
32. A fountain or aerator may be beneficial for oxygenating water in the permanent pool. Considerations must be given in the design of this fountain or aerator not to disturb settling within the pond or prevent settling. Use of such fountains is discouraged during storm events.

As-Built Certification

An as-built certification of the pond by a registered professional engineer, must be submitted to Metro prior to the release of the site's bond or issuance of a Use and Occupancy permit. The as-built certification must verify that the BMP was installed as designed and approved. If components of the stormwater pond constructed in the field differ from the design approved by Metro, the as-built certification must:

1. Note any differences between the measure in the field and the design approved by Metro;
2. Demonstrate that the design meets the requirements of Metro's stormwater program; and/or
3. Propose additional measures to be included on the site to mitigate the differences.

The following components should be addressed in the as-built certification:

- Sediment forebay of sufficient size to pretreat runoff.
- Access to all components of the pond.
- Sufficient water depth to prevent the creation of stagnant water.
- Depth of treatment area.
- Side slopes and benches created as noted in the plans.
- Properly functioning spillway systems.

Operation and Maintenance

Each BMP on a site must be addressed in the overall Operations and Maintenance (O&M) Agreement (refer to Volume 1, Appendix C) for the development and submitted to Metro for approval with the plans submittal. This information should be included in the O&M Agreement for the development.

The O&M Agreement is to be used by the BMP owner or owners in performing routine inspections. The owner is responsible for the cost of maintenance and annual inspections, and maintaining and updating the BMP operations and maintenance plan at least annually. At a minimum, the operations and maintenance plan must address:

1. The inspection of the embankment and spillway components;
2. The removal of sediment deposits from the forebay and permanent pool area;
3. The removal of spillway blockages or dead vegetation.

Design Procedures

Design Procedures for standard wet pond, extended detention, and micropool extended detention ponds are described separately below. Some of the steps for extended detention and micropool extended detention ponds are the same as for a standard wet pond and these common steps will refer back to the standard wet pond design steps.

Design Procedures for Wet Pond

Wet Pond

Step 1. Compute the Water Quality Volume.

Calculate (WQ_v).

$$\mathbf{WQ_v = P \times Rv \times A/12}$$

Where:

WQ_v = water quality treatment volume, ac-ft
P = rainfall for the 85% storm event (1.1 in)
Rv = runoff coefficient (see below)
A = site area, acres

$$\mathbf{Rv = 0.015 + 0.0092I}$$

Where:

I = site impervious cover, % (for example, 50% imperviousness is 50)

Step 2. Determine if the development site and conditions are appropriate for the use of the wet pond.

Consider the Site and Design Considerations discussed previously in this section. Available land area and drainage area are key components.

Step 3. Determine pretreatment volume.

A sediment forebay is sized for each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond. The forebay should be sized to contain 0.1 inches per impervious acre of contributing drainage and should be 4-6 feet deep. The forebay storage volume (F_v) counts toward the total WQ_v requirement and may be subtracted from the WQ_v for subsequent calculations.

$$\mathbf{F_v = 0\ .1\ inches \times A_I\ acres \times .0833}$$

Where:

F_v = Forebay volume (ac-ft)
A_I = Impervious area of drainage basin, acres
0.0833 = conversion factor of acre inches to acre feet

Design Procedures for Wet Pond (Continued)

Often, it is more manageable to work with forebay volumes in cubic feet rather than acre feet, because they are small volumes. To convert F_v in acre feet to cubic feet, multiply F_v by 43560 square feet.

Step 4. Determine permanent pool volume.

Size permanent pool volume to 1.0 WQ_v.

Step 5. Determine pond preliminary geometry and storage available for pool areas.

Establish contours and determine the stage-storage relationship for the pond. Include safety and aquatic benches. Any live pool volume is dependent on the necessity for flow attenuation only. If no flow attenuation is necessary, no live pool is necessary.

Step 6. Size the outlet system for other storm events.

If the pond is to serve as a multifunctional pond addressing flow attenuation, the downstream impacts must be considered for the 2- through 100-year storm events. Determine the downstream point in the watershed where the proposed site makes up 10% or less of the total drainage area to the point in question (considered the 10% point). Check the peak discharge for pre- and post-development runoff rates at the 10% point and at major junctions within the downstream watershed. Where an increase is realized, the stormwater pond can be designed for flow attenuation to the pre-development runoff rate or less through the use of multiple orifices in the primary spillway structure. (See Volume 2, Chapter 8).

Establish a stage-storage-discharge relationship for the design storms of interest, based upon the downstream analysis (see Section 6.6.1 in Volume 1).

Step 7. Design embankment and spillway.

Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year and for instances of malfunction/clogging of primary outlet structure.

Step 8. Investigate potential dam hazard classification.

The design and construction of ponds in Tennessee must follow the requirements of the Safe Dams Act. Contact the Tennessee Department of Environment and Conservation, Division of Water Supply for more information about building dams in Tennessee.

Design Procedures for Wet Pond (Continued)

Step 9. Design inlets, sediment forebays, outlet structures, maintenance access and safety features.

See the *Site and Design Considerations* section for information on design.

Step 10. Prepare the vegetation and landscaping plan.

See the Landscaping section of *Site and Design Considerations* section.

Design Procedures for Wet Extended Detention (ED) Pond

Wet Extended Detention (ED) Pond

Step 1. Compute the Water Quality Volume.

Calculate (WQ_v).

$$WQ_v = P \times Rv \times A/12$$

Where:

WQ_v = water quality treatment volume, ac-ft
P = rainfall for the 85% storm event (1.1 in)
Rv = runoff coefficient (see below)
A = site area, acres

$$Rv = 0.015 + 0.0092I$$

Where:

I = site impervious cover, % (for example, 50% imperviousness is 50)

Step 2. Determine if the development site and conditions are appropriate for the use of the wet ED pond.

See standard Wet Pond Design Procedures Step 2.

Step 3. Determine pretreatment volume.

See standard Wet Pond Design Procedures Step 3.

Step 4. Determine permanent pool volume.

Size permanent pool volume to 0.5 WQ_v. Size extended detention volume to 0.5 WQ_v.

Design Procedures for Wet Extended Detention (ED) Pond (Continued)

Step 5. Determine pond preliminary geometry and storage available for pool areas.

Establish contours and determine the stage-storage relationship for the pond. Include safety and aquatic benches.

Set permanent pool elevation and live pool elevation based on volume calculated previously.

Step 6. Compute extended detention orifice release rate(s).

Based on the elevations established in Step 5 for the extended portion of the water quality volume, the water quality orifice is sized to release this extended detention volume in 24-48 hours. The water quality orifice should have a minimum diameter of 3 inches or use the perforated riser pipe and should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool, is a recommended design. Adjustable gate valves can also be used to achieve this equivalent diameter.

Three different types of control structures are listed below. More information can be found on the design of outlet structures in Volume 2, Chapter 8.

Flow Control Using a "V" Notch Weir
The outlet control "V" notch weir should be sized using the following formula (Metro, 2000). See Figure 1.8

$$Q = C_1 H^{5/2} \tan\left(\frac{\theta}{2}\right)$$

Where

θ = notch angle, in degrees
H = head or elevation of water over the weir, ft
C_1 = discharge coefficient (see Figure 1.9)

The notch angle should be 20° or more. If calculations show that a notch angle of less than 20° is appropriate, then the outlet should be designed as a uniform width notch. This will generally necessitate some sort of floatables control such as a skimmer on the outlet or trash rack on the inlet.

Flow Control Using a Single Orifice
The outlet control orifice should be sized using the following equation (Metro, 2000).

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

Design Procedures for Wet Extended Detention (ED) Pond (Continued)

Where:
a = area of orifice (ft^2)
A = average surface area of the pond (ft^2)
C = orifice coefficient, 0.66 or 0.80
T = drawdown time of pond (hrs)(must be greater than 24 hours)
g = gravity (32.2 ft/sec^2)
H = elevation when pond in full (ft)
H_o= final elevation when pond is at permanent pool elevation (ft)

With a drawdown time of 40 hours the equation becomes:

$$a = \frac{(1.75 \times 10^{-5}) A (H - H_o)^{0.5}}{CT}$$

Care must be taken in the selection of "C": 0.60 is most often recommended and used. However, based on actual tests the following is recommended:

C = 0.66 for thin materials, that is, the thickness is equal to or less than orifice diameter
C= 0.80 when the material is thicker than the orifice diameter

Drilling the orifice into an outlet structure that is made of concrete can result in considerable impact on the coefficient, as does the beveling of the edge.

Flow Control Using the Perforated Riser
For outlet control using the perforated riser as the outflow control, incorporate flow control for the small storms in the perforated riser but also provide an overflow outlet for large storms, as illustrated in Figure 1.10. If properly designed, see Table 1.1, the facility can be used for both water quality and quantity control by: 1) sizing the perforated riser as indicated for water quality control; 2) sizing the outlet pipe to control peak outflow rate from the 2-year storm; and 3) using a spillway in the pond berm to control the discharge from larger storms up to the 100-year storm. To prevent clogging of an orifice and the bottom orifices of the riser pipe, wrap the bottom three rows of orifices with geotextile fabric and a cone of one to three inch rock.

Table 1.1 Perforated Riser Sizing Guidance *(Metro, 2000)*

Riser Pipe Diameter	Vertical Spacing Between Rows (Center to Center)	Number of Perforations	Perforation Diameter
6 in. (15.2 cm)	2.5 in. (6.4 cm)	9 per row	1 in. (2.54 cm)
8 in. (20.3 cm)	2.5 in. (6.4 cm)	12 per row	1 in. (2.54 cm)
10 in. (25.4 cm)	2.5 in. (6.4 cm)	16 per row	1 in. (2.54 cm)

Design Procedures for Wet Extended Detention (ED) Pond (Continued)

Step 7. Size the primary spillway system for other storm events.

See standard Wet Pond Design Procedures Step 6.

Step 8. Design embankment and spillway.

Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year and for instances of malfunction/clogging of primary outlet structure.

Step 9. Investigate potential dam hazard classification.

The design and construction of ponds in Tennessee must follow the requirements of the Safe Dams Act. Contact the Tennessee Department of Environment and Conservation, Division of Water Supply for more information about building dams in Tennessee.

Step 10. Design inlets, sediment forebays, outlet structures, maintenance access and safety features.

See the *Site and Design Considerations* section for information on designing these features

Step 11. Prepare the vegetation and landscaping plan.

See the Landscaping section of *Site and Design Considerations* section.

Design Procedures for Micropool ED Pond

Micropool ED Pond

Step 1. Compute the Water Quality Volume.

Calculate (WQ_v).

$$\mathbf{WQ_v = P \times Rv \times A/12}$$

Where:

WQ_v = water quality treatment volume, ac-ft
P = rainfall for the 85% storm event (1.1 in)
Rv = runoff coefficient (see below)
A = site area, acres

$$Rv = 0.015 + 0.0092I$$

Where:

I = site impervious cover, % (for example, 50% imperviousness is 50)

Design Procedures for Micropool ED Pond (Continued)

<u>Step 2. Determine if the development site and conditions are appropriate for the use of the wet pond.</u>

See standard Wet Pond Design Procedures Step 2.

<u>Step 3. Determine pretreatment volume.</u>

See standard Wet Pond Design Procedures Step 3.

<u>Step 4. Determine permanent pool volume.</u>

Size permanent pool volume to minimum of either 20% of WQ_v or 0.1 inch per impervious acre. Size extended detention volume (live pool) to remainder of WQ_v.

<u>Step 5. Determine pond preliminary geometry and storage available for pool areas.</u>

Establish contours and determine the stage-storage relationship for the pond. Include safety and aquatic benches.

Set micropool permanent pool elevation and live pool elevation based on volume calculated previously.

<u>Step 6. Compute extended detention orifice release rate(s).</u>

See standard Wet ED Design Procedures Step 6.

<u>Step 7. Size the primary spillway system for other storm events.</u>

See standard Wet Pond Design Procedures Step 6.

<u>Step 8. Design embankment and spillway.</u>

Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year and for instances of malfunction/clogging of primary outlet structure.

<u>Step 8. Design embankment and spillway.</u>

Size emergency spillway for any overtopping of pond in case of rain event in excess of 100-year and for instances of malfunction/clogging of primary outlet structure.

Design Procedures for Micropool ED Pond (continued)

Step 9. Investigate potential dam hazard classification.

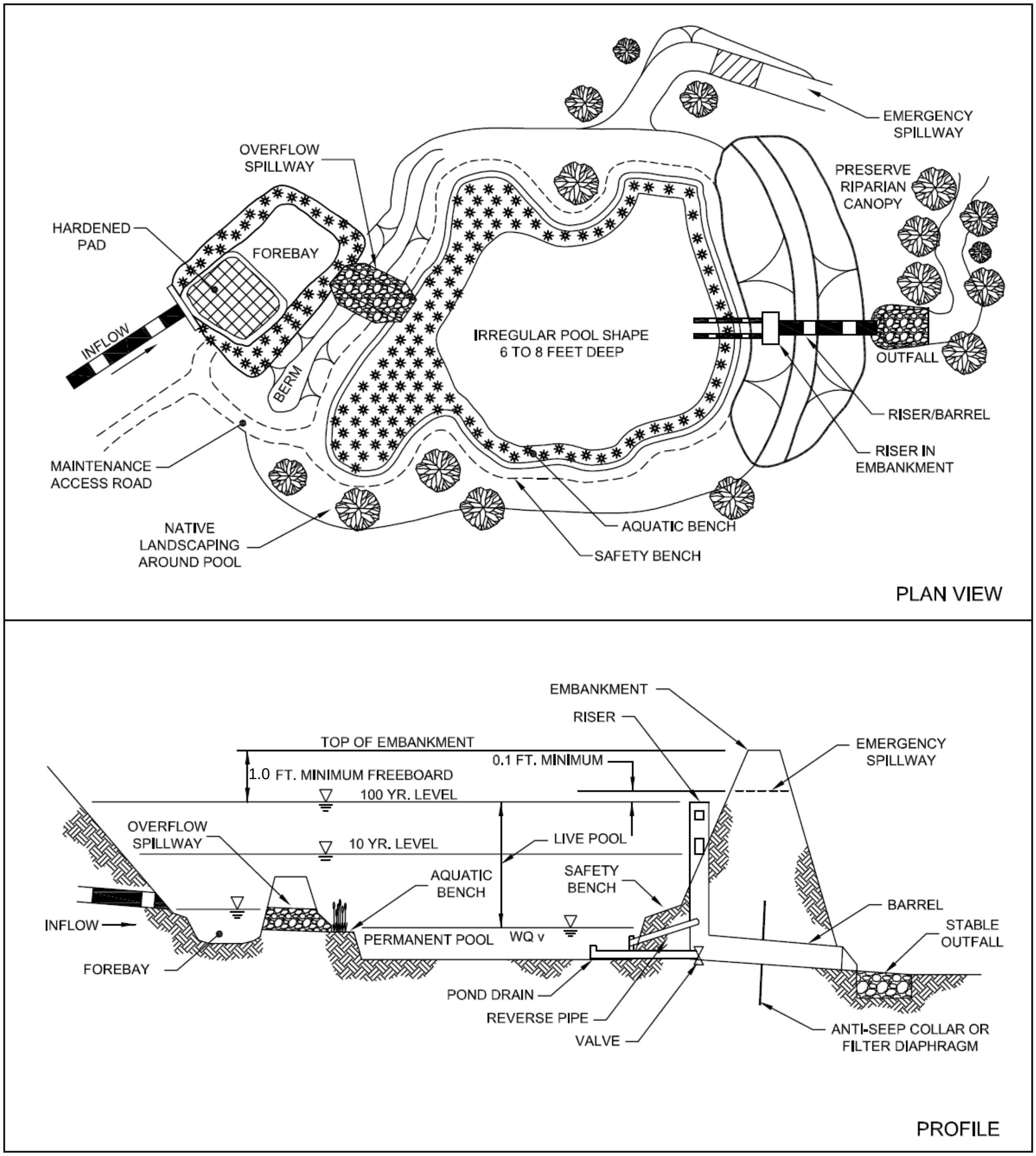
The design and construction of ponds in Tennessee must follow the requirements of the Safe Dams Act. Contact the Tennessee Department of Environment and Conservation, Division of Water Supply for more information about building dams in Tennessee.

Step 10. Design inlets, sediment forebays, outlet structures, maintenance access and safety features.

See the *Site and Design Considerations* section for information on designing these features.

Step 11. Prepare the vegetation and landscaping plan.

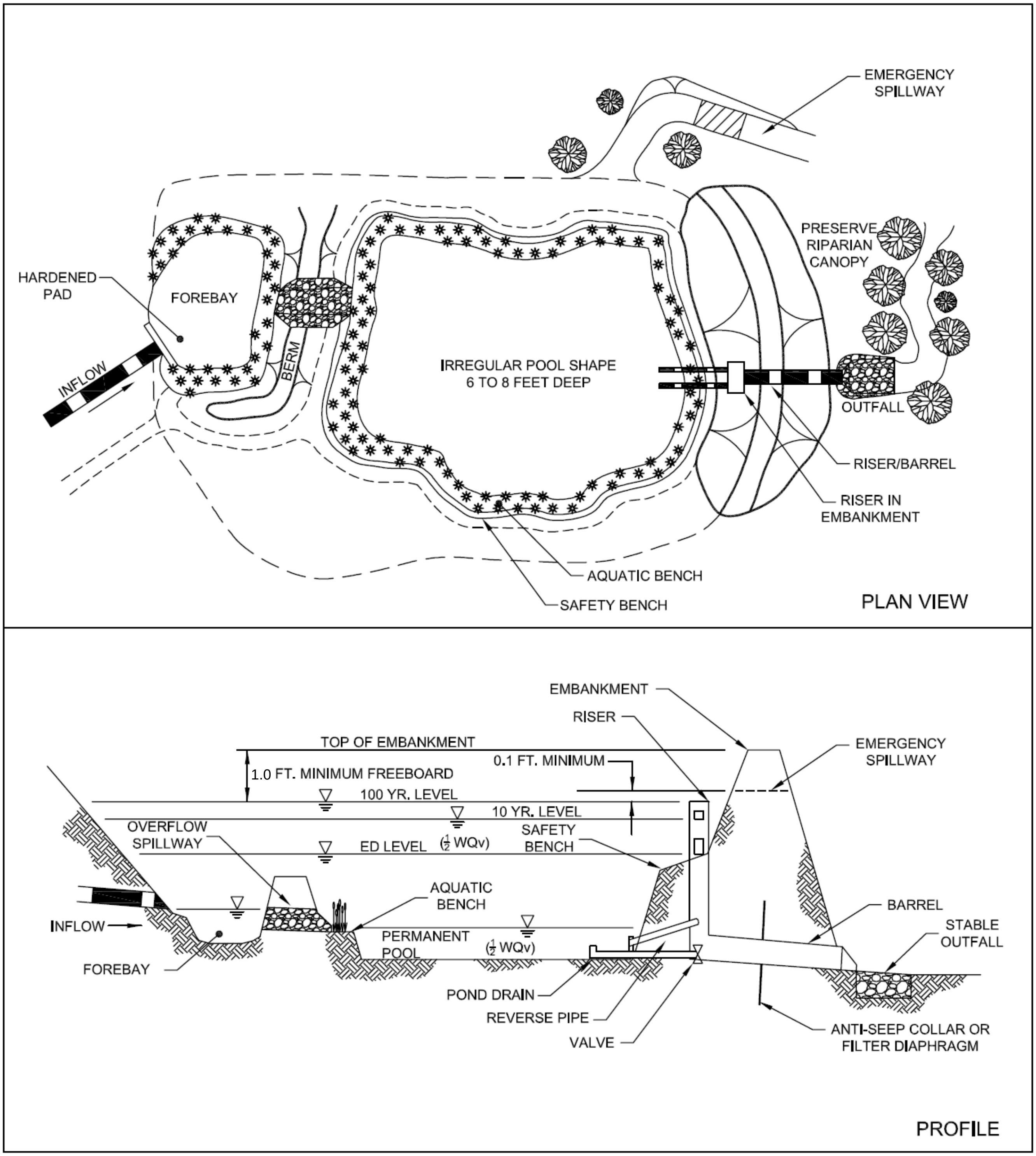
See the Landscaping section of *Site and Design Considerations* section.



Note: Storm attenuation levels vary depending on site detention requirements.

(Adapted from the Center for Watershed Protection)

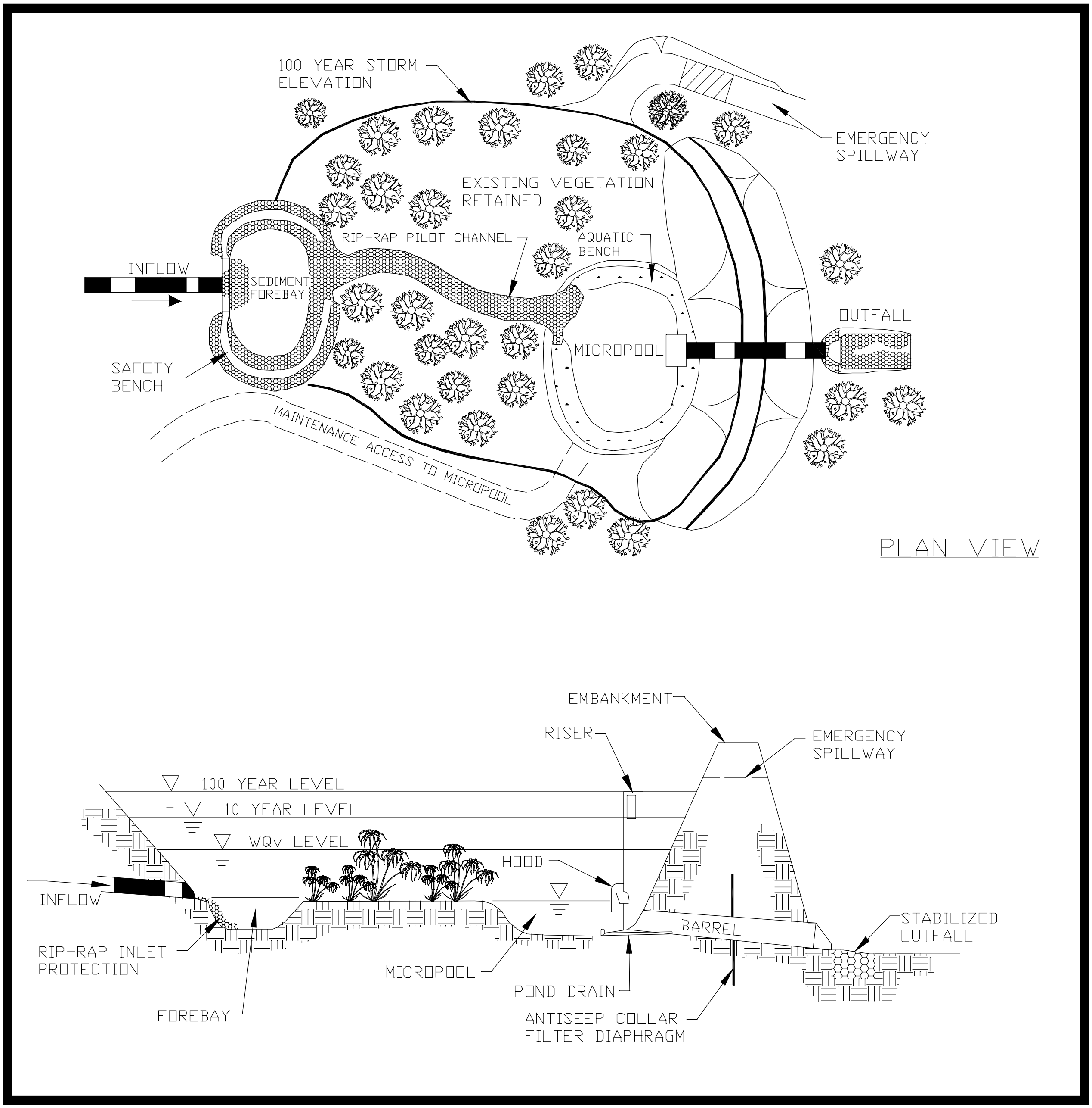
Figure 1.1 Typical Schematic for a Wet Pond



Note: Storm attenuation levels vary depending on site detention requirements.

(Adapted from the Center for Watershed Protection)

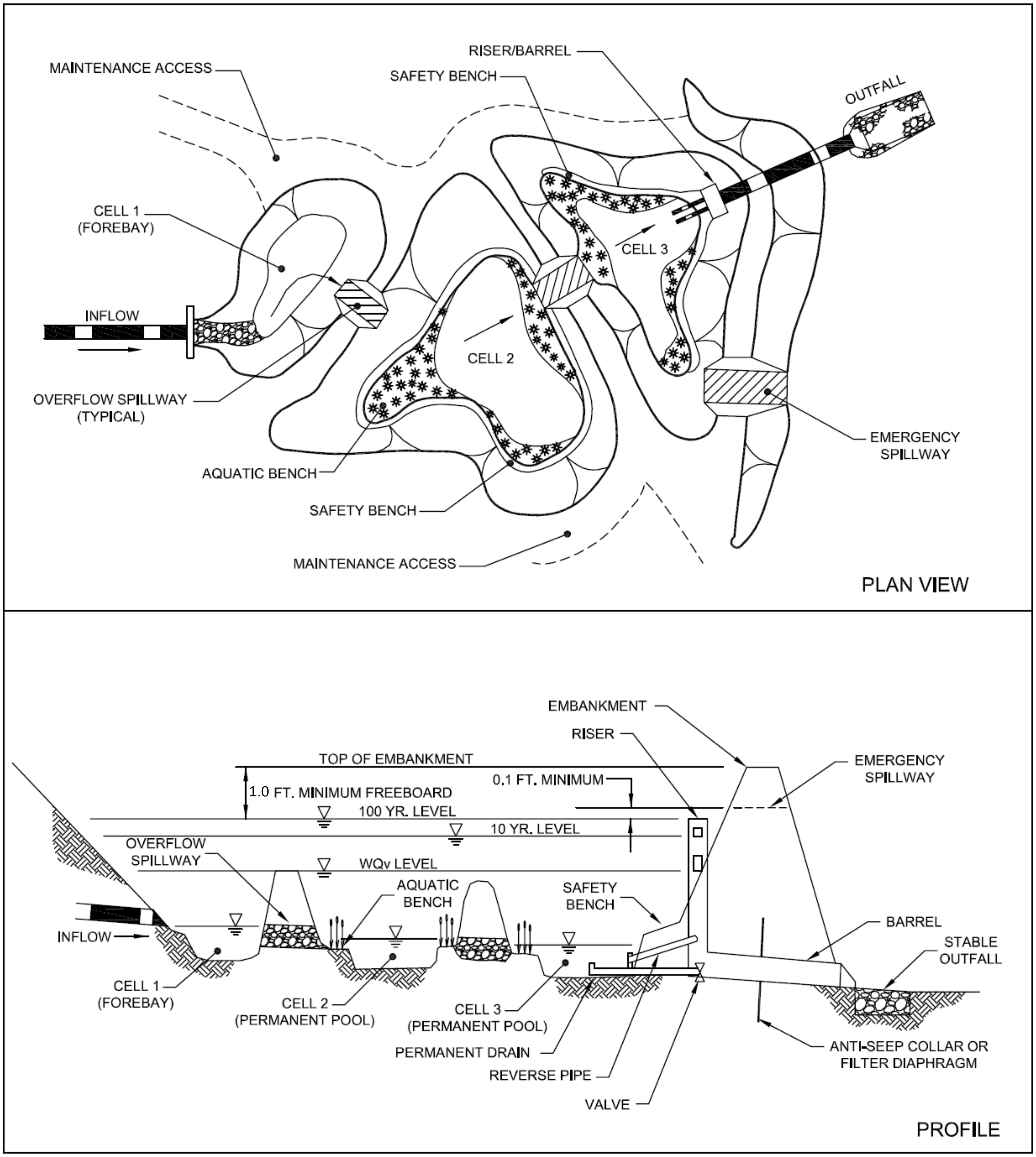
Figure 1.2 Wet Extended Detention Pond



Note: Storm attenuation levels vary depending on site detention requirements.

(Source: Center for Watershed Protection)

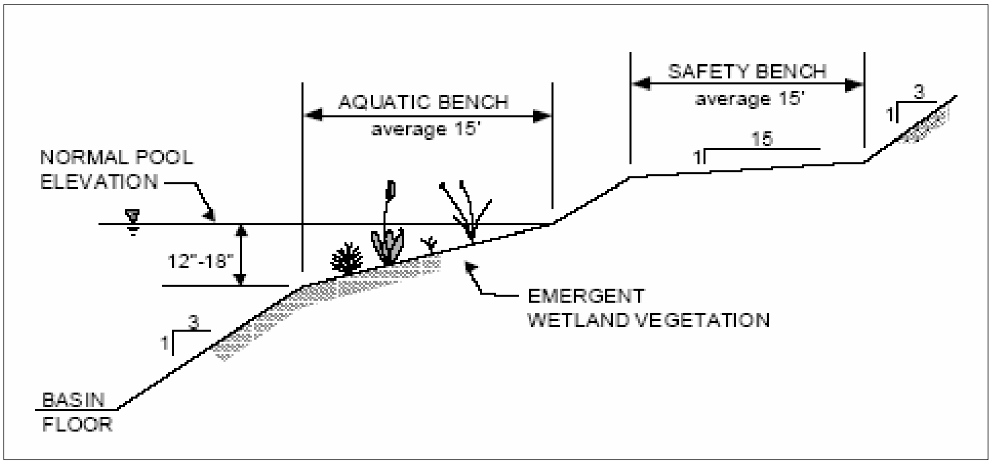
Figure 1.3 Micropool Extended Detention Pond



Note: Storm attenuation levels vary depending on site detention requirements.

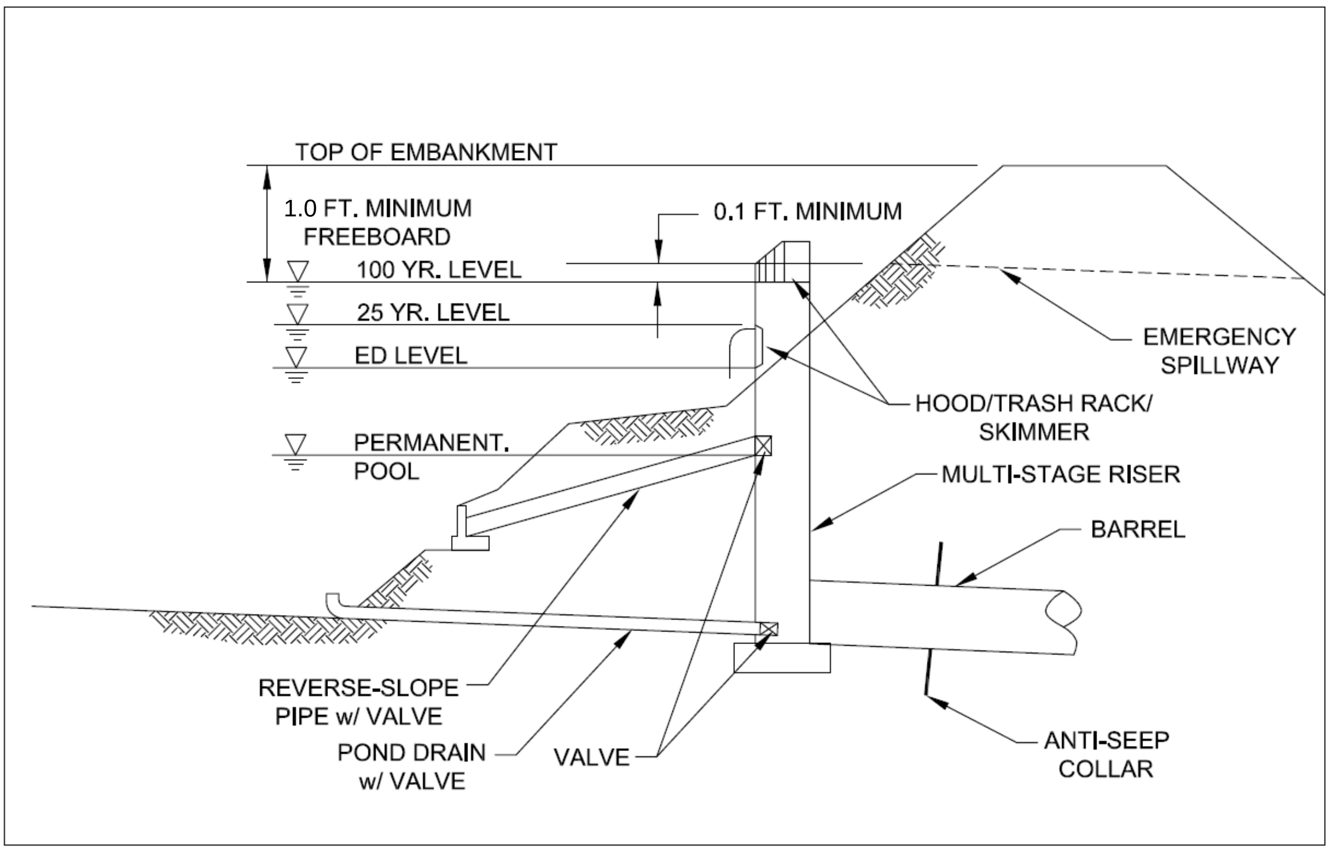
(Adapted from the Center for Watershed Protection)

Figure 1.4 Multiple Pond System



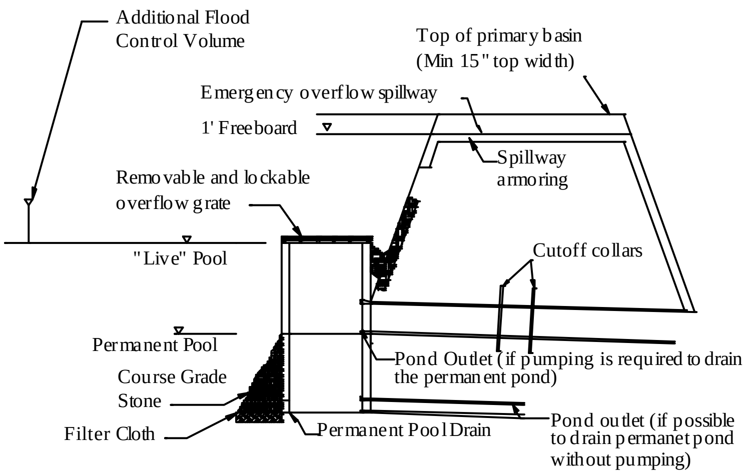
(Adapted from the Center for Watershed Protection)

Figure 1.5 Stormwater Pond Cross-Section with Benches

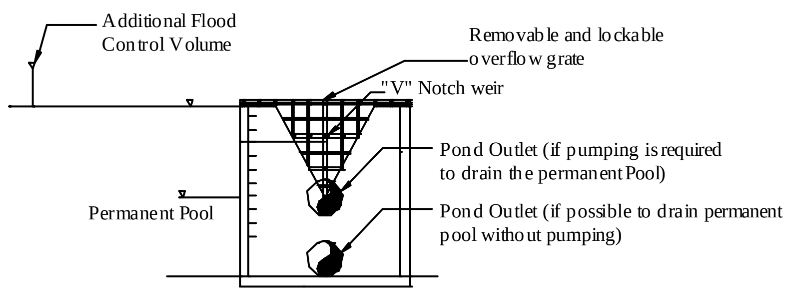


(Adapted from the Center for Watershed Protection)

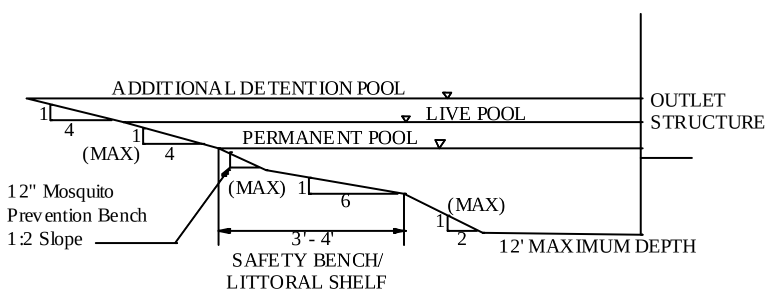
Figure 1.6 Outlet Configuration (Includes Extended Detention Level)



SECTION OUTLET STRUCTURE
NTS



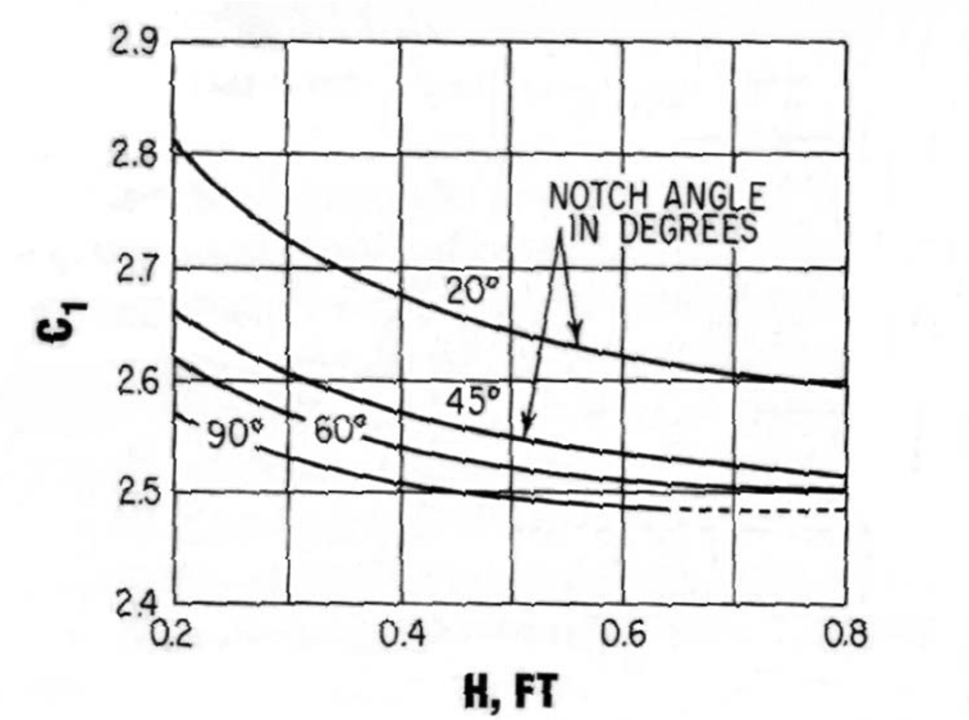
PROFILE OUTLET STRUCTURE
NTS



POND GRADING
NTS

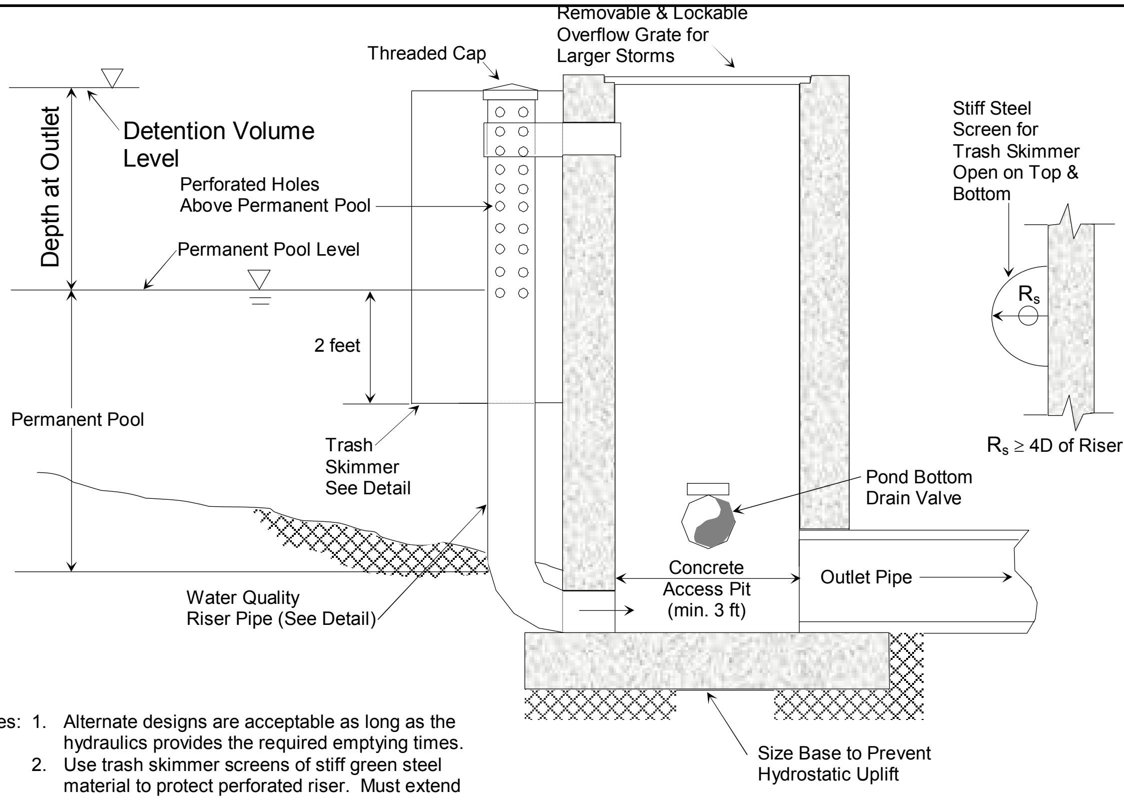
(Source: Metro, 2000)

Figure 1.7 V-Notch Weir Outlet Structure



(Source: Metro, 2000)

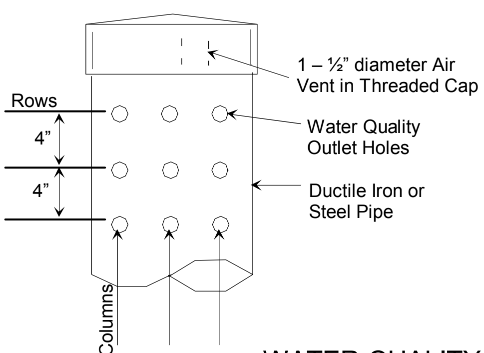
Figure 1.8 Sharp-Crested V-Notch Weir Discharge Coefficients



Notes:
1. Alternate designs are acceptable as long as the hydraulics provides the required emptying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft. below the permanent pool level.

OUTLET WORKS
NOT TO SCALE

Notes:
1. Minimum number of holes = 8
2. Minimum hole diameter = 1/8” Dia.



WATER QUALITY
RISER

See Table 1.1, page 13 for perforated riser design guidance.

(Adapted from Metro, 2000)

Figure 1.9 Perforated Riser Outlet Structure

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