Water Resources Division

Extended Detention Basin

Definition

Extended detention basins are designed to receive and detain storm water runoff for a prolonged period of time, typically up to 48 hours. Extended detention is achieved through the use of an outlet device that regulates the flow out of the basin at a rate which reduces peak runoff rate, reduces flooding, and provides moderate pollutant removal. In the past, dry extended detention basins have typically been designed exclusively for flood control. Extended detention basins may be designed as either single-stage or two-stage.

Extended detention controls the rate of storm runoff but does not reduce runoff volume. Extended detention alone does not provide adequate stream bank erosion protection.

Single-stage extended detention basins consist of single chambers that are expected to completely drain after each storm event. They are normally used strictly for flood control and are not usually recommended where water quality benefits are needed.

Two-stage extended detention basins detain water from small, frequent storms, or the first flush of large storms in a lower, second stage, with a normally dry upper stage for detention of larger storms for flood control. Managing the second stage as shallow marsh increases pollutant removal effectiveness. Consider using extended detention in combination with other best management practices.

Description & Purpose

A single-stage extended detention basin can be effective at removing sediment, non-soluble metals, organic matter, and nutrients, through settling. Up to 90 percent of particulates may be removed if the storm water is detained for 24 hours or more. Single-stage extended detention basins are ineffective at removing soluble pollutants.

A two-stage extended detention basin is also effective at settling out non-soluble pollutants and sediment. Additional pollutant removal is gained when the second stage is managed as a shallow marsh. The marsh area helps prevent suspension of sediment, and provides some removal of soluble pollutants through plant uptake and bacterial activity. Still greater pollutant removal would be expected from a single-stage basin, followed by a Wet Detention Basin.

Extended detention basins may also reduce peak discharges of storm runoff, thereby reducing flooding. Extended detention alone does not control storm runoff volume and therefore cannot provide adequate stream bank protection. Extended detention may actually help increase low flows, and reduce the peak discharge rate from urbanized areas.

Simply maintaining the pre-settlement peak runoff rate may not protect stream channels; therefore, in those cases, more stringent design requirements will be required. When extended detention is used as a post-construction storm water runoff control, additional practices will likely be needed to maintain the pre-development runoff volume and peak rate for all storms up to the two-year, 24-hour event, either through on-site green infrastructure, or through appropriate off-site practices.

Extended detention basins can significantly warm the water in the marsh area over a short period of time. Therefore, if the receiving stream is sensitive to increases in temperature, such as in designated cold-water streams, extended detention basins may not be appropriate. Refer to the Low Impact Development Manual for Michigan (SEMCOG, 2008) for specific design considerations regarding mitigating temperature effects.

Location

Extended detention basins are suitable for urbanized, urbanizing, or agricultural areas.

Soils with low infiltration rates may cause standing water problems. Extremely permeable soils may prohibit the establishment of a marsh area.

Extended detention basins may be applied to new or existing developments, and are usually considered permanent, year-round control measures. If used as a sediment basin during construction, at the end of the project, remove the accumulated sediment, and stabilize the banks.

Use a hydrologic analysis of the watershed to determine optimal basin locations. A drainage area that is too small (less than 10 acres) may not provide sufficient volume to support wetlands, or may require a release orifice smaller than what is practical.

Companion & Alternate Practices

Riprap is used to protect side slopes and inlet and outlet areas. Grassed Waterways are used to direct water from the inlet or to the outlet. Consider using Sediment Basins upstream of extended detention basins to remove large sediment particles. This technique will increase the pollutant removal efficiency and reduce the maintenance of the extended detention basin.

Planning

Determine suitable basin locations through a hydrologic analysis of the watershed. Improper timing of the peak discharges from multiple basins within a single drainage area has the potential to increase in-stream flow, which in turn can increase the chance of erosion, and decrease stream habitat.

Place any Sediment Basins so they work in combination with any other storm water basins (whether extended detention or any other type) on a site.

Assure adequate right-of-way access. Make any access roads at least of 10 feet wide and stabilized, to provide for the passage of heavy equipment.

Develop a spill response plan that clearly defines the steps to be taken in the event of any accidental release of large quantities of harmful substances to the basin. Depending on what the spill response plan stipulates, design elements such as shut-off valves or gates may be required.

Design

NOTE: It is recommended that all structural best management practices be designed by a registered professional engineer.

The design of an extended detention basin can vary, depending on whether the primary function is flooding/erosion control, or water quality enhancement. The optimal design is one that factors in all criteria, in the development of a basin that maximizes both functions.

Develop basin designs with multiple uses in mind.

An example of a typical two-stage extended detention basin is shown in Figure 1.

Buffer Strip: Provide a minimum 25-foot buffer between the basin and any adjoining property line. Landscape the buffer to improve the appearance for local residents, provide wildlife habitat, and meet any other local design criteria.

Volume: The minimum treatment volume is the water quality treatment volume defined in the unified sizing criteria. The larger the basin volume, the greater the potential for pollutant removal. Consider additional capacity, especially in two-stage basins, to account for 5 to 10 years of sediment accumulation. Consider a forebay at the inlet to the basin to trap sediment. Additional volume up to the 100-year storm is recommended for flooding and erosion control.

Detention Time: For optimum pollutant removal, design the basin to detain the water quality volume for a minimum of 24 hours. Detain volumes from storms smaller than the design storm for a minimum of six hours. Use a hydrologic analysis of the receiving stream to determine the optimum release rate.

Outlets: The basin outlet controls the release rate from the basin, both for the design storm, and lesser storms. Multiple outlets may be necessary to control discharge from a range of storms. Example outlets for dry extended detention basins are shown in Figures 2, 3, 4, and 5. Three example outlets for extended detention basins with permanent pools or marsh areas are shown in Figure 5. A hydraulic analysis of the outlet structures at the low flow and design storm will be necessary to size the outlets to achieve the desired release rate. Provide all outlets with accessible, above-ground capped clean-outs, to allow for easy cleaning and maintenance. Position outlets within the basin such that blockages can be removed safely if necessary.

Outlet design can be extremely complex. One useful source of information is the *Stormwater Management Guidebook* (Menery, 1999), which provides a detailed design method.

Use a stabilized outlet structure to prevent scouring at the discharge point. Stabilized Outlets are normally constructed using Riprap, corrugated pipe or concrete.

Basin Configuration: Set the length of the basin to at least three times the width. Use baffles or berms to increase basin flow length, and to prevent short-circuiting. Set the shape of the basin so that it's narrow at the inlet, and wide at the outlet.

Area: The required surface area of an extended detention basin depends on:

1. The basin volume (which is the runoff design volume being detained, plus any additional sediment storage space factored in), and the depth of the extended detention basin (i.e., the deeper the basin, the smaller the required surface area, for a given design volume. Some references recommend basin depths not exceeding three feet, to limit hazard and liability potential); and

2. Meeting the minimum flow path requirement, specified in 'Basin Configuration' above.

Estimates of the required surface area of a typical extended detention basin range anywhere from 2-3 percent, up to 5-10 percent, of the contributing drainage area. This may limit the feasibility of an extended detention basin where land prices are high, or where adequate space is unavailable.

Side Slopes: Set berm side slopes to not more than 3H:1V, and not less than 20H:1V. Set the basin floor of the dry portion with a slope of two percent toward the outlet.

Emergency Spillway: Include an emergency spillway to handle storms greater than the design storm. Design and install the spillway to protect against erosion. Construct the banks to provide two feet of freeboard above the emergency spillway elevation.

Low-flow Channel: Provide a low-flow channel through the dry portion of the basin. Line the channel with riprap to prevent scouring. Drain the remainder of the basin toward this channel. Where recreational uses are desired, locate the low-flow channel along one side, versus in the middle of the basin.

Anti-seep Collars: Install anti-seep collars on any piping passing through the sides or bottom of the basin.

Construction

At the conclusion of construction, stabilize the surrounding area, following the guidance in the Seeding and Mulching, or Sodding BMPs. Do not put the basin into service until the side slopes are stabilized.

Maintenance

Regular maintenance includes mowing the riparian buffer, and removing debris from the basin. Follow mowing specifications in the Riparian Buffer BMP. A properly-designed extended detention basin will require sediment removal only every five to ten years. Provide convenient access for sediment removal. Considering including a benchmark, such as a staff gage or permanent physical feature, to help determine the depth of accumulated sediment.

Inspect the basin regularly during wet weather, paying particular attention to the outlet structure and low-flow channel, and any seepage through berms. Inspect berms annually for structural integrity.

Literature Cited

Menery, Bruce. 1999. *Stormwater Management Guidebook*. Michigan Department of Environmental Quality. Lansing, Michigan.

Schueler, Thomas R. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Department of Environmental Programs. Washington, D.C.

SEMCOG. 2008. *Low Impact Development Manual for Michigan: A Design Guide for Implementors and Reviewers*. Detroit, Michigan.

Somerset County, New Jersey. 1991. *Handbook for Storm Water Detention Basins.* Elson T. Killam Associates.

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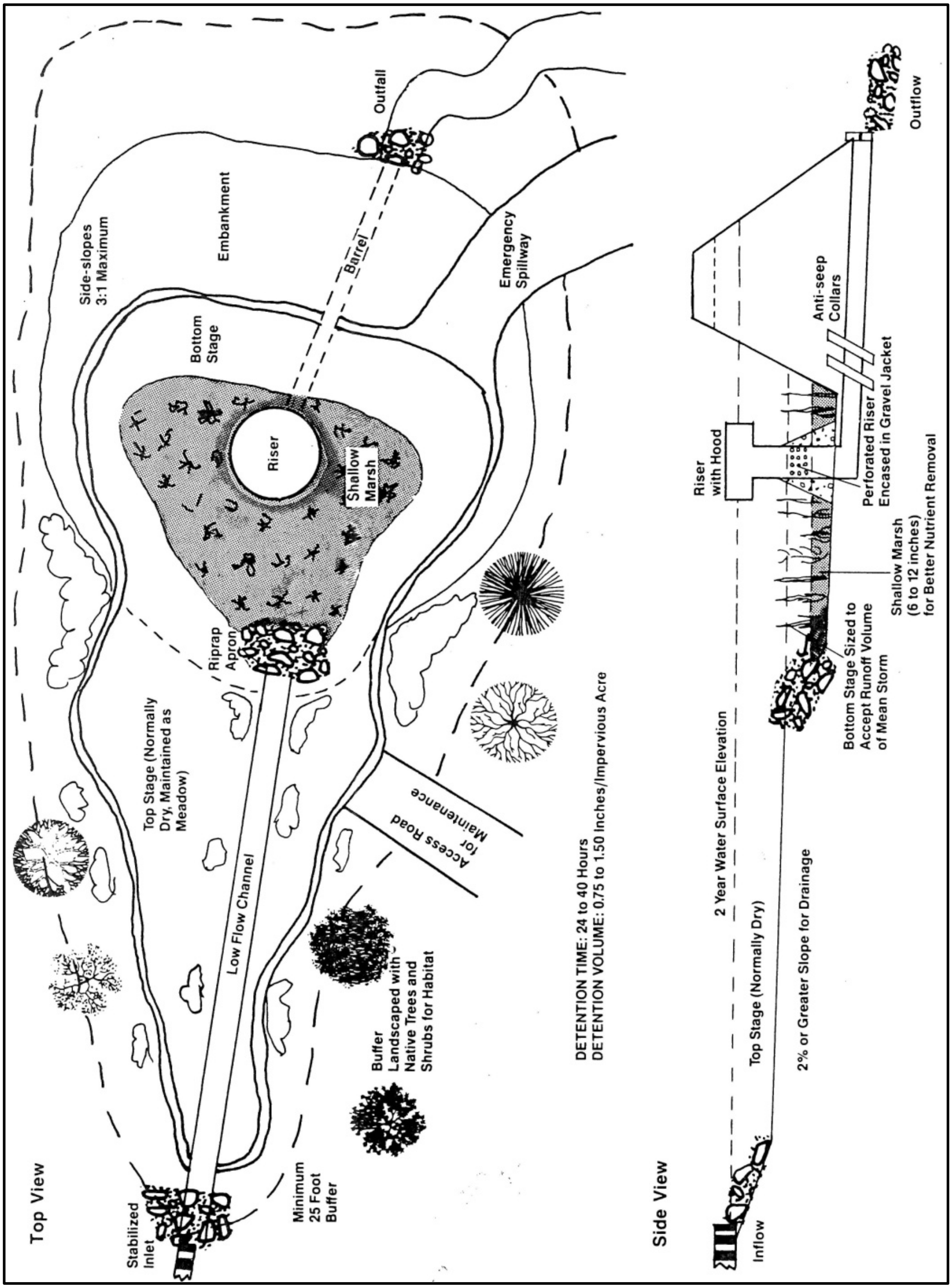

Figure 1. Two-Stage Extended Detention Pond Design
Source: Schueler, 1987.

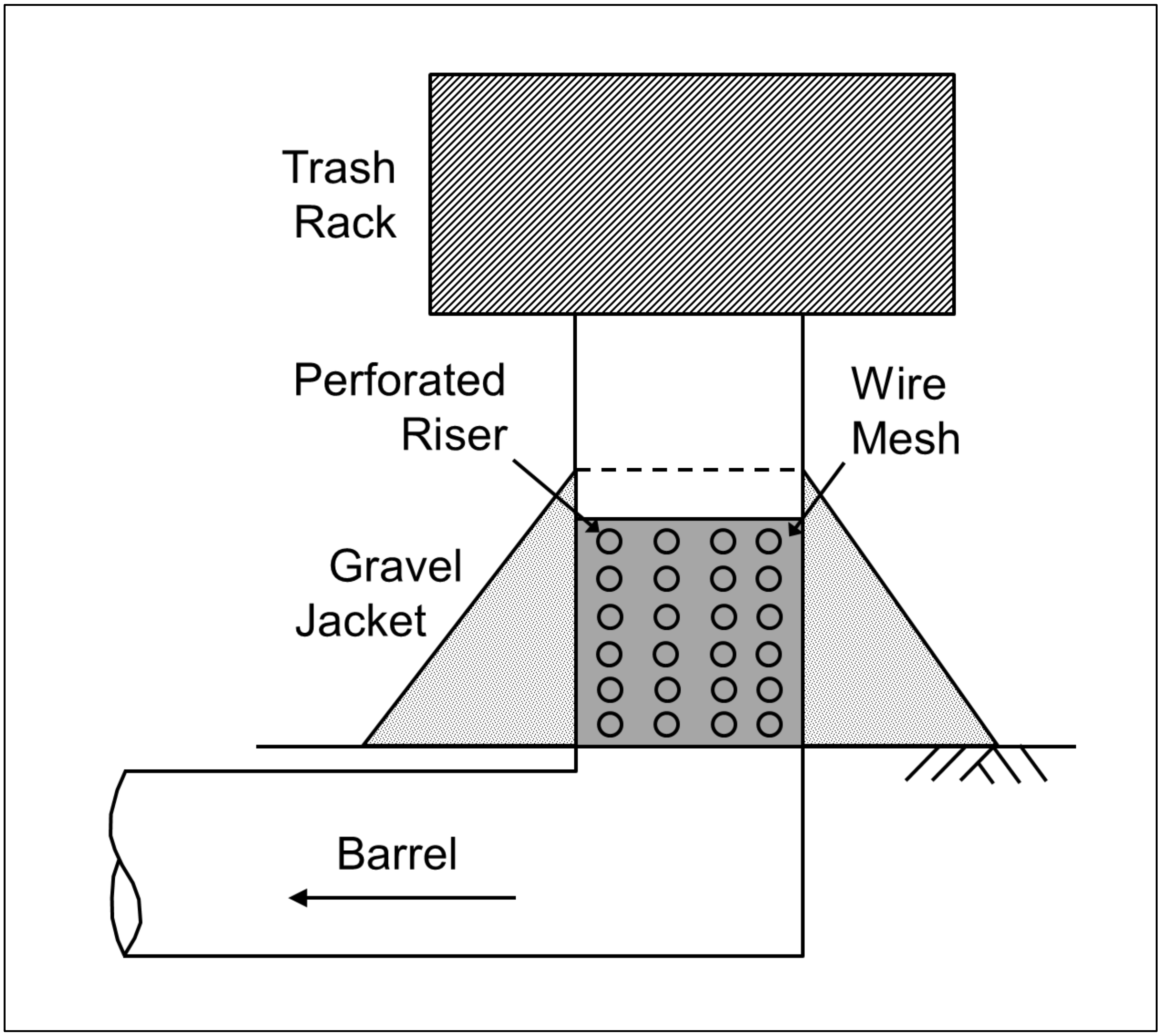

Figure 2. Cross-Sectional Profile View of Perforated Riser
Source: Schueler, 1987.

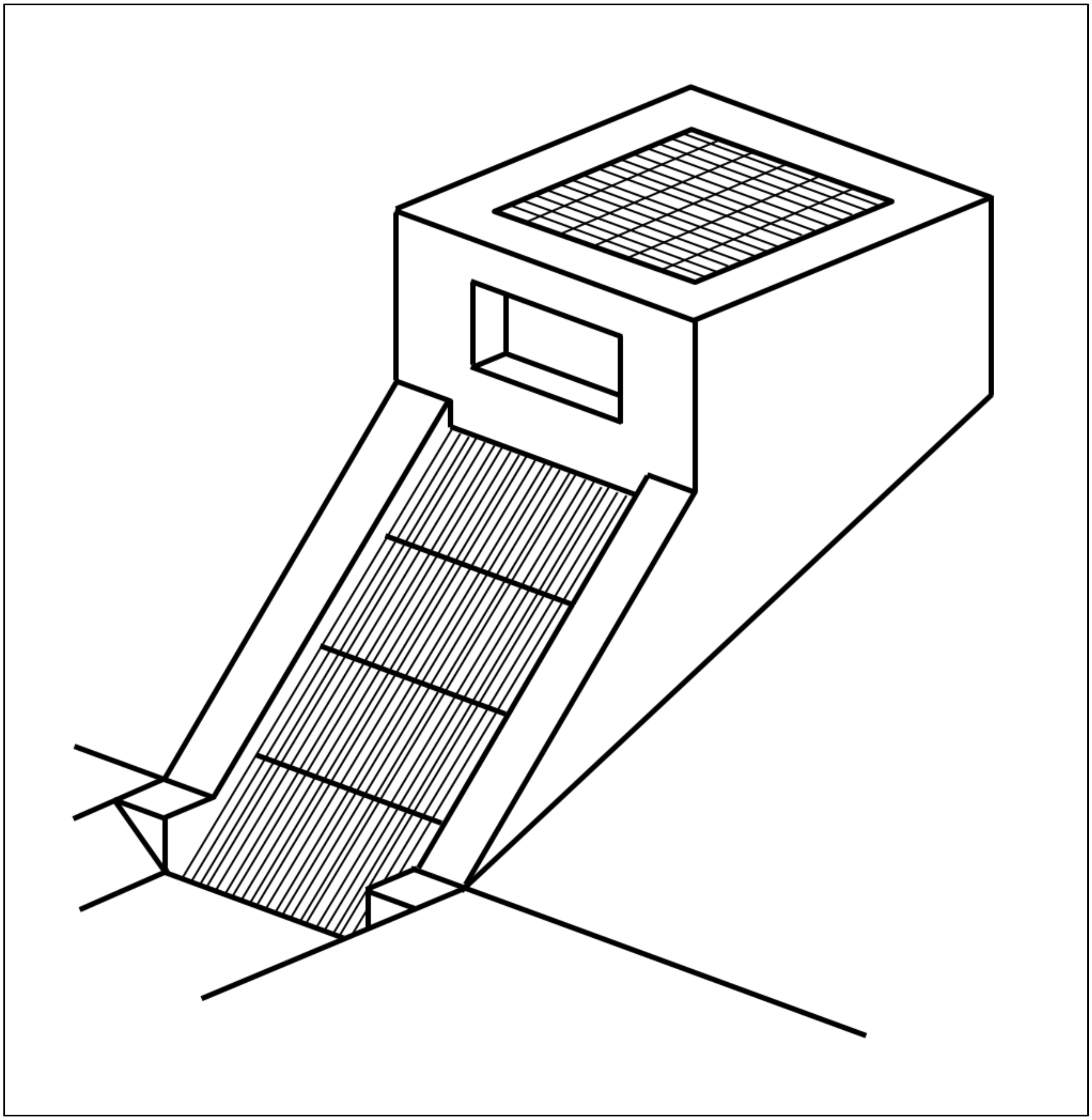

Figure 3. Typical Detention Basin Trash Rack and Grating
Source: Somerset County, New Jersey, 1991.

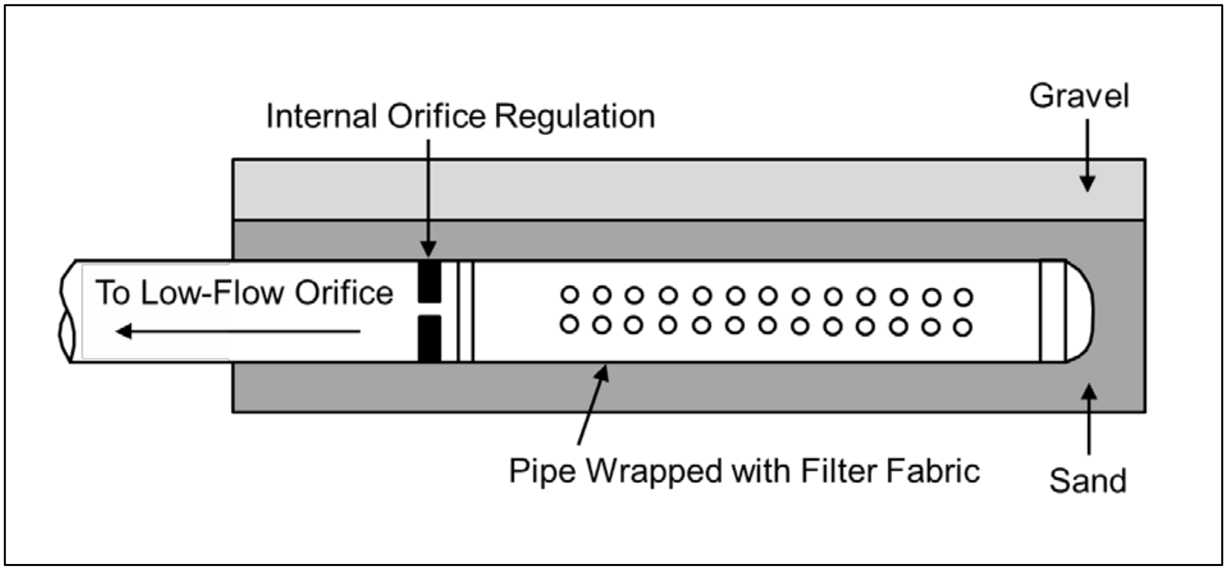

Figure 4. Cross-Sectional Profile View of Internally Controlled Perforated Pipe
Source: Schueler, 1987.

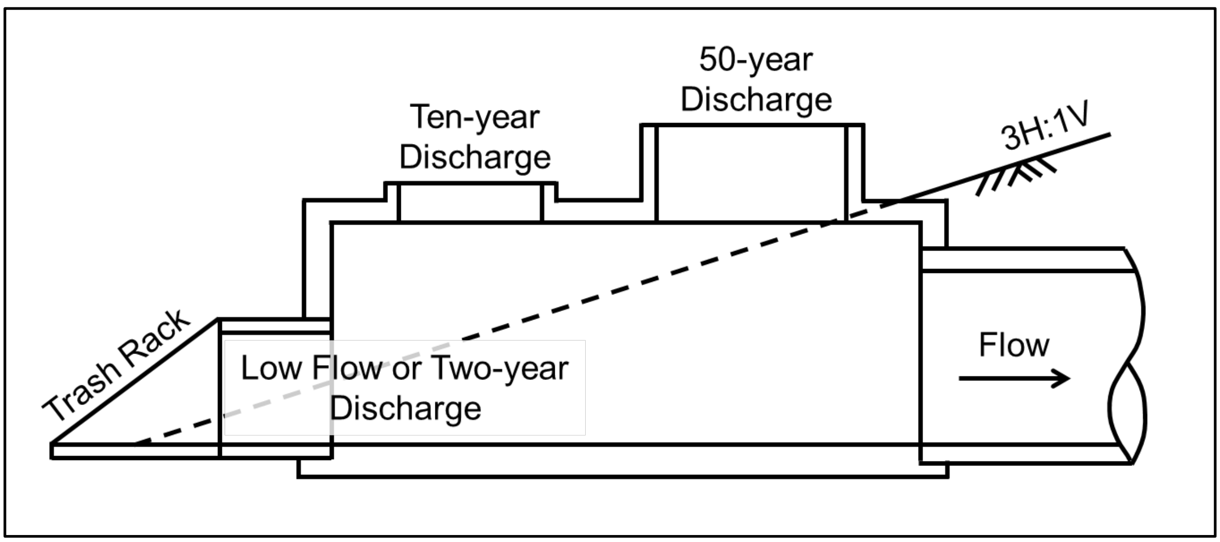

Figure 5. Cross-Sectional Profile View of Multiple-Outlet Structure with Example Flows Specified
Source: UW, 1990.

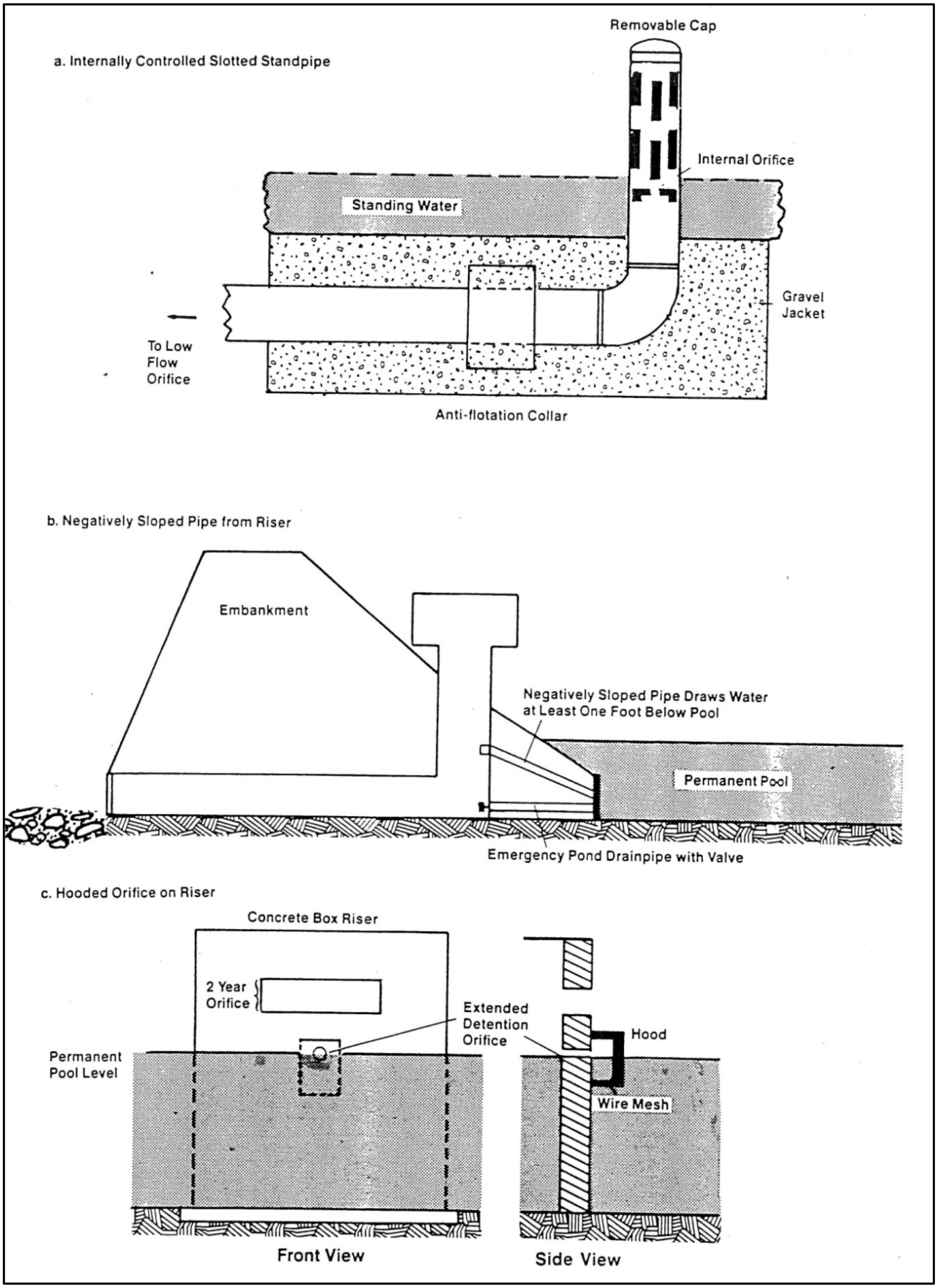

Figure 6. Cross-Sectional Profile View of Three Outlet Types for Extending Detention Time in Wet Ponds

Source: Schueler, 1987.