Town of Smyrna
Dry Detention Basin Policy

Section I – Description

A detention basin (also known as a detention pond) is the most common method to satisfy storm water detention requirements. It is applicable to small and large developments, can be easily designed and constructed, and is long-lasting and durable while reducing peak flows (with adequate inspection and maintenance). This practice can also provide a reduction in sediment, as well as a reduction in nutrients, toxic materials, heavy metals, floatable materials, oxygen demanding substances, and oil and grease.

A dry detention basin is intended to drain dry between storm events but sometimes may not have a chance to drain completely between closely occurring storm events. The detention basin begins to fill as storm water runoff enters the facility. The first flush volume is captured in order to improve water quality. One or more outlet structures then release the storm water runoff slowly to reduce peak discharge rates and to provide time for sediments to settle. Litter and debris are prevented from leaving the detention basin, and soluble pollutants are captured by a combination of vegetation and soils.

Section II - Selection Criteria

- The primary objective is to reduce the incoming peak flow discharge and slow the storm water runoff response from a particular property or development, thus reducing flooding downstream.
- The secondary objective is to remove suspended nutrients, sediments, trash and debris, oil, grease and other pollutants to protect the water quality of Tennessee streams and channels. Although dry detention basins are usually not as effective at removing soluble pollutants as wet detention basins and wetlands, dry detention basins are usually easier and less expensive to construct, inspect, and maintain. Dry detention basins can be used wherever a lack of sufficient water supply would prevent the use of wet detention basins or wetlands.
- Dry detention basins can also supply multiple benefits for passive recreation during dry periods (recreational trails, ball fields, picnicking). Portions of a dry detention basin that are not wetted frequently can be attractively landscaped or used for other purposes. Conversely, portions of dry detention basins that are frequently wetted can be attractively landscaped with hardy wetland plants.

Section III – Design and Sizing Considerations

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- A permanent detention basin design and as-built plan must be stamped by a professional engineer licensed in the state of Tennessee. The professional engineer must be qualified by education and experience to perform the necessary hydrologic and hydraulic calculations and have authority over other associated engineers involved in the design and construction portions of the project.

- Historical rainfall data, obtainable from the U.S. Weather Service (Nashville airport), should be analyzed for storm event frequency, duration, and intensity before designs are initiated.
- As the primary objective, dry detention basins must be designed to have adequate detention storage and outlet structures to limit the peak discharge rate for the post-development conditions to be no greater than the peak discharge rate for the predevelopment conditions. Multi-stage detention is required for the 1-year, 2-year, 5-year, 10-year, and 25-year storms (with NRCS Type II 24-hour rainfall distribution). Additional stages (i.e. 50-year and 100-year) may be required for special watersheds.
- As the secondary objective, water quality improvement is obtained through the use of the first flush treatment volume. The first 0.5 inches of storm water runoff, over the entire contributing drainage area of the development, is defined as the first flush volume (with a minimum value of 4,500 cubic feet). The initial wave of storm water runoff is more likely to contain aerially-deposited sediments, and fluids and particulates from vehicles (such as coolant, oil, transmission and brake fluids, incomplete combustion, dust from brake linings, and tire particles), leaves, trash, and cigarette butts. The first flush volume must be captured and then slowly released over a 24-hour minimum and 72-hour maximum period.
- Additional measures may be required to improve storm water quality, depending upon the nature of the land use and expected pollutants. Pretreatment of storm water runoff with a media filtration inlet or oil/water separator may be necessary. A trash rack for capturing floating debris is generally considered to be standard equipment for a storm water treatment BMP.

Section IV – Location and Layout

Basic elements of a dry detention basin are illustrated in Figure 1. The recommended design includes the use of a sediment forebay to reduce sediment loading, particularly if the post-construction detention basin is a modification from a temporary sediment basin during the construction phase. The use of an upper stage (for storage of infrequent storms) is optional; there are both benefits and drawbacks. A shallow detention basin with a large surface area will usually perform better than a deeper detention basin with the same volume. However, shallow storage areas increase the overall surface area needed for detention.

Design flow paths to minimize potential short-circuiting by locating the drainage inlets to the basin as far away from the outlet structure as possible. The length-to-width ratio of a basin should be at least 3:1. Baffles or backslope drains may be used to prevent short-circuiting for ratios less than 3:1. Increase pond area and volume to compensate for dead spaces if topography or aesthetics require the pond to have an irregular shape. It is important to reduce the velocity of incoming storm water using riprap or other energy dissipaters.

Although dry detention basins are generally less expensive to construct and maintain than wet detention basins, they provide lower water quality benefits. The primary disadvantage of a dry detention basin is the amount of surface area required, which can be reduced somewhat by using concrete retaining walls on one or more sides. In general, concrete retaining walls should not face southward in order to reduce the potential for heating on hot summer days.

Bedrock and topography must be considered during preliminary design. Depth to bedrock studies, comprised of closely spaced shallow soil borings or probings, should precede any design effort to ensure the absence of sinkholes and throats as well as adequate depth to bedrock. Karst topography may indicate fractured bedrock, dissolved limestone passages, or sinkholes, for which a detention basin would be highly detrimental. The additional water volume that is introduced to the underground limestone passages, or even the additional weight of ponded water, could intensify karst activity and eventually collapse the bed of the detention basin. Consequently, detention basins should never be constructed on or in close proximity to any sinkhole or spring.

Interaction with site utilities must be considered during preliminary design. Typical utilities include electrical, telephone, cable TV, water, sewer, natural gas, petroleum, etc. These utilities may or may not be in a dedicated utility easement, so it is always necessary to conduct a careful site survey. Detention basins (including embankments) should not be allowed over utility lines. Conversely, utility trenches should not be constructed on existing detention basin structures.

Detention basin easements and access must be considered during preliminary design, in order to allow for the construction easement and maintenance. Detention basins that are not frequently inspected and maintained often become more of a nuisance than a beneficial part of a storm water management program. In particular, provide access for inspection and maintenance to the sediment forebay and to the outlet control structure. It may also be desirable to encourage or discourage public access to the detention basin (by using site grading, signs, fences, or gates). Additional safety elements include trash racks, grating over pipes and culverts, gentle side slopes whenever possible, increased visibility and/or lighting in residential areas, etc. Installation of guard rails may be necessary to prevent moving vehicles from accidentally entering the basin.

Small detention basins serving individual properties do not offer as much recreational benefits as community or regional detention basins would. Regional facilities can often be landscaped to offer recreational and aesthetic benefits. Jogging and walking trails, picnic areas, and ball fields are some of the typical uses. For example, portions of the facility for flood control of major design storms can be used for exercise areas, soccer fields, football fields, or grasslands well-suited for feeding and nesting of fowl and other wildlife. Wildlife benefits can also be provided in the form of islands, buffer areas, or preservation zones. It is important to maintain such areas, however as their primary purpose is for storm water management. Under no circumstances should debris be allowed to accumulate near the outlet.

Section V – Volume and Size

The volume of a dry detention basin consists of two elements: the live pool (the upper portion of the basin representing detention capability) and the first flush volume (the lower portion of the basin representing storm water quality treatment). Since the post-development peak runoff may not exceed the pre-development peak flow rate, the upper section's volume should be based on a standard storage routing method.

Detention basins shall be sized to collect the 0.5 inches of storm water runoff from the entire contributing area, or the first 4500 cubic feet of storm water runoff, whichever is greater. The first flush volume must be released at a controlled rate over a 24-hour minimum and a 72-hour maximum period.

As a warning to those who design detention basins, it should be realized that future storm water regulations are likely to be more stringent than the current regulations. This is mostly driven by national and state laws and regulations, which will require municipalities and county governments to accomplish additional pollution reduction with a proportional effort for water quality monitoring and enforcement.

Section VI – Grading

Side slopes of detention basins and embankment dams shall be 3: 1 (H:V) or flatter, except where approved by the engineering reviewing authority. This encourages a strong growth of vegetation on the side slopes, helps to prevent soil erosion, and allows for safer mowing. Steep slopes, particularly on embankments or other fill soils, will contribute to soil erosion if not properly vegetated or stabilized, perhaps to the extent of using geotextile materials, and thereby reduce or negate the effectiveness of a dry detention basin with respect to water quality. Vegetate, with grasses, the side slopes and basin bottom to the maximum extent practical, using geotextile materials as a protective cover on steeper, less stabile slopes. If significant side erosion is expected, consider the use of soil stabilization or armoring techniques. Detention basins should not be located immediately above or below a steep slope or grade, because impounded water may create slope stability problems.

Minimum width for top of embankment is 6 feet. The embankment height should allow for up to 10% settlement of embankment, unless the embankment is thoroughly compacted with vibratory equipment or sheepsfoot rollers. The top of embankment (after expected settlement) shall generally be at least 2 feet above the top of outlet structure and at least 1 foot above the peak 100-year water surface elevation. Compaction in the immediate area of the emergency spillway can be difficult, but is necessary.

The use of a backslope drain can be very beneficial in preventing erosion at detention basins. See Figure 5 for a typical detail. The backslope drain is also useful for increasing lengths of flow paths to prevent short circuiting of the detention basin. Intercepted storm water can be routed around the detention basin to enter at the most hydraulically distant point from the outlet structure.

Section VII – Outlet Structure

Detention basin outlet structures should be constructed of durable materials, such as concrete or masonry block. Corrugated metal pipe (CMP) and plastic (HDPE) risers and drain pipes are popular in engineering design, but are susceptible to crushing, corrosion, and flotation in detention basins. A concrete outlet structure is generally preferable to a masonry block structure because it is sturdier and more durable. Provisions should be made for sufficient reinforcement and anchoring of the riser and drain pipe system.

The specific flow-controlling elements of an outlet structure may include one or more of the following: a circular orifice, a noncircular orifice, a rectangular weir, a trapezoidal weir, a triangular weir, a V-notch weir, culvert entrance control or a riser overflow opening.

Figures 2 and 3 illustrate possible designs for the outlet structure. These details are only two possible ways to accomplish storm water detention and quality control. The first-flush volume is typically drained during a minimum time of 24 hours by using an orifice with a designed size. Maximum drain time should be less than 72 hours to allow for sufficient volume recovery prior to the next period of rainfall. The first-flush volume can be filtered through sand by using an underdrain system (shown in Figure 2) or by an aboveground filter box with sand or aggregate (shown in Figure 3). Figure 4 shows an alternative outlet structure with a water quality manhole. Provide an emergency spillway in order to route large storms through the facility without overtopping.

Section VIII - Emergency Spillway

An emergency spillway should be included in addition to the primary outlet structure on a detention pond. The purpose of this spillway is to pass storm events that exceed the design capacity of the pond, in order to prevent overtopping the embankment. The emergency spillway should be located over an undisturbed abutment area and not over the embankment fill for stability reasons, except where approved by an engineering reviewing authority. The emergency spillway capacity should be designed to prevent overtopping the embankment structure or dam during a storm event commensurate with the impoundment volume, dam size, and downstream flood hazard potential in event of dam failure. The minimum spillway capacity should be capable of handling a 100-year storm event. Where feasible, the emergency spillway should be made independent from the riser control structure to avoid the possibility of overtopping from riser or drain pipe clogging from vandalism or trash and lined with a geotextile material. The designer is referred to the requirements set forth in the Tennessee Safe Dams Act and Regulations at: www.state.tn.us/environment/permits/safedam.htm.

Section IX – Other Design Elements

- Sediment forebay – to facilitate the cleanout of sediment, trash, debris, leaves, etc. The sediment forebay typically contains 5% to 10% of the total volume. It should be located at a point where velocities have dissipated, to allow large sediments and debris to settle out. A forebay can be separated from the remainder of a detention basin by several means: a lateral sill with rooted wetland vegetation, rock-filled gabion, rock retaining wall, or rock check dam placed laterally across the basin. The sediment forebay should be easily accessible so that it can be inspected and maintained. Growth of trees should be prevented.
- Public safety should be considered, particularly in residential and institutional areas. Operating detention basins often attract neighborhood children. Avoid steep slopes and drop-offs; consider routes for escaping the detention basin if a person accidentally falls in. Avoid depths over 4 feet when possible; provide fencing and signs in areas where children may potentially play, and where steep slopes are used in the detention area.
- A low-flow channel (or concrete trickle ditch) can assist in completely draining detention basins with flat slopes. It also assists with the observation and removal of accumulated sediment. A typical design would be a triangular ditch, 4' wide and 3" deep with a slope of 0.5 to 1.0 percent.
- Anti-seep collars or a cutoff layer of compacted non-free-swelling clay are required around the outlet pipe to prevent internal piping and erosion. An anti-seep collar should extend at least one pipe diameter from the culvert in all directions, with compacted clay backfill using small mechanical tampers. The designer is referred to the Tennessee Department of Environment and Conservation (TDEC) Tennessee Erosion & Sediment Control Handbook for anti-seep collar considerations.
- To prevent the outlet riser from clogging, include trash racks or other debris barriers with a maximum opening size of 6 inches on all outlet structures, except for any emergency spillway structures that are designed for a 25-year storm or greater return period. Trash racks that are placed at an angle to the direction of flow tend to force debris up and away from the outlet opening, thus rendering the riser less vulnerable to clogging. These racks should be regularly cleaned and maintained.

- Provide a permanent means for vehicle access to the detention basin, using hardy grasses on slopes. Detention basins must be located in a maintenance easement so that authorities have the right to inspect the facility. This easement should be free of large trees and excessive vehicle grades.
- A skimmer, oil/water separator, or other type of storm water runoff pretreatment is recommended for drainage areas having greater than 50 percent impervious surface or where there may be a potential source of oil and grease contamination. In addition to most large parking lots, oil and grease contamination is also likely to be found at vehicle fueling and maintenance facilities.
- An anti-vortex device for the outlet structure may be needed for very large detention basins in areas where public access is not controlled. The anti-vortex device may be a combination of vanes above the outlet structure or guide walls around the outlet structure, that increases the inlet flow efficiency and might lessen the chance of humans drowning or reduce the potential for erosion and structural undercutting. The designer is referred to the TDEC Tennessee Erosion & Sediment Control Handbook for anti-vortex and trash rack considerations.

Section X – Construction and Inspection Considerations

Inadequate storage is the most frequent problem that occurs in the design review before construction, and also for the as-built review after construction, despite them being reviewed by a certified engineer. This can occur for several reasons:

- The design engineer may not allow enough room to construct the detention basin (most often due to insufficient design detail such as slope transitions, setbacks, property lines, drainage easements, parking lot widths, inaccurate contours, or incorrect/omitted utilities locations).
- The engineer who performs the storm water computations may not be the same person who does the site layout and grading details. The required detention storage volume and outlet structure details must be clearly communicated to the design engineer for inclusion on the plans and for construction layout. A final review of the entire plan by a certified engineer should eliminate this shortcoming.
- The construction contractor may not correctly follow the design plans, and consequently, does not excavate deep enough or build berms of sufficient height to hold the required detention volume. This may occur due to rock formations encountered or to groundwater. It is important that the elevation-volume configuration shown on the plans be preserved during construction so that the detention basin functions according to intended design. Close inspection by an engineer during all construction phases should eliminate this shortcoming.
- The construction contractor changes the basin configuration during the construction without being aware of the required volume. Approval from the engineer was not obtained for a design change. Close inspection by an engineer during all construction phases should eliminate this shortcoming.

The design engineer must be involved in the construction and inspection phases of the detention basin. Special attention should be given to the requirements for detention basin volume, elevations and sizes of each outlet, embankment crest and emergency spillway crest elevations; embankment compaction, side slopes, size and shape of various weirs or orifices, outlet structure anchoring, trash racks, installation of anti-seepage collars, as well as thickness of soil between basin floor and underlying bedrock (preferably 1-foot or greater).

Proper hydraulic design of the outlet is critical to achieving good performance for both storm water detention and storm water quality of the dry detention basin. The two most common problems for detention basin outlets are:

- The discharge capacity of the outlet system is too great at the detention design depth. This causes excessive basin outflows and results in fast drawdown times and inadequate filling of the detention basin volume. Both storm water outflow and quality will suffer.
- The outlet structure clogs because it is not adequately protected against trash and debris. The use of innovative trash racks is recommended. Effective trash racks are often created using welded rebar with 6-inch openings. Sloped trash racks are preferable to vertical ones for forcing floating debris upward and away from the opening, rather than being forced against the trash rack, and causing clogging. This is sufficient to stop most beverage cans, fast food containers, tree limbs, etc. Properly designed and installed trash racks also provide a measure of safety to children who may otherwise be pulled toward and held against the opening.

Section XI – Inspection and Maintenance

Effective and safe operation of a detention basin depends on continuous maintenance of all system components. Detention basin easements and access must be considered during the planning stage in order to allow for proper inspection and maintenance.

- Inspect the dry detention basin regularly (e.g. at least semi-annually) and particularly after heavy rainfall events. Record all observations and problems. Perform any maintenance and repair erosion promptly. Remove debris and trash after storm events. Check all outlet structures regularly for clogging.
- Detention basins should be surveyed approximately every 5 years to check for adequate embankment settlement and freeboard and for storage volume as per intended engineering design calculations and plans.
- Determine if installation of any additional impervious surfaces in the drainage area cause volume modifications for the basin.
- Remove sediment when accumulation becomes noticeable (1” to 2” over a wide area) or if resuspension is observed or probable. Sediment may be permitted to accumulate if the detention basin volume has been overdesigned with adequate controls to prevent further sediment movement. If a sand underdrain is used, look for reduced first-flush infiltration or ponded water; sand layer replacement or maintenance may be needed.
- Maintain a thick and healthy stand of vegetation (preferably grasses). Mow, trim, or de-thatch at regular intervals to encourage thick growth. Remove leaves, grass clippings, or sticks from detention basin regularly to prevent storm water pollution. Remove trees or nuisance vegetation as necessary to ensure structural integrity of embankments. Signs should be posted at detention ponds to discourage local homeowners from depositing

yard trimmings, waste, and fill materials inside the basin. Appropriate signs and barriers such as fences should also be considered at detention basins where children have easy access to the site.

Section XII– Sediment Removal

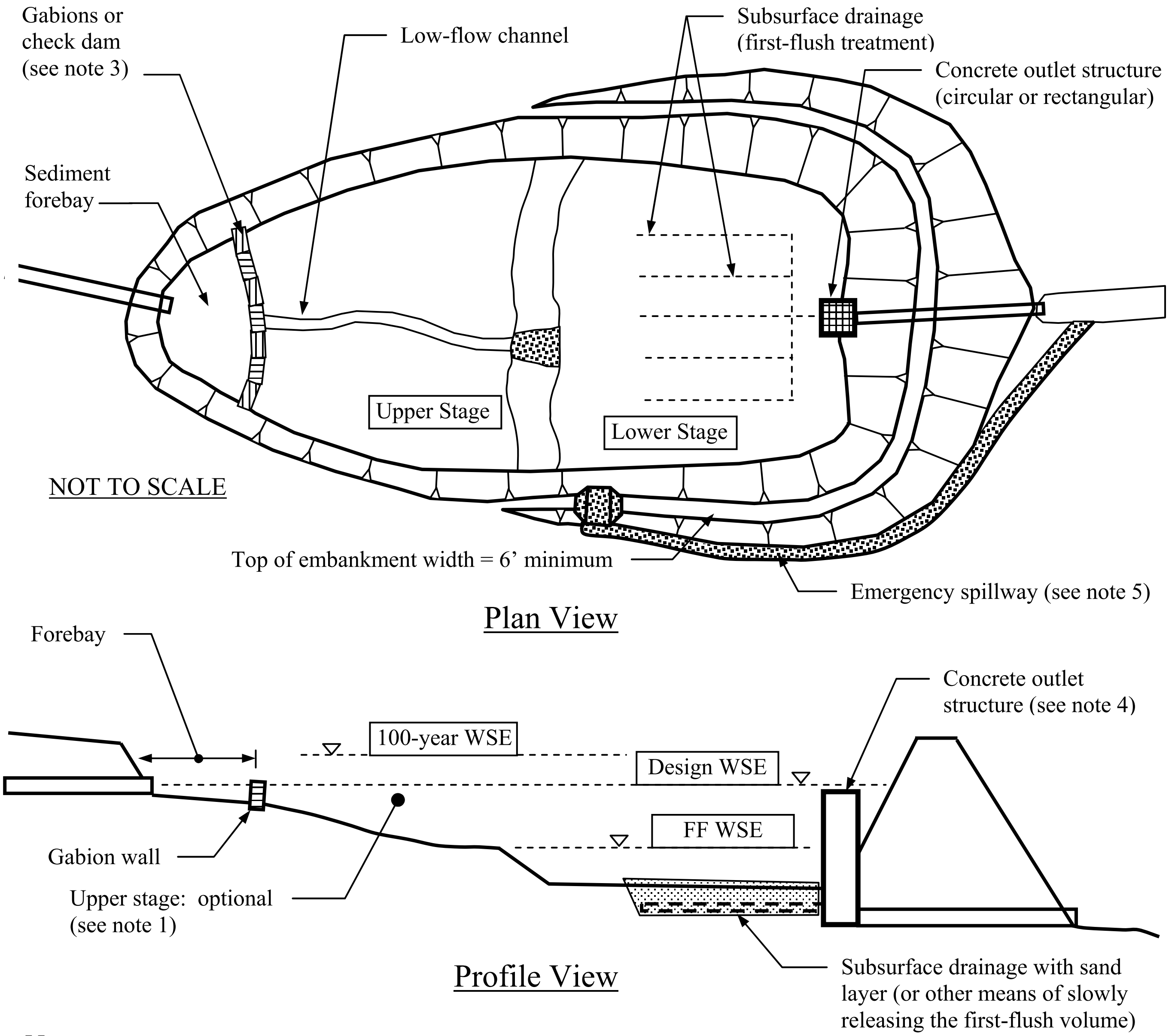
A primary function of storm water treatment BMPs is to collect and remove sediment, which is a pollutant itself and is associated with several other attached pollutants. The sediment accumulation rate is dependent on a number of factors including watershed size, facility sizing, construction upstream, and nearby industrial or commercial activities, etc. Sediment should be identified before sediment removal and disposal is performed. Special attention or sampling should be given to sediments accumulated from industrial or manufacturing facilities, heavy commercial sites, fueling centers or automotive maintenance areas, parking areas, or other areas where pollutants are suspected. Sediment should be treated as potentially hazardous until proven otherwise.

Some sediment may contain contaminants for which TDEC requires special disposal procedures. Consult TDEC – Division of Water Pollution Control if there is any uncertainty about what the sediment contains or if it is known to contain contaminants. Clean sediment may be used as fill material or land spreading. It is important that this material not be placed in a way that will promote or allow re-suspension in storm water runoff. Some demolition or sanitary landfill operators will allow the sediment to be disposed at their facility for use as cover. This generally requires that the sediment be tested to ensure that it is innocuous.

Section XIII–Limitations and Special Requirements

- A dry detention basin will require frequent inspection and maintenance. Trash, debris, leaves, and other large items should be removed from the detention basin following each rain event. If upstream erosion is not properly controlled, dry detention basins can be maintenance-intensive with respect to sediment removal, nuisance odors, insects, especially mosquitoes, etc.
- A dry detention basin may not have sufficient vegetation on the slopes and bottom to prevent erosion. Vegetation must be maintained and cut at adequate intervals. Remove grass clippings from detention basin immediately after cutting, using rakes or other hand equipment.
- A dry detention basin that impounds more than 30 acre-feet of volume (and minimum 6 feet high) or which is higher than 20 feet (and minimum 15 acre-feet of volume) is subject to the Tennessee Safe Dams Act of 1973 and as amended by law. The Safe Dams Act is administered by the TDEC Division of Water Supply; further information on design standards, regulations and permit applications is available at the TDEC website:

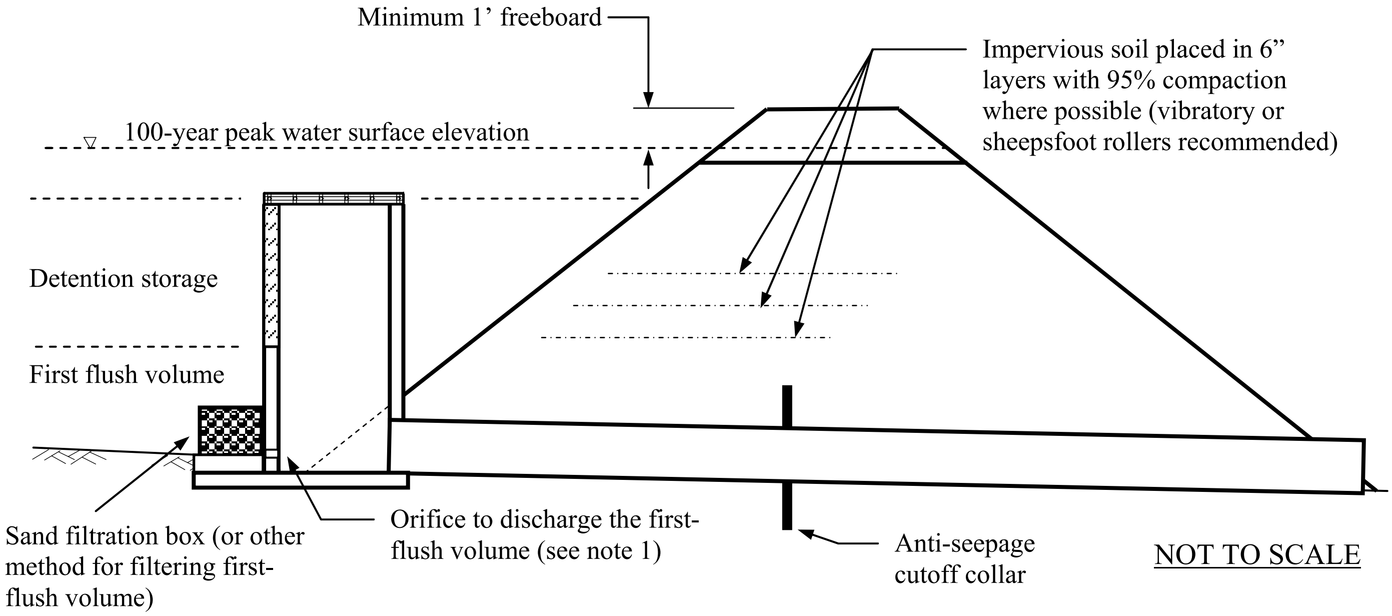
  http://www.state.tn.us/environment/permits/safedam.htm



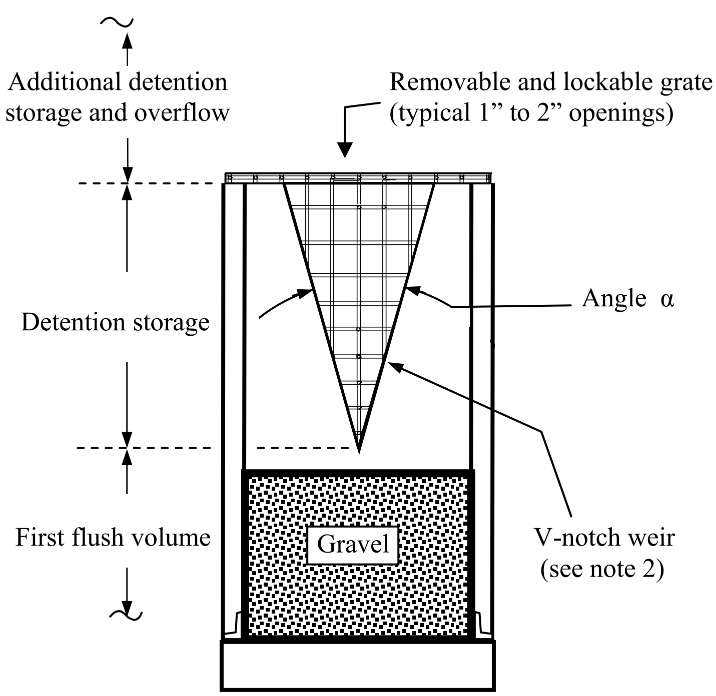
Notes:

1. This example of a typical dry detention basin layout shows an upper stage which is used for stormwater detention on infrequent storms. An upper stage can also be located on the side of a dry detention basin, eliminating the need for a low-flow channel.
2. The lower stage is sized to handle the first-flush volume.
3. A forebay can be constructed from gabions, rock check dams, or a separate berm with culvert. A forebay can facilitate the capture and cleanup of coarse sediments, debris, and trash.
4. The outlet structure typically has orifices or weirs at computed elevations that will release the 1-year, 2-year, 5-year, 10-year, and 25-year storms at the specified pre-development peak flow rates.
5. The emergency spillway is generally constructed on natural ground or excavated areas (rather than fill soils) to reduce the potential for erosion and washout.
6. There are several types of first-flush and outlet structures available. The designer should check with the design reviewing authority before submitting novel or alternative design approaches.

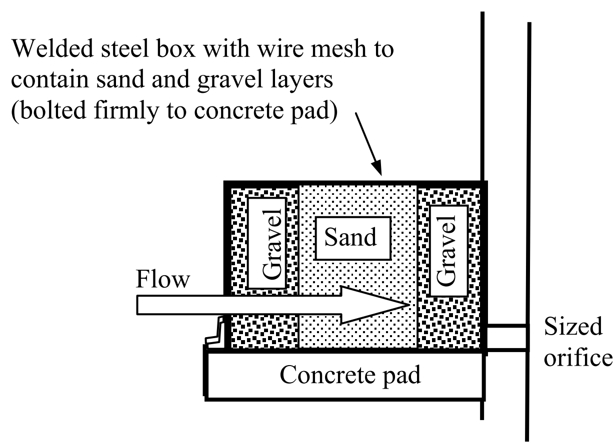
Figure 1 - Typical Dry Detention Basin Layout



Typical Outlet Structure (V-notch)



V-Notch Weir
(to control outflows)



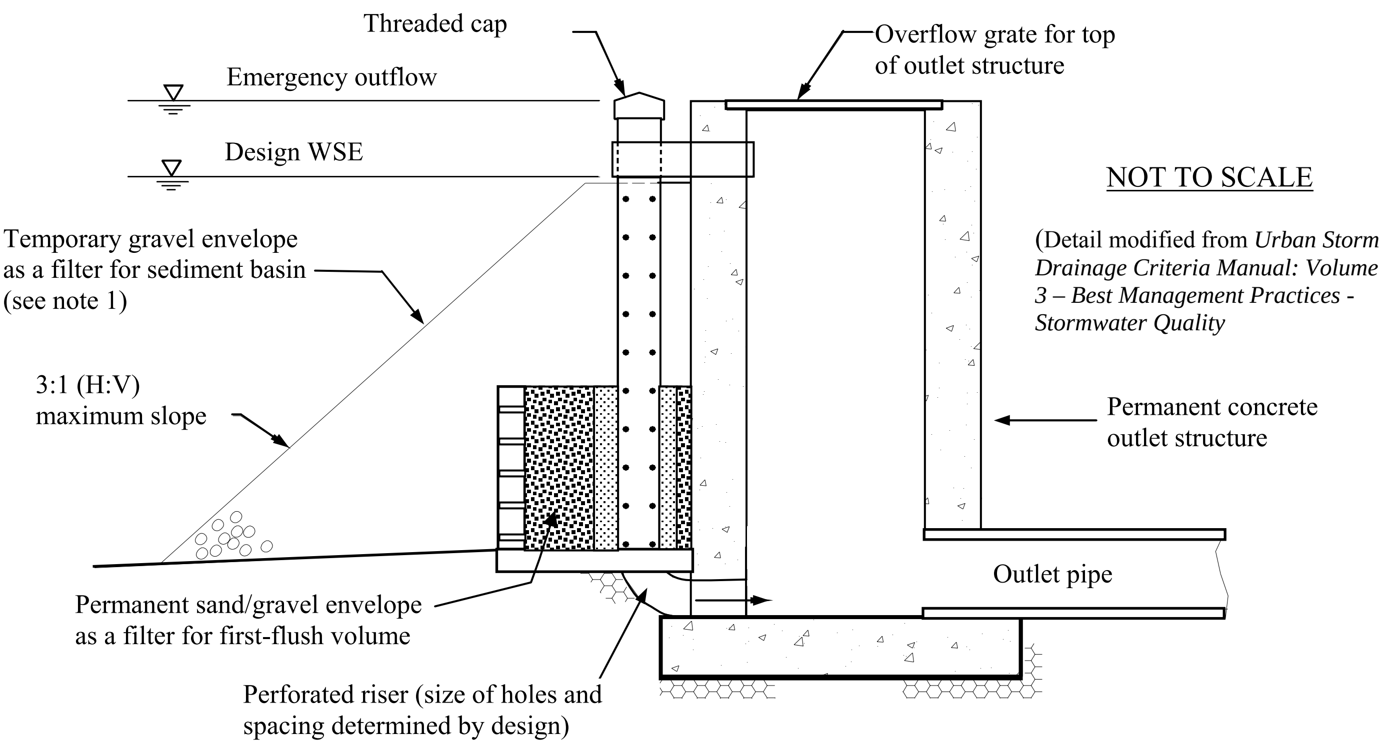
Sand Filtration Box
(first-flush release)

Notes:

1. The orifice is sized to release the first flush volume over a period from 24 to 72 hours. Protect the orifice from clogging by a sand filtration box, gravel filtration box or with a trash rack.

2. This example of a typical outlet structure shows a V-notch weir which should be sized to release the 1-year, 2-year, 5-year, 10-year, and 25-year storm peak flows at the predevelopment rates. Other control geometries such as orifices or culverts may also be used.

Figure 2 - Typical Outlet Structure
(shown with a V-notch weir & sand filtration box)



Notes:

2. This type of outlet structure may be used as a temporary modification to a dry detention basin (so that it may also be function as a sediment basin). A temporary plastic riser is securely fastened using bolts, screws, or threaded connectors.

1. This type of outlet structure may be used as a permanent outlet structure for a dry detention basin. Maintain clean sand/gravel envelope in unclogged condition within an enclosure in front of outlet structure to protect the perforated riser.

Figure 3 – Alternative Outlet Structure (A)

(also shown as a temporary sediment basin during construction)

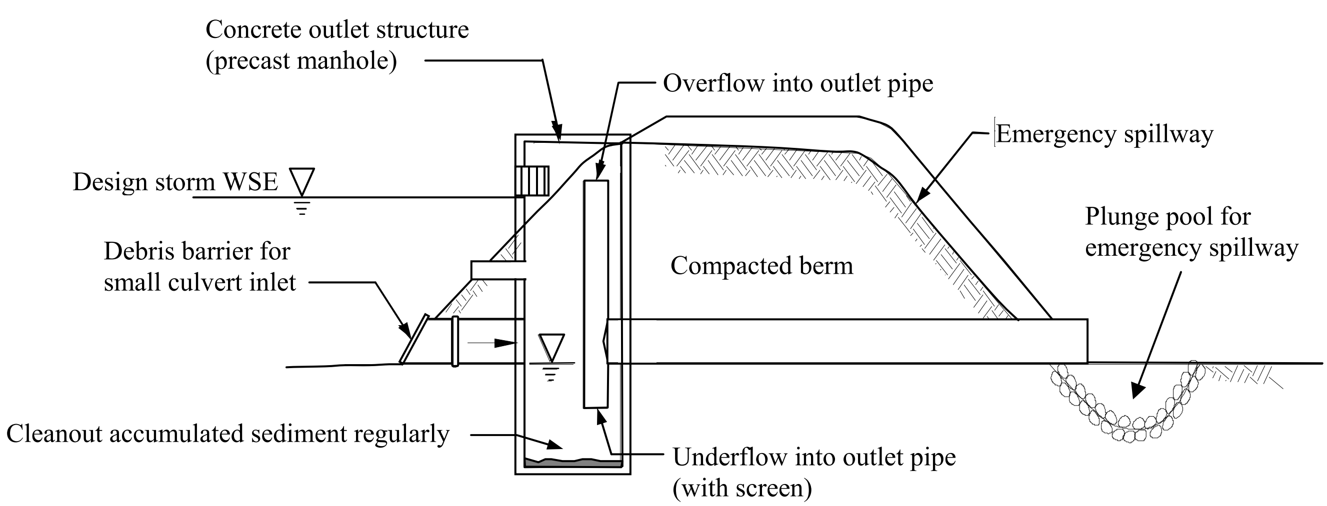


Figure 4 – Alternative Outlet Structure (B)

(includes water quality manhole with underflow)

A backslope drain has two purposes:

1. Safely convey stormwater to the bottom of a detention basin slope.
2. Increase flow paths by channeling storm water into the detention basin far from outlet structure.

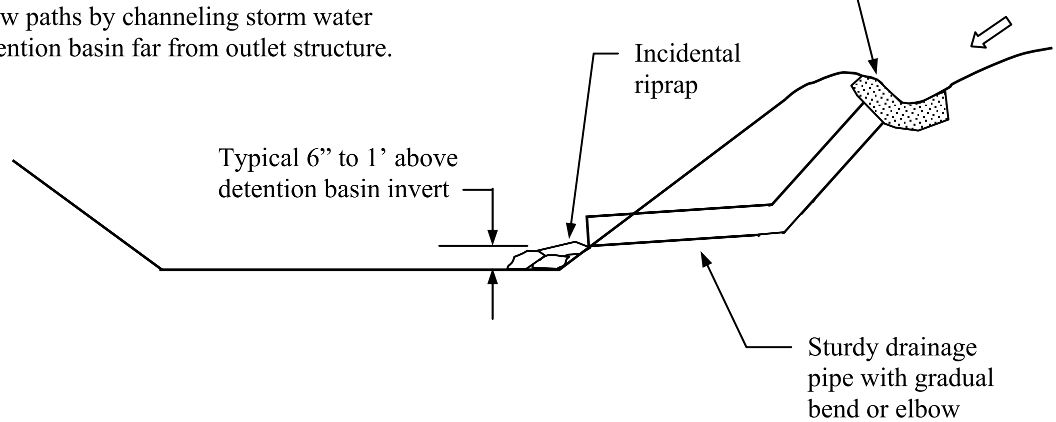


Figure 5
Typical Detail - Backslope Drain