4.4.12.2.2 Skimmer

Source: City of Franklin

Definition and Purpose
A skimmer is a floating device used to dewater a sediment basin (Section 4.4.7) at a controlled rate by discharging water to the principal spillway. Runoff captured in the sediment basin is dewatered by the skimmer from just below the water surface elevation and back to the sediment storage elevation.

Appropriate Applications
Skimmers are applicable in most sediment basins. They are generally used to enhance sediment trapping capabilities compared to perforated riser pipes (Section 4.4.12.2.1).

Limitations and Maintenance
In order to comply with specific sediment basin detention requirements (i.e., 48 to 72 hours), skimmers are selected by the size of the opening (orifice) used to dewater the basin. The orifice size is computed by equations governed by basin dimensions and the flow capacity of the orifice. While these methods are generally reliable for a particular skimmer, manufacturers produce various products that have their own hydraulic characteristics that can impact the dewatering rates (Sharpe et al., 2023; Sprague et al., 2015). Thus, it is important to periodically inspect the dewatering rate of skimmers to ensure it matches the anticipated dewatering rate. Most skimmers come with an adjustable orifice; therefore,

adjusting its size to ensure proper dewatering times is simple, such that there is adequate access to the skimmer.

A few other limitations also exist for skimmer use. Skimmers are likely to clog, whether it be from trash and debris or from freezing conditions (IDEM, 2021). Avoid using skimmers if extended periods of freezing conditions are anticipated. Further, ropes tied to the floating head of the skimmer and extending to the embankment can be a valuable tool to dislodge any debris partially clogging the skimmer without needing to access the basin. The rope may also be useful if needing to adjust the orifice size. Additionally, because the skimmer is a floating device, a stone pad should be constructed below the skimmer (setting the sediment storage height) such that the skimmer does not dewater the entire basin. Lastly, ensure all skimmer components and connections are free of cracks, leaks, and deterioration.

Planning and Design Considerations

Manufactured skimmers are highly encouraged as opposed to contractor-assembled devices. Various manufacturers produce products that are readily available with technical specifications and performance standards, making the process of selecting a skimmer quick and simple. Skimmers typically consist of a flexible boom attached to a perforated inlet and outlet pipe, with pipe diameters typically ranging from one and a half to eight inches. The boom should be free to rise with water levels and should be protected from twisting, kinking, or breaking, especially in cold weather, using restraints like guide bars, rope tethers, or landing devices such as aggregate pads, concrete blocks, or gabion baskets. These landing devices also prevent the skimmer from settling into sediment, blocking inlet perforations (if used), and dewatering the entire basin. The stone pad should be of sufficient size to hold the skimmer and constructed from #57 stone. Further, the pad is to be at a minimum of four inches in thickness, extending to an elevation that corresponds to the elevation of the sediment storage zone. Skimmer orientation should also be considered; directing the boom toward shallow shoreline areas can simplify maintenance and allow for effective landing device placement.


Source: TDEC

To begin the sizing of the skimmer, first note the design volume of water that will be released from the basin in cubic feet (V, i.e., live storage volume) and the desired dewatering time in days (t_d). Then divide the V by t_d to obtain a dewatering flow rate. Next, use manufacturer performance charts to select the appropriate skimmer size and orifice diameter. However, most skimmers come with a plastic plug that can be drilled, forming a hole that will limit the orifice of the skimmer to any desired rate. Thus, for a basin that requires a more specific dewatering time, an orifice diameter can be calculated via the orifice equation (Eqn 29) as described in Section 4.4.12.2.1.

Because skimmers are floating mechanisms, they dewater the basin from or just below the water surface elevation. This is advantageous because basins retain/capture sediments through the sedimentation process. Thus, as the hydraulic retention time in the basin increases, settling sediments will migrate further down the water column, yielding cleaner water at the top of the column. Because of this theory, skimmers have been labeled as the most effective basin-dewatering mechanism (Zech et al., 2014). In fact, Schussler (2022) found that sediment basins equipped with a floating skimmer retained 12% more sediment by weight than a sediment basin equipped with a perforated riser, an impressive increase considering sediment basins already capture large amounts of sediment within the basin itself [e.g., typical removals of 95% or greater when basins were constructed following TDOT and TDEC recommendations (Emmett, 2022)].

Example Application

Example 1:

-Example from ALSWCC (2018)-

Given:

A sediment basin with a live storage zone of 20,000 cubic feet and a desired dewatering time of 72 hours.

Determine:

An appropriately sized skimmer from manufacturer XYZ.

Solution:

Step 1 – Compute the required outflow rate: Divide the outflow volume by the desired dewatering time.

$$Q = V / t_d = 20{,}000 / 72 = 278 \text{ ft}^3\text{/hour} = 6{,}670 \text{ ft}^3\text{/day}.$$

Step 2 – Use provided specifications from the manufacturer to size the skimmer: Manufacturer XYZ specifies a 2-inch skimmer with no orifice has an outflow rate of 5,429 ft^3/day, and a 4-inch skimmer with a 2.5-inch diameter orifice has an outflow rate of 8,181 ft^3/day. The 4-inch skimmer with a 2.5-inch diameter orifice was selected as the other skimmer does not meet the dewatering rate and therefore would dewater the basin in a time longer than 72 hours.

Step 3 – After upsizing the dewatering rate to match that of a manufactured device, ensure it does not dewater the basin too quickly. Divide the live storage volume by the dewatering rate of the manufactured device, and ensure the dewatering time is still within 48 to 72 hours.

$$t_d = V / Q = 20{,}000 / 8{,}181 = 2.44 \text{ days} = 58.7 \text{ hours}$$

The actual dewatering time is within the allowable range and therefore, the 4-inch skimmer with 2.5-inch diameter orifice is an acceptable size from XYZ is an acceptable skimmer.

Example 2:

-Example courtesy of ALSWCC (2018)-

Given:

A sediment basin with a live storage zone of 20,000 cubic feet and a 4-inch skimmer from XYZ manufacturing with a desired outflow rate of 6,670 ft^3/day, such that the actual dewatering time is 72 hours.

Determine:

The orifice diameter.

Solution:

Apply the orifice equation (Eqn 29) and convert units where necessary. The head will vary depending upon the manufacturer's design depth of submergence for a given orifice diameter. Assume manufacturer XYZ has a driving head (H) of four inches for a 4-inch skimmer.

$$Q = N \times C_d \times A \times (2 \times g \times H)^{1/2}$$

$$6670 \frac{ft^3}{d} = 1 \times 0.6 \times \frac{\pi \times d^2}{4} \times \left(2 \times 32.2 \frac{ft}{s^2} \times 4 \text{ in}\right)^{1/2}$$

$$0.0772 \frac{ft^3}{s} = 1 \times 0.6 \times \frac{\pi \times d^2}{4} \times \left(2 \times 32.2 \frac{ft}{s^2} \times 0.333 \text{ ft}\right)^{1/2}$$

$$d = 0.187 \text{ ft} = 2.24 \text{ inch}$$

Thus, a plastic plug drilled to a diameter of 2.24 inches and placed in the 4-inch plastic skimmer would result in a dewatering time of 72 hours for a live storage volume of 20,000 cubic feet.

References

ALSWCC. (2018). *Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas.*

Emmett Jr, J. C. (2022). Performance Evaluation of Sediment Basin Designs for Highway Construction Sites In Tennessee.

IDEM. (2021). *Indiana Storm Water Quality Manual: Sediment Traps and Basins*.

Schussler, J. C. (2022). *Improvements in Stormwater Detention Technologies through Large-Scale Testing Techniques*. Auburn University.

Sharpe, C., Perez, M. A., & Donald, W. N. (2023). Evaluation of Surface Skimmer Flow Rates and Size Selection. *Transportation Research Record*, *2677*(9), 199-211.
Sprague, J. E., Sprague, C. J., & Ruzowicz, B. (2015). Evaluating Floating Surface Skimmers. In *2015 IECA Annual Conference*.
Zech, W. C., Logan, C. P., & Fang, X. (2014). State of the practice: Evaluation of sediment basin design, construction, maintenance, and inspection procedures. *Practice Periodical on Structural Design and Construction*, *19*(2), 04014006.