Water Resources Division

Sediment Basin

Definition

Sediment basins are temporary ponds with appropriate control structures, used on construction sites to capture eroded or disturbed soil that are washed off during or after rainstorms or other runoff events. Sediment basins are designed to protect the water quality of nearby streams, rivers, lakes, and wetlands, and to protect neighboring properties from damage. Some sediment basins are converted to permanent storm water controls following the completion of construction activity.

Purpose and Description

The primary purpose of sediment basins is to prevent sediment from entering streams, rivers, lakes, or wetlands. They do this by collecting and detaining runoff, allowing suspended solids to settle out prior to the runoff leaving a site.

Sediment basins are also sometimes called settling basins, sumps, debris basins, or dewatering basins.

Pollutant Controlled: Suspended solids

Treatment Mechanism: Settling

Removal Efficiency

- Sediment basins remove only 70 to 80 percent of medium- and coarse-sized sediment particles, so use them in conjunction with other erosion control best management practices (BMPs).
- Sediment basins are not effective at controlling fine soil particles such as silt or clay.

Companion and Alternative BMPs

- Construction Barrier
- Mulching
- Polyacrylamide
- Riprap-Stabilized Outlet
- Seeding
- Sodding

www.michigan.gov/deq

Advantages and Disadvantages

Advantages

- Sediment basins are a cost-effective measure for treating sediment-laden runoff from drainage areas ranging from five (5) to 100 acres in size, with soil particle sizes of predominantly sand, or medium to large silt.
- Sediment basins are relatively easy to construct.

Disadvantages

- The construction and proper functioning of sediment basins require adequate space and topography. Basins require large surface areas to facilitate the settling of sediment. The available area can limit the potential maximum size of sediment basins.
- Install sediment basins only within the property or special easement limits, and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Sediment basins can attract children, and therefore can be very dangerous. Adhere to all local ordinances regarding health and safety. If fencing of basins is required, show the fence type and location on the soil erosion and sedimentation control plan, and in the construction specifications. Refer to the Construction Barrier BMP.
- Sediment basins effectively remove sediment down to only about medium-sized silt. Removing smaller particles—such as fine silt or clay—typically requires additional controls or practices, such as polyacrylamide.
- Standing water has the potential to cause the breeding of mosquitoes or other pests.

General Characteristics

- It is recommended that sediment basins be designed by licensed professional engineers.
- Utilize sediment basins until the contributory drainage area has been stabilized.
- Sediment basins are temporary and can serve drainage areas up to 100 acres in size. However, other conservation practices might be more economical for smaller drainage areas, typically less than five (5) acres in size.

Materials

- Earth
- Riprap
- Risers
- Collars
- Seed for stabilization of disturbed soil

Planning

- Utilize sediment basins during construction activities in areas of concentrated flow or at points of discharge.
- Conduct a site investigation to determine the size of the drainage area, and the best location for the basin or basins.
- Select the site for the sediment basin based on the natural drainage of the area and the soil type.
- Site conditions must allow for runoff to be directed into sediment basins.
- Do not locate sediment basins in perennial streams or wetlands. In-stream sediment basins are allowed only through a permit from the Michigan Department of Environmental Quality (MDEQ) Water Resources Division.
- Choose an area to which runoff can be easily diverted to the sediment basin. The most logical location is typically the lowest part of a site.
- Determine soil types. If the soils are predominantly clay, the basin size required might be larger than practical. However, if soils are sand or silts there will be little structural integrity of the basin if constructed with on-site soils. With clay soils it is particularly important to make the best use of soil erosion control measures, because sedimentation measures, including sediment basins, do not readily retain clays. Sediment basins by themselves are not effective at settling out fine silt or clay particles; additional treatment must be used, such as polyacrylamide.
- Determine the number of basins needed. In some cases, it is more effective to have multiple smaller basins versus one large basin. This is particularly important in areas with larger-grained sediments. In addition, potential damage from basin failure can be minimized by using multiple smaller basins, versus one large basin.
- There are three classes of sediment basins, based on drainage area, embankment height, and the use of mechanical controls:
    - Class 1 is a simple, temporary basin, frequently used on construction sites. This basin consists of an excavated area or an earth embankment less than three (3) feet high, constructed of the soil or stone which is available on the site. These basins can be quickly located and constructed with equipment available on most construction sites. Stabilization of the embankment with vegetation or paving is necessary. The recommended maximum drainage area to a Class 1 basin is 20 acres.
    - Class 2 is a carefully constructed temporary or permanent sediment basin. It consists of an embankment of selected soil materials constructed under controlled procedures, with provisions for an emergency discharge for storm water to prevent embankment failure. A Class 2 basin is most applicable in situations where significant damage can result to downstream and off-site areas if the basin fails. The recommended maximum drainage area to a Class 2 basin is 30 acres.
    - Class 3 is a carefully engineered basin, with sophisticated controls, and is usually permanent. Both outlets and embankments are intended to serve as grade stabilization structures, which will continue to function as storm water control measures after construction activities are completed. Always use a Class 3

basin if it is to be converted to a permanent storm water detention practice. Class 3 basins must be restored to original design specifications prior to conversion to a storm water control. The recommended maximum drainage area to a Class 3 basin is 100 acres.

- Select the appropriate basin type. If a basin is to be temporary, use either a Class 1 or a Class 2. If a basin is to be permanent, use either a Class 2 or Class 3, and note that the design criteria for both the temporary sediment basin and the permanent storm water basin must be met.
- Determine the ultimate fate of the basin. If the basin is to become part of a storm water runoff “treatment train” upon completion, then the design of the basin must be coordinated with the design of the future use of the basin. If the ultimate fate of the basin is an infiltration basin, avoid using heavy equipment in the area so as not to compact the soils. Soil compaction will decrease the ability of the soil to infiltrate water. If the basin is to be a temporary structure which will be filled and stabilized upon completion of the project, then proceed with the design criteria below.
- Locate sediment basins so that they can easily be cleaned out periodically.
- Construct sediment basins at locations that are accessible for cleanout.
- Incorporate into the overall site plan the locations for disposal of the material removed from sediment basins.

Design

- The effectiveness of reducing runoff velocity and allowing suspended solids to settle out depends on:
    - Surface area of the basin. In general, the greater the surface area, the greater the detention time, and the less the flow velocity.
    - Sizes of the sediment particles entering the basin.
    - Concentration of sediment particles entering the basin.
    - Rate of flow into the basin.
    - Volume: As sediment accumulates, the volume decreases, as does the effectiveness of the basin.
    - Travel distance.
- Temporary structures are expected to last no more than three years. Design sediment basins which will be in place longer than three years as permanent structures (i.e., with emergency spillways).
- Side Slopes: For safety, make the side slopes of sediment basins at least 2H:1V. Use even flatter slopes (i.e., larger ratios) in urban or urbanizing areas. To prevent access in the first place, consider construction barriers around both construction sites, and sediment basins.
- Shape: To maximize settling and improve sediment trapping efficiency, design sediment basins with at least a 4:1 length-to-width ratio. If construction sites cannot accommodate basins of this dimension, to increase the effective flow path length, use baffles perpendicular to the direction of flow.

- Make sediment basins at least four times longer than they are wide, unless baffles are used to increase the flow path length. Refer to Figure 1, which depicts (a) an example baffle, and (b) the use of such a baffle in three irregularly-shaped basins, to increase flow path length, and prevent short-circuiting. These flow paths are also depicted in the figure.
    - It is critically important to the proper operation of the sediment basin that the inlet and outlet are not placed too close together, or that baffles are used, if necessary. An adequately long flow path through the basin provides the pollutant removal capacity, by giving small, light sediment particles enough time to settle out of the water column.
- Basin Capacity: Refer to the "Hydrology" section of the *BMP Manual* "Introduction" for guidance on determining the appropriate design precipitation event, on which to base the basin capacity.
- Design sediment basins so that discharges from a site approximate the pre-development runoff.
- Depth: Make sediment basins at least two (2) feet deep, and no shallower than the average flow path distance from the inlet to the outlet (the 'flow length') divided by 200.
- Basin dimensions can be determined using the following equations:
    - [Volume] = [Length] x [Width] x [Depth]
    - Basins less than 80,000 ft^3 in volume:

$$[\text{Width}] = \sqrt{\frac{[Volume]}{8}}$$

$$[\text{Length}] = 4 \times [\text{Width}]$$

$$[\text{Depth}] = 2 \text{ feet (a constant)}$$

    - Basins greater than 80,000 ft^3 in volume:

$$[\text{Width}] = \sqrt[3]{12.5 \cdot [Volume]}$$

$$[\text{Length}] = 4 \cdot [\text{Width}]$$

$$[\text{Depth}] = \frac{[Flow\ Length]}{200}$$

- Principal Outlet: Class 2 and Class 3 basins include principal outlets to allow controlled discharges of water. The outlet structure is located at the deepest part of the basin, connected to a nearly-horizontal pipe, called the "barrel" (described below), which discharges through the embankment and out of the basin.
    - Preferred Outlet Type—Floating Skimmer: A type of outlet being used with increasing frequency is the floating skimmer, which is depicted in Figures 2 and 3. Some early tests indicate that the skimmer (which draws water only from the surface) might be more effective at retaining sediment in the basin than the

previous standard riser and barrel configuration. This is especially true if the perforated type of riser is used, which draws water from the entire water column.

- Alternate Outlet Type—Riser Pipe: An alternate outlet type is the riser pipe, which was traditionally used prior to the advent of the floating skimmer. The riser can be solid or perforated.
  - Solid Riser: A solid riser allows flow only through the top of the pipe. Thus, a sediment basin with a solid riser will have a permanent pool up to the invert elevation of the riser pipe.
  - Perforated Riser: An alternative to the solid riser pipe is the perforated riser, which can consist of any of various orifices along the length of the riser pipe. It is important that any outflow allowed to discharge through a perforated riser pipe be adequately filtered, such as with wire mesh and a mound of well-graded gravel. However, do not wrap geotextile fabric around the perforated riser, because it can clog quickly, effectively blocking the perforations, preventing discharge through the outlet.
  - Set the top of the riser at least three (3) feet below the top of the embankment or crest of the emergency spillway.
  - Place a trash rack over the top of the riser to prevent debris from entering and clogging the outlet.
  - To maximize the efficiency of this type of outlet, set the cross-sectional area of the riser pipe at least 1.5 times that of the barrel (described below).
  - Refer to Figure 4 for a depiction of a perforated riser pipe with adequate filtering provided, and to Figures 5 and 6 for examples of sediment basins with solid and perforated riser pipes, respectively.

- Barrel: The barrel is the nearly horizontal pipe which carries flow from the vertical outlet pipe of a floating skimmer or riser pipe, to the sediment basin point of discharge.
  - To facilitate installation and reduce blockage potential, use a minimum barrel pipe diameter of eight (8) inches for corrugated metal pipe, and six (6) inches for smooth pipe.
  - Provide the barrel with anti-seep collars to prevent piping along the outside of the pipe.
  - Following the specifications in the Riprap-Stabilized Outlet BMP, stabilize Class 2 and Class 3 basin principal outlet discharge point with riprap. The Class 1 basin does not have an outlet.
- Design Discharge: Design the outlet system to carry the peak runoff from design storm with a two-foot (2-foot) freeboard, and so that velocity of the discharge from the basin does not exceed that allowable for the receiving water body. Size the principal outlet to pass at least 80 percent of the calculated peak discharge from the drainage area. For Class 1 basins, base the peak discharge on the storm frequency equivalent to the lifetime of the project in years. Design the Class 2 and Class 3 basins on 10-year and 25-year storm frequencies, respectively. If a sediment basin will also be used as a storm water basin, design the outlet using the appropriate storm water basin procedure.

- Emergency Spillway: Class 2 and Class 3 basins require emergency spillways to protect embankments, by providing outlets from the basins for runoff volumes exceeding principal outlet capacity:
  - Size the emergency spillway to pass the difference in discharge between the design storm frequency and the capacity of the principal outlet.
  - If the practice will be used as a storm water basin, design the emergency spillway to pass the 100-year storm.
  - Emergency spillways can be as simple as a slope drain constructed of a half section of corrugated metal pipe, or a riprap channel constructed down the embankment slope.
  - Set the crest of the spillway at least three (3) feet above the crest of the primary outlet structure, and a minimum of two (2) feet above the expected water level following the design storm.
  - Make the spillway trapezoidal in cross-section, with side slopes 3H:1V or flatter.
  - Following the specifications in the Riprap-Stabilized Outlet BMP, stabilize the emergency spillways outlets of Class 2 and Class 3 basins. The emergency spillway for a Class 1 basin can consist of a simple berm alongside the outlet to channel water to a stabilized area.
- Embankments: Construct embankments with the most stable fill material available. For permanent embankments, appropriate material might have to be hauled in. Where possible, use soils other than sand, which tends to shift.
- Sediment basins with embankments over six (6) feet in height and with impoundment areas of five (5) or more acres are considered dams, and are therefore regulated under Part 315, Dam Safety of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended; information on which is available from the MDEQ Dam Safety Program. Other permits might also be needed.

Construction

- Construct sediment basins before any other land clearing or grading is done. Construct according to the design and by following the guidelines below.
- Stabilize the basin before the upstream area is cleared.
- Preserve as much existing natural vegetation as possible. Clear and strip any trees, other vegetation, and roots from the natural ground under any proposed embankment. Clear the remainder of the basin area of trees and larger vegetation to allow easy periodic removal of sediment. Retain natural grasses and groundcover to provide stabilization.
- To allow a good bond between any fill and existing soil, disc or scarify areas where embankment fill will be placed. Place and compact fill in controlled, uniform layers.
- Stabilize all exposed embankment areas by seeding and mulching or sodding. Embankment stabilization is particularly important with Class 1 basins, since the embankment functions as the spillway.
- Immediately after sediment basins are constructed, stabilize the top banks of the basins and all surrounding areas with vegetation.

Post-Construction

- Temporary Basins: After construction is completed at a site, dewater all sediment basins, removed all bulkheads or other structures, then fill and grade the basins to the contours of the surrounding land. Stabilize the areas by seeding and mulching or sodding.
- Permanent Basins: Using a sediment basin as a post-construction permanent storm water control (such as a detention basin) requires that the practice be properly converted from one control type to the other. Failure to properly convert a sediment basin can result in improper operation as a permanent storm water control, resulting in any number of undesirable outcomes, including (a) required maintenance well before the intended design life of the practice, and/or (b) undesirable and illegal sediment discharges to the receiving stream.
- Conversion of a sediment basin to a permanent storm water control can require any or all of the following steps, depending on the situation: 1. Dewatering; 2. De-mucking; 3. Removing sediment from the forebay and sediment pond area; 4. Removing dewatering structures; 5. Surveying and checking basin dimensions, dams, and spillways; 6. Re-engineering storage and outlet facilities; 7. Reshaping and re-excavating the pond area to meet storm water control requirements; 8. Installing peak flow controls; 9. Repairing any damaged areas; and 10. Stabilizing the entire facility (Tschantz, 2012).

Monitoring

- Check the basin depth to ensure the capacity of the basin is adequate for storm water and sediment deposition.
- Check the basin for piping, seepage, and other mechanical damage.
- Check for the presence of soil caking around the perforated riser pipe, which would prevent proper drainage from the basin.
- Check the outfall to ensure drainage is not causing erosive velocities, and to ensure the outlet is not clogged.

Maintenance

- Immediately address any problems discovered during the maintenance monitoring.
- Remove sediment when it has accumulated to no more than 50 percent of the design depth.
- Place sediment removed during cleaning in an upland area, and stabilize it so that it does not re-enter the drainage course.

Literature Cited

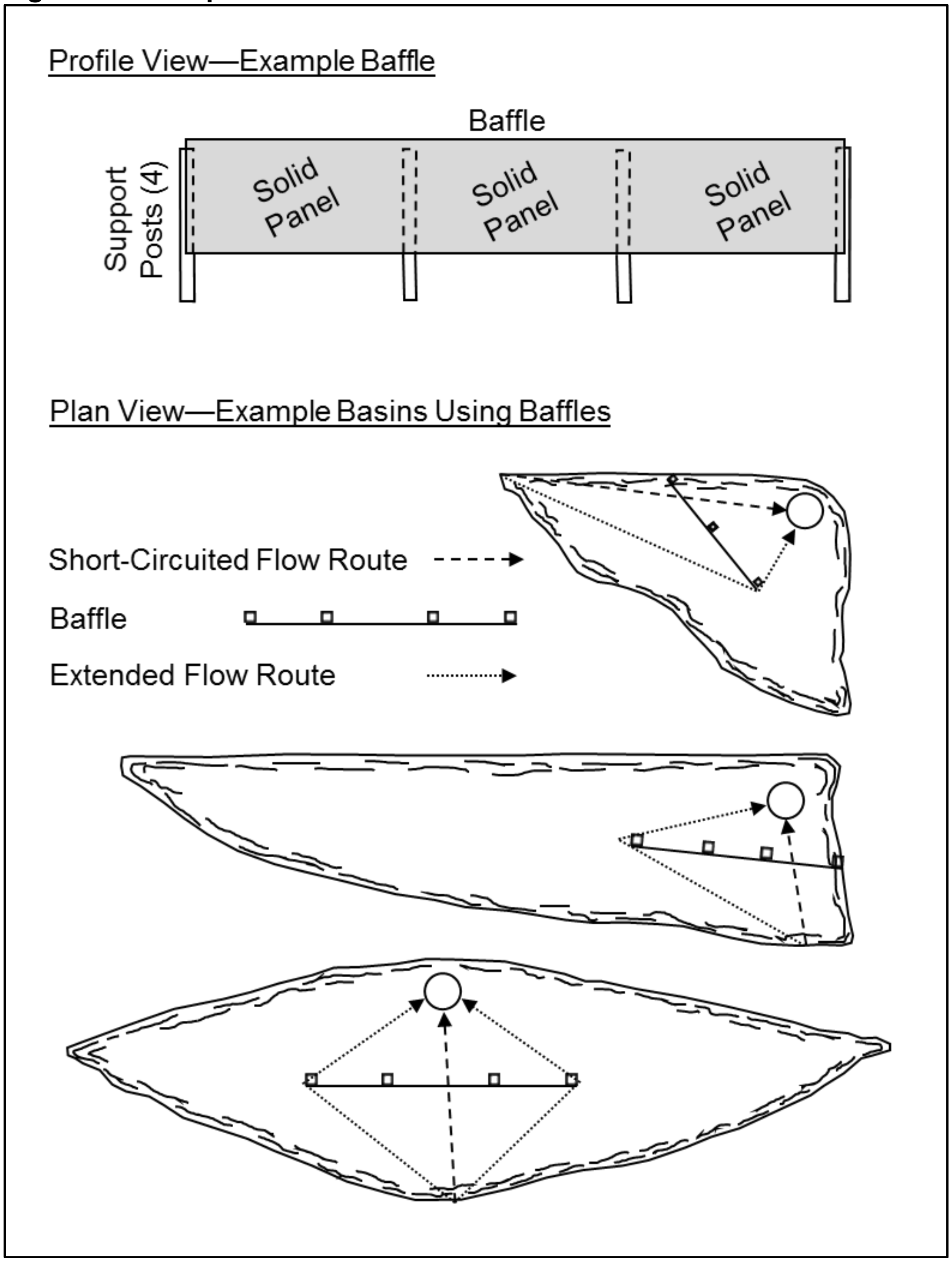
California Department of Transportation (Caltrans). 2017. *Caltrans Storm Water Quality Handbooks: Construction Site Best Management Practices Manual*.

Delaware Department of Transportation (DelDOT). 2013. *Erosion & Sediment Control Field Guide*. Section 3.2.3.1: Skimmer Dewatering Device.

Tennessee Department of Environment and Conservation (TDEC). 2012. *Tennessee Erosion & Sediment Control Handbook*. Fourth edition.

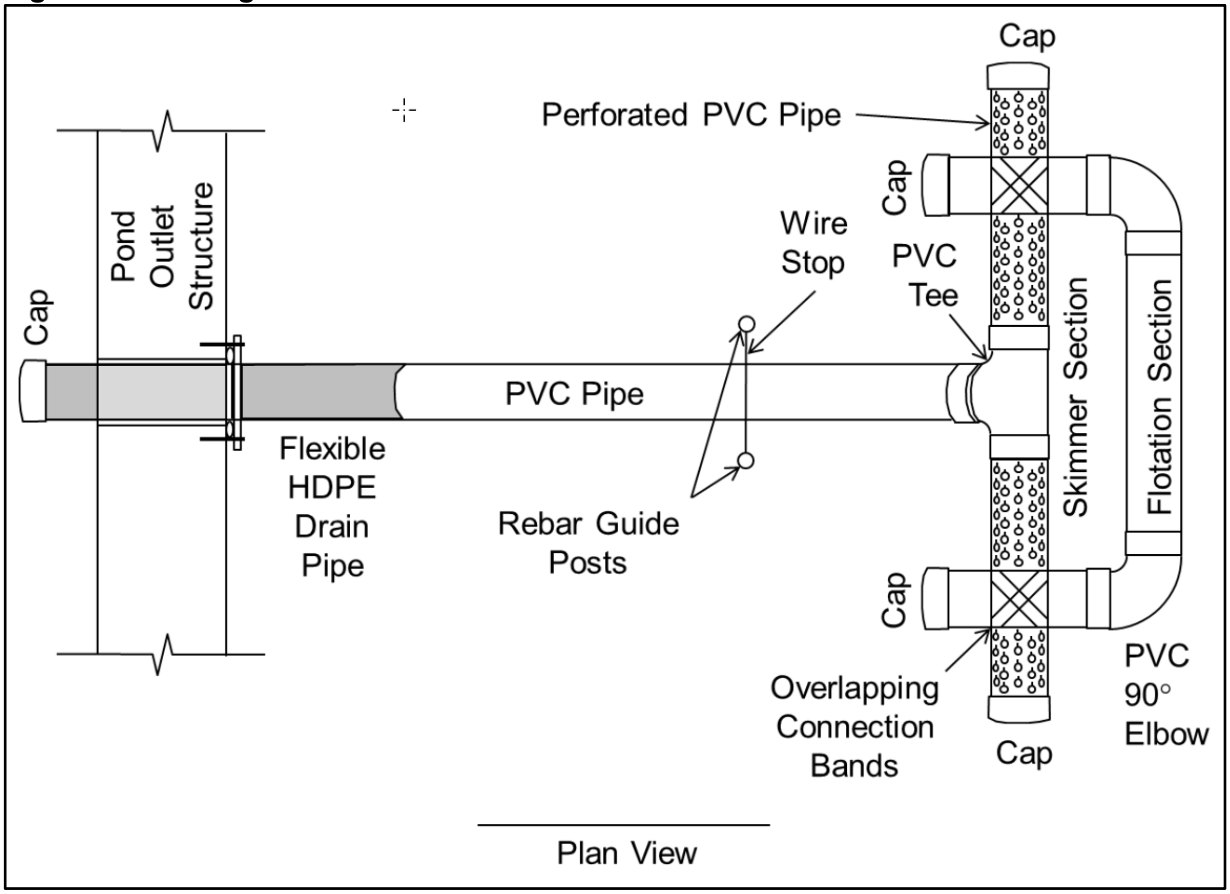
Tschantz, Dr. Bruce A. 2012. *Converting Temporary Sediment Basins to Permanent Stormwater Detention Ponds in Tennessee*. Prepared for ASCE-TSPE-ACEC Joint Annual Meeting presentation, Sept. 13-14, 2012, Murfreesboro, TN.

Figure 1. Example Sediment Basin Baffles



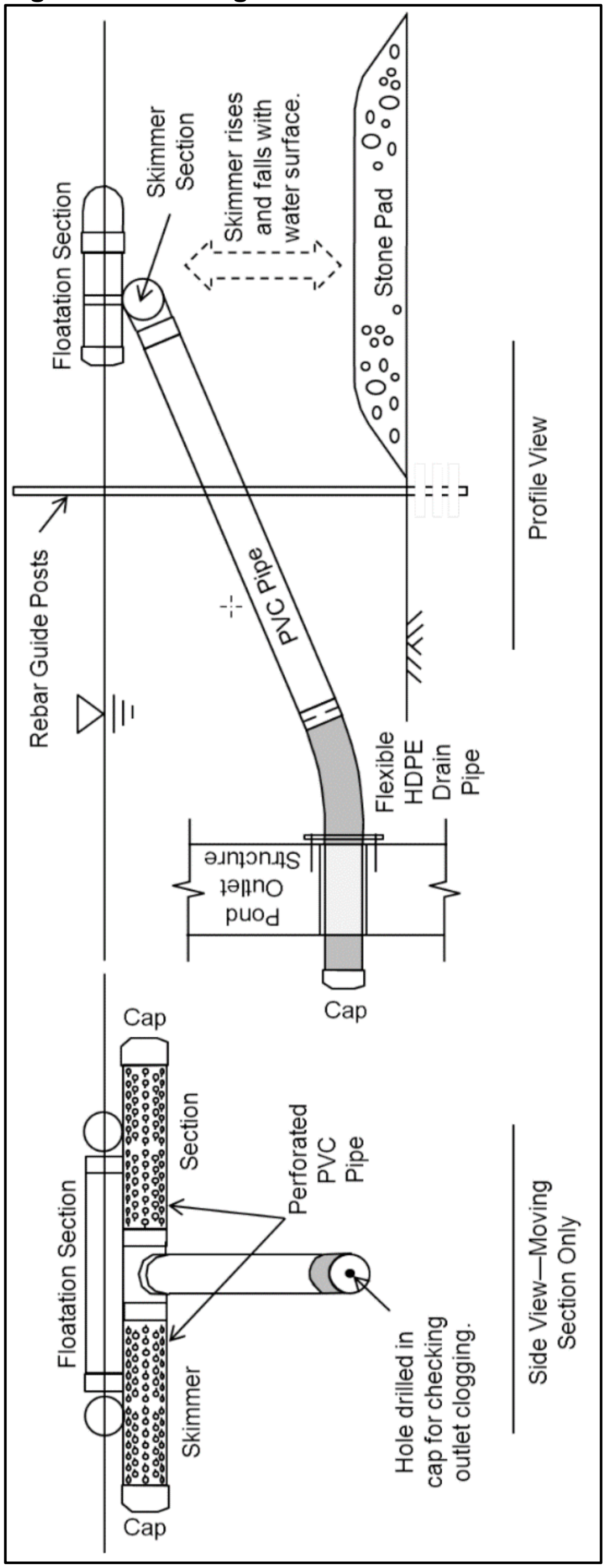
Source: TDEC, 2012.

Figure 2. Floating Skimmer—Plan View



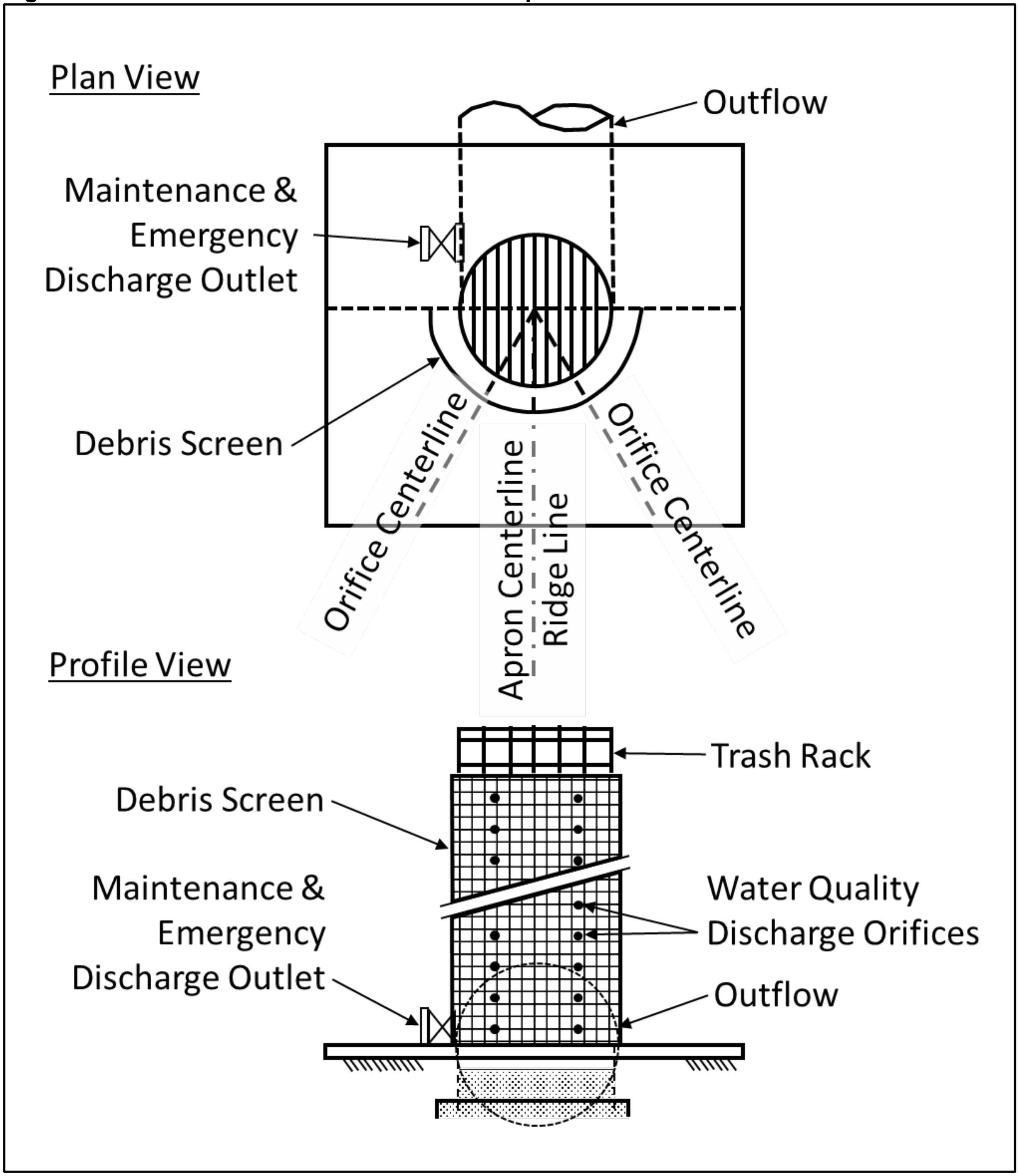
Source: DelDOT, 2013.

Figure 3. Floating Skimmer—Side and Profile Views



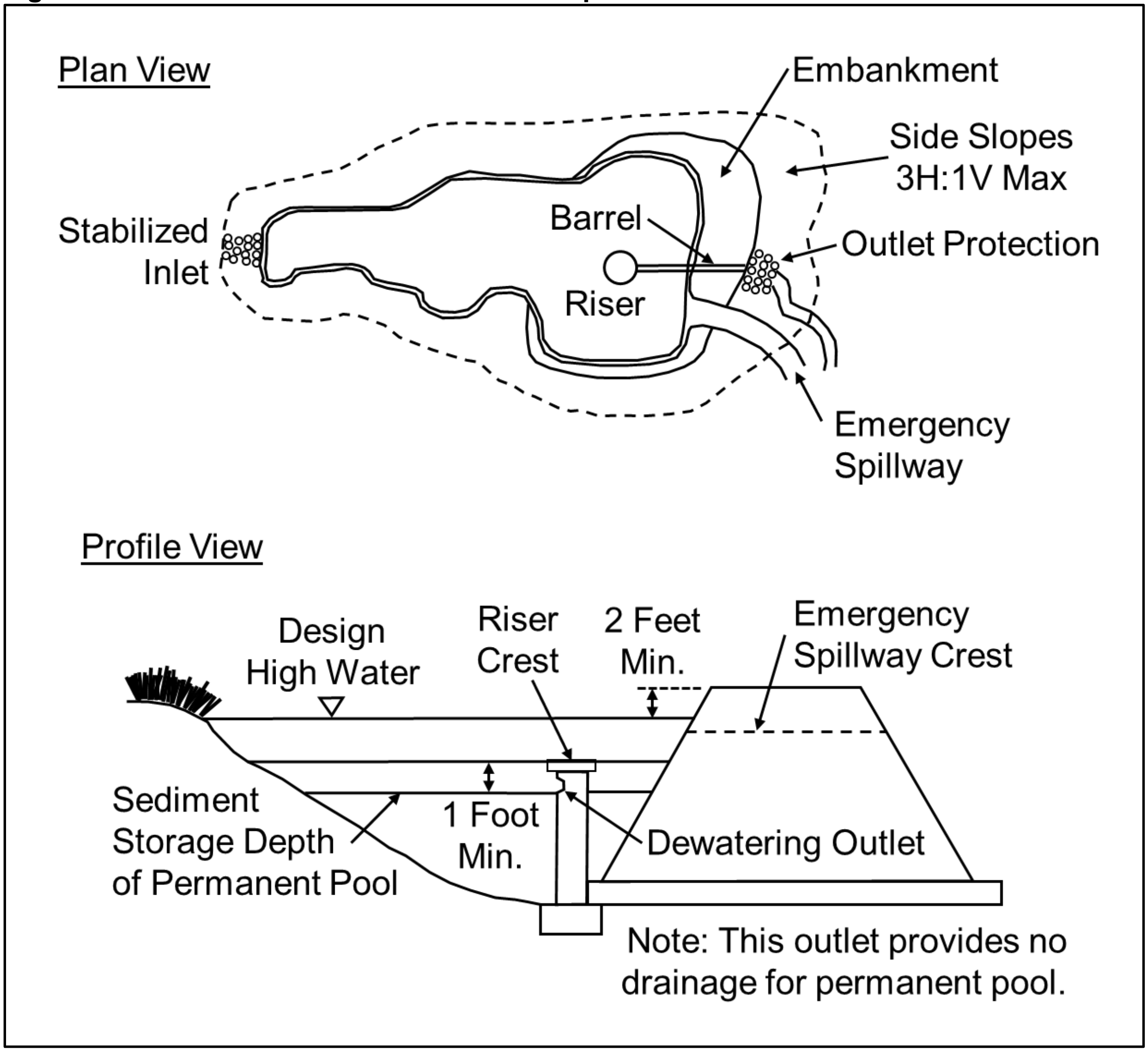
Source: DelDOT, 2013.

Figure 4. Sediment Basin Perforated Riser Pipe



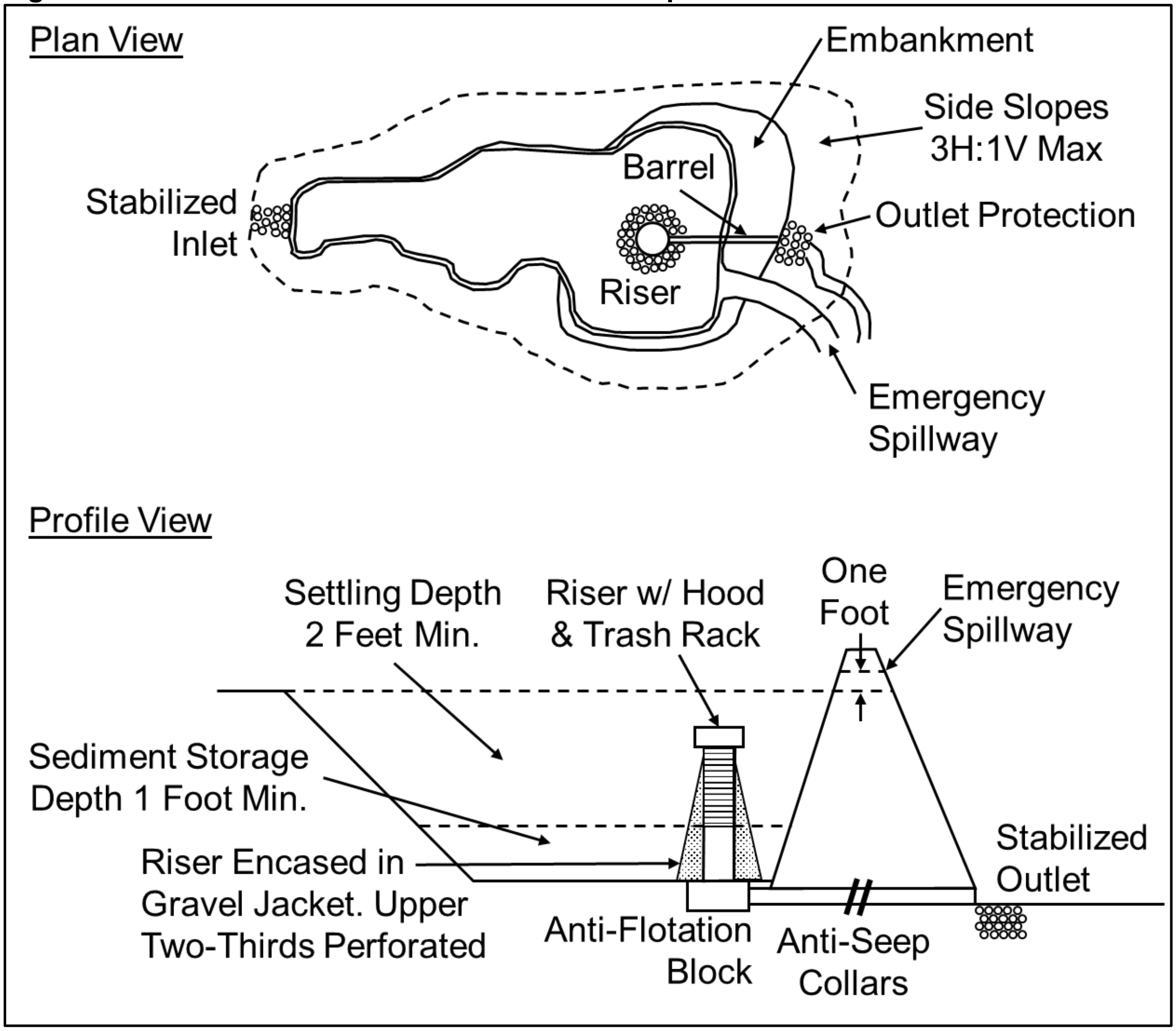
Source: Caltrans, 2003.

Figure 5. Sediment Basin with Solid Riser Pipe



Source: Caltrans, 2003.

Figure 6. Sediment Basin with Perforated Riser Pipe



Source: Caltrans, 2003.