Chapter 3 - Detention Basins for Flooding Control

Peak flow control generally involves the use of a detention structure to temporarily store excess runoff and gradually release it over a period of time to the receiving watercourse. Typically, a detention facility is designed to control outflow at a rate no greater than the pre-development peak discharge rate.

Generally, detention facilities will not significantly reduce the total volume of runoff, but will redistribute the rate of runoff over a period of time by providing temporary "live" storage of a certain amount of stormwater. The purpose is to reduce downstream flooding and erosion problems. The most common detention structure is the dry detention basin, although wet ponds can also be used for peak flow control. This chapter focuses on detention basins, since their primary function is peak control, with little water quality benefit. Wet ponds are discussed in Chapter 4 for use as both water quality and peak flow control.

A dry detention basin is normally designed for quantity control or peak flow control and pollutant removal is only a minimal benefit. Although detention basins are effective at controlling peak discharge rates leaving a site, they may do little to limit increases in flow rates further downstream and, in some cases, may actually increase the peak flows at some points.

This Chapter discusses the design of detention basins for quantity control and extended detention for stream channel protection. Other BMPs presented in this manual (i.e., wet ponds, buffers, infiltration and underdrained soil filters) must be used for water quality improvements.

> ***IMPORTANT:***
> Detention basins may only be used for water quantity control. They must be combined with other water quality BMPs to receive credit for water quality improvements.

Basin Siting: A detention basin is an impoundment designed to temporarily store runoff and release it at a controlled rate and should be dry 2-3 days following a rain event.

- *Subsurface Investigation:* Subsurface explorations (test pits or borings) should be made within the basin area to identify depths to seasonal high groundwater and bedrock. Explorations should extend to below the proposed basin bottom elevation.
- *Separation from Seasonal High Watertable:* The bottom of the constructed basin, including any underdrain soil filters should be one (1) foot above the seasonal high groundwater table to avoid standing water in the basin.
- *Separation from Bedrock:* The bedrock surface may be no closer than 1 foot from the bottom of the basin, unless an impermeable liner (not clay) or other design elements are employed.
- *Permeable Soils: A* detention basin should not be located in hydrologic soil groups A and B (sand and gravel), unless an impermeable liner (not clay) or other measures are provided in the design to prevent infiltration.
- *Basins on Slopes:* When basins are created by cutting and filling a slope, the seasonal groundwater table on the slope above the basin may be exposed and may cause the destabilization of the embankment from groundwater seepage without riprap or the installation of a subsurface interceptor drainage system.

Basin Plan: One acre-foot of storage in a detention basin is recommended for each four acre of drainage area. The design of a detention basin is shown on Figure 8.1.

- *Access:* A maintenance access should be at least 10 feet wide with a maximum slope of 15% and a maximum cross slope of 3%. This access should never cross the emergency spillway, unless the spillway has been designed for that purpose. An easement may be required.

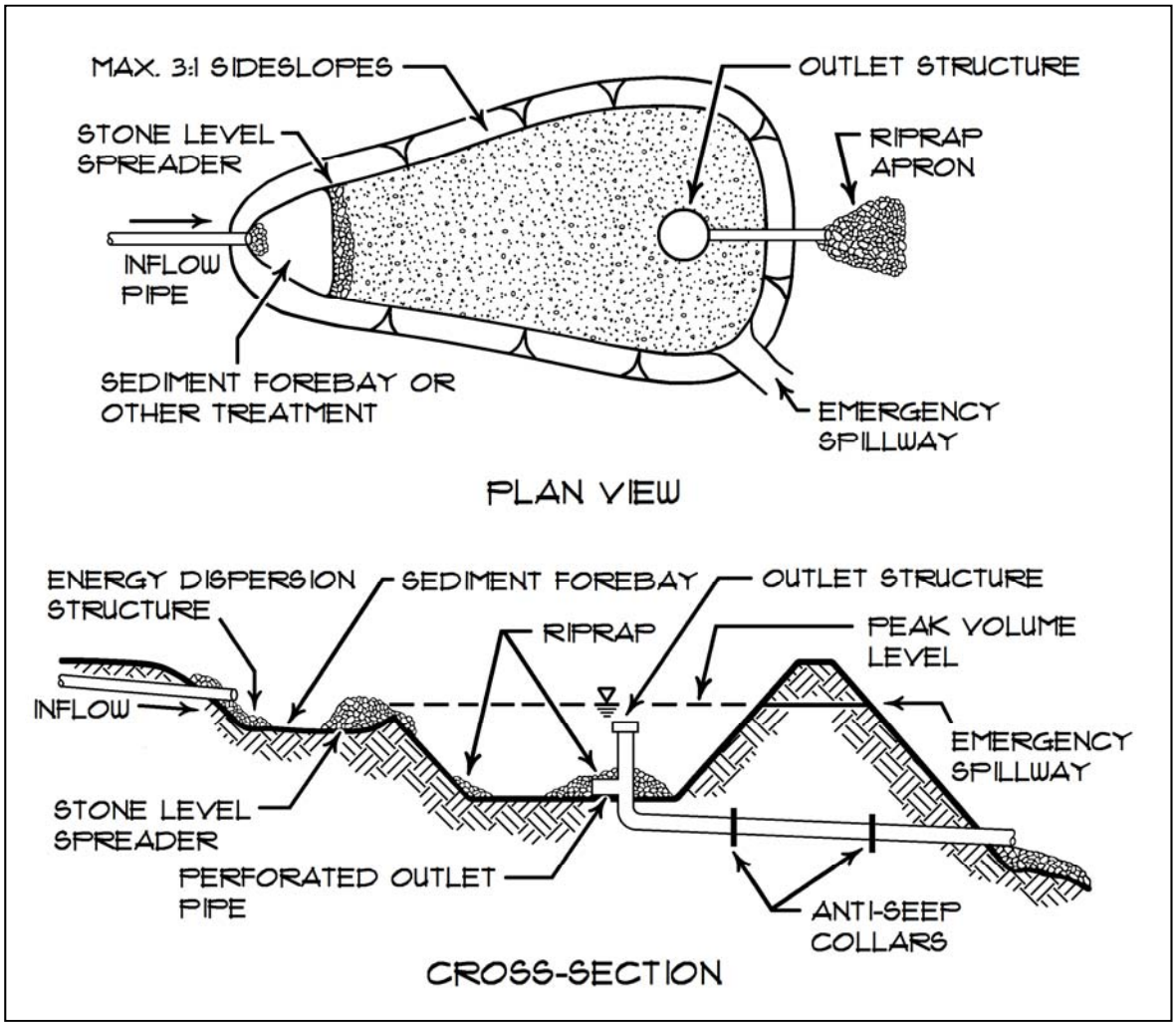

Figure 3.1- Detention Basin Design

- *Sediment Pretreatment:* A pre-treatment device such as grassed swale, underdrained swale, filter strip, and sediment trap should be provided to minimize the discharge of sediment to the basin. Pretreatment structures should be sized to hold an annual sediment loading or be routinely cleaned.
- *Basin Slopes:* Basin side slopes should be no steeper than 2:1. Flatter slopes provide easier access for maintenance (mowing). At a minimum, one side slope (interior or exterior) should be 3:1, such that the combined interior and exterior embankments total 5:1 (2:1 + 3:1).
- *Basin Shape:* Provide a long and narrow basin shape, with a minimum length to 2:1 width ratio (3:1 is best). Runoff should travel the longest distance through the basin before being discharged with the inlet and outlet as far apart as possible. The path of flow can be increased with an irregularly shaped basin or by using baffles. The basin should be shallow and narrow at the inlet, and deep and wide at the outlet.

Inlet Design: Prevention of scour at the inlet will reduce maintenance problems and prevent damage to basin floor vegetation. Provide energy dissipation at the inlet in accordance with practices outlined in the Maine Erosion and Sediment Control Practices Manual.

- *Inlet Protection:* The inlet should be protected with riprap or other energy dissipater, such as a baffle below the inflow structure to remove sediment. A forebay should be designed with a minimum length to width ratio of 2:1.

- *Scour:* Energy dissipation should be provided at the inlet and outlet to prevent scour and reduce the velocity of stormwater. The velocity of flow through the inlet sediment control structure and basin should not exceed 2.5 feet per second.

Embankments: Embankments should be designed by a professional engineer registered in the State of Maine and must be designed to meet engineering standards for foundation preparation, fill compaction, seepage control, and embankment stability. Basic standards for small basins can be found in the Maine Erosion and Sediment Control Practices Manual. The design must include an investigation of the subsurface conditions at the proposed embankment location to evaluate the depth to bedrock and groundwater, settlement potential, and the need for seepage controls. The department may require a geotechnical report for any embankment over 10 feet in effective height or posing a hazard to downstream property or life.

- *Key:* Embankments must be keyed into undisturbed subsurface soils.
- *Safety Bench:* A safety bench should be designed into all embankments greater than 10 feet high.
- *Crest width:* The minimum crest width for any embankment must be as shown on Table 8.1
- *Crest elevation:* The minimum elevation of the top of the settled embankment must be at least one foot above the peak water surface in the basin with the emergency spillway flowing at design depth for a discharge routed through the emergency spillway only.
- *Fill Material:* Fill must be free of frozen soil, rocks over six inches, and sod, brush, stumps, tree roots, wood, or other perishable materials. Embankment fills less than 10 feet in fill height must be compacted using compaction methods that would guarantee a fill density of 90% of the maximum density as determined by standard proctor (ASTM-698). All embankment fills more than 10 feet in fill height must be compacted to 90% of the maximum density and must have their density verified by field density testing.

Table 3.1 – Embankment Crest Width

HEIGHT OF EMBANKMENT (feet)	CREST WIDTH (feet)
Less than 10	6
10-15	8
15-20	10
More than 20	12

Outlet Protection: Outflow from the basin must be directed to a stable channel or area. A channel may need to be riprapped to prevent erosion. The discharge onto a buffer needs to be spread through a level spreader that will distribute the runoff as a sheet flow.

Principal Spillways: The principal spillway should control the runoff from a 24-hour storm for the 2-year, 10-year, and 25-year frequencies such that these peak flows never exceed the peak flows prior to undertaking the project.

- *Trash Racks:* All basin outlets must have a trash rack to control clogging by debris and to provide safety to the public. The surface area of each rack must be at least four times the outlet opening it is protecting. The spacing between rack bars must be no more than six inches or one-half the dimension of the smallest outlet opening behind it, whichever is less. Trash racks should be inclined to be self-cleaning.
- *Seepage Controls:* All pipes that extend through an embankment should have anti-seep collars or filter diaphragms to control the migration of soil materials and, to prevent embankment failure from "piping" within the backfill along the conduit. All smooth outlet pipes greater than eight inches and all corrugated outlet pipes greater than 12 inches must have seepage controls.
- *Anti-floatation:* All outlets employing a riser structure must be designed to prevent the riser floating.

Emergency Spillways: Emergency spillways should independently convey the runoff from the 25-year, 24-hour storm while maintaining at least one foot of freeboard between the peak storage elevation and the top of the embankment crest; and should safely convey the 100-year storm without overtopping the embankment. Overflow must discharge to a stable channel or stable area.

- *Location:* Emergency spillways should be located on undisturbed, non-fill soil. If the spillway must be located on fill soils, it should be horizontally offset at least 20 feet from the principal outlet; and be ripraped or reinforced with turf lining, or a non-flexible lining.
- *Exit channel:* The grade of the spillway's exit channel should not exceed 20% unless a non-flexible lining (concrete or asphalt) is provided. Vegetation, reinforced turf, riprap, and modular blocks are considered flexible linings. Large woody species growing in the emergency spillway will interfere with its function and must be removed.
- *Flow depth:* The design flow depth in the exit channel may not exceed one-half the d_{50} stone size for channels lined with riprap and three inches for channels with vegetation. The channel should remain stable through the full range of design flows.

Naturalized Basins: Conventional detention basins should be naturalized wherever feasible and achieve the maximum benefit by incorporating the following:

- *Soil Amendment:* If the basin soil needs amendment to support vegetation, the added material needs to be at least 6 inches thick with the bottom 3 inches rototilled into the native soils. Wood waste compost and other highly organic material work best.
- *Low Flow Channel:* Construct the basin with a natural low flow channel to remove pollutants and prevent erosion.
- *Landscaping:* Incorporate a naturally landscaped area at the ground surface. The ground surface around the basin should be large enough to be in scale with the overall landscaped area. Soften views from residential areas by grouping trees or shrubs to avoid a spotty effect. A minimum of six inches of topsoil with at least 6% organic content should be provided if the soil requires amendment.
- *Mulch:* Mulch all shrub beds located within the pool area with a non-floating type mulch over a weed barrier material.
- *Maintenance Access:* Blend access area in with the surrounding landscape to the extent feasible.
- *Vegetation:* Plant all areas of the basin, including basin floors, side slopes, berms, impoundment structures, or other earth structures, with grasses such as naturalized meadow plantings or lawn grass specifically suited for stormwater basins. Six inches of loam, composted wood waste or fine erosion control mix should be added to amend dry mineral soils. Avoid the unintended introduction of invasive species (such as purple loosestrife or common reed - *Phragmites australis*). It is recommended that a qualified wetland biologist be consulted when planning the revegetation of a basin.

Construction: Construction can be started no later than September 1 or before June. If side slopes and banks cannot be revegetated and stabilized by the end of the growing season, basin construction should be delayed to the following growing season. Basin construction should not be delayed beyond 2 weeks excluding for major weather. Seeding must occur by September 15 or other stabilization measures must be implemented before winter. Do not discharge stormwater to the basin until the basin is fully stabilized or provide a sediment barrier at the outlet.

- *Soil compaction:* Prevent soil compaction on the floor of the basin during construction.
- *Sediment Disposal:* Construction sediments should be disposed such that water draining from the material could not flow directly to a water resource.

Subsurface Detention Basin Criteria: In addition to the general design and construction criteria, the following criteria apply to subsurface detention basins.

- *Pretreatment:* All subsurface systems should include pretreatment for the removal of sediments.
- *Observation Wells:* An observation port for monitoring sediment levels and determining when rehabilitation is necessary should be installed to the bottom of the system. The observation well should be a 4-inch diameter, perforated PVC pipe fitted with a removable yet securable well cap, foot plate, and rebar anchor. Set the observation well prior to backfilling with stone fill.
- *Access Ports:* Access to the subsurface system must be provided to allow for the removal of accumulated sediments.

IMPORTANT - Vegetation
Seed mixtures should be selected for the soil type, moisture content, the amount of sun exposure, and the level of use found at the site. Examples are as follows:

- **Lots of sun and mostly dry:** Creeping red or tall fescue, perennial rye grass and clover
- **Shady areas:** Creeping red fescue, Kentucky bluegrass, Canada bluegrass
- **Wetlands:** Creeping red fescue, Reed canary grass, Timothy
- **Steep slopes:** Crown vetch, clove
- **Naturalized basins:** Contact your Soil and Water Conservation District for specific mixtures. The mixture should include some annual rye for quicker green-up. Apply at the approximate rate of 0.5 -1 lbs per 1,000 SF (30-50 lbs per acre).
  - *Grasses:* Big Blue Stem, Switchgrass and wildflower mixes. In wet areas, plant Sweet Flag, Yellow Iris and Soft Rush for color and texture
  - *Shrubs:* Red Chokeberry (Aronia arbutifolia), Silky Dogwood (*Cornus ammomum*), Arrowwood (*Viburnun Dentatum*), Cranberrybush (*Viburnum trilobum*). If shrubs are used, they must be adapted to wet or moist soils conditions
  - *Trees:* Red Maple (*Acer rubrum*), River Birch (*Betula nigra*), Sweetgum *(Liquidambar styraciflua*), various Willows. Trees may not be planted below the pool area of the basin.

Avoid the introduction of invasive species.

Maintenance: Basins should be inspected annually for erosion, destabilization of side slopes, embankment settling and other signs of structural failure, and loss of storage volume due to sediment accumulation. Corrective action should be taken immediately upon identification of problems.

- *Maintenance Agreement:* A legal entity should be established or inspecting and maintaining any detention basin. The legal agreement should list specific maintenance responsibilities (including timetables) and provide for the funding to cover long-term inspection and maintenance.
- *Inlet & Outlet Inspections:* The inlet and outlet of the basin should be checked periodically to ensure that flow structures are not blocked by debris. Inspections should be conducted monthly during wet weather conditions (March to November). Flow structures should be easily accessible for inspection and the removal of debris blockage during storm conditions.
- *Embankment Maintenance:* Embankments should be maintained to preserve their integrity as impoundment structures, including: mowing, control of woody vegetation, rodent, and outlet maintenance and repair. Basins should be mowed no more than twice a year during the growing season to maintain maximum grass heights less than 12 inches. All accumulated trash and debris should be removed.
- *Sediment Removal:* Sediment should be removed from the pretreatment structure at least annually and from the basin when necessary.

NOTE:
An annual sediment load shall be calculated using a predicted sand application rate of 500 lbs/acre for sanding of roadways, parking areas and access drives within the subcatchment area, a sand density of 90 lbs per cubic foot and assuming a minimum frequency of ten storms per year.