CANADIAN ENVIRONMENTAL TECHNOLOGY VERIFICATION

Enhancing the Credibility of Environmental Technologies

TECHNOLOGY VERIFIED: DOWNSTREAM DEFENDER®

Performance Claim(s)

1. During the sediment capture test, the Downstream Defender® unit removed 72, 68, 58, 52, 43, 36, and 27 percent of sediment at individual surface loading rates of 40 L/min/m^2, 80 L/min/m^2, 200 L/min/m^2, 400 L/min/m^2, 600 L/min/m^2, 1000 L/min/m^2, and 1400 L/min/m^2, respectively.

2. During the scour and resuspension test, the Downstream Defender® unit generated effluent concentrations of 1 mg/L, 2 mg/L, and 7 mg/L at continuous surface loading rates of 1400 L/min/m^2, 2000 L/min/m^2, and 2600 L/min/m^2, respectively.**

***Note: The scour and resuspension test entailed the application of five (5) separate surface loading rates. The concentrations at the surface loading rates of 200 and 800 L/min/m^2 were measured below the method detection limit (MDL) of 1 mg/L; therefore, these values are not cited in Performance Claim #2.*

Verification is based on independent performance testing completed in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).*

VERIFIED PERFORMANCE*:
SEPTEMBER 2016

John D. Wiebe, PhD
Executive Chairman
GLOBE PERFORMANCE SOLUTIONS

License Number: ETV 2016-03

Issued to: Hydro International

Expiration Date: SEPTEMBER 30, 2019

Canada

* This verification conforms to the Canadian ETV Program's General Verification Protocol and the ISO/FDIS 14034:2015(E). Please refer to Technology Fact Sheet for additional information on the verification of this performance claim.

Downstream Defender®

Technology Fact Sheet for Hydro International

Technology Description and Application

The Downstream Defender® is an advanced vortex separator designed to utilize the principles of swirl-enhanced gravity separation to remove Total Suspended Solids (TSS), trash and hydrocarbons from stormwater runoff. The Downstream Defender® has a tangential inlet to introduce a rotary flow path to the precast treatment chamber while flow-modifying internal components stabilize the swirling flow path to reduce turbulence. The swirling flow path of the Downstream Defender® augments gravitational (F_G) forces with swirl-induced forces (F_{CF}, F_{CT}) to remove solids from stormwater runoff (Figure 1).

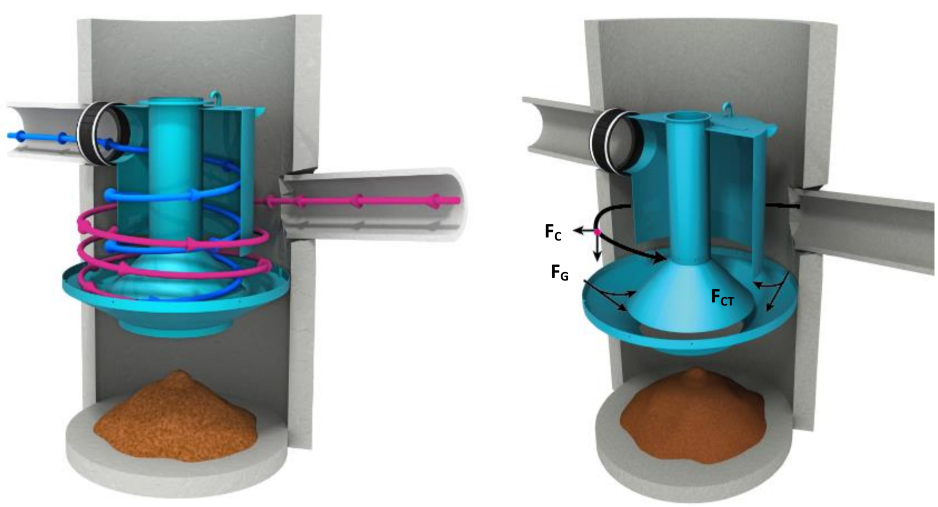

Figure 1: Downstream Defender® Diagram

Stormwater enters the Downstream Defender® through a submerged tangential inlet. Hydrocarbons and other floatables rise to the surface where they are captured in the chamber as the stormwater spirals downward around the interior cylindrical baffle. When flow reaches the center cone it changes direction from downward to upward, passing through a zero velocity "shear" zone, encouraging solids to settle out of the flow scheme and into the pollutant storage sump. After flow is deflected upward by the center cone, it spirals upwards around the center shaft inside the cylindrical baffle and discharges via the effluent pipe. The internal baffles are positioned within the precast treatment chamber to minimize turbulence and protect captured pollutants from scour velocities that cause re-suspension and washout for the entire operating flow range. There is no internal bypass feature to ensure all pollutants enter the treatment chamber prior to discharge.

Performance Conditions

The data and results published in this Technology Fact Sheet were obtained from the testing program conducted on the Downstream Defender® in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).* The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) Program requirements. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

Performance Claim(s)

1. During the sediment capture test, the Downstream Defender® unit removed 72, 68, 58, 52, 43, 36, and 27 percent of sediment at individual surface loading rates of 40 L/min/m^2, 80 L/min/m^2, 200 L/min/m^2, 400 L/min/m^2, 600 L/min/m^2, 1000 L/min/m^2, and 1400 L/min/m^2, respectively.

2. During the scour and resuspension test, the Downstream Defender® unit generated effluent concentrations of 1 mg/L, 2 mg/L, and 7 mg/L at continuous surface loading rates of 1400 L/min/m^2, 2000 L/min/m^2, and 2600 L/min/m^2, respectively.*

**Note: The scour and resuspension test entailed the application of five (5) separate surface loading rates. The concentrations at the surface loading rates of 200 and 800 L/min/m^2 were measured below the method detection limit (MDL) of 1 mg/L; therefore, these values are not cited in Performance Claim #2.*

Performance Results

The Oil-Grit Separator test procedure requires that the three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD to the ETV specified PSD in Figure 2 indicates that the test sediment met this condition.

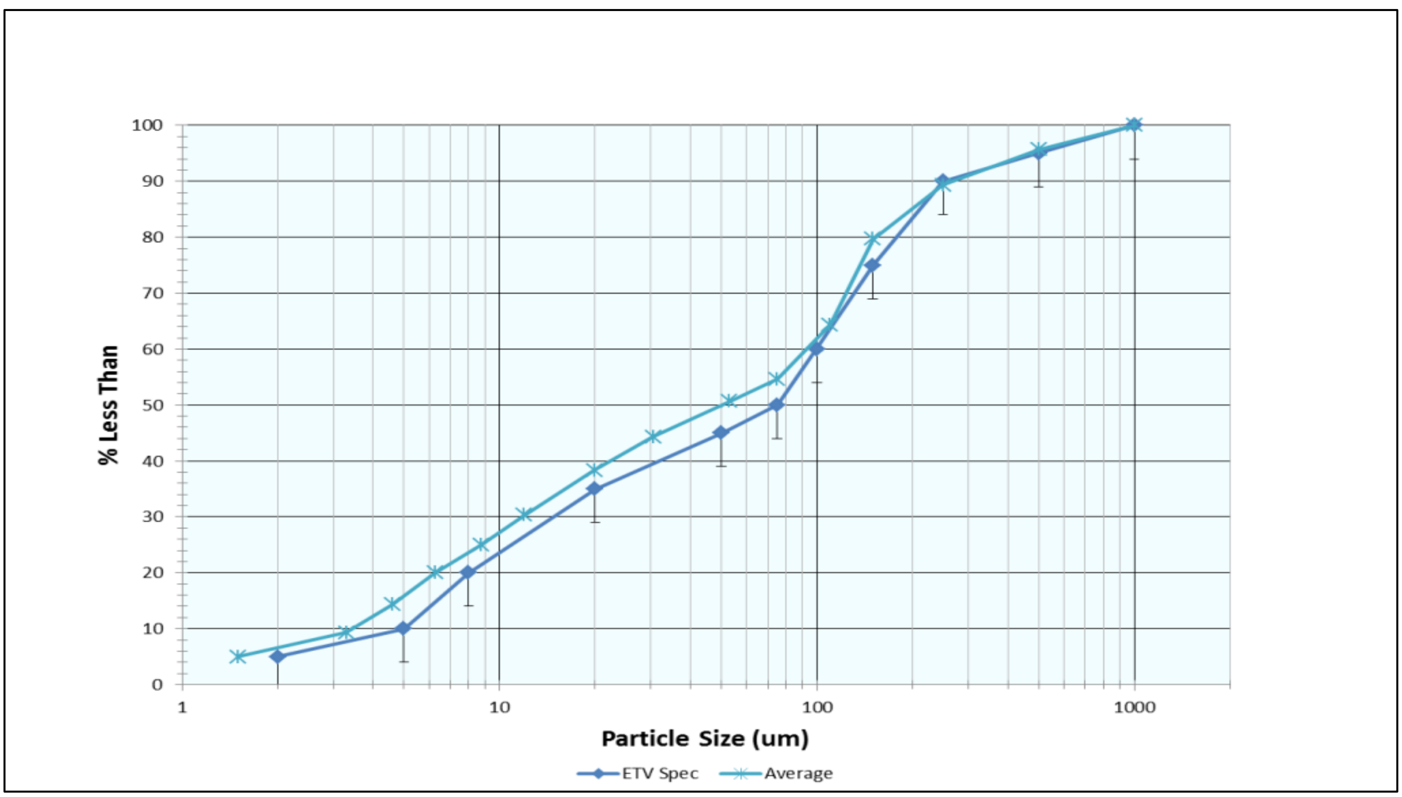

Figure 2: Test Sediment Particle Size Distribution in Relation to Specified PSD

Figure 3 compares the PSD of the three sample average of the test sediment to the PSD of the retained sediment at each of the tested surface loading rates.

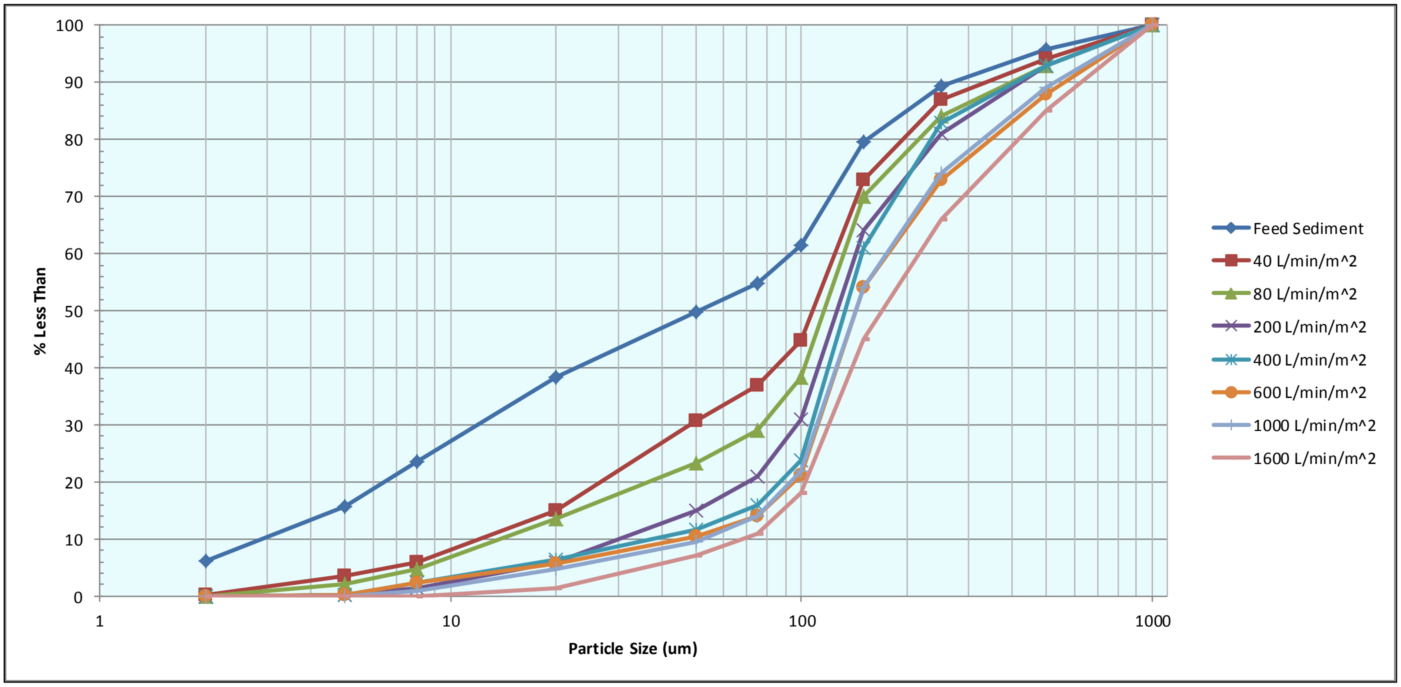

Figure 3: Particle Size Distribution of Retained Sediment in Relation to Injected Sediment

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. Based on these results, removal efficiencies for individual particle size classes and for the test sediment as a whole were determined for each of the tested surface loading rates (Table 1).

In some instances, the removal efficiencies were above 100% for certain particle size fractions (marked with asterisks in Table 1). These discrepancies are attributed to errors inherent to the analytical method used to measure PSD. Due to these errors, application of this data for purposes of sizing the tested device should take into consideration that the data is not absolute but may be suitable for use as a guideline (refer to Bulletin # CETV 2016-11-0001 published on the Canadian ETV website at www.etvcanada.ca). The results for removal efficiencies by mass balance are based on measurements of the total injected and retained sediment mass, and are therefore not subject to PSD analysis errors.

Table 1: Removal Efficiencies by Particle Size Class and Based on Mass Balance at Required Surface Loading Rates

Particle Size Fraction (µm)	Removal Efficiency (%)						
	40 (L/min/m^2)	80 (L/min/m^2)	200 (L/min/m^2)	400 (L/min/m^2)	600 (L/min/m^2)	1000 (L/min/m^2)	1400 (L/min/m^2)
> 500	100*	100*	100*	91.6	100*	98.8	99.7
250 - 500	84.5	100*	100*	87.3	91.3	89.8	84.2
150 - 250	100*	100*	89.5	100*	89.9	79.9	62.0
100 - 150	95.8	100*	91.0	97.9	68.0	56.9	34.7
75 - 100	99.6	97.7	100*	57.6	47.3	49.4	29.5
50 - 75	84.2	75.0	89.7	44.5	29.2	31.2	20.7
20 - 50	74	45.4	39.1	21.8	18.2	10.7	12.3
8 - 20	48	44.5	17.1	12.6	8.9	9.8	2.6
5 – 8	22.6	23.3	12.5	22.3	14.5	3.8	0.0
< 5	21.9	10.7	0.0	0.0	0.3	0.0	0.0
Removal Efficiency based on mass balance (%)	72.4	67.7	57.9	52.4	42.6	35.9	26.6

** Removal efficiencies were calculated to be above 100%. Calculated values were between 101.3 and 128.0%. See text and Bulletin # CETV 2016-11-0001 for explanation.*

Table 2 below shows the results of the sediment scour and re-suspension test. This test involved preloading fresh test sediment into the sedimentation chamber of the device. The sediment was placed on a false floor to mimic a device filled to half of the maximum recommended sediment storage depth. Clean water was run continuously through the device at five surface loading rates over a 30 minute period. Each flow rate was maintained for 5 minutes with a one minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water and the smallest 5% of particles captured during the 40 L/min/m^2 sediment capture test, as per the method described in Bulletin # CETV 2016-09-0001 of the *Procedure for Laboratory Testing of Oil-Grit Separators* on the Canadian ETV website, www.etvcanada.ca.

Table 2: Scour Test Effluent Sediment Concentration

Run	Surface loading rate (L/min/m^2)	Run time	Background sample concentration (mg/L)	Adjusted Effluent Suspended Sediment Concentration (mg/L)*	Average (mg/L)
1	200	1:00	2	0	0
		2:00		0	
		3:00		0	
		4:00		0	
		5:00		0	
		6:00		0	
2	800	7:00	0.5	0	0
		8:00		0	
		9:00		0	
		10:00		0	
		11:00		0	
		12:00		0	
3	1400	13:00	0.5	0	0
		14:00		0	
		15:00		0	
		16:00		0	
		17:00		0	
		18:00		0	
4	2000	19:00	0.5	0	0
		20:00		0	
		21:00		0	
		22:00		0	
		23:00		0	
		24:00		0	
5	2600	25:00	0.8	0	0.6
		26:00		0.4	
		27:00		0.8	
		28:00		0.8	
		29:00		0.8	
		29:50		0.9	

* The adjusted effluent suspended sediment concentration represents the actual measured effluent concentration minus the smallest 5% of sediment particles (i.e. D5) removed during the 40 L/min/m^2 capture test, minus the background concentration. For more information see Bulletin # CETV 2016-09-0001.

Variances from CETV Standardized OGS Testing Procedure

The following deviation from the Procedure for Laboratory Testing of Oil-Grit Separators has been noted:

- The lowest flow rate used during the Sediment Scour and Re-suspension Test was outside of the calibrated range of the flow meter of 100 – 1000 gpm. Therefore, additional flow calibration was performed comparing the flow meter reading to the actual amount of water pumped out of a storage tank.

The recommended sediment sampling interval as per the protocol is minimum 0.1 L or a collection interval of 1minute, whichever comes first. However, due to the very low feed rate, an accurate weight could not be obtained after 1 minute. Starting from the 3 hour time point, the sampling time was extended to 2 minutes.

Verification

The verification was completed by the Centre for Alternative Wastewater Treatment (CAWT) at The Sir Sandford Fleming College of Applied Arts and Technology in Lindsay, Ontario, using the Canadian ETV Program's General Verification Protocol (March, 2000) and taking into account ISO/FDIS 14034:2015(E). Data and information provided by Hydro International to support the performance claim included the following: Performance test report prepared by Good Harbour Laboratories of Mississauga, Ontario, and dated March 22, 2016; the report is based on testing completed in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).

What is Canadian ETV?

Canadian Environmental Technology Verification (ETV) is delivered by GLOBE Performance Solutions under a license agreement from Environment Canada. Canadian ETV is designed to support Canada's environment industry by providing credible and independent verification of technology performance claims.

For more information on the Downstream Defender® please contact:

Hydro International
94 Hutchins Drive,
Portland, ME
04102 USA
Tel : 207-756-6200
Fax : 207-756-6212
enquiries@hydro-int.com
www.hydro-int.com

Canadian ETV Contact Information:

c/o GLOBE Performance Solutions
World Trade Centre
404 – 999 Canada Place
Vancouver, BC
V6C 3E2 Canada
Tel: 604-695-5018
Toll Free: 1-855-695-5018
etv@globeperformance.com
www.etvcanada.ca