Technical Abstract
Downstream Defender®

Performance Verification of Very Fine Sediment Removal with 50-Micron Silica Sand

The Downstream Defender® is an advanced Hydrodynamic Vortex Separator that removes sediment, oil and floatables from stormwater runoff. It has flow modifying internal components to stabilize the flow regime within the device, providing higher pollutant removal capabilities and protection from high scour velocities during intense storm events (Fig.1).

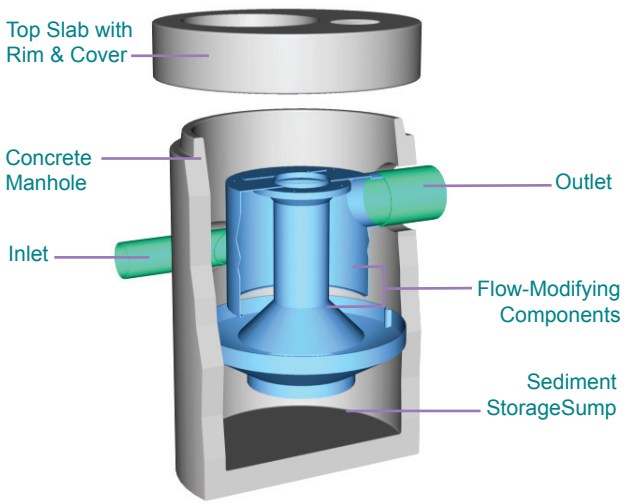


Fig.1 The flow modifying components stabilize the flow regime to provide higher pollutant removal capabilities.

Verification of Fine Sediment Removal

Although runoff from intense storm events has enough energy to mobilize large pollutants such trash and coarse sediments, small storm events tend to mobilize very fine sediment. To evaluate the ability of the Downstream Defender® to capture these pollutants, a full-scale 4-ft diameter unit was tested under controlled laboratory conditions (Fig.2).

Test procedures were based on requirements to obtain General Use Level Designation (GULD) for Pretreatment by the Washington Department of Ecology (WA DOE) and a Certificate of Technology Assessment under the New Environmental Technology Evaluation (NETE) Program by the Ontario Ministry of the Environment.

Clean water from a 23,000 gal reservoir was pumped to the Downstream Defender® for 4 test runs with target flow rates of 0.4 cfs to 2.2 cfs with no bypassed flows, and inlet concentrations of 200 to 300 mg/L (Fig.3). A very fine gradation of test sediment was produced by mechanically sieving U.S. Silica grade F-110 sand with a #200 sieve to ensure that all test sediment was less than 75-micron with an approximate mean particle size of 50-micron.

Five influent and effluent grab samples were collected per test run, for a total of 18 sample pairs. All samples were analyzed for Total Suspended Solids (TSS) by APHA SM2540D. Background influent and effluent samples were analyzed to ensure the reservoir supplied clean water. The average removal efficiency was calculated for each flow rate.

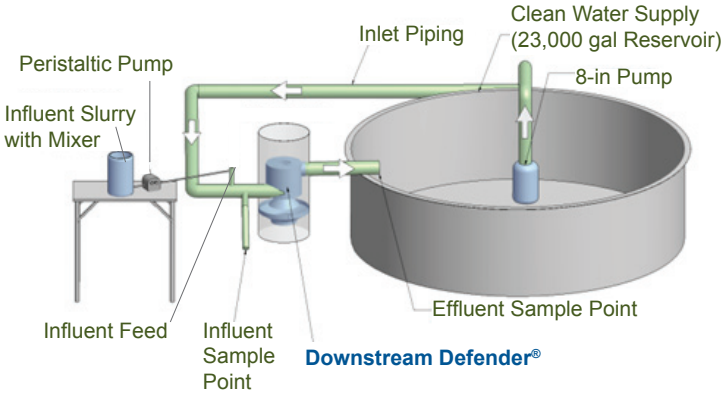


Fig.2 Hydro International's Portland, Maine test facility.

Fig.3 Grab samples were taken from the effluent discharge (pictured, left) and the influent to determine removal efficiency.

Downstream Defender®

Performance Testing Results

Test data demonstrates 80% removal of very fine sediment for all flows up to 1.2 cfs (Fig.4). As the Downstream Defender® does not incorporate an internal bypass, it will continue to capture sediment as flows increase. Whereas internally bypassing units will begin to discharge higher flows without any treatment, the test results project that the Downstream Defender® will continue to provide positive removal efficiencies up to its Peak Treatment Flow Rate of 3 cfs (Fig.4).

These results confirm the efficiency of the Dowstream Defender® over the wide range of tested flow rates and highlight the benefit of internal components that stabilize the flow regime and prevent bypassing of untreated flow.

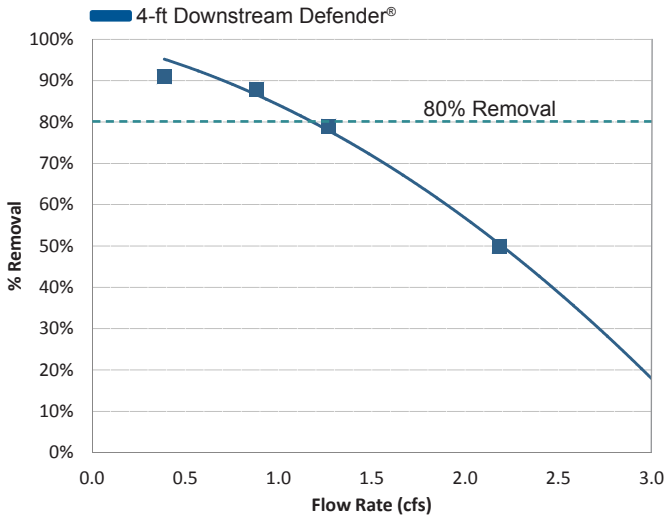


Fig.4 Results of the testing show 80% removal of the very fine test sediment up to 1.2 cfs.

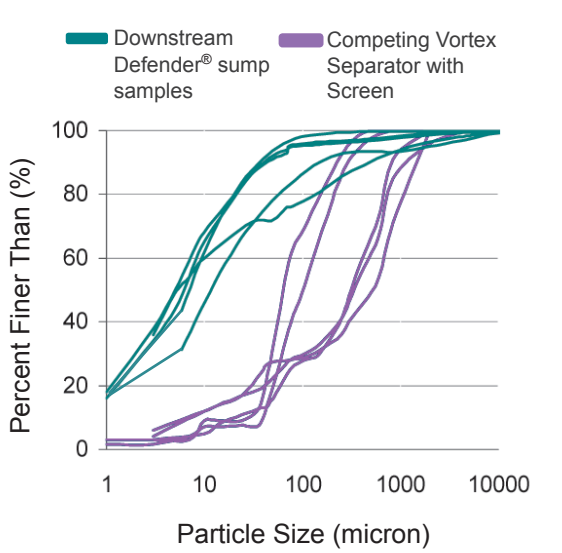
Downstream Defender® Sizing

Flow rates for the 6, 8, 10 and 12-ft diameter Downstream Defender® models for 80% removal of 50-micron sediment are shown in the table below.

Model Unit Diameter	Treatment Flow Rates (80% Removal)	Peak Treatment Flow Rates
(ft)	(cfs)	(cfs)
4	1.2	3.0
6	3.4	8.0
8	6.9	15.0
10	12.1	25.0
12	19.0	38.0

Field Samples Confirm Fine Sediment Removal Performance

The results from the 50-micron sediment removal laboratory testing are consistent with observations from field sampling of Downstream Defender® sump material at many different sites. Sediment captured and retained in the sumps of various Downstream Defender® installations has been shown to be significantly finer than the sediment captured and retained in other stormwater treatment chambers (Faram et al., 2007)[1]. This observation has been corroborated from comparing particle size distributions of sediments captured in a competing vortex separator installed at sites with equivalent land use. In most cases, at least 80% of the material in the Downstream Defender® sump samples was 20-micron or finer. Sump samples from the competing vortex separator showed much less capture and retention of fine material, with only 10 - 18% of sump material in the range of 20-micron or finer.



Gradation of Sediment Captured in Sump

References

1. Faram, M. G., Iwugo, K.O. and Andoh, R.Y.G., 2007, "A Field Study of Sediments Captured by Flow-Through Stormwater Interceptors", Novatech: 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, 25-28 June, pp 641-648.

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Stormwater Solutions