Sediment Basin

Definition

A sediment basin is a temporary pond with appropriate control structures built on a construction site, to capture eroded or disturbed soil that is washed off during rain storms; designed to protect neighboring properties from damage; and to protect the water quality of nearby streams, rivers, lakes, and wetlands. Some sediment basins are converted to permanent storm water control practices following the completion of construction activities.

Description and Purpose

Sediment basins collect and detain runoff to allow suspended solids to settle out prior to leaving the site. The primary purpose of sediment basins is to prevent sediment from entering streams, rivers, lakes, and wetlands.

Sediment basins may also be called settling basins, sumps, debris basins, or dewatering basins.

Pollutants controlled:

- Suspended solids

Treatment Mechanisms:

- Settling of coarse and medium size particles in the basin

Pollution Removal Efficiencies:

- Sediment basins are not effective in controlling fine particles (i.e. silt, clay)
- Sediment basins remove only 70 to 80 percent of large-sized sediment particles, so use them in conjunction with other erosion control best management practices (BMP).

Companion and Alternative BMPs

- [Construction Barrier](#)
- [Mulching](#)
- [Riprap-Stabilized Outlet](#)
- [Seeding](#)
- [Sodding](#)
Advantages and Disadvantages

Advantages:

- Cost-effective measure for treating sediment-laden runoff from drainage areas ranging from five to 100 acres in size, with soil textures of predominantly sand, or medium to large silt.

- Relatively easy to construct.

Disadvantages:

- There must be adequate space and topography for the basin to be constructed and for it to function properly.

- Sediment basins must be installed 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 type of fence and its location on the soil erosion and sedimentation control plan, and in the construction specifications. Refer to the Construction Barrier BMP.

- Sediment basins are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.

- Standing water may cause mosquitoes or other pests to breed.

- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Location

- Sediment basins are utilized during construction activities in areas of concentrated flow or points of discharge.

- Sediment basins shall be constructed at locations accessible for clean out.

- Site conditions must allow for runoff to be directed into the basin.

- Do not locate sediment basins in perennial streams or wetlands. In-stream sediment basins are only allowed upon permit by the Michigan Department of Environmental Quality (MDEQ) Water Resources Division.
General Characteristics

• It is recommended that sediment basins be designed by licensed professional engineers.

• Sediment basins are designed to be in place 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 may be more economical for smaller drainage areas (typically less than five acres in size).

• 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 ways in which baffles can be used in irregularly-shaped basins.

• Make sediment basins at least two feet deep, and no shallower than the average flow path distance from the inlet to the outlet divided by 200.

Materials

• Earth

• Riprap

• Risers

• Collars

• Seed for stabilization of disturbed soil.

Design Specifications

• Conduct a site investigation to determine the size of the drainage area and the best location for the basin or basins.

• Determine soil types. If the soils are predominantly clay, the basin size required may 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).

• Select the site for the sediment basin based on the natural drainage of the area and the soil type.
• Determine the number of basins needed. In some cases, it is more effective to have a number of smaller basins rather than one large basin. This is particularly important in areas with larger-grained sediments. In addition, the damage caused by one small basin which fails is much less than the damage caused by one large basin which fails.

• Choose an area to which runoff can be easily diverted to the sediment basin. The most logical location is usually at the lower end of the drainage area.

• Design the basin so that the discharge approximates the pre-development runoff from the site.

• Locate sediment basins so that they can easily be cleaned out periodically.

• 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. Soils 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.

• Select the appropriate type of basin based on the information below. There are three classes of sediment basins. Classification is based on:

  1. The maximum drainage area a basin serves.
  2. The height of the embankment.
  3. The extent of the mechanical control devices provided with a basin.

• If the practice is to be temporary, use either a Class 1 or a Class 2 basin. If the practice is to be permanent, use either a Class 2 or Class 3 basin, and note that the design criteria for both the sediment basin and the storm water basin must be met:

  1. 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.

  2. 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.
3. Class 3 is a carefully engineered basin, with sophisticated controls, and is usually permanent. Both spillways 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.

- Stabilize the basin before the upstream area is cleared.

- Incorporate into the overall site plan the locations for disposal of the material removed from sediment basins.

- Sediment basins with embankments over six feet in height and with impoundment areas of five 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 Dam Safety Program. Other permits may also be needed.

- 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 into 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.
• **Basin Capacity:** At a minimum, size sediment basins so that they hold at least the volume equal to one inch of runoff from the entire drainage area. This is roughly equivalent to 3,600 ft³/acre.

• **Depth:** Make sediment basins at least two feet deep, and no shallower than the average distance from the inlet to the outlet (length) divided by 200.

Basin dimensions can be determined using the following equations:

1. \[ Volume = \text{[Length]} \times \text{[Width]} \times \text{[Depth]} \]

2. Basins less than 80,000 ft³ in volume:
   \[
   \begin{align*}
   Width &= \sqrt[8]{Volume} \\
   Length &= 4 \times Width \\
   Depth &= 2 \text{ feet (a constant)}
   \end{align*}
   \]

3. Basins greater than 80,000 ft³ in volume:
   \[
   \begin{align*}
   Width &= \sqrt[3]{12.5 \times Volume} \\
   Length &= 4 \times Width \\
   Depth &= \frac{Length}{200}
   \end{align*}
   \]

• **Spillway System:** Design the spillway system to carry the peak runoff from the design storm allowing for a two-foot freeboard, and so that velocity of the discharge from the basin does not exceed that allowable for the receiving water body.

• **Principal (Mechanical) Spillway:** Class 2 and 3 basins include the design of a principal spillway to allow a controlled discharge of water. The principal spillway normally consists of a vertical pipe, solid or perforated, called the 'riser', located at the deepest part of the basin, connected to a nearly-horizontal pipe, called the 'barrel', which discharges through the embankment and out of the basin. Refer to Figures 2 and 3 for depictions of principal spillways.

   • Set the top of the riser at least three feet below the top of the embankment or crest of the emergency spillway.

   • The riser may be solid or perforated. Perforated risers are surrounded by wire mesh and a mound of well-graded gravel. A trash rack over the top of the riser prevents debris from entering and clogging the spillway. **Do not wrap geotextile fabric around perforated risers, because it can blind off quickly, effectively blocking the perforations, prevent discharge through the outlet.** Refer to Figure 4 for a depiction of a riser pipe.

   • Provide the barrel with anti-seep collars to prevent piping along the outside of the pipe.

   • Follow the specifications in the **Riprap-Stabilized Outlet** BMP, stabilize Class 2 and Class 3 basin principal spillway outlets with riprap. Class 1 basins do not have spillways.
• Size the principal spillway 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 spillway using the appropriate storm water basin procedure.

• **Alternate Spillway--Floating Skimmer:** A type of spillway being used with increasing frequency is the floating skimmer, which is depicted in Figures 5 and 6. Some early tests indicate that the skimmer (which draws water only from the surface) may be more effective at retaining sediment in the basin than the standard riser and barrel configuration (which draws water from the entire water column).

• **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 spillway capacity.

  • Size the emergency spillway to pass the difference in discharge between the design storm frequency and the capacity of the principal spillway.

  • 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 mechanical riser, 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.

• **Riser and Barrel:** 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. To maximize the efficiency of the principal spillway system, set the cross-sectional area of the riser pipe at least 1.5 times that of the barrel.

• **Embankments:** Construct embankments with the most stable fill material available. For permanent embankments, selected material may have to be hauled in. Where possible, use soils other than sand. Sandy soils tend to shift.
Construction Guidelines

1. **Never build a sediment basin in a perennial stream or in wetlands. In-stream sediment basins are allowed only by permit through the MDEQ Water Resources Division.**

2. Construct the sediment basins before any other land clearing or grading is done. Construct according to the design and by following the guidelines below.

3. 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.

4. Disc or scarify the area where embankment fill will be placed to allow a good bond between the fill and the existing soil. Place and compact fill in controlled, uniform layers.

5. 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.

6. Immediately after sediment basins are constructed, stabilize the top banks of the basins and all surrounding areas with vegetation.

7. After construction is completed, dewater temporary sediment basins, removed all bulkheads or other structures, then fill and grade the basins to the contours of the surrounding land. Stabilize the area by Seeding and Mulching or Sodding.

8. For sediment basins that will be converted to permanent storm water controls, remove all sediment accumulated in the basin during construction, to accommodate the conversion.

**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**

- Remove sediment when it has accumulated to no more than 50 percent of the design depth.

- Immediately address any problems discovered during the maintenance monitoring.
• Place sediment removed during cleaning in an upland area, and stabilize it so that it does not re-enter the drainage course.

Literature Cited


Figure 1. Sediment Basin Baffle Placement
Figure 2. Sediment Basin with Solid Riser Pipe
Figure 3. Sediment Basin with Perforated Riser Pipe
Figure 4. Sediment Basin Perforated Riser Pipe
Figure 5. Floating Skimmer--Plan View
Source: Adapted from DelDOT, 2012.
Figure 6. Floating Skimmer—Side and Profile Views

Source: Adapted from DelDOT, 2012.

- Skimmer
- Perforated PVC Pipe
- Cap
- Hole drilled in cap for checking outlet clogging.
- Rebar Guide Posts
- Floatation Section
- Flexible HDPE Drain Pipe
- Pond Outlet Structure
- PVC Pipe
- Stone Pad

Side View—Moving Section Only

Profile View

Skimmer rises and falls with water surface.