Verification Statement

BaySaver BayFilter™ Enhanced Media Cartridge (EMC)
Registration number: (V-2018-10-02)
Date of issue: (2018-October-29)

Technology type	Stormwater Filtration Device	
Application	Stormwater filtration technology to remove sediments, nutrients, heavy metals, and organic contaminants from stormwater runoff	
Company	BaySaver Technologies, LLC.	
Address	1030 Deer Hollow Dr., Mount Airy MD 21771, USA	**Phone** +1-800-229-7283
Website	https://baysaver.com	
E-mail	info@ baysaver.com	

Verified Performance Claims

The BaySaver BayFilter™ Enhanced Media Cartridge (EMC), commercial unit model 545, was tested at the Mid-Atlantic Storm Water Research Center (MASWRC), under the supervision of Boggs Environmental Consultants, Inc. The performance test results were verified by Good Harbour Laboratories Inc. (GHL), following the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. Based on the single BayFilter™ EMC cartridge (model 545) tested, the following performance claims were verified:

Total Suspended Solids (TSS) Removal Efficiency - The BayFilter™ EMC achieved 84% +/- 2% removal efficiency of suspended sediment concentration (SCC) at a 95% confidence level.

Maximum Treatment Flow Rate (MTFR) - Although the MTFR varies among the BayFilter™ EMC model sizes and the number of cartridges, the surface loading rate remains the same, 0.5 gpm/ft^2 (0.34 L/s/ m^2) of filter treatment surface area. The single BayFilter™ EMC cartridge had a MTFR of 45 gpm (2.8 L/s) and an effective filtration treatment area (EFTA) of 90 ft^2 (8.4 m^2).

Maximum Sediment Storage Depth and Volume - The single BayFilter™ EMC cartridge had a maximum sediment storage volume of 2.84 ft^3 (0.0804 m^3) at a sediment depth of 6 inches (0.15m).

Detention Time and Volume - The single BayFilter™ EMC cartridge tested had a wet volume of 14.1 ft^3 (0.399 m^3) and a detention time of 140 seconds.

Effective Sedimentation/ Filtration Treatment Areas – For the single BayFilter™ EMC cartridge tested, the effective sedimentation area (ESA) was 6.5 ft^2 (0.60 m^2). The ratio of ESA to EFTA was 6.5/90 (0.072).

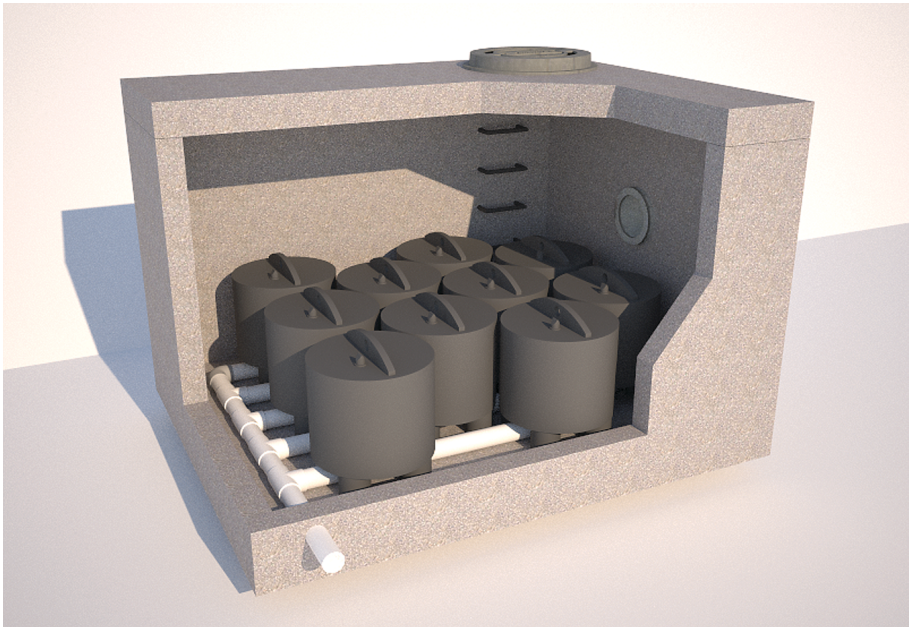
Technology Application

The BayFilter™ system is a stormwater quality treatment device that removes contaminants from stormwater runoff via media filtration. This technology has proven effective at removing sediments, nutrients, heavy metals, and a wide variety of organic contaminants. The target pollutants, hydraulic retention time, filter media, pretreatment, and flow rate all affect the removal efficiency of the BayFilter™.

Technology Description

BayFilter™ cartridges are enclosed in a housing, which may be a vault, manhole, or other structure. This structure contains the inlet and outlet pipes, as well as an internal manifold that delivers treated water to the outlet of the BayFilter™ stormwater filtration system. Stormwater runoff enters the manhole or concrete vault via an inlet pipe and begins to fill the structure. Coarse sediments typically settle on the floor of the vault. When the water surface elevation in the vault/manhole reaches operating level, water flows through the BayFilter™, driven by hydrostatic head. Within the BayFilter™, the water flows through an enhanced filter medium, and drains via a vertical pipe. The vertical drain is connected to the under-drain system, which conveys filtered water to the outfall. System design is offline with an external bypass that routes high-intensity storms away from the system to prevent sediment re-suspension. Flow through the filter cartridge is gravity-driven and self-regulating.

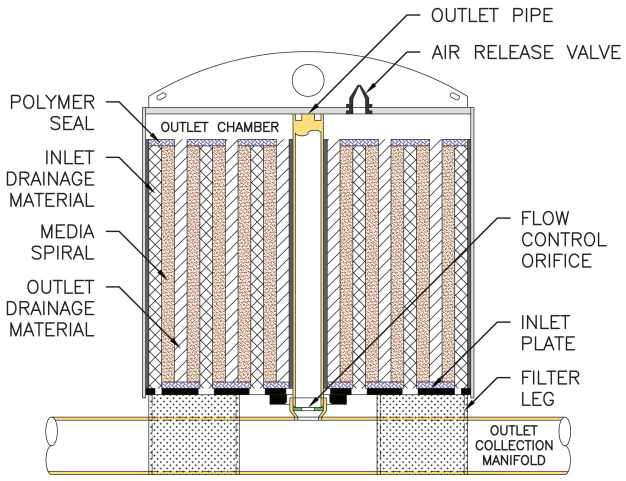
Figure 1. Illustration of a Typical BaySaver Vault



The BayFilter™ relies on a vertically configured, spiral-wound construction that optimizes the potential filter media area in a horizontal plane. Media area and media composition, with flow regulation, control the particle and nutrient removal efficiency, total load of removed material, and life cycle of the filter. BayFilter™ cartridges come in a variety of sizes and use approximately 0.5 gpm/ft^2 (0.34 L/s/m^2) of media area to determine the operating flow rate.

The most popular size of BayFilter™ has 90 square feet (8.4 m^2) of media in a 30-inch (76 cm) tall, 28-inch (71 cm) diameter cartridge. The flow through the media of this size cartridge yields approximately 45 gpm (2.8 L/s). BayFilter™ systems are typically housed within precast manholes or vaults, depending on the size of the system. These structures can be configured to allow for high flow bypass.

Figure 2 – Bayfilter Enhanced Media Cartridge Cross-section



BaySaver possesses full ownership of the BayFilter™ technology. Two United States patents are currently granted for the BayFilter™ technology: #6,869,528 (Filtering system for runoff water) and #7,708,149 (System for feeding a liquid fluid through a filter).

Test Procedure

In October, 2015, one BayFilter™ Enhanced Media Cartridge (commercial unit model 545) was installed at the Mid-Atlantic Storm Water Research Center (MASWRC, a subsidiary of BaySaver), in Mount Airy, Maryland, to evaluate the performance of BayFilter™ on Total Suspended Solid (TSS) removal. All testing and data collection procedures were supervised by Boggs Environmental Consultants, Inc., and were in accordance with the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 2013)*.

Prior to the start of testing, a Quality Assurance Project Plan (QAPP), revision dated September 2, 2015, was submitted and approved by the New Jersey Corporation for Advanced Technology (NJCAT), c/o Center for Environmental Systems, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ 07030.

The test unit was a single BayFilter™ EMC cartridge (BayFilter™ model 545) with a MTFR of 45 gpm (2.8 L/s) and an effective filtration treatment area (EFTA) of 90 ft^2 (8.4 m^2). The flow through each cartridge is regulated by a flow disk, which is situated inside the vertical riser of the manifold connection.

Verification Results

Good Harbour Laboratories (GHL) verified the performance test data and other information pertaining to the BayFilter™ Enhanced Media Cartridge. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

The verifier conducted a site visit and assessment of the MASWRC test facility in April 2018, as well as interviews with the test facility director and the primary third party observer, Boggs Environmental Consultants, Inc. During the site assessment, copies of all the relevant supporting documents were obtained and clarifying questions were answered to confirm that the test data met the independence and quality requirements of ISO14034. Quality Assurance procedures were followed during data collection. Replicates were unnecessary due to the large number of identical runs, effectively serving as replicates.

Particle size distribution (PSD) analysis was performed by GeoSystems Analysis Inc., Tucson, AZ, using ASTM D422-63/162. This is a sieve and hydrometer method where the larger particles, > 75 microns, are measured using a standard sieve stack while the smaller particles are measured base on their settling time in a hydrometer.

The PSD meets the requirements of NJDEP, which is generally accepted as representative of the type of particle sizes a stormwater filtration device would be designed to treat. Actual PSD is site specific, and even rainfall event specific, so it was necessary to choose a standard PSD to make testing and comparison manageable. Table 1 shows the NJDEP PSD specification. Table 2 and Figure 3 show the incoming material PSD as determined by GeoSystems Analysis Inc. and confirmed by the verifier.

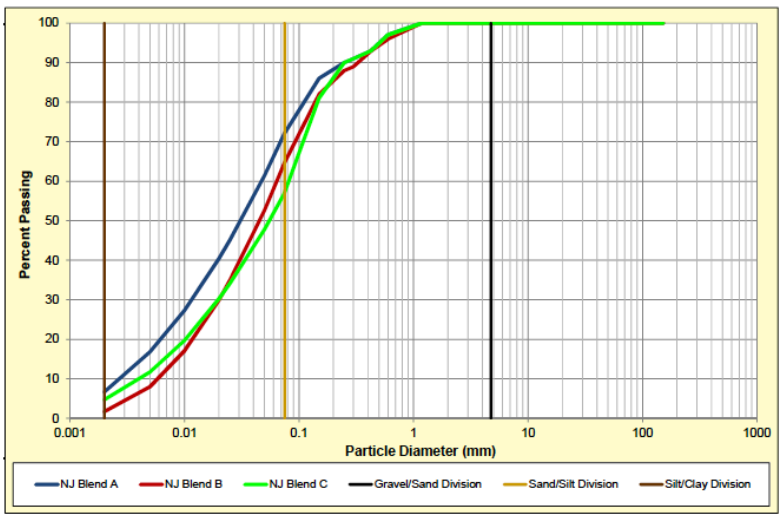
Table 1 – NJDEP PSD Specification

Particle Size (µm)	NJDEP Minimum Specification
1000	98
500	93
250	88
150	73
100	58
75	48
50	43
20	33
8	18
5	8
2	3
d_{50}	< 75 µm

Table 2 – Particle Size Distribution (PSD) of Incoming Material (GeoSystems Analysis Inc.)

Pre-Test PSD				
Mesh (mm)	Sieve	Sample ID		
		NJ Blend A	NJ Blend B	NJ Blend C
		Percent Passing		
152	6"	100	100	100
100	4"	100	100	100
75	3"	100	100	100
50.8	2"	100	100	100
38.1	1.5"	100	100	100
25.4	1"	100	100	100
19.05	3/4"	100	100	100
12.7	1/2"	100	100	100
9.525	3/8"	100	100	100
6.4	0.25"	100	100	100
4.75	#4	100	100	100
2	#10	100	100	100
1.18	#16	100	100	100
0.6	#30	97	96	97
0.425	#40	93	93	93
0.3	#50	91	89	91
0.25	#60	90	88	90
0.15	#100	86	82	81
0.075	#200	72.1	64.7	57
0.05	Hydrometer	61.4	52.6	47.8
0.025		45.1	34.9	34.1
0.02		40.4	29.9	30.2
0.01		27.3	17.1	19.7
0.005		16.8	8	11.7
0.002		6.7	1.7	4.7

Figure 3 – Particle Size Distribution (PSD) Chart (GeoSystems Analysis Inc.)



The sample concentration analysis was done by Fredericktowne Labs Inc. of Meyersville, Maryland. Fredericktowne Labs Inc. is a professional laboratory with a quality system subject to external audits that is accredited by the Maryland Department of Environment as a Maryland Certified Water Quality Laboratory. The sample procedure was ASTM D3977-97, Suspended Sediment Concentration. The samples sent to the lab were blind and randomly chosen by the independent observer, Boggs Environmental Consultants, Inc.

Quality Assurance

Performance testing and verification of the BaySaver BayFilter™ Enhanced Media Cartridge (EMC) were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

Specific QA/QC measures reviewed by the verifier are summarized in Table 3 below.

Table 3. Validation of QA/QC Procedures

QC Parameter	Acceptance Criteria
Independence of observer	Confirmed by audit and in letter from Boggs Environmental Consultants, Inc. to NJCAT
Consistency of procedure	Daily logs confirm proper procedure
Existence of T/QAPP	Confirmed: *QAPP For BayFilter EMC New Jersey Department of Environmental Protection Testing* *(August 11, 2015)*
Use of appropriate sample analysis method – ASTM D3799	Confirmed by letter from Fredericktowne Labs Inc.
Test method appropriate for the technology	Used industry stakeholder approved protocol: *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 2013)*
Test parameters stayed within required limits	Confirmed in report: *NJCAT Technology Verification BayFilter™ Enhanced Media Cartridge BaySaver Technologies, LLC. (December 2017)*
Third party verified data	10 runs were compared to Fredericketowne Lab, influent and effluent, 2 samples each, and the average relative percent difference was -4.2% (the Lab data was lower).

Variance

There were no deviations to the verification plan; however, following review of the test data, the performance claim was modified in order to account for the fact that not all of the analysis was third party validated. Only 11 of the 76 runs were analyzed by a third party lab and one of these did not meet the flow coefficient of variation (COV) requirements so only 10 data points were used to support the claim. It should be noted that the data was very consistent and the removal performance claim based on the 10 data points was within a percentage point of the claim based on all 76 points.

Verification Summary

The BayFilter™ Enhanced Media Cartridge (EMC) is a stormwater treatment technology that removes contaminants from stormwater runoff via media filtration. Verification of performance claims for the BayFilter™ EMC was conducted by Good Harbour Laboratories, Inc. based on third-party performance test results obtained at the Mid-Atlantic Storm Water Research Center (MASWRC) under the supervision of Boggs Environmental Consultants, Inc., as well as additional information provided by BaySaver. Table 4 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the BayFilter™ EMC.

Table 4 - Summary of Verification Results Against Performance Parameters

Parameters	Verified Claims	Accuracy
Total Suspended Solids (TSS) Removal Efficiency	Based on the laboratory testing conducted, the BayFilter™ EMC achieved 84% removal efficiency of SCC	± 2% (95% confidence level)
Maximum Treatment Flow Rate (MTFR)	Although the MTFR varies among the BayFilter™ EMC model sizes and the number of cartridges, the surface loading rate remains the same 0.5 gpm/ft^2 (0.34 L/s/ m^2) of filter treatment surface area. The test unit was a single BayFilter™ EMC cartridge (BayFilter™ model 545) with a MTFR of 45 gpm (2.8 L/s) and an effective filtration treatment area (EFTA) of 90 ft^2 (8.4 m^2). The flow through each cartridge is regulated by a flow disk, which is situated inside the vertical riser of the manifold connection.	± 1%
Maximum Sediment Storage Depth and Volume	The sediment storage volume and depth vary according to the BayFilter™ EMC model sizes and the system size. For the BF545 single cartridge tested system, the maximum sediment storage volume is 2.84 ft^3 (0.0804 m^3) at a sediment depth of 6 inches (0.15m).	± 4% on depth and ± 7% on volume
Detention Time and Volume	The BayFilter™ EMC detention time and wet volume varies with model size. The unit tested had a wet volume of 14.1 ft^3 (0.399 m^3) and a calculated detention time of 140 seconds.	± 7% on volume and ± 8% for detention time
Effective Sedimentation/ Filtration Treatment Areas	The Effective Sedimentation Area (ESA) increases as the number of cartridges increases, with a large-scale system having a higher ESA. The Effective Filtration Treatment Area (EFTA) also increases as the number of cartridges. Under test conditions with a single cartridge, the ESA and the ratio of ESA/EFTA were 6.5 ft^2 (0.60 m^2) and 6.5/90 (0.072), respectively. This is conservative compared to commercial applications where vault area to cartridge area is always smaller.	EFTA & ESA are calculated from drawings

In conclusion, the BayFilter™ Enhanced Media Cartridge is a viable technology that can be used to remove contaminants from stormwater runoff via media filtration. This technology has proven effective at removing sediments and, by extension, particle bound nutrients, heavy metals, and a wide variety of organic contaminants. Performance is a function of pollutant properties, hydraulic retention time, filter media, pretreatment, and flow rate, such that proper design of the system is critical to achieving the desired results.

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 BaySaver BayFilter™ Enhanced Media Cartridge (EMC), contact:	For more information on VerifiGlobal, contact:
BaySaver Technologies, LLC. 1030 Deer Hollow Dr., Mount Airy MD 21771, USA t: +1-800-229-7283 e: info@baysaver.com w: https://baysaver.com	VerifiGlobal c/o ETA-Danmark A/S Göteborg Plads 1, DK-2150 Nordhaven t +45 7224 5900 e: info@verifiglobal.com w: www.verifiglobal.com
Signed for BaySaver Technologies: *Original signed by:* *Daniel J. Figola* Daniel J. Figola, PE General Manager BaySaver Technologies, LLC	Signed for VerifiGlobal: *Original signed by:* *Thomas Bruun* Thomas Bruun, Managing Director *Original signed by:* *John Neate* John Neate, Managing Director