Sizing Methodologies for the Stormwater Management StormFilter®

Across the country, many regulatory agencies are establishing criteria for sizing stormwater treatment devices to meet their water quality standards. Depending on these local requirements, there are a number of ways to size the StormFilter, including: flow-based, volume-based, and storage-based sizing methodologies, which are summarized below.

Flow-Based Sizing Methodology

For a flow-based sizing methodology, a design storm event is used to calculate a design discharge flow rate (volume per time). Typically, the design storm event is specified by the regulatory agency as some depth of rainfall over a certain period of time (for example: 1 inch in 24 hours) or as an intensity (for example: 0.5 inch per hour), with a specified distribution. The distribution may vary with time or may be a straight-line relationship. Depending on how the storm is specified, a number of hydrologic models could be used to calculate the discharge flow rate from the site given the design storm. Some models will simply result in a single flow rate value (for example: Rational Method). Others will result in a peaked hydrograph (for example: TR-55 and Santa Barbara Urban Hydrograph (SBUH)). For a peaked hydrograph, the discharge flow rate is considered to be the peak flow rate of the hydrograph. The discharge flow rate is primarily influenced by the distribution of the rainfall.

Key components of the design include:

- the design storm event or intensity;
- time of concentration;
- rainfall distribution.

To size a StormFilter using a flow-based methodology, the design flow rate is divided by the StormFilter cartridge flow rate to determine the number of cartridges required. The cartridge flow rate may vary from 2 gpm up to 15 gpm, depending on the targeted pollutants. The StormFilter structure can then be sized to accommodate the required number of cartridges.

Key features of the system include:

- 2.3 feet of head required from StormFilter inlet to outlet;
- filter cartridges use standard restrictor discs per design flow rate;
- filter cartridges control the flow through the system;
- standard baffle walls, unless otherwise required by the local agency;
- upstream structures may not be required, unless a high-flow bypass is necessary.

Maintenance of a flow-based system typically requires removal of accumulated sediments and replacement of the filter cartridges on a regular basis (typically, annually).

Examples of jurisdictions using a flow-based design methodology include:

- State of Washington;
- City of Portland, Oregon;
- City of Houston, Texas and Harris County.

Volume-Based Sizing Methodology

For a volume-based sizing methodology, a design rainfall is used to calculate a water quality volume (WQv) that must be treated (note: this is different than detention). Typically, the local agency specifies a depth of runoff over the site that must be captured and treated (for example: 0.5 or 1.0 inches per impervious acre, also commonly referred to as "first flush"). Some may specify a depth of rainfall that must be routed over the site to create an equivalent depth of runoff. The WQv is then calculated by multiplying the depth of rainfall or runoff by the site area. The volume to be treated is primarily influenced by the total amount of rainfall or runoff. A typical volume-based system must also meet the local agency's drain-down requirements (for example: in less than 40 hours; between 5 and 24 hours; etc.).

Key components of the design include:

- depth of rainfall;
- depth of runoff;
- drain-down requirements.

To size a StormFilter using a volume-based methodology, the WQv must be captured in some type of storage facility and then slowly routed through the StormFilter. The storage facility may be composed of a pipe gallery or box culvert followed by a separate StormFilter structure. Another option is to contain the storage component and filtration component in a single, box-culvert structure, also known as a Volume StormFilter. **The storage component and filtration component are hydraulically connected (no restriction between storage and filters), so that when the storage component is full, high-head is placed on the filter cartridges. The restrictor disc for the cartridges is then sized accordingly**.

There are two subdivisions of this design methodology:

1. Whole volume storage: the storage component is required to capture and hold the entire WQv (100%). This results in the largest storage facility. The treatment volume is then slowly released through the filtration component. The number of cartridges is determined using a mass-loading calculation, or other calculation as specified by the jurisdiction.
2. Volume storage with some routing: some jurisdictions allow for some credit for treatment through the StormFilter as the storage tank is filling. This helps minimize the size of the storage facility. A credit may be specified by the jurisdiction (for example: 25% credit while filling so only 75% of the WQv needs to be captured, resulting in treatment of 100% of the WQv) or a routing routine may be used to determine how much flow is actually treated while the storage tank is filling. The storage tank volume could then be reduced accordingly. An inflow hydrograph is needed to route the storm through the tank. The number of cartridges is determined using a mass-loading calculation, or other calculation as specified by the jurisdiction.

Key features of the system include:

- volume may be stored in same structure as filter cartridges;
- allows high head on the cartridges;
- filter cartridges control the flow through the system;
- no control structure required for the volume storage tank;
- full height downstream baffle wall in the StormFilter;
- in some cases, the number of cartridges required may be reduced if dead storage or a sump is provided as part of the storage component (reduces the pollutant loading to the cartridges).

Maintenance of a volume-based system typically requires drain-down of the dead storage (if applicable), removal of accumulated sediments from the storage component and the filtration component of the system, and replacement of the filter cartridges. Cartridge replacement frequency may be reduced if more pretreatment or dead storage is provided.

Examples of jurisdictions using a volume-based sizing methodology:

- State of Maryland;
- State of New York.

Storage-Based Sizing Methodology

A storage-based sizing methodology may be used to meet either a flow-based or volume-based sizing requirement. Similar to a volume-based sizing methodology, this methodology would result in a system consisting of two components: a storage component followed by a filtration component. Depending on the regulatory requirements, the storage component would be sized either to capture the WQv (or some portion thereof) or to capture the volume of a storm generated by a hydrograph. The storage component may be composed of a pipe gallery or box culvert followed by a separate StormFilter structure. **However, unlike the volume-based methodology, the storage component and filtration component are not hydraulically connected. Therefore, a control structure is required between the storage component and filtration component. As a result, the StormFilter cartridges require only the standard drop and use standard restrictor discs.**

There are three subdivisions of this design methodology:

1. Standard storage: the storage component is required to capture and hold either the entire WQv or the volume of the peaked hydrograph. The treatment volume is then slowly released through a control structure (or orifice) to the filtration component, operating at a standard cartridge flow rate. The number of cartridges is determined using a mass-loading calculation, or other calculation as specified by the jurisdiction. The number of cartridges may be reduced if dead storage or a sump is provided as part of the storage component or control structure (reduces the pollutant loading to the cartridges).
2. Downstream of detention: Another purpose of stormwater regulations is to require detention facilities in order to reduce the peak flow rate off newly developed impervious areas, to meet pre-existing conditions. Many jurisdictions across the country require some type of rate control, requiring the post-developed flow off a site be reduced to pre-developed flow

conditions in order to reduce the erosion of receiving streambeds. In areas where such a detention facility (which is typically sized to meet release rate requirements) is located upstream of a StormFilter, the detention facility may provide similar functions as a simple storage facility. The detention facility will typically slowly release the flow through a control structure to the StormFilter, which operates at a standard cartridge flow rate. The number of cartridges is determined using a mass-loading calculation, or other calculation as specified by the jurisdiction. The number of cartridges may be reduced if dead storage or a sump is provided as part of the detention facility (reduces the pollutant loading to the cartridges). It is important not to confuse detention with storage. Hydraulically they are the same thing, but the term "detention" implies that the facility is for rate control as well as water quality.

3. Surge Tank: when a hydrograph results in an extremely high peak flow rate, a surge tank can be used to "trim the peak" and reduce the size of the StormFilter. The minimum number of cartridges is determined using a mass-loading calculation, or other calculation as specified by the jurisdiction. This dictates the peak hydraulic capacity of the StormFilter. More cartridges can be used, if desired, to fill the vault and increase the hydraulic capacity. During a storm, the runoff flows directly into the StormFilter, until the capacity of the filter cartridges is achieved. If the inflow exceeds cartridge capacity, the peak of the hydrograph is routed off to the surge tank, typically located in parallel with the StormFilter. The size of the surge tank is determined by calculating the volume of water remaining in the peak of the hydrograph, above the capacity of the cartridges. Once the storm subsides, and the water level in the StormFilter begins to drop, the volume stored in the surge tank is gradually released back into the cartridge chamber, until empty. This ensures full treatment of the design storm.

Key features of these systems include:

- 2.3 feet of head required from StormFilter inlet to outlet;
- filter cartridges use standard restrictor discs per design flow rate;
- filter cartridges control the flow through the system;
- standard StormFilter baffle walls, unless otherwise required by the local agency.