Verification Statement

StormTrap LLC StormSettler® Oil Grit Separator
Registration number: V-2023-09-01
Date of issue: (2023-09-13)

Technology type	Oil Grit Separator	
Application	Technology to remove sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals	
Company	StormTrap	
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Verified Performance Claims

The StormTrap StormSettler® Oil Grit Separator was tested by Good Harbour Laboratories Inc. (GHL), Mississauga, Ontario, Canada in 2022 and early 2023. The performance test results were verified by Toronto and Region Conservation Authority (TRCA), Vaughan, Ontario, Canada following the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The following performance claims were verified:

Capture test: With a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and an influent test sediment concentration of 200 mg/L, the StormSettler® OGS device removes 80.5, 76.6, 71.2, 62.9, 63.6, 55.1, and 41.8 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Scour test: With 10.2 cm (4 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment storage depth, the StormSettler® OGS device generates corrected effluent concentrations of 1.2, 1.2, 4.4, 2.2, and 1.2 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively. Values below the Method Limit of Quantification (LOQ) of 2.3 mg/L were assigned a value equal to half the LOQ (1.2 mg/L).

The claims can be applied to other units smaller or larger than the tested unit provided that the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014). Review of model sizes as part of this verification showed that the 3-, 6-, and 7-foot units met the scaling rule.

Technology Application

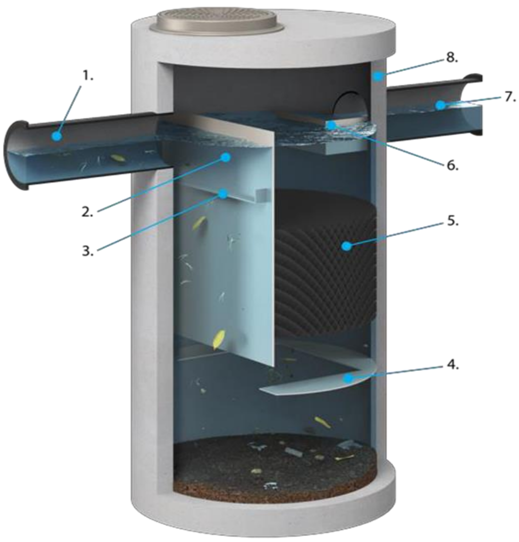
The StormSettler® Oil Grit Separator can be used to treat stormwater from development sites prior to release into receiving waters. StormSettler® applications include: (i) stormwater treatment at the point of entry into the drainage line; (ii) sites constrained by space, topography or drainage profiles with limited slope and depth of cover; (iii) retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line; (iv) pretreatment for downstream filtration MTDs, infiltration practices or other sedimentation BMPs.

Technology Description

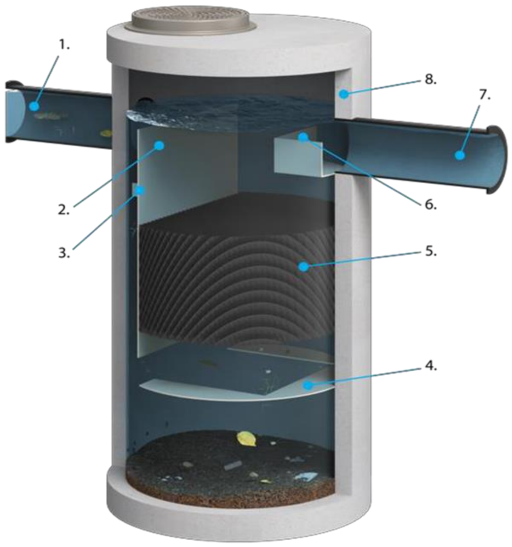
StormSettler® is a patent pending oil grit separator manufactured treatment device developed and designed by StormTrap to remove sediment and associated contaminants from runoff using inclined tube settling technology. An inclined tube settler enhances settling by providing many small channels that reduce the settling distance and the settling time required for a particle to be captured.

In addition to the inclined tube settler, hereafter referred to as an enhanced settling pack (ESP), the StormSettler® employs several flow modifiers to control the flow and optimize performance. The flow modifiers were designed using computational fluid dynamics (CFD) modelling to create an optimal flow distribution that increases removal while decreasing scour potential. The internal components are typically fabricated using plastic parts however in some applications the components may be metal. StormSettler® is typically housed within a concrete structure.

Figure 1 shows the system components under low and high flow conditions. During normal operation, stormwater from the inlet pipe (1) is directed towards the vertical baffle (2) where it is forced down into the sump. A vortex disruptor (3) on the baffle helps prevent high velocity vortices on the inlet side. Water then flows under the vertical baffle where additional flow modifiers (4) help distribute the flow more evenly in the sedimentation chamber prior to the flow entering the enhanced settling pack (5).



a. Low flow condition



b. High flow condition

Legend: 1. inlet 2. vertical baffle 3. vortex disruptor 4. flow modifiers 5. enhanced settling pack 6. outlet control diverter 7. outlet 8. tank wall

Figure 1: StormSettler® in low flow condition (left) and high flow condition (right). The view is reversed in each of the diagrams to show the internal components more clearly.

The ESP consists of a large number of interconnected channels (each with an approx. 38 mm hexagonal opening) designed to enhance the settling of solids. The open area of the pack was measured to be at least 95%. Upon exiting the ESP, the water is directed through an outlet diverter (6) to prevent any short circuiting, and then to the outlet pipe (7).

During high flow events the vertical baffle acts as an internal bypass. All excess flow is directed over the baffle and the top of the settler pack and outlet control diverter. The remaining flow follows the low flow path and is fully treated. The internal components are affixed to the tank wall (8).

The test unit was a commercially available unit, 1.2 m (4 foot) in diameter with a 1.83 m (6 foot) sump depth measured from the outlet invert to the floor of the unit. The system components were housed in a metal manhole prototype. The effective treatment area (i.e., effective sedimentation area) is 1.13 m^2 (10.76 ft^2).

Maintenance is performed by accessing the tank floor from the inlet side. The maximum distance between the inlet side of the tank wall and the vertical baffle for maintenance access was approximately 0.31 m (1 foot). The maximum recommended sediment storage depth prior to maintenance was 0.36 m (14 inches).

Small units (0.91 and 1.2 m diameter) will require a maximum 15 cm (6 inch) vac truck suction hose to allow wand maneuverability during system clean outs. The ESP is designed to be cleaned by removing floatables prior to drain down of the unit. Once the water is removed, visible debris on the top of the ESP is vacuumed off and the ESP is power washed from the top to remove sediment and debris trapped within the pack itself. A camera or mirror on a pole may be used to inspect the bottom of the ESP if there is a concern of clogging from below. Special and more elaborate procedures for removal of the ESP if it is damaged or not responsive to cleaning are provided in the unit maintenance manual.

Description of Test Procedure

The test data and results for this verification were obtained from independent testing conducted on a 1.2 m (48 inch) diameter StormTrap StormSettler® OGS device, in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)* and associated bulletins. The laboratory test procedure was originally prepared by the Toronto and Region Conservation Authority (TRCA) in association with a 31-member advisory committee from various stakeholder groups.

Verification Results

Toronto and Region Conservation Authority verified the performance test data and other information pertaining to the StormTrap StormSettler® Oil Grit Separator. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

Test Sediment

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* current at the time of testing (2022) required 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%, and a median particle size no greater than 75 µm.

Comparison of the individual sample and average test sediment PSD to the specified PSD shown in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition.

The median particle size (d_{50}) of the three-sample average was 65 μm (which is lower than the 75 μm target). However, the PSD used for the sediment removal test could not be regarded as conservative because the average PSD of feed samples used for the individual test runs (n=7) had medians slightly greater than 75 μm, despite having more fine particles than the specified PSD in the <2 to 5 µm range. The difference between the three-sample average and feed sample PSDs can be attributed to errors associated with extraction of sediment from the larger test sediment batch for use in the individual test runs. The test sediment used for sediment scour testing had a finer median particle size of 60 μm.

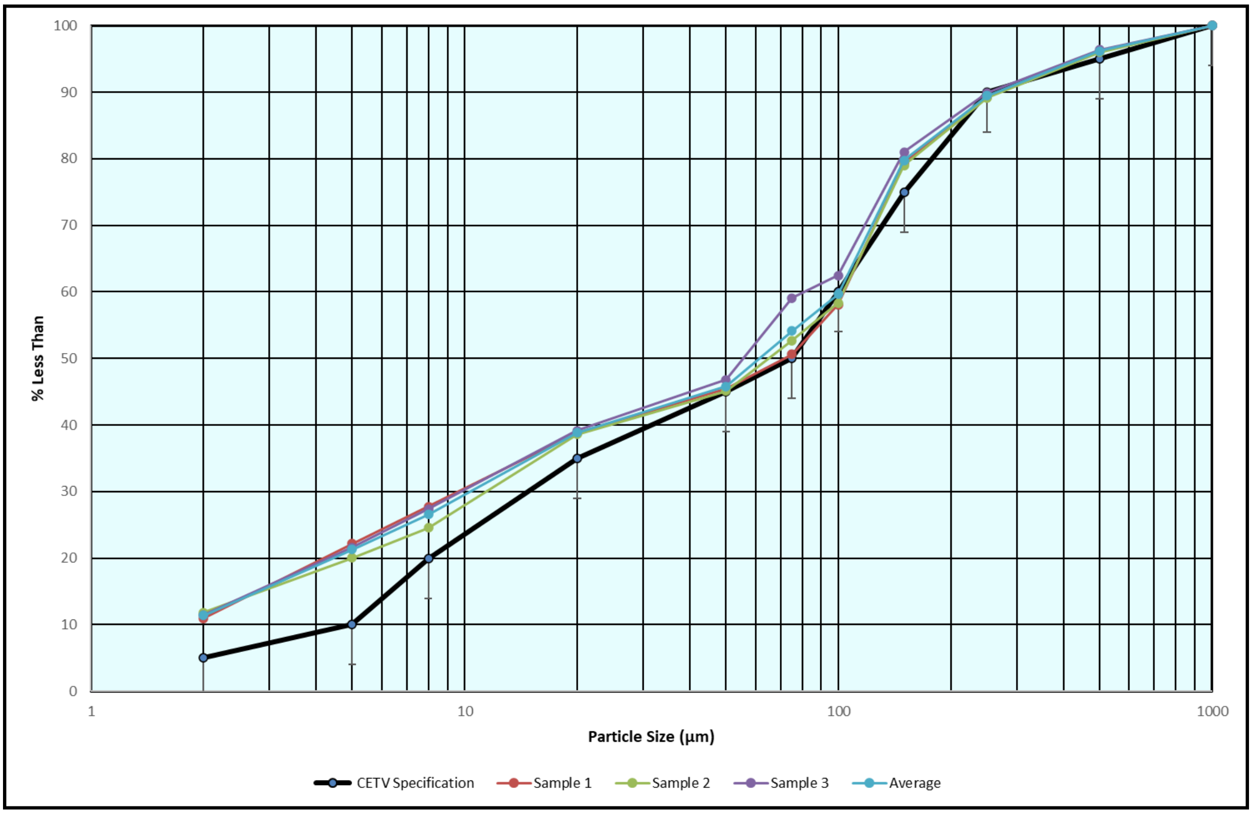


Figure 2 - The three-sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD.

Sediment Removal Testing

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. Performance was evaluated with a false floor simulating the device filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the total mass injected and retained by the unit were determined for each of the tested surface loading rates (see Table 1). Sediment was retained in the inlet pipe during the 400 SLR test (6% of retained mass). The inlet pipe sediment was not included as part of the retained mass in the removal efficiency calculation.

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and are attributed to errors relating to the blending and disaggregation of retained sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001).

The results for “all particle sizes by mass balance” (see Table 1) are based on measurements of the total injected and retained sediment mass, and are therefore not subject to blending, sampling, or PSD analysis errors.

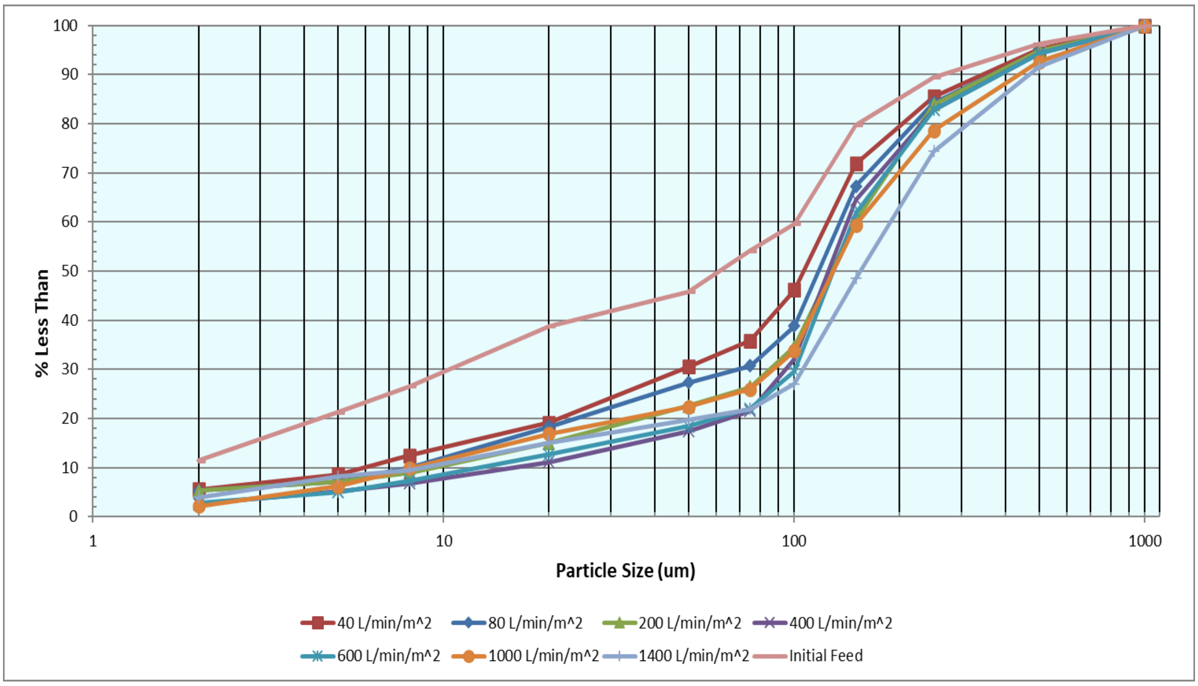
Table 1 - Removal efficiencies (%) of the StormSettler® at specified surface loading rates.

Particle size fraction (µm)	Surface loading rate (L/min/m²)						
	40	80	200	400	600	1000	1400
>500	100*	100*	98	100*	100	98	100*
250 - 500	100*	100*	100*	97	99	98	100*
150 - 250	74	100*	100*	76	97	90	100*
100 - 150	100*	100*	88	100*	100*	68	42
75 - 100	100*	74	77	100*	75	59	27
50 - 75	100*	65	71	95	65	56	23
20 - 50	100*	68	77	51	42	39	21
8 - 20	50	66	34	24	27	33	24
5 – 8	55	51	20	24	26	36	8
<5	23	17	15	17	18	23	21
All particle sizes by mass balance	**80.5**	**74.6**	**71.2**	**62.9**	**63.6**	**55.1**	**41.8**

* Removal efficiencies were calculated to be above 100%. See text and Bulletin # CETV 2016-11-0001 for more information on the source of errors.

Figure 3 compares the particle size distribution (PSD) of the three-sample average of the test sediment to the PSD of the sediment retained in the StormSettler® device at each of the tested surface loading rates. As expected, the capture efficiency for fine particles was generally found to decrease as surface loading rates increased.

Figure 3 - Particle size distribution of sediment retained in the StormSettler® in relation to the injected test sediment average.



Sediment Scour Testing

Table 2 shows the results of the sediment scour and re-suspension test for the StormSettler® unit. The scour test involved preloading 10.2 cm (4 inches) of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth (18 cm above sump bottom). Clean water was run 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 methods specified in the OGS *Procedure*. The effluent samples were subsequently adjusted based on the background concentration of the influent water. The smallest 5% of particles captured during the 40 L/min/m^2 sediment capture test (13.5 μm in this case) was not used to further adjust the effluent sediment concentrations, as per the method described in Bulletin # CETV 2016-09-0001, because the combined effluent samples had concentrations below the method limit of quantification (LOQ). Results showed average adjusted effluent sediment concentrations below 4.4 mg/L at all surface loading rates. Effluent concentrations would be expected to decrease at higher flow rates since bypass over the insert bypass weirs was observed to begin at 1419 L/min/m^2.

Table 2 - Scour test adjusted effluent sediment concentration at each surface loading rate.

Run	Target Surface loading rate (L/min/m^2)	Run time (min)	Initial averaged effluent suspended solids concentration (mg/L)	Average adjusted effluent suspended sediment concentration (mg/L)
1	200	1:00 – 6:00	<LOQ	<LOQ
2	800	7:00 – 12:00	<LOQ	<LOQ
3	1400	13:00 – 18:00	5.4	4.4
4	2000	19:00 – 24:00	3.4	2.4
5	2600	25:00 – 30:00	<LOQ	<LOQ

a. The effluent suspended sediment concentration is adjusted based on the background concentration of feed water. The d_5 correction, as described in Bulletin # CETV 2016-09-0001, was not applied.
b. LOQ refers to lower limit of quantification (2.3 mg/L). The initial concentration value was set at half the LOQ (1.2 mg/L) for the purposes of calculating averages when only some of the 6 samples in a run were below the LOQ.

Hydraulic testing

Head loss was measured by comparing the water level elevation on the influent and effluent side of the test OGS with a false floor set at 50% of the maximum sediment maintenance depth. The test was conducted by manually measuring the water level as the flow rate was increased incrementally. Bypass over the vertical baffle weir was observed to occur at 1419 L/min/m^2 (1703 L/min). Head loss increased from 1.3 cm at 46.6 L/min to 14.3 cm at 1749 L/min. A maximum elevation difference at 25.3 cm occurred at a flow rate of 4838 L/min.

To simulate partial clogging of the enhanced settling pack, head loss measurements were repeated at rates up to and including 1419 L/min,/m^2 with a weighted board placed over 50% of the settler pack openings at the top. Results showed that the system hydraulics were not significantly affected by the obstruction. These results were substantiated by CFD modelling that showed that the tubes are not fully utilized during normal flow rate operation. Since the tubes are interconnected, flow is redistributed to other areas of the pack when a portion of the tubes are blocked. The clogging threshold that will cause an appreciable change in head loss leading to more frequent flow bypass is not known.

Variances from the Procedure

Minor variances from the *Procedure for Laboratory Testing of Oil-Grit Separators*, which was used as the basis of testing for this verification, were as follows:

1. The *Procedure* states that the tested device "must be a full scale commercially available device with the same configuration and components as would be typical for an actual installation." The unit tested for this verification had the same internal components as would be typical for a commercial installation, but the internal components were placed inside a structure constructed of metal, rather than a manhole made of concrete, the latter of which is typical for field installations. The dimensions of the structure were the same as would have been the case had the manhole been concrete. The use of alternate materials for the structure was not believed to significantly affect system performance.

2. As part of the capture test, evaluation of the 40 and 80 L/min/m^2 surface loading rate was split into 3 and 2 parts, respectively. The test was conducted in parts because of the long duration (i.e., over 10 hours) needed to feed the required minimum of 11.3 kg of test sediment into the unit. At the end of the first and second parts of the test, the flow rates were gradually shutdown to prevent capture of particles that would have been washed out under normal circumstances. The requirement to split the test into parts was not anticipated during the writing of the *Procedure*, but has been a common feature of testing at the 40 and 80 L/min/m^2 surface loading rates. The breaks were not deemed to have significantly impacted results.

3. Sediment removal testing for the 400, 1000, and 1400 L/min/m^2 tests were conducted as part of the NJDEP testing of the unit following the same procedures. The flow rates for these tests were 6, 25, and 19% higher than required under the CETV Procedure and therefore the removal efficiency results are regarded as a conservative estimate of true performance. The criteria governing the use of NJDEP data for CETV verification are provided in Bulletin #CETV 2022-01-0001.

Although the *Procedure* in use at the time of testing only requires that the three-sample average of the batch meet the PSD specification, there as an implicit expectation that the individual feed samples for the sediment removal test runs extracted from the larger batch would also meet the specification. As noted above, the median PSDs for these feed samples were slightly coarser than the 75 μm target. The coarser median particle size would favour higher sediment removal as coarse sediment is more easily removed. This is not considered a variance from the *Procedure* because the version of the *Procedure* used for testing only required that the three-sample average meet the 75 μm target. Conversely, the sediment used to pre-load the false floor of the device for the sediment scour test was considerably finer than required (60 μm median), which may have contributed to more conservative scour test results. While these are not 'variances' from the *Procedure*, they are noted here to aid in the interpretation of results.

Quality assurance

Performance testing and verification of the StormSettler® Oil Grit Separator were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, Toronto and Region Conservation Authority, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

Verification Summary

In summary, the StormSettler® Oil Grit Separator is designed to remove sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals. Verification of performance claims for the StormTrap StormSettler® Oil Grit Separator was conducted by Toronto and Region Conservation Authority based on independent third-party performance test results provided by Good Harbour Laboratories, and additional information provided by StormTrap. Table 3 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the StormSettler® Oil Grit Separator.

Table 3 - Summary of Verification Results Against Performance Parameters.

Performance Parameter	**Verified Performance**
Sediment Removal Rate	The sediment removal rate of the StormSettler® is dependent upon flow rate, particle density and particle size. Removal efficiencies varied between 41.8% at a surface loading rate of 1400 L/min/m^2 to 80.5% at a surface loading rate of 40 L/min/m^2. The weighted average removal efficiency achieved by the unit will vary depending on the rainfall distribution of the jurisdiction in which it is installed, and site characteristics.
Sediment Scour	When pre-loaded with sediment with a particle size distribution matching that of the feed sediment used in the sediment capture test, the StormSettler® generated effluent suspended solids concentrations of less than 4.4 mg/L at surface loading rates ranging from 200 to 2600 L/min/m^2.
Bypass flow rate	The flow rate at which bypass occurs will vary based on model size. For the 1.2 m (4 foot) diameter test unit, the flow rate at which bypass occurred over the insert bypass weirs was 1419 L/min/m^2 (1703 L/min).
Head loss	The loss of hydraulic head across the unit was determined by measuring the water elevation difference between the inlet and outlet sides of the insert. Head loss may vary based on model size. For the tested unit the head loss ranged from 1.3 cm at 93.5 L/min to 14.3 cm at 1703 L/min when bypass was observed to occur. The highest water elevation difference was 25.3 cm at a flow rate of 4838 L/min.

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

For more information on the StormSettler® Oil Grit Separator, contact:	For more information on VerifiGlobal, contact:
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