Module 8: Sediment Trap and Sediment Basin Problems

Learning Objectives

At the end of this module, you will be able to:

- Review common calculations and design considerations for sediment traps and basins.
- Assess the proper application of sediment traps and basins.
- Evaluate proposed designs for compliance with Virginia Erosion and Stormwater Management Regulation.

8a. Sediment Trap Problems

Use the Virginia Stormwater Management Handbook (VSWHB), Chapter 7.4, C-SCM-11.

Round final answers to one decimal place, when practical.

1. Use Figure 8-1 and Figure 8-2 to help answer the following questions.

1a. If the sediment trap receives drainage from 2.46 acres of disturbed area on site and receives runoff from 0.40 acres of undisturbed area off site, what is the total volume of storage needed (V)?

Total Volume (V_{Total}) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 134 cubic yards per acre (cy/ac)

$$V_{Total} = A \times 134$$

1b. What is the required volume (V) for the permanent pool for wet storage?

Wet Volume (V_{Wet}) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 67 cubic yards per acre (cy/ac)

$$V_{Wet} = A \times 67$$

1c. How much volume (V) is required for the drawdown pool for dry storage?

Temporary Pool Volume (V_{Dry}) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 67 cubic yards per acre (cy/ac)

$$V_{Dry} = A \times 67$$

1d. What is the embankment height? Use the sediment trap cross-section shown in Figure 8-1.

1e. What should the minimum top width of the embankment be? Use Table C-SCM-11-2, Chapter 7.4 of the VSWHB.

1f. What should the length of the stone outlet be? Use Figure 8-2.

Outlet length in feet (ft) = 6 × Drainage Area (A) in acres (ac)

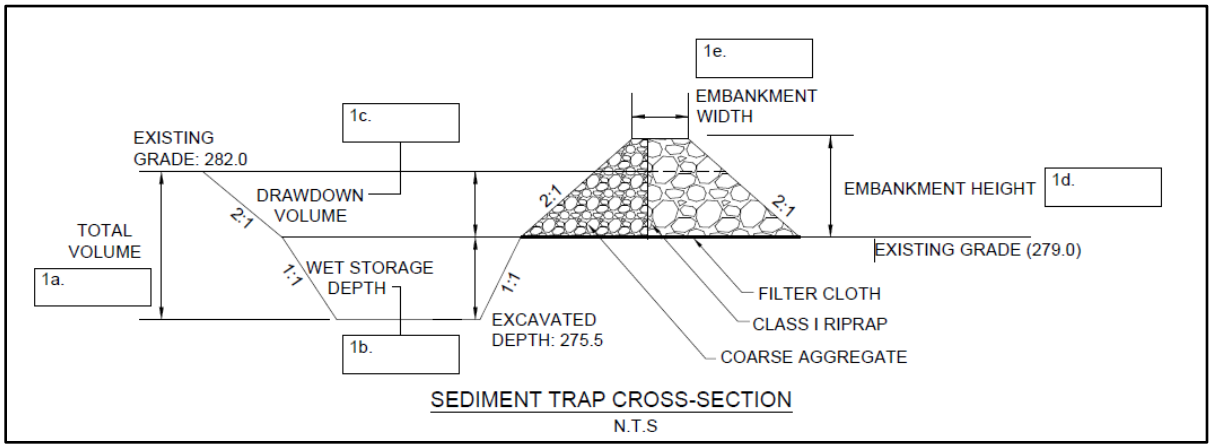

Figure 8-1. Sediment Trap Cross-Section

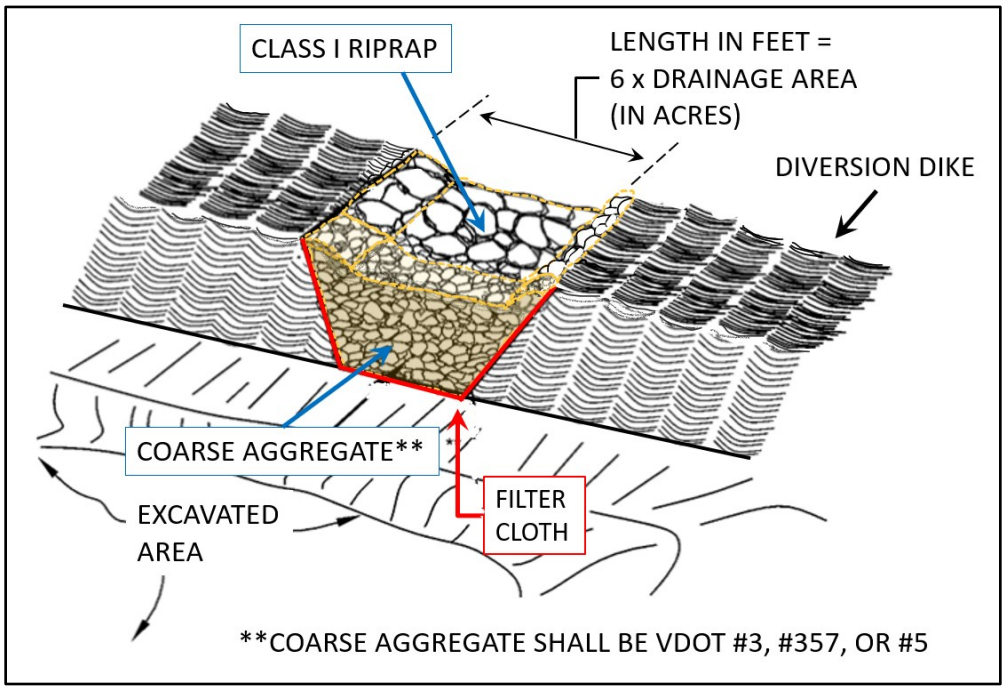

Figure 8-2. Sediment Trap Outlet (Perspective View)

8b. Sediment Basin Problems

Use the VSWHB, Chapter 7.4, C-SCM-12.

Round final answers to one decimal place, when practical.

1. Use the sediment basin schematic in Figure 8-3 to help answer the following questions.

1a. For a sediment basin receiving 12 acres of disturbed area and 3 acres from undisturbed area, what total volume (V) is required?

Total Volume (V) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 134 cubic yards per acre (cy/ac)

$$V = A \times 134$$

1b. What is the volume (V) of the permanent pool (wet storage)?

Wet Storage (V) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 67 cubic yards per acre (cy/ac)

$$V = A \times 67$$

1c. What is the volume of the drawdown pool for dry storage?

Temporary Pool Volume (V) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 67 cubic yards per acre (cy/ac)

$$V = A \times 67$$

1d. When does sediment need to be cleaned out of the basin?

2. Determine the diameter for the dewatering orifice for a sediment basin receiving the drainage area mentioned in Question 1, using the minimum required drawdown time of 24 hours per Table C-SCM-12-1 of the VSWHB.

Step 1: Calculate total dry storage (S).

Dry Storage (S) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 67 cubic yards per acre (cy/ac)

$$S = A \times 67$$

Step 2: Convert cubic yards to cubic feet.

1 cubic yard (cy) = 27 cubic feet (cf)

Step 3: Convert drawdown time from hours ($T_{D(hr)}$ to seconds, $T_{D(s)}$):

$$T_{D(s)} = T_{D(hr)} \times \frac{60\ minutes}{hour} \times \frac{60\ seconds}{minute} = \_\_\_\_\_ \text{ seconds}$$

Step 4: Calculate the flow rate needed (Q) in cubic feet per second (cfs) to get the required drawdown time in seconds ($T_{D(s)}$).

$$Q = \left(\frac{S}{T_{D(s)}}\right)$$

Step 5: Find the flow area of the orifice (A) in square feet (sf).

$$A = \frac{Q}{(64.32 \times h_d)^{1/2}\ (0.6)}$$

h_d = head over the dewatering orifice

Step 6: Using the flow area (A), find the diameter (d) of the dewatering orifice.

$$d = 2 \times \left(\frac{A}{3.14}\right)^{1/2}$$

3. Use the sediment basin in Figure 8-3 to answer Questions 3a and 3b.

3a. What is the required riser diameter?

Step 1: Determine the peak flow rate (Q_p) using Figure 8-3. Q_p is equal to a two-year storm if there's an emergency spillway, or a 25-year storm if there is no emergency spillway.

2-year storm peak flow (during development) = 31 cubic feet per second (cfs)

25-year storm peak flow (during development) = 82 cfs

Step 2: Use Figure C-SCM-12-8 in the VSWHB (Chapter 7.4, Appendix A) to determine the smallest riser that will pass the required flow. The head between the riser crest and the emergency spillway (h_r) is given in Figure 8-3 below as 1 foot. You will also need Q_p from step 1.

3b. If the existing stormwater conveyance system is not adequate for the proposed discharge flow from the sediment basin, what should the riser diameter be to ensure compliance with water quantity requirements without needing to improve the system? Use the site predevelopment runoff peak flows provided in Table 1. (See GM 22-2012, Chapter 2.303 and 9VAC25-875-560.)

Table 1. Predevelopment Runoff Peak Discharge Flow (in cubic feet per second)

1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
1.99	5.47	13.37	21.38	34.9	47.54	62.36

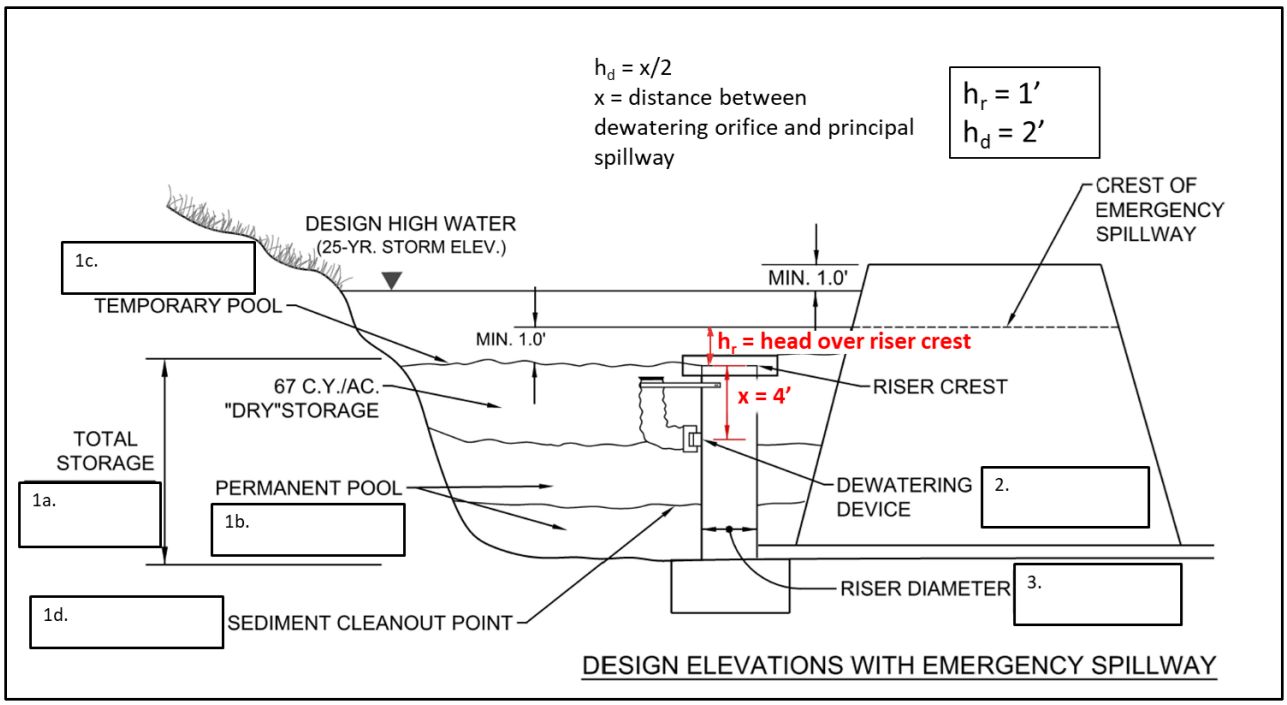

Figure 8-3. Schematic for Sediment Basin with Emergency Spillway

4. Using the riser diameter from Question 3b, what are the required dimensions for the concentric trash rack and anti-vortex device? (Use Table C-SCM-12-7, Anti Vortex Device Design, Chapter 7.4 of the VSWHB, Section 9.0 Appendix A Design Procedure for Temporary Sediment Basins.)

Step 1: Find the riser diameter in the furthest left column.

Riser diameter in inches (in) = _____

Step 2: Move one column to the right to "Cylinder Diameter."

Trash rack diameter size (in) = _____

Step 3: Move an additional two columns to the right to "Height."

Trash rack height (in) = _____

5. Use the sediment basin drawings shown in Figure 8-4 and Figure 8-5 to answer the following questions.

5a. Determine if the basin in Figure 8-4 requires baffles.

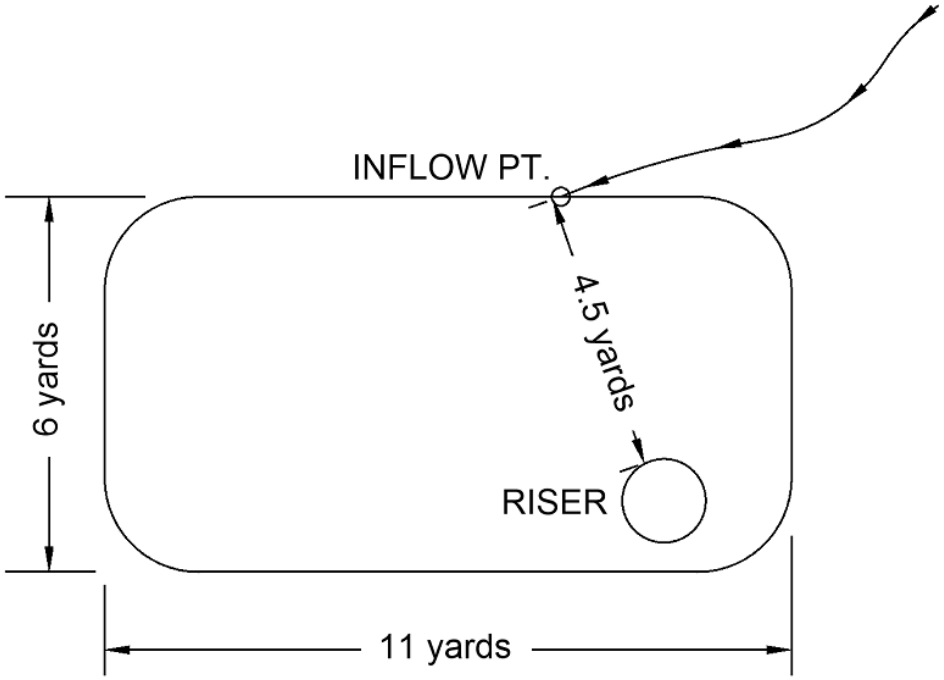

Figure 8-4. Sediment Basin for Baffle Determination

Step 1: Calculate the effective width (W_e).

$$W_e = \frac{\mathbf{A}}{\mathbf{L}}$$

A = surface area of pond L = flow path length from inflow to outflow

Step 2: Calculate the length-to-width ratio.

$$\text{Length-to-width ratio} = \frac{L}{W_e}$$

5b. Baffles were added to the sediment basin. Are they sufficient as shown in Figure 8-5?

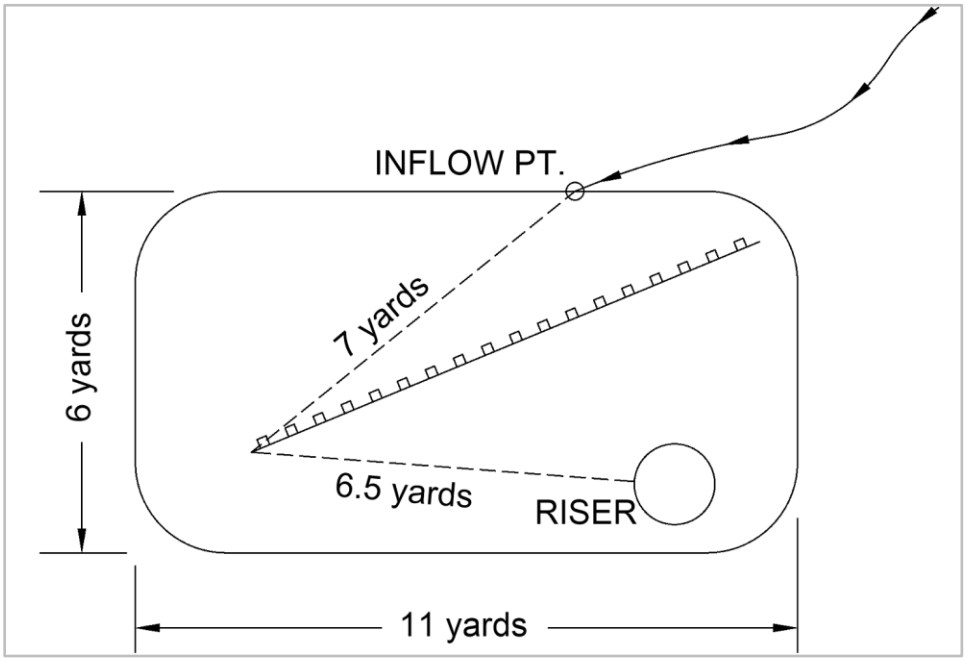

Figure 8-5. Sediment Basin with Baffles

Step 1: Calculate the effective width.

$$W_e = \frac{A}{L}$$

A = surface area of pond L = flow path length from inflow to outflow

Step 2: Calculate the length-to-width ratio.

$$\text{Length-to-width ratio} = \frac{L}{W_e}$$

6. What is the minimum embankment width if the height of the embankment is 12 feet, given the discussion in the embankment cross-section discussion in Table C-SCM-12-1 from Chapter 7.4 of the VSWHB?

7. Use the basin shown in Figure 8-6 to answer the following questions. Note that the basin is designed for a total drainage area of 15 acres.

7a. Determine if the basin is adequately sized.

Step 1: Calculate the total storage **needed** for the drainage area.

Total Volume (V) in cubic yards (cy) = Total Drainage Area (A) in acres (ac) × 134 cubic yards per acre (cy/ac)

$$V = A \times 134$$

Step 2: From the plan view of the sediment basin in Figure 8-6, determine the wet storage volume provided:

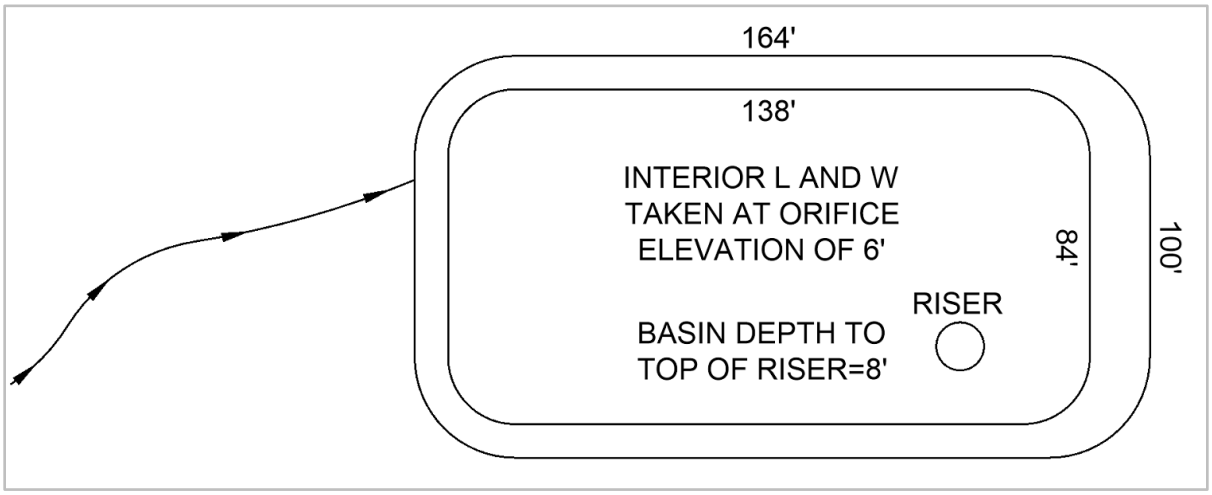

Figure 8-6. Plan View of Sediment Basin

Wet Storage Volume in cubic feet (V_1) = $0.4 \times A_1 \times D_1$

A_1 = surface area of flooded area at dewatering orifice, in square feet

D_1 = depth from low point in the basin to the dewatering orifice

Step 3: From the plan, determine the dry storage volume provided:

$$\text{Dry Storage Volume in cubic feet } (V_2) = \frac{A1 + A2}{2} \times D_2$$

A_2 = surface area of flooded area at the crest of the principal spillway, in square feet

D_2 = depth from the dewatering orifice to the crest of the principal spillway, in feet

Step 4: Add the wet and dry storage volumes (in cubic feet).

$$\text{Total Storage Volume provided} = V_1 + V_2$$

Step 5: Convert cubic feet to cubic yards and compare to the amount of storage required from step 1. Remember, 1 cubic yard = 27 cubic feet.

8. Given an 80-foot-long, corrugated metal pipe, what is the diameter of the barrel required for a peak flow, if Q = 25 cubic feet per second (cfs) with 10 feet of head (H)? 1

Step 1: Find Table C-SCM-12-4, n=0.025 (corrugated metal pipe)

Step 2: On the left vertical column, select the head, H (feet) = _____

Step 3: Read across the table, select the pipe peak flow, Q_{70} (cfs) = _____

Step 4: Read up the table to determine the pipe diameter, D (inches) = _____

Step 5: Since pipe length is not 70 feet, proceed to next step

Step 6: Read from bottom of chart for pipe length (feet) = _____;

Get the conversion factor (CF) = _____.

Step 7: The pipe capacity for this length pipe is determined:

$$Q_l = CF \times Q_{70}$$

Step 8: If pipe capacity flow rate, Q_l (cfs), is less than the required peak flow rate, Q (cfs), select the next larger pipe size and repeat above calculations.

Pipe Diameter, D (inches) = _____

Notes