

College of Agricultural Sciences Cooperative Extension
Agricultural and Biological Engineering

F-253

# Controlling the Dewatering of Sedimentation Basins A. R. Jarrett, Professor of Agricultural Engineering

S edimentation basins are impoundments placed on earth disturbance sites to capture and treat sediment-laden runoff. The purpose of sedimentation basins is two fold; (1) to capture and detain the sediment-laden runoff originating from the site thus providing an opportunity for the suspended sediment to settle from the water, and (2) to provide storage for the captured sediment. In Pennsylvania, earth disturbance sites are required to have a sedimentation basin with 1,000 ft<sup>3</sup> of sediment storage and 5,000 ft<sup>3</sup> of water storage for each upland disturbed watershed acre. However, the 5,000 ft<sup>3</sup>/acre water storage volume maybe reduced to a minimum of 3,600 ft<sup>3</sup>/acre, if one or more of the following conditions are included in the basin's design:

- A skimmer-type dewatering device is installed; reduction allowed =  $700 \text{ ft}^3/\text{acre.}$
- A permanent pool is maintained in the basin; reduction allowed =  $700 \text{ ft}^3/\text{acre.}$
- The basin has a Length: Width ratio of at least 4:1; reduction allowed =  $350 \text{ ft}^3/\text{acre.}$
- The basin's dewatering time, for a storm that fills the water storage volume, is greater than 4 days and less the 7 days; reduction allowed =  $350 \text{ ft}^3/\text{acre.}$

Basin volume requirements vary greatly from state to state. Be sure you use your state's design criteria.

# **Controlling Dewatering**

The only two major design parameters relating to sedimentation basin performance are (1) how long the sediment-laden runoff is detained in the basin, and (2) where the water is extracted from the vertical water column. It follows that longer is better with four- to seven-day dewatering times being desirable.

The purpose of this fact sheet is to provide design criterion that can be used by engineers to properly size various dewatering control features used as part of the basin's principal spillway. Dewatering is usually controlled by (1) a perforated riser with openings throughout the water storage zone, (2) a single orifice with its invert at the top of sediment storage, or (3) a skimmer designed to dewater the water storage zone. The perforated riser and single orifice extract water from low in the water column and have been shown to capture about 80% of the fines suspended in the captured water. The skimmer extracts water from the ponded-water surface and has been shown to capture 90% of the fines suspended in the captured water. These performance results assume at least a 24 hour dewatering time.

### **Perforated Riser**

A perforated riser is a vertical stand pipe, resembling in many ways the riser pipe often used to control normal water level on small wet impoundments, that has been drilled with regularly spaced holes, Figure 1. Perforated risers often have several columns of holes with a vertical spacing of between 0.5 and 1.0 feet. The number of columns of holes, the vertical spacing between holes, and the diameter of the holes must be selected carefully. Figure 2 is a perforated riser hole design chart for a perforated riser with four columns of holes. Two decisions must be made before Figure 2 can be employed; (1) the water storage volume (in ft<sup>3</sup>), and (2) the desired dewatering time to be used for a design storm. The following example will illustrate.

*Perforated Riser Example*: Determine the hole diameters needed in a four-column perforated riser that will cause a 40,000 ft<sup>3</sup> sedimentation basin to dewater in two days.

Solution: Using a four-column riser, the basin volume of 40,000 ft<sup>3</sup>, and the specified dewatering time of 2.0 days, Figure 2 can be used to determine the required hole diameter of 0.67 inches. Therefore the perforated riser for this basin would be a vertical pipe with four vertical columns of 0.67-inch diameter holes drilled with the bottom row of holes located at the top of the sediment storage volume, with additional 0.67-inch diameter holes located on a 0.5-foot interval upwards from the bottom holes.

#### Single Orifice

A single orifice is a carefully-sized, circular hole cut into the inflow end of the principal spillway's barrel, Figure 3. In some cases this single orifice is the first stage of the stormwater detention basin outlet, in other cases it is necessary to cut an orifice into an end cap attached to the entrance end of the principal spillway barrel. Properly sized, this single orifice can control the dewatering process. When construction has ended and the basin's sedimentation function is complete, the end cap is usually removed, exposing spillway barrel for installation of any stormwater detention outlet control facility.

*Single Orifice Example*: Determine the orifice diameter needed to dewater a 40,000 ft<sup>3</sup> sedimentation basin in two days.

*Solution*: With the stated desire to use a single orifice, the basin volume of 40,000 ft<sup>3</sup>, and specified dewatering time of 2.0 days, Figure 4 can be used to determine the required single orifice diameter of 2.50 inches. Therefore the principal spillway for this sedimentation basin would be a barrel with an end cap having a 2.50-inch diameter single orifice cut into the end cap with the orifice invert located at the bottom of the water storage zone.

#### The Faircloth Skimmer

A Faircloth skimmer is shown in Figure 5. The "C" enclosure floats on the water surface suspending the water entry unit just below the water surface. All water leaving the basin is withdrawn through the water entry unit, which skims the highest quality water from near the water surface. An orifice located just below the water surface controls the flow of water entering the skimmer and exiting the basin. The water is discharged from the arm assembly into the basin's barrel. It is assumed that the barrel is sized to carry the skimmer's discharge as open channel flow. In addition it is important to know that the Faircloth skimmer is a patented item and is available from J. W. Faircloth and Sons, Inc at (http://www.fairclothskimmer.com) in specific sizes (see Table 1). The skimmer size refers to the diameter of the float and arm. The Faircloth Skimmer should be sized by first determining the required (or desired) basin outflow rate. This means you must determine the volume of water, V to be dewatered from the basin in cubic feet (ft<sup>3</sup>) and decide how many days you want the skimmer to take to remove this volume of water, the dewatering time, t<sub>d</sub>. With these two requirements determined, compute the required outflow rate, Q (in cubic feet per day,  $ft^3/d$ ) as

$$Q = \frac{V}{t_d}.$$
 (1)

With the required outflow rate (in ft<sup>3</sup>/day) known, select a skimmer and orifice (if needed) from the Selection Charts (see Table 1). The skimmer selection procedure is illustrated below and in an Example.

*Skimmer Example*: Select a skimmer that will dewater a 20,000 ft<sup>3</sup> skimmer basin in 3 days.

Solution: First compute the required outflow rate as

$$Q = \frac{V}{t_d} = \frac{20000 \, ft^3}{3d} = 6670 \, ft^3 \, / \, d$$

Now go the Selection Charts (Table 1) and select an appropriate skimmer. If the 2-inch skimmer with no orifice is chosen, the outflow rate will be 5,429  $ft^3/d$ , which will require about 3.5 days to dewater the basin. An alternative might be to use a 4-inch skimmer with a 2.5-inch diameter orifice, which will have an outflow rate of 8,181  $ft^3/d$  and dewater the basin in about 2.5 days.

A More Precise Alternative: Each skimmer comes with a plastic plug that can be drilled forming a hole that will limit the skimmer's outflow to any desired rate. Thus, for a specific skimmer the orifice that will dewater a basin in a more precisely chosen time can be determined. The flow through an orifice can be computed in ft<sup>3</sup>/d using the diameter D (in inches) and the head H (in feet) as

$$Q = 2310D^2\sqrt{H} \cdot (2)$$

In the Example, if we solve the orifice equation, in the form of Equation 2, for the orifice diameter using the desired outflow rate (6670 ft<sup>3</sup>/d) and the head driving water through the skimmer (0.333 ft for a 4-inch skimmer) as

$$D = \sqrt{\frac{Q}{2310\sqrt{H}}} = \sqrt{\frac{6670}{2310\sqrt{0.333}}} = 2.24 \text{ inches}$$

We see that if the plastic plug were drilled to a diameter of 2.24 inches and placed in a 4-inch skimmer, the dewatering rate would be  $6{,}670 \text{ ft}^3/\text{d}$  and the 20,000 ft<sup>3</sup> basin would dewater in 3 days.

## **Table 1. Faircloth Skimmer Selection Charts**

1.5-inch skimmer (H = 0.125 ft)				
Orifice	Outflow			
(in)	Rate (ft <sup>3</sup> /d)			
None	2,079			
1.0	809			
0.5	193			

2-inch skimmer (H = 0.167		 2.5-inch skimmer (H = 0.167 ft)		
Orifice (in)	Outflow Rate (ft <sup>3</sup> /d)	Orifice (in)	Outflow Rate (ft <sup>3</sup> /d)	
None	5,429	None	9,548	
1.0	924	1.0	1,039	
0.5	231	0.5	250	

3-inch skimmer (H = 0.25 ft)		4-inch skimm	mer (H = 0.333 ft)	
Orifice	Outflow	Orifice	Outflow	
(in)	Rate (ft <sup>3</sup> /d)	(in)	Rate (ft <sup>3</sup> /d)	
None	10,588	None	16,863	
1.5	2,541	2.5	8,181	
1.0	1,136	2.0	5,236	
0.5	289	1.5	2,945	
		1.0	1,309	
		0.5	327	

5-inch skimmer (H = 0.333 ft)

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Orifice (in)	Outflow Rate (ft <sup>3</sup> /d)	Orifice (in)	Outflow Rate (ft <sup>3</sup> /d)	Orifice (in)	Outflow Rate (ft <sup>3</sup> /d)
None	10,588	None	16,863	None	26,276
1.5	2,541	2.5	8,181	3.5	16,035
1.0	1,136	2.0	5,236	3.0	11,781
0.5	289	1.5	2,945	2.5	8,181
		1.0	1,309	2.0	5,236
		0.5	327	1.5	3,715
				1.0	1,309
				0.5	327







perforated riser principal spillway.



Figure 2. Design chart for a perforated riser with four columns of holes.





Figure 5. Faircloth skimmer.

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