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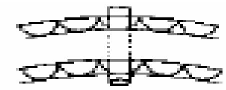

Sediment Basin

Description

Sediment basins can be used to capture sediment from stormwater runoff before it leaves a construction site. They allow a pool to form in an excavated or natural depression where sediment can settle. The pool is dewatered through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment. The water is released more slowly than it would be without the control structure.

A sediment basin is constructed by excavation or by erecting an earthen embankment across a low area or drainage swale. The basin can be temporary (up to 3 years) or permanent. Some sediment basins are designed to drain completely during dry periods. Others are constructed so that a shallow pool of water remains between storm events.

TDEC defines a sediment basin as a “temporary basin consists of an embankment constructed across a drainage way, or an excavation that creates a basin, or by combination of both. A sediment basin typically consists of an impoundment, a dam, a riser pipe outlet, and an emergency spillway. The size of the structure will depend upon the location, size of the drainage area, soil type land cover/use, rainfall amount, and any unique site conditions favorable to producing high runoff volume, velocity, or sediment. Retention and detention ponds are both designed and constructed for the purpose of managing the runoff from a development. A retention pond retains most of sediment in the pond. A detention pond detains the higher flows and releases the flow over a longer time and at a reduced rate; it may or may not offer any sediment control. (Tennessee General Permit No. TNR100000, Storm Water Discharges Associated with Construction Activities, effective June 17, 2005 to May 30, 2010.)

Selection Criteria

Sediment basins are usually used for drainage areas of 5 to 100 acres. They can be temporary or permanent. Sediment basins designed to be used for up to 3 years are usually described as temporary. Those designed for longer service are considered permanent. Temporary sediment basins can be converted into permanent stormwater runoff management ponds, but they must meet all regulatory requirements for wet (or dry) ponds with frequent inspection and maintenance performed.

For permittees (EPA Construction General Permit), a sediment basin or its equivalent should accomplish the following for drainage areas of different sizes:

- 10 or more acres of disturbed area: For common drainage locations that serve an area with 10 or more acres disturbed at one time, a temporary (or permanent) sediment basin that provides storage for a calculated volume of runoff from the drainage area from a 2-year, 24-hour storm (5-year, 24-hour storm for impaired/high quality waters), or equivalent control measures, must be provided where attainable until final stabilization of the site.

- Where no such calculation has been performed, a temporary (or permanent) sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures, must be provided where attainable until final stabilization of the site. When computing the number of acres draining into a common location, it is not necessary to include flows from offsite areas and flows from on-site areas that are either undisturbed or have undergone final stabilization where such flows are diverted around both the disturbed area and the sediment basin. In determining whether installing a sediment basin is attainable, the operator may consider factors such as site soils, slope, available area on-site, etc. In any event, the operator must consider public safety, especially as it relates to children, as a design factor for the sediment basin, and alternative sediment controls must be used where site limitations would preclude a safe design. For drainage locations which serve 10 or more disturbed acres at one time and where a temporary sediment basin or equivalent controls is not attainable, smaller sediment basins and/or sediment traps should be used. At a minimum, silt fences, vegetative buffer strips, or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions).
- Less than 10 acres of disturbed area: For drainage locations serving less than 10 acres, smaller sediment basins and/or sediment traps should be used. At a minimum, compost filter socks, silt fences, vegetative buffer strips, or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions) of the construction area unless a sediment basin providing storage for a calculated volume of runoff from a 2-year, 24-hour storm (5-year, 24-hour storm for impaired/high quality waters) or 3,600 cubic feet of storage per acre drained is provided. Sediment basins are applicable in drainage areas where it is expected that other erosion controls, such as sediment traps, will not adequately prevent offsite transport of sediment.

Design Considerations

Investigate potential sites for sediment basins during the initial site evaluation. Construct the basins before any grading takes place in the drainage area. For permanent structures, a qualified professional engineer experienced in designing dams should complete the basin design.

Limit sediment basins with rock dams to a drainage area of 50 acres. Limit the rock dam height to 8 feet with a top width of at least 5 feet. Side slopes for rock dams should be no steeper than 2:1 on the basin side of the structure and 3:1 on the outlet side. Cover the basin side of the rock dam with fine gravel from top to bottom for at least 1 foot. This slows the drainage rate from the pool that forms and gives sediments time to settle. The detention time should be at least 8 hours.

Outfit sediment basins with earthen embankments with a dewatering pipe and riser set just above the sediment removal cutoff level (Figure 1). Place the riser pipe at the deepest point of the basin and make sure it extends no farther than 1 foot below the level of the earthen dam. Place a water-permeable cover over the primary dewatering riser pipe to prevent trash and debris from entering and clogging the spillway with gravel to keep sediment out of the spillway piping. To provide an additional path for water to enter the primary spillway, you can drill secondary dewatering holes near the base of the riser pipe, but make sure you protect the holes near the base of the riser pipe, but make sure you protect the holes with gravel to keep sediment out of the spillway piping.

To ensure adequate drainage, use the following equation to approximate the total area of dewatering holes for a particular basin (Smolen et al., 1988):

A_o = $(A_s \times (2h) / (T \times C_d \times 20{,}428)$ where

A_o = total surface area of dewatering holes, ft^2;

A_s = surface area of the basin, ft^2;

h = head of water above the hole, ft;

C_d = coefficient of contraction for an orifice, approximately 0.6; and

T = detention time or time needed to dewater the basin, hours.

In all cases, an appropriate professional should design such structures. The designer should consider local hydrologic, hydraulic, topographic, and sediment conditions.

Principal Outlet

The principal outlet or spillway should be sized to adequately convey stormwater runoff from the 2-year, 24-hour storm (5-year, 24-hour storm for impaired/high quality waters). The principal outlet should have a trash rack to prevent debris from clogging the structure. It is recommended that smaller orifices, less than 4 inches diameter, should also have some sort of wire cage structure to prevent clogging from trash or debris.

A pipe and riser outlet combination, shown in Figure 2, is typically used as the principal outlet for a temporary sediment basin. Typical materials for the pipe culvert are corrugated metal pipe (CMP) and reinforced concrete pipe (RCP). The circular riser is typically made from CMP or from precast manhole sections. A rectangular structure will serve the same purpose as a circular riser, and is often made from precast units, pour-in-place concrete, or even cement block construction.

CMP is often used because it is an inexpensive material, sturdy, easy to transport, and can be handled in manageable lengths. The most commonly available CMP is helically (spirally) corrugated throughout its length, with rerolled ends to allow metal coupling bands for watertight pipe connections. CMP material should be structurally sound and of sufficient gauge to resist traffic loadings.

The pipe culvert should be designed to handle the 2-year, 24-hour storm (5-year, 24-hour storm for impaired/high quality waters) without using the emergency spillway. The minimum pipe size should be 12 inches diameter, and the minimum riser size should be at 1.5 times the pipe diameter. At least one anti-seep collar should be provided around the outlet pipe, to prevent seepage through the embankment. Metal collars are inexpensive and easy to install for corrugated metal pipe. The anti-seep collar should extend 18 inches beyond the pipe in all directions.

Limitations

Do not use a sediment basin with an earthen embankment or a rock dam in an area of continuously running water (live streams). Do not use a sediment basin in an area where failure of the earthen or rock dam will result in loss of life or damage to homes or other buildings. Do not use sediment basins in areas where failure will prevent the use of public roads or utilities.

Maintenance

Routine inspection and maintenance of sediment basins is essential to their continued effectiveness. Inspect basins after each storm event to ensure proper drainage from the collection pool and determine the need for structural repairs. Replace material eroded from earthen embankments or stones moved from rock dams immediately. Locate sediment basins in an area that is easily accessible to maintenance crews for removal of accumulated sediment. Remove sediment from the basin when the storage capacity has reached approximately 50 percent. Remove trash and debris from around dewatering devices promptly after rainfall events.

Effectiveness

The effectiveness of a sediment basin depends primarily on the sediment particle size and the ratio of basin surface area to inflow rate (Smolen et al., 1988). Basins with a large surface area-to-volume ratio are the most effective. Studies have shown that the following equation relating surface area and peak inflow rate gives a trapping efficiency greater than 75 percent for most sediment in the Coastal Plain and Piedmont regions of the southeastern United States (Barfield and Clar, in Smolen et al., 1988):

$$A = 0.01q$$

where A is the basin surface area in acres and q is the peak inflow rate in cubic feet per second.

USEPA (1993) estimates an average total suspended solids removal rate for all sediment basins of 55 percent to 100 percent. The average effectiveness is 70 percent.

Dam Requirements

Embankments which impound more than 30 acre-feet of volume (and minimum 6 feet high) or which are higher than 20 feet (and minimum 15 acre-feet of volume) are subject to the Tennessee Safe Dams Act of 1973 and any further amendments by law. The impounded volume of a dam is measured at the top of embankment. The height of a dam is measured from the lowest point of natural grade (at downstream toe of embankment) to the top of embankment.

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

A regulated dam is required to have a principal spillway with trash rack, an emergency spillway, a means of dewatering, minimum top width for embankment, compaction requirements, spillway design and analysis for large storms, a seepage control system designed by seepage analysis, permanent benchmark, etc.

Figure 1
Typical Sediment Basin

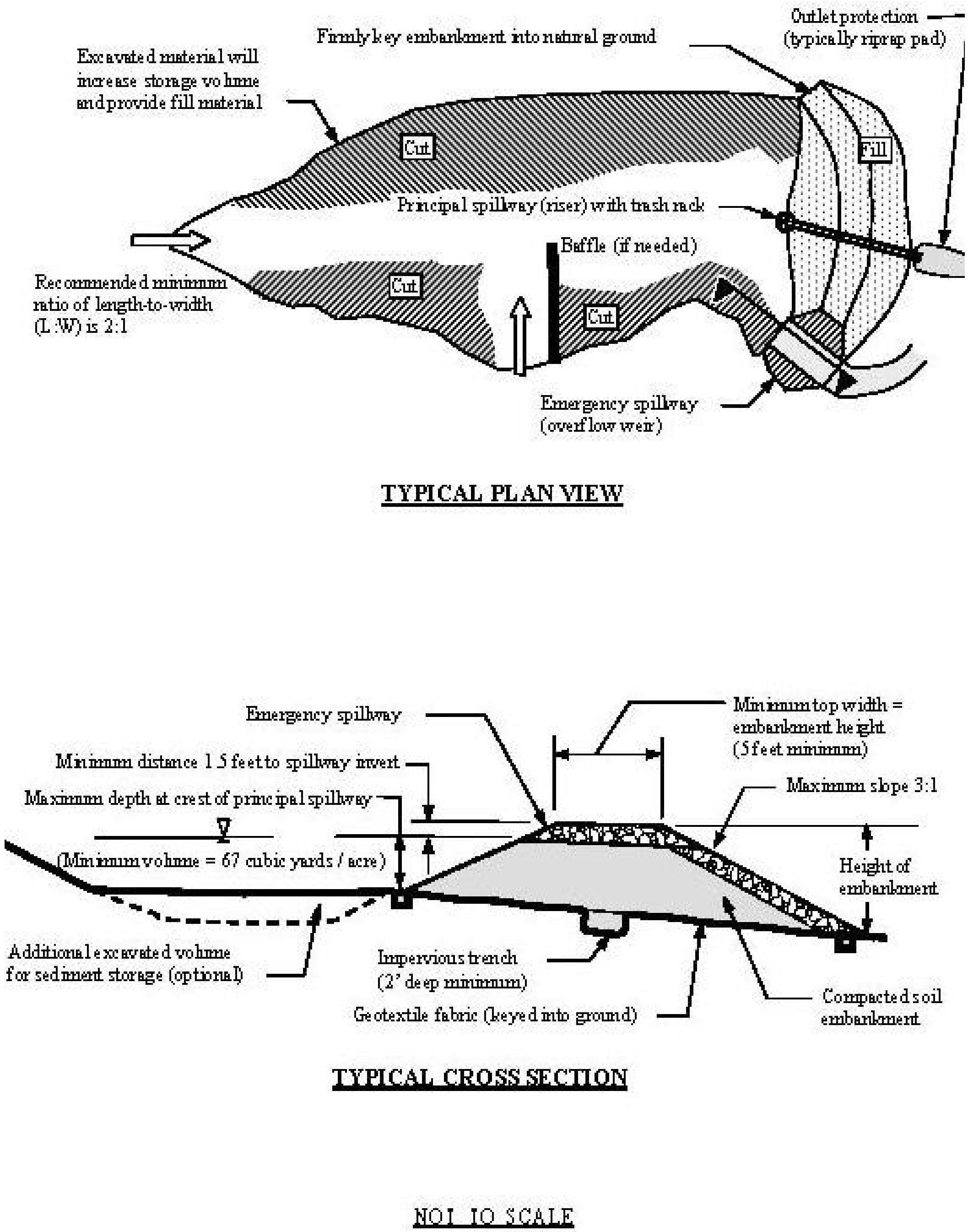

Figure 2
Temporary Sediment Basin-Riser and Pipe Outlet

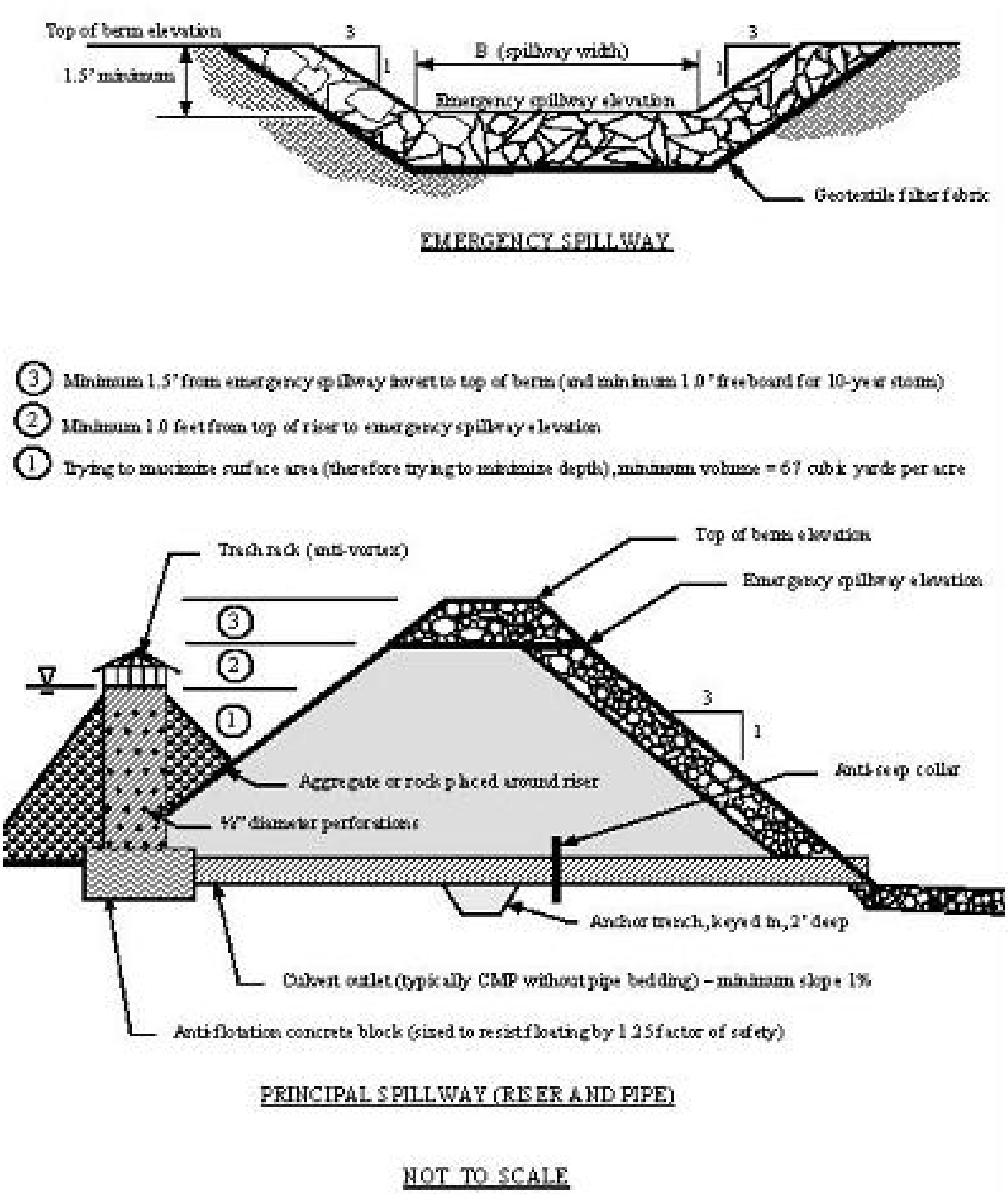

Figure 3
Possible Alterations to Permanent Detention Basin Outlet Structures

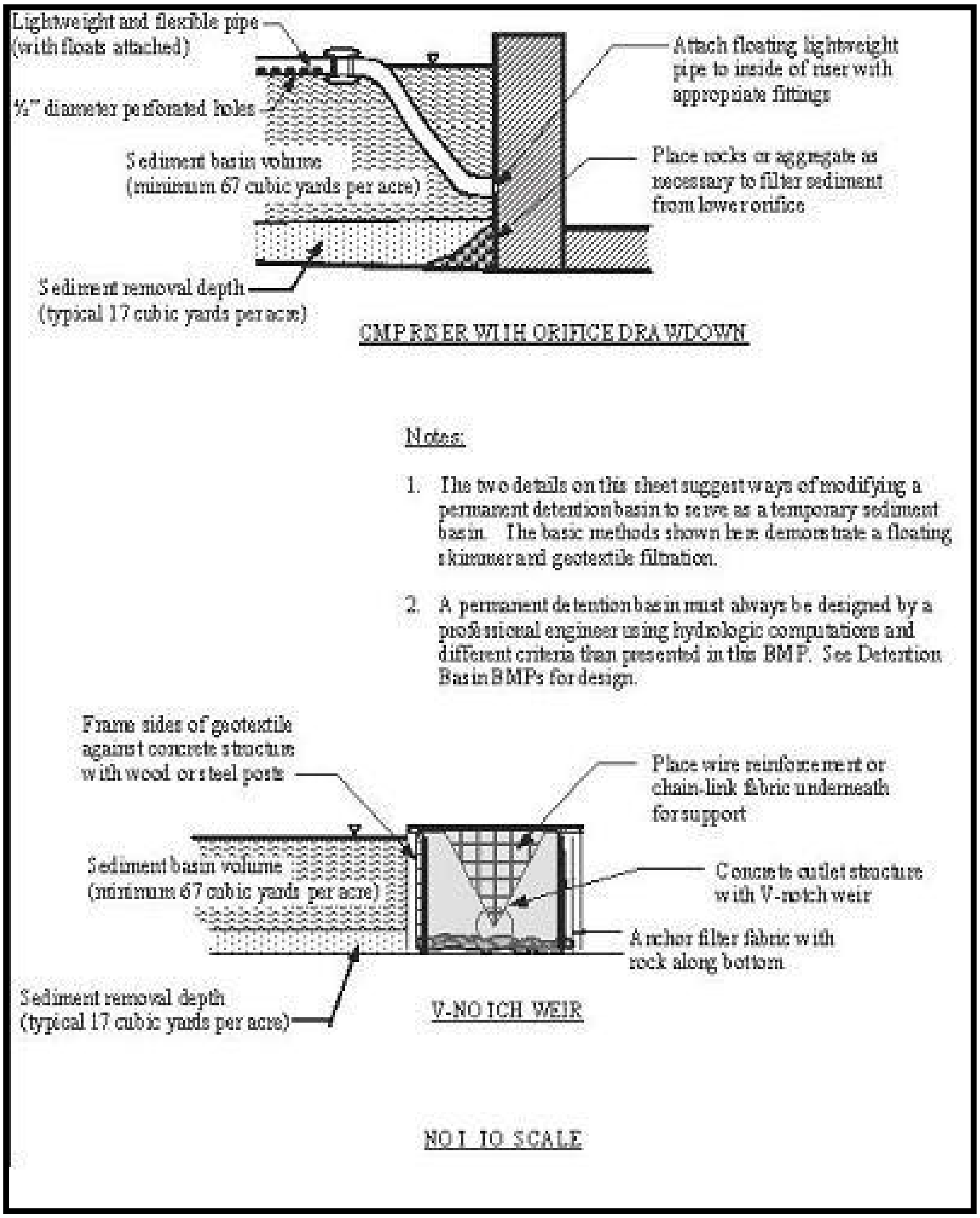

Photo 1 – 3 Sediment Basins

Photo source:
http://www.fairfaxcounty.gov/nvswcd/newsletter/esc.htm

Photo 4 - 5
Sediment Basin

References

Knoxville (City of). October 2007. Knoxville Stormwater Engineering Division. City of Knoxville BMP Manual. http://www.ci.knoxville.tn.us/engineering/bmp_manual/

Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission. North Carolina Department of Environment, Health, and Natural Resources; and Division of Land Resources. Land Quality Section. Raleigh, NC.

USEPA (U.S. Environmental Protection Agency). 1992. Stormwater Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices. EPA 832-R-92-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.