Determining In Situ Hydraulic Conductivity

Tech Note

Standard Operating Procedure for Determining in Situ Hydraulic Performance of High Flow Rate Bioretention Media using the Rub I Infiltrometer

The Rub-I Infiltrometer is the most effective way to field verify engineered soil performance for bioswale, applications where effective soil drainage is an imperative. The Rub-I was designed to test the effectiveness of high flow soils and to ensure quality control in the field, and for years beyond initial installation. Current ASTM standards for infiltration testing are not valid for flow rates exceeding 16 in/hr.

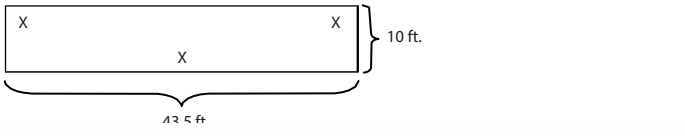
Objective:

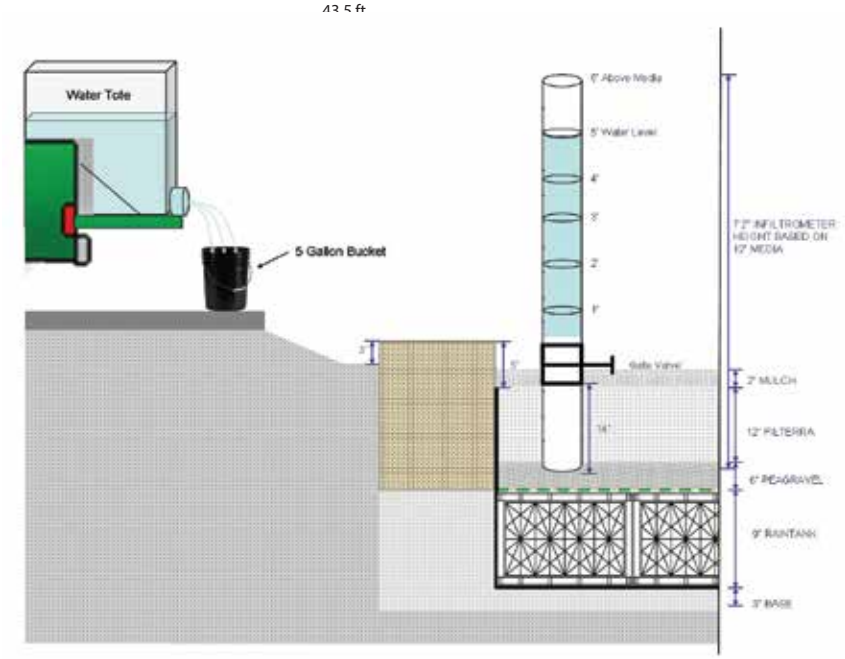
Provide as-built confirmation of proper installation and hydraulic performance, to meet minimum infiltration rate requirements, of bioretention media in newly-placed bioretention systems. This procedure measures the entire media profile under saturated conditions to insure a reliable and accurate result.

Example Site Test Layout and Design Schematic:

(FSA = filter surface area, DA = drainage area)

For bioretention systems with a surface area less than 50 m^2 (538 ft^2), in situ hydraulic testing should be conducted at three points that are spatially distributed. For systems with a surface area greater than 50 m^2, an extra monitoring point should be added for every additional 100m^2 (1076 ft^2). (Values are based on recommendations from the Facility for Advancing Water Biofiltration.) Testing should be performed on the perimeter since this is the area most likely to be impacted by sediment in the runoff.





Media Depth (inches)	Max Drawdown Time (min:sec)
12	18:18
14	21:24
16	24:18
18	27:00
20	29:30
22	31:54
24	34:06
26	36:12
28	38:12
30	40:00
32	41:42
34	43:24
36	44:54
38	46:18
40	47:42
42	49:00
44	50:12
46	51:24
48	52:30

Test Methodology:

1. Carefully scrape away any surface covering (e.g. mulch, gravel, leaves) without disturbing the soil filter media surface.
2. Confirm media profile depth by using a shovel to dig to under drain stone and place measuring tape in hole to determine depth from top of under drain stone to top of media bed. A flash light may be needed to ensure the under drain stone has been reached before a depth measurement is taken.

Test Methodology:

Figure 3: Hammering Pipe Into Media

Figure 4: Pipe Installed Into Media

Figure 5: Oil Application

Figure 6: Dissipater Stones

3. At another location cleared of mulch, locate the 6 inch wide white PVC pipe (beveled end down) on the surface of the media. Ensure testing is not too close to vegetation. Place the wooden board over the pipe and then gently pound with the sledge hammer on top of the board (figure 3). Hammer the PVC pipe through the entire media profile, based on the depth previously determined (Figure 4). Check with level. Note: It is important that the pipe is driven in slowly and carefully to minimize disturbance of the filter media profile. The media may slightly move downward in the pipe during hammering, but not more than 1 inch, and will not significantly affect hydraulic performance.
4. If pipe is less than 3 inches from media surface, remove media around outside of pipe so that the pipe is 3 inches from the media bed so that the gate valve coupling will properly slide into the pipe.
5. Remove board and rub mineral oil on outside of PVC pipe (Figure 5).
6. Place 2 inch dissipater stones into pipe (Figure 6).
7. Slide gate valve with clear PVC cylinder down into the PVC pipe (Figure 7) in media. Note: Disregard black coupling on clear pipe as well as pipe plug. These were space pieces used for the demonstration but are not part of the final design.
8. Measure from the original surface of the media within the column to the 1ft, 2ft, 3ft, 4ft, and 5ft gradations, and mark them on the clear PVC cylinder (Figure 8). The 1ft and 5ft. marks are the critical marks, since the time to fall between these two intervals will be the pass/fail criteria for the test. (The time at other intervals between 1ft and 5ft can be recorded for additional information, but will not be used in the pass/fail criteria.)
9. Fill a 5 gallon bucket with 3 gallons from the filled 55 gallon water drum. Leave cap off of drum at test site to prevent airlock.
10. Ensure the gate valve is closed. Fill with the 3 gallons of water (Figure 9). To create a worst case flow rate scenario (i.e. saturated condition), an initial wetting of the media using the infiltrometer is conducted by opening up the gate valve completely. The gate valve should be slowly opened by tapping on the handle with a hammer or wrench to prevent disturbance of the media surface by a sudden high flow of water. Pulling open by hand tends to force the valve to open too quickly.
11. After the water level disappears from the clear column, a drain down time of 25 minutes must be allowed to ensure free water has drained from the system. The media is now at field capacity (fully saturated).
12. After 25 minutes, close the gate valve. Fill the 5 gallon bucket with water and fill the column until water level reaches the very top of the clear pipe. Water is then re-introduced by opening the gate valve slowly by tapping the handle with a tool. The stopwatch should be started at the 5 ft. gradation and time recorded at every 1 ft. gradation. The stopwatch time is stopped when the water level reaches 1 ft.
13. Pass / Fail criteria is based on the maximum drawdown times (Table 1). For example, a media profile depth of 12 inches should not exceed a drawdown time of 18 minute and 18 seconds between the 5 ft. and 1 ft. gradations.
14. For bioretention systems with a surface area less than 50 m^2 (538 ft^2), in situ hydraulic testing should be conducted at three points that are spatially distributed. For systems with a surface area greater than 50 m^2, an extra monitoring point should be added for every additional 100 m^2 (1076 ft^2). These values are based on recommendations from the Facility for Advancing Water Biofiltration in Australia.

Figure 7: Infiltrometer Placement

Figure 8: Gradation of Clear Pipe

Figure 9: Filling Infiltrometer with Water

For information on components & assembly of Rub - I Infiltrometer see the SOP (Standard Operating Procedure) document in CWT VAR.