2.7 Dry Extended Detention Basin (with Forebay and Micropool)

Description

A dry extended detention basin temporarily ponds runoff from a storm event to attenuate and delay peak runoff discharge rates. To develop the pollutant removal efficacy necessary for water quality management, a dry extended detention basin must 1) extend the detention time of the Water Quality Volume to 48 hours with a protected outlet, 2) include a wet forebay or equivalent pretreatment, 3) prevent hydraulic short-circuiting within the basin, and 4) limit the resuspension of previously settled sediment (ASCE/WEF).

Credits

Table 2.7.1 Credits for a Dry Extended Detention Basin Meeting the Criteria in this Chapter

Objective	Credit
Runoff Reduction Volume (RRv)	None.

Planning and Feasibility

A dry extended detention basin is not recommended to serve as recreational area or residential yard due to the frequency of ponding, prolonged wetness, and the application of fertilizers and herbicides typical of lawn care.

Where the basin is to be formed by an embankment, suitable soil must be available to construct it. Do not rely solely on NRCS web soil survey data to characterize the engineering properties of soils for embankment construction. A qualified professional should conduct an on-site soil evaluation to characterize the adequacy of the soil for use as embankment fill.

Dams are regulated under the Ohio Revised Code (ORC) 1501: 21 Dam Safety Administrative Rules. A dam is exempt from the state's authority (ORC Section 1521.062) if it is six feet or less in height regardless of total storage; less than ten feet in height with not more than 50 acre-feet of storage, or not more than 15 acre-feet of total storage regardless of dam height. Check with the Ohio Department of Natural Resources for the most current requirements.

Existing dry flood control basins that pre-date water quality requirements may be retrofitted to meet the criteria in this chapter.

Design Criteria

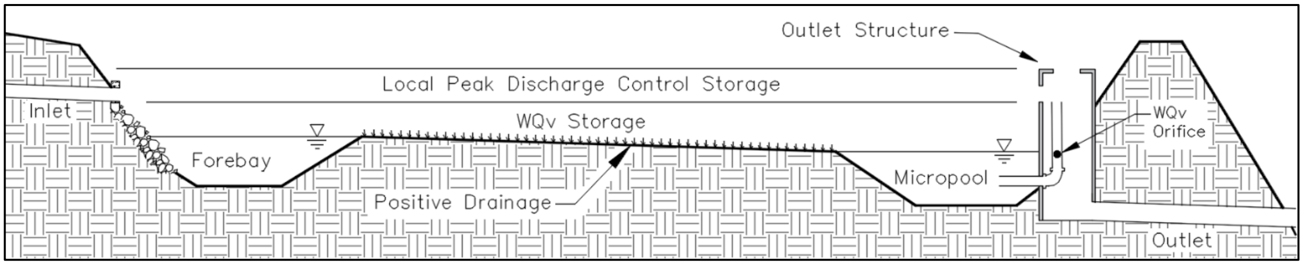

Figure 2.7.1 Typical Dry Extended Detention Basin Profile

Water Quality Volume Storage

Provide a temporary (live or detention) storage volume equal to the Water Quality Volume (WQv) as illustrated in Figure 2.7.1. The WQv storage does not include forebay and micropool volumes. Calculate the WQv for the total area draining to the basin as described in Chapter 2.16 and as required by the Ohio EPA NPDES general permit for construction activities.

Local government may require additional detention volume for peak discharge control (flood attenuation) using the critical storm (see Appendix 2.A.3) or other hydrologic method. Depending on local regulations, it is not necessary to stack these storage volumes (flood control storage and discharge may include the WQv storage and discharge).

Water Quality Outlet Structure and Drawdown

Design an outlet structure to draw down the WQv over 48 hours with less than 50 percent of the WQv storage emptying within the first 16 hours. Targeting a 48-hour drawdown detains the WQv long enough to provide treatment but short enough to provide storage for subsequent rainfall events. It also reduces the energy of runoff from common storm events that are responsible for most channel erosion. A maximum WQv drain time of 72 hours is recommended to limit mosquito breeding and preserve vegetation within the basin.

The 48-hour drawdown period is calculated as the time it takes to drain the peak storage or brimful WQv. This “pull-the-plug” method assumes that the brimful volume is present in the basin prior to any discharge. In reality, runoff is flowing out of the basin prior to the brimful volume being reached, which the WQv value already accounts for.

The WQv control orifice must be protected from clogging but accessible for maintenance. Either of the following protected outlet configurations is recommended.

Micropool With Reverse Slope Pipe. A permanent micropool equal to ten percent of the WQv improves sediment capture and enables a reverse slope pipe to protect a small water quality orifice. The advantage of the reverse slope pipe is that a pipe entrance below the water surface protects the orifice from being clogged by floatable debris. The micropool should have a minimum depth of three feet to deter emergent vegetation. See Chapter 2.6 for guidance on reverse slope pipe outlet design.

Perforated Pipe Intake Screen. Create an intake screen by placing a perforated pipe laterally within a gravel envelope to draw water from outside the structure. Place the control orifice into a riser or a pipe cap located on the interior side of the structure. This configuration, as shown in Figure 2.7.2, can prevent floatable material from clogging the control orifice. Design pipe perforations smaller in diameter than the control orifice to provide filtering and of sufficient quantity to not restrict flow to the control orifice, even when partially clogged. Do not wrap the perforated pipe with filter fabric which will be highly susceptible to clogging.

If the drawdown calculations result in a control orifice the designer deems too small or exceeds minimums in local regulation, reduce the hydraulic head by designing a broad, shallower basin or select another post-construction stormwater management practice from this chapter.

In addition to the sizing and configuration of the outlet structure, the designer should specify:

- durable pipe and other material that will resist degradation under ultraviolet light, rust, and other corrosion;

- proper grouting or sealing of any pipe penetrations; and
- anti-seep collars or other seepage provisions where necessary.

When necessary, an additional orifice or weir may be placed in the outlet structure above the WQv storage elevation to provide peak discharge (flood) control.

An outfall to a stream or ditch must be stable for the maximum (pipe-full) design discharge. Use outlet protection as detailed in chapter four to prevent erosion of the receiving channel bed or banks. Minimize any necessary modifications to the receiving stream.

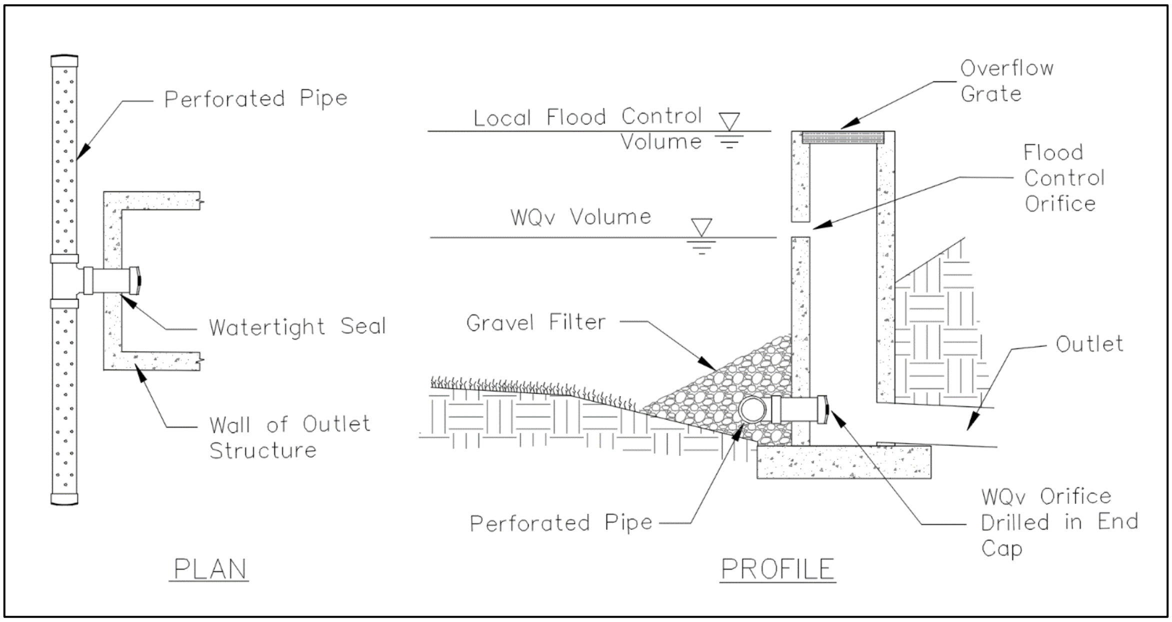

Figure 2.7.2 Schematic of Perforated Pipe Intake Screen

Sediment Storage

Size the forebay and micropool each at least ten percent of the WQv to provide maintainable sediment storage at the volume required by Ohio EPA's NPDES Construction Stormwater General Permit (20 percent of the WQv). If the outlet is protected without a micropool, size the forebay to equal or exceed the full 20 percent of the WQv. To maintain practice performance, remove sediment that accumulates in the forebay and micropool once their storage capacity is reached and as described in the operation and maintenance plan prepared for the practice.

Wet Forebay

A wet forebay is a small permanent pool located at an inlet to the basin that improves the settling efficiency of a dry extended detention basin, acts as a stilling basin to reduce inflow energy, and reduces maintenance by promoting settling in a confined, easily accessible location.

Size the forebay volume to equal ten percent of the WQv (20 percent if the outlet is protected without a micropool). A single forebay may serve multiple inlets that are in proximity. For basins with multiple isolated inlets, proportion forebay volumes according to the percent of the site draining to each inlet. Minor inlets may be excluded from the forebay but may not in sum exceed five percent of the basin's total contributing drainage area and must not drain an area that will generate an excessive sediment load (for example, bulk storage areas).

A forebay depth of three feet or deeper will trap sediment and discourage emergent vegetation. A concrete-lined forebay may facilitate cleanout.

A forebay pool may be placed below the bottom elevation of the primary basin as shown in Figure 2.7.1 or separated by an impermeable berm within the basin. Utilize a non-erosive weir to protect the berm from erosion. The forebay may be configured to aid in achieving the necessary flow length-to-width ratio.

Alternative Pretreatment

Where standing water in a wet forebay is a concern, the designer should plan a different BMP such as bioretention. If other BMPs are not feasible, an alternative pretreatment practice may be selected in place of a wet forebay. At a minimum, the alternative pretreatment practice must 1) be proven capable of removing at least 50 percent of the total suspended solids (TSS) as defined in Ohio EPA's NPDES general permit for construction activities and 2) dissipate the energy of concentrated inflow to minimize scour and the resuspension of sediment within the basin. Potential pretreatment options for a dry extended detention basin are listed below.

Grass swale. A grass swale can be designed per Chapter 2.3 to provide pretreatment. Design flow depths and residence times for the water quality event and maintain non-erosive velocities. Ensure any transition in grade or elevation from the swale into the basin will be non-erosive.

Grass filter. Sheet flow through a grass filter can provide effective pretreatment. Design a grass filter in accordance with Chapter 2.2.

Manufactured treatment device. Manufactured treatment devices are typically compatible with a dry extended detention basin where solids are the primary pollutant. Certain devices may be outfitted with additional measures to remove other pollutants. The pretreatment manufactured treatment device must be certified through either the New Jersey DEP or Washington State TAPE certification programs to provide 50 percent or greater TSS removal and must be designed per the criteria listed in Chapter 2.14. The certified flow rate for the device must equal or exceed the water quality flow (see Chapter 2.18) from the contributing drainage area.

Manufactured treatment devices typically have limited storage capacity for sediment and trash. The operation and maintenance plan must prescribe a maintenance schedule with a frequency that correlates to the expected loading from the site. Clean-out will commonly be on an annual basis.

A dry extended detention basin with multiple inlet locations may require multiple alternative pretreatment practices. Minor inlets may be excluded but may not in sum exceed five percent of the basin's total contributing drainage area and must not include area that will contribute an excessive sediment load.

A catch basin with a basket-type insert or a deep sump, while beneficial, is not an adequate pretreatment practice.

Flow Length

A dry extended detention basin relies on the process of sedimentation to remove runoff pollutants. Therefore, the basin should be configured to maximize the opportunity for gravitational settling to occur. Elongated basins that are broad, shallow, and have a large surface area-to-depth ratio will provide better sedimentation than smaller, deeper basins.

Shape a dry extended detention basin to develop a flow length between the inlet(s) and outlet at least three times the flow width (length-to-width ratio of 3:1). This is best accomplished by designing a long, narrow basin with the inlet(s) and outlet at opposite ends. If site conditions prohibit an elongated basin, use internal baffles as illustrated in figure 2.7.3 up to the WQv elevation to lengthen the flow path.

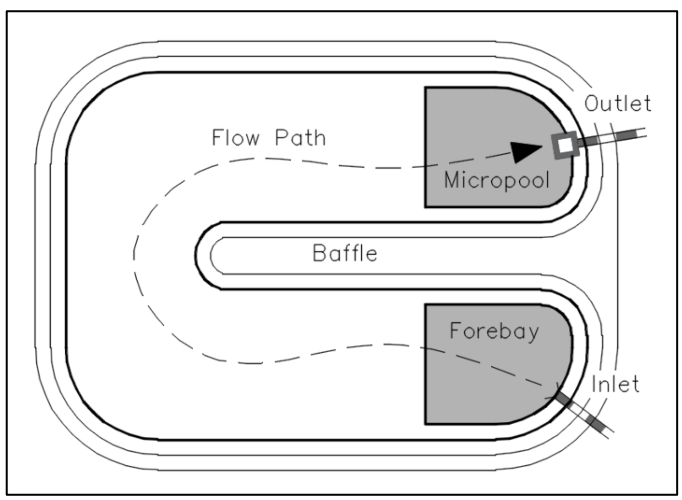

Figure 2.7.3 Dry Extended Detention Basin with a Baffle

Depth

A shallow basin provides a shorter vertical travel distance for solids to settle. Store the WQv in a temporary pool with a maximum depth of four feet to promote settling and limit scour.

The basin must not intercept the groundwater. Seasonal ponding of groundwater reduces the runoff storage volume. Excessive soil saturation may also kill or convert bottom vegetation as well as increase mosquito breeding and hinder mowing. Determine the depth to the seasonal high water table (SHWT) and design a basin with at least two feet of separation between the bottom of the basin and the SHWT or use subsurface drainage to lower the SHWT.

Positive Drainage

Slope the basin floor at a uniform longitudinal grade of one-half to one percent to promote drainage. Distribute flow across the full bottom width to prevent basin floor erosion and maximize the treatment area. **A dry extended detention basin for water quality shall not have a lined low-flow or pilot channel connecting inlets to the outlet.** A subsurface drain tile (see Figure 2.7.4) may be used to facilitate the drying of the basin floor and reduce internal erosion concerns if there is sufficient elevation to outlet subsurface piping through the control orifice. Design measures to prevent a subsurface drain tile from also draining a wet forebay and/or micropool.

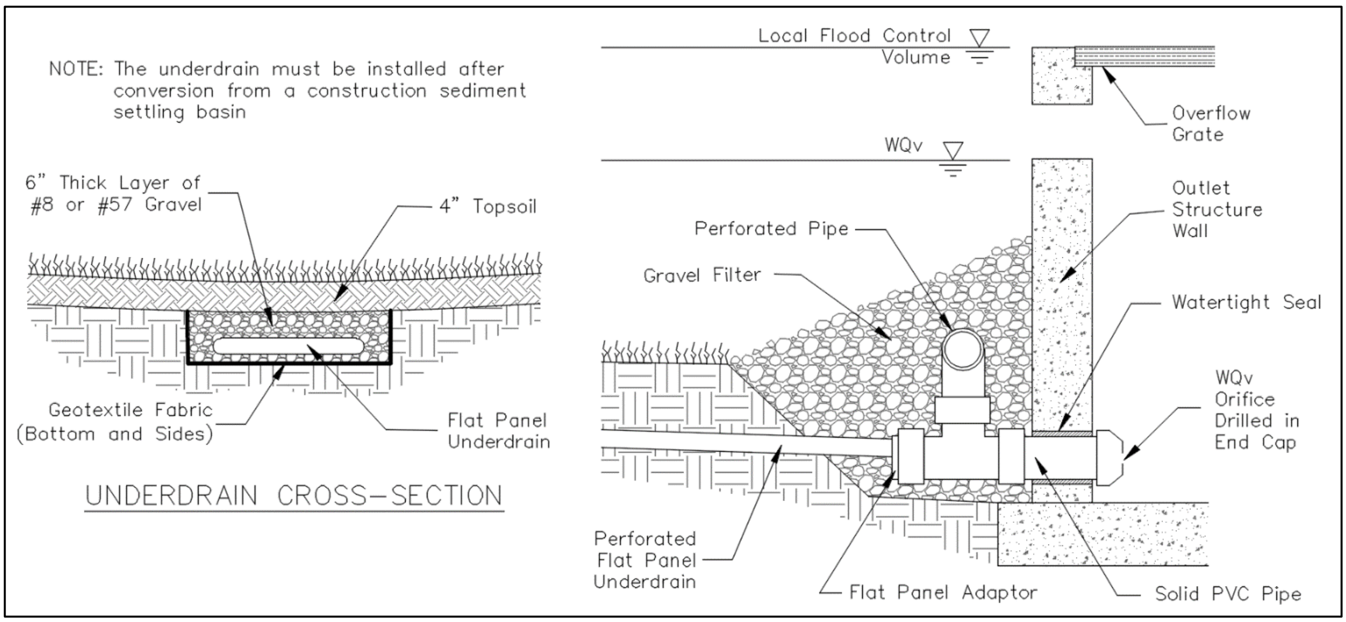

Figure 2.7.4 Dry Extended Detention Basin Outlet with Underdrain (after Delaware County Engineer's Office)

Side Slopes

Side slopes should not be steeper than 3:1, with 4:1 preferred to limit rill erosion, facilitate mowing, and as a safety measure.

Vegetation

Healthy vegetation in the dry extended detention basin is key to stabilizing captured pollutants, entrapping sediment, and preventing internal erosion. Landscape the floor of a dry extended detention basin with plant species that will tolerate frequent inundation and prolonged saturation from stormwater as well as dry periods over summer. Establish dense grass cover over the side slopes to protect them from rill erosion.

A "low-mow" basin that creates meadow-like conditions over the bottom of the basin is recommended. It can provide better water quality treatment and has several advantages over turfgrass. Mowed only once in the spring and once in the fall, a low-mow basin requires less overall maintenance than turf grass. Furthermore, turfgrass creates habitat and resting places for Canada geese whose fecal matter adds bacteria to stormwater. Native plants are encouraged in a low-mow basin. Maintenance may be required during establishment to limit the growth of invasive plants.

Design Considerations

Structural Integrity

Designers are encouraged to review both *Conservation Practice Standard Code 378 - Pond* and *Engineering Field Handbook Chapter 11 - Ponds and Reservoirs* [1] for guidance on the structural design of excavated and embankment dry extended detention basins. In all cases:

- design an emergency spillway that safely conveys flow exceeding the outlet structure capacity,
- design the outlet structure to withstand floatation,
- incorporate an anti-vortex device and trash rack where necessary, and
- utilize proper soil compaction methods, a core trench, and anti-seep measures to reduce the risk of structural failure of an embankment.

Safety

Public safety is an inherent concern with any open water, temporary or permanent. Plan appropriate safety measures such as gradual banks, warning signs, and/or personal flotation device stations. Fencing may also deter access to ponded water. Outlet structures should be designed to prevent entry.

Construction Considerations

Converting a temporary construction sediment settling basin into a dry extended detention basin requires the following steps 1) dewater the sediment storage zone without discharging sediment laden water to the receiving waters and remove the skimmer outlet device, 2) perform final grading, including the forebays and micropool (accumulated construction-generated sediment can be incorporated into the landscape), 3) seed disturbed portions of the basin, and 4) modify the outlet structure to its WQv control design configuration.

Maintenance Considerations

To ensure a consistent level of treatment occurs over the life of the practice, the designer must develop an operation and maintenance plan for the owner that details the maintenance activities necessary and their expected schedule.

While maintenance is inevitable, the frequency of maintenance activity, level of effort, and cost can vary considerably depending on the initial practice design. Designers are encouraged to consider measures that will ease the maintenance burden for owners and develop a detailed operation and maintenance plan for the practice.

Where direct equipment access to the basin is not available, maintenance easements must be established to allow access to the basin and accommodate frequent sediment cleanouts of the forebay and other pretreatment practices

An operation and maintenance plan should describe vegetation maintenance, especially for low-mow basins.

A dry extended detention basin is intended to trap pollutants and the fate of these pollutants must be considered. Sediment trapped within a basin is not typically considered toxic or hazardous unless the practice serves a hotspot land use or has received spills. In these cases, soil tests should be conducted to see whether dredged sediment can be spoiled on site or must be hauled away due to high concentrations of hydrocarbons, nutrients, or heavy metals.

Transporting the sediment is often the largest cost associated with basin cleanout. This can be avoided by designating an area on-site for future sediment disposal.

[1] These documents are publicly available from the U.S. Department of Agriculture, Natural Resource Conservation Service on their website.

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