VEGETATED ROCK FILTER CALCULATOR

These calculators determine the vegetated rock filter (VRF) dimensions needed to treat the Water Quality Volume (WQv) or Water Quality Flow Rate (WQf).

Input cell =		User enters value
Default value =		User should only change value if able to provide explanation for adjustment
Calculation cell =		User should not change cell

CALCULATOR

Vegetated Rock Filter Calculator - by Water Quality Volume

1	Water Quality Volume - WQv	2500	cubic feet
2	% of WQv stored in Forebay	10%	% of total WQv stored by forebay (usually 10-20%)
3	% of WQv stored in VRF	90%	% of total WQv stored in VRF
4	Volume of Forebay	250	cubic feet
	Volume in VRF	2250	cubic feet
5	Depth of Forebay	2	feet, typically 1 to 3 feet
6	Depth of Permanent Pool Gravel	2.5	feet, typically 1.5 to 3.5 feet, recommend 2.5 feet
7	Depth of Gravel above Permanent Pool in VRF	0.5	feet, typically 0.25 to 0.75 feet, recommend 0.5 feet
8	Total Depth of Gravel - d	3	feet, typically 2 to 4 feet, recommend 3 feet
9	Max Ponding Depth Above VRF - Pd	1	feet, typically 0.5 to 2 feet
10	Total WQv Storage Depth in VRF	1.5	feet, sum of the ponding depth and the depth of gravel above permanent pool
11	Porosity of Gravel - n	0.35	typically 0.3 to 0.4, recommend 0.35
12	**Surface Area needed for Forebay**	**125**	square feet
	Surface Area needed for VRF	**1915**	square feet
13	Width	25	feet
14	Length	**77**	feet
15	Length to Width Ratio	3.1	
16	Hydraulic Conductivity of Gravel - k	2000	ft/day
17	Flow Rate through Filter	0.017	cubic feet per second
18	**Calculated WQv Drain Time - t**	**41**	hrs, must be between 12 and 48 hrs. If t <12, decrease width or provide outlet control.

Vegetated Rock Filter Calculator - by Water Quality Flow Rate

19	Water Quality Flow Rate - WQf	0.18	cubic feet/second
20	Hydraulic Conductivity of Gravel - k	2000	ft/day
21	Length of VRF	22	feet (adjust length until residence time in Step 28 is greater than 12 hours)
22	Depth of Permanent Pool Gravel	2.5	feet, typically 1.5 to 3.5 feet, recommend 2.5 feet
23	Depth of Gravel above Permanent Pool in VRF	0.5	feet, typically 0.25 to 0.75 feet, recommend 0.5 feet
24	Total Depth of Gravel - d	3	feet, typically 2 to 4 feet, recommend 3 feet
25	Cross-sectional Area Required	342	square feet
	Width Required	114	feet
26	**Surface Area**	**2509**	square feet
27	Velocity through Filter	0.0005	feet per second
28	**Residence Time**	**12**	hrs, must be between 12 and 48 hrs. If t <12, increase length or provide outlet control.

INSTRUCTIONS

For volume-based sizing, use steps 1-18 to determine the required dimensions of the VRF. Volume-based VRFs provide a storage area above the filter to capture the WQv, and the filter area is sized to drain the WQv within the desired drain time.

For flow-based sizing, use steps 19 - 28. The cross-sectional area of flow-based VRFs are sized to convey the WQf, and the length of the VRF is sized to provide the desired residence time.

Step	
To Determine the Required Dimensions for Volume-based VRFs (i.e., those capturing the WQv).	
1	Enter the Water Quality volume (WQv) for the DMA. The WQv is calculated in Step 14 of the Water Quality Volume and Water Quality Flow Rate Calculator.
2	Enter the percent of the WQv to be stored by the pretreatment forebay, typically between 10% - 20%, recommend 10%.
3	The percent of the WQv to be stored by the VRF is calculated as 100% - Forebay Storage %.
4	The forebay and VRF storage volumes are calculated based on their percentages and the total WQv.
5	Enter the storage depth in the forebay, typically between 1 and 3 feet.
6	Enter the depth of the permanent pool gravel. This is the depth from the bottom of the VRF to the permanent pool level.
7	Enter the depth of the gravel above the permanent pool level. This is the portion of the gravel that drains (i.e., the gravel depth above the outlet weir or standpipe).
8	The total depth of the gravel is calculated. It is equal to the sum of depths entered in Steps 6 and 7.
9	Enter the depth of ponding above the filter bed. A highly impermeable wetland soil layer should be provided at the surface of the VRF to prevent short-circuiting of the ponded runoff. A perforated riser is used to convey the ponded water through the impermeable soil layer to the underlying rock filter media.
10	The total storage depth is calculated. The depth is equal to the sum of the ponding depth and the gravel depth above the permanent pool.
11	Enter the porosity of the gravel. A default value of 0.35 is recommended.
12	The required surface area of the forebay and VRF are calculated here.
13	Enter the width of the VRF.
14	The required length of the VRF is calculated here.
15	The length to width ratio of the VRF is calculated here.
16	Enter the design hydraulic conductivity of the gravel. A default value of 2000 ft/day is recommended.
17	The flow rate through the filter is calculated here. Runoff flows horizontally from the upstream end to the downstream end of the VRF.
18	The drawdown time for the WQv is calculated here. If the drawdown time is less than 12 hours, decrease the VRF width or provide an outlet flow control device.
To Determine the Required Dimensions for Flow-based VRFs (i.e., those sized to convey the WQf).	
19	Enter the Water Quality Flow Rate (WQf) for the drainage management area (DMA). The WQf is calculated in Step 13 of the Water Quality Volume and Water Quality Flow Rate Calculator.
20	Enter the design hydraulic conductivity of the gravel. A default value of 2000 ft/day is recommended.
21	Enter the length of the VRF.
22	Enter the depth of the permanent pool gravel. This is the depth from the bottom of the VRF to the permanent pool level.
23	Enter the depth of the gravel above the permanent pool level. This is the portion of the gravel that drains (i.e., the gravel depth above the outlet weir or standpipe).
24	The total depth of the gravel is calculated. It is equal to the sum of depths entered in Steps 22 and 23.
25	The required cross-sectional area and width of the VRF are calculated here.
26	The surface area of the VRF is calculated here.
27	The velocity through the filter is calculated here. Runoff flows horizontally from the upstream end to the downstream end of the VRF.
28	The residence time for the WQf is calculated here. If the residence time is less than 12 hours, increase the VRF length or provide an outlet flow control device.

DEFINITIONS

Water Quality Volume (WQv)	The runoff volume to be managed by the stormwater BMP such that treatment requirements are met. The WQv is calculated by the Water Quality Volume and Water Quality Flow Rate Calculator.
Water Quality Flow Rate (WQf)	The required flow rate to be managed by the stormwater BMP such that the treatment requirements are met. The WQf is calculated by the Water Quality Volume and Water Quality Flow Rate Calculator.
Depth of Forebay	The depth of water that can be stored in the forebay.
Depth of Permanent Pool	The depth of the filter that does not drain, controlled by a weir or standpipe at the downstream end of the filter.
Depth of Gravel (d)	The depth of the VRF from the surface of the gravel to the base of the filter.
Ponding Depth (Pd)	The depth above the filter surface where runoff is ponded temporarily before filtering through the media.
Porosity (n)	Volume of void space to total volume. This is expressed as a ratio, e.g. 0.35 means that one cubic foot of gravel contains 0.35 cubic feet of empty space.
Length	The longitudinal length of the VRF.
Width	The width of the VRF.
Hydraulic Conductivity (k)	The rate at which water flows through the gravel bed, in this case, horizontally.
Flow Rate through Filter	Horizontal rate of flow through the cross-sectional area of the filter. Cross-sectional area is calculated as width x depth. Flow is in the longitudinal direction.
Drawdown Time (t)	The time for the storage area to drain the water quality volume.
Residence time	The time for runoff to travel from the upstream end of the VRF to the downstream end.