THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**STORMWATER TREATMENT TECHNOLOGY**	
APPLICATION:	**SUSPENDED SOLIDS AND ROADWAY POLLUTANT TREATMENT**	
TECHNOLOGY NAME:	**THE STORMWATER MANAGEMENT CATCHBASIN STORMFILTER™**	
TEST LOCATION:	**ST. CLAIR SHORES, MICHIGAN**	
COMPANY:	**STORMWATER MANAGEMENT, INC.**	
ADDRESS:	**12021-B NE Airport Way** **Portland, Oregon 97220**	PHONE: **(800) 548-4667** FAX: **(503) 240-9553**
WEB SITE:	**http://www.stormwaterinc.com**	
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NSF International (NSF), in cooperation with the U.S. Environmental Protection Agency (EPA), operates the Water Quality Protection Center (WQPC), one of six centers under the Environmental Technology Verification (ETV) Program. The WQPC recently evaluated the performance of the CatchBasin StormFilter™ (CBSF) manufactured by Stormwater Management, Inc. (SMI), of Portland, Oregon. The CBSF was installed at the St. Clair Shores Department of Public Works (DPW) yard in St. Clair Shores, Michigan. Environmental Consulting & Technology, Inc. (ECT) of Detroit, Michigan performed the testing.

The ETV program was created to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

TECHNOLOGY DESCRIPTION

The following description of the CBSF was provided by the vendor and does not represent verified information.

The four-cartridge CBSF consists of a storm grate and filter chamber inlet bay, flow spreader, cartridge bay, overflow baffle, and outlet bay, housed in a 10.25 ft by 2 ft steel vault. The inlet bay serves as a grit chamber and provides for flow transition into the cartridge bay. The flow spreader traps floatables, oil, and surface scum. This StormFilter was designed to treat stormwater with a maximum flow rate of 60 gpm. Flows greater than the maximum flow rate would pass the overflow baffle to the discharge pipe, bypassing the filter media.

The CBSF contains filter cartridges filled with SMI's CSF filter media (an organic granular media made from composted deciduous leaves), which is designed to remove sediments, metals, and other stormwater pollutants from wet weather runoff. Water in the cartridge bay infiltrates the filter media into a tube in the center of the filter cartridge. When the center tube fills, a float valve opens and a check valve on top of the filter cartridge closes, creating a siphon that draws water through the filter media. The filtered water drains into a manifold under the filter cartridges and to the outlet bay, where it exits the system through the discharge pipe. The system resets when the cartridge bay is drained and the siphon is broken. The CBSF is equipped with an overflow weir designed to bypass flows exceeding the peak hydraulic treatment capacity and prevent catch basin backup and surface flooding. The bypass flow is discharged through the outlet pipe along with the treated water.

The vendor claims that a single StormFilter cartridge configured to treat flows at 15 gpm using a coarse perlite media was shown to have a TSS removal efficiency of 79% (with 95% confidence limits of 78% and 80%) for a sandy loam material comprised of 55% sand, 45% silt, 5% clay (USDA) by mass, in laboratory studies using simulated stormwater, and can also remove metals and oil and grease from wet-weather flows. The vendor did not provide specific claims for the removal efficiency of the CSF media, used in this verification. Further detail about the specific vendor claims appears in the verification report.

VERIFICATION TESTING DESCRIPTION

Methods and Procedures

The test methods and procedures used during the study are described in the *Test Plan for Stormwater Management, Inc. Storm Filter*, November 5, 2002. The CBSF received runoff collected from an impervious 0.16-acre portion of the DPW yard, where uncovered stockpiles of sand, gravel, construction debris and excavated aggregate consisting of sand, silt, topsoil and clay, are maintained. Southeast Michigan receives an annual average of nearly 37 in. of precipitation, and experiences warm to hot summers and cold, snowy winters.

Verification testing consisted of collecting data during a minimum of 15 qualified events that met the following criteria:

- The total rainfall depth for the event, measured at the site, was 0.2 in. (5 mm) or greater (snow fall and snow melt events did not qualify);
- Flow through the treatment device was successfully measured and recorded over the duration of the runoff period;
- A flow-proportional composite sample was successfully collected for both the influent and effluent over the duration of the runoff event;
- Each composite sample was comprised of a minimum of five aliquots, including at least two aliquots on the rising limb of the runoff hydrograph, at least one aliquot near the peak, and at least two aliquots on the falling limb of the runoff hydrograph; and
- There was a minimum of six hours between qualified sampling events.

Automated monitoring and sample collection devices were installed to collect composite samples from the influent and effluent during qualified flow events. Additional influent and effluent sample ports were also installed so that discrete samples could be collected by manually actuating peristaltic pumps to collect samples for hydrocarbon analysis. In addition to the flow and analytical data, operation and maintenance (O&M) data were recorded. Samples were analyzed for the following parameters:

Sediments
- total suspended solids (TSS)
- suspended sediment concentration (SSC)

Metals
- total and dissolved cadmium, lead, copper and zinc

Hydrocarbons
- total petroleum hydrocarbons (TPH), gasoline-range organics (GRO) and diesel-range organics (DRO)
- polynuclear aromatic hydrocarbons (PAH)

VERIFICATION OF PERFORMANCE

Verification testing of the CBSF lasted approximately 13 months, with four months off during the winter of 2004. Sixteen storm events were successfully sampled. However, due to problems with the automated sampling equipment in 2003, ECT collected flow-weighted aliquots for all analyses by manually actuating the peristaltic pump for events 1 through 6 and event 8. During remobilization in the spring of 2004, ECT and SMI debugged the automated sampling equipment, and for all subsequent events, samples for sediment and metals analyses were collected with the automated sampling equipment.

Test Results

The ETV protocol and test plan do not specify maximum sediment concentration in stormwater, nor did SMI's literature specify a maximum sustained concentration for their stormwater treatment devices to function effectively. However, the vendor, TO, and VO recognized that the sediment loadings in this drainage basin were atypical, and exceeded a concentration and mass loading range in which a valid measure of the removal performance of the CBSF could be conducted. According to the vendor, the four-cartridge CBSF has a maximum sediment storage capacity of 27 ft^3 or 200 gal in the sump, plus a maximum of 100 lb in the cartridges (25 lb per cartridge). The influent calculated sum of loads (SOL) mass for TSS and SSC was approximately 2,000 lb for all events. Based on SOL calculations, the sediment loadings for qualified events likely exceeded the CBSF sediment capacity after only a few events.

The precipitation data for the rain events are summarized in Table 1. The peak runoff intensity exceeded the CBSF peak hydraulic treatment capacity of 60 gpm during 10 of the 16 events, which means that a portion of the flow bypassed the filtering process during these events. During high flow conditions, the effluent includes both filtered and unfiltered water, so these values do not represent the performance of the system under designed flow conditions. Recorded flow volumes were substantially higher than predicted using the rational method, especially during events with higher peak discharge rates.

The monitoring results were evaluated using event mean concentration (EMC) and SOL comparisons. The EMC or efficiency ratio comparison evaluates treatment efficiency on a percentage basis by dividing the effluent concentration by the influent concentration and multiplying the quotient by 100. The efficiency ratio was calculated for each analytical parameter and each individual storm event. The SOL comparison evaluates the treatment efficiency on a percentage basis by comparing the sum of the influent and effluent loads (the product of multiplying the parameter concentration by the precipitation volume) for all storm events. The calculation is made by subtracting the quotient of the total effluent load divided by the total influent load from one, and multiplying by 100. SOL results can be summarized on an overall basis since the loading calculation takes into account both the concentration and volume of runoff from each event. The analytical data ranges, EMC range, and SOL reduction values are shown in Table 2.

Table 1. Rainfall Data Summary

Event Number	Start Date	Start Time	Rainfall Amount (in.)	Rainfall Duration (hr:min)	Runoff Volume (gal)	Peak Discharge Rate (gpm)
1	9/22/03	7:40	0.31	1:45	2,990	196
2	9/26/03	23:50	0.26	2:00	1,510	44
3	10/14/03	11:14	0.68	6:30	2,950	41
4	11/18/03	7:50	0.44	17:45	4,940	13
5	11/24/03	4:09	0.33	10:45	17,900	99
6	12/10/03	14:05	0.75	7:45	19,800	85
7	12/23/03	3:34	0.42	10:30	11,200	85
8	12/29/03	8:25	0.31	7:45	2,270	9
9	1/1/04	21:51	0.20	2:30	868	10
10	5/10/04	22:26	0.29	3:30	4,450	273
11	5/23/04	18:45	1.39	3:45	22,500	335
12	6/10/04	13:09	0.28	2:30	5,030	171
13	7/7/04	15:12	0.30	1:45	3,700	274
14	7/14/04	16:25	0.18	0:45	3,330	175
15	8/28/04	7:21	0.52	2:45	10,100	223
16	10/23/04	19:25	0.21	4:30	3,970	39

Table 2. Analytical Data, EMC Range, and SOL Reduction Results

Parameter	Units	Influent Range	Effluent Range	EMC Range (%)	SOL Reduction (%)
TSS	mg/L	1,100 – 5,200	570 – 8,600	-120 – 63	11
SSC	mg/L	930 – 9,100	700 – 12,000	-44 – 53	9.2
Total cadmium	µg/L	0.6 – 44	<0.2 – 7.6	-41 – 87	52
Total copper	µg/L	6.0 – 390	6.6 – 250	-64 – 42	20
Total lead	µg/L	15 – 580	3.2 – 200	-47 – 79	20
Total zinc	µg/L	72 – 1,800	24 – 1,100	-82 – 70	29
Dissolved cadmium[1]	µg/L	<0.2 – 2.0	<0.2 – 1.8	-9 – 10	-20
Dissolved copper[1]	µg/L	<1.0 – 35	<1.0 – 120	-3,400 – 31	-34
Dissolved lead[1]	µg/L	<1.0 – 49	<1.0 – 80	-560 – 33	-0.44
Dissolved zinc[1]	µg/L	<2.0 – 200	<2.0 – 170	-3,400 – 69	-3.9
TPH-GRO	µg/L	<100 – <100	<100 – <100	NC	NC
TPH-DRO	mg/L	<0.001 – 52	<0.001 – 19	-41 – 93	62
PAH[2]	µg/L	<1.0 – 7.5	<1.0 – 3.6	52 – 81	64

1. Negative EMC values for dissolved metals were skewed by non-detected concentrations in the influent sample and detected concentrations in the paired effluent sample.2. Ten of 17 PAH compounds were detected only during events 4, 12, and 14. PAH SOL reduction calculated from sum of all detected PAH compounds during these three events.

NC: Not calculated.

In spite of the excessive sediment loadings, the sediment SOL data were further evaluated to assess the performance impacts of maintenance activities and events where bypass did not occur. This data indicated a 34% TSS SOL reduction for the first three events following maintenance, as compared to a 3.1% reduction for all other events. Furthermore, the data indicated a 40% SSC SOL reduction for events where bypass did not occur, compared to a 1.5% reduction for events where bypass occurred.

System Operation

The StormFilter was installed by DPW personnel, under the supervision of ECT. The installation took approximately two days. No major problems with the CBSF were noted during installation; however, pipe scaling and blockage downstream of the CBSF was detected after the CBSF was installed. Addressing this issue delayed the start of verification testing.

The CBSF was cleaned and equipped with new filter cartridges prior to the start of verification and in the spring of 2004, before verification resumed after winter demobilization, and at the end of verification. The CBSF vaults are easily accessible from the ground surface, which makes cartridge replacement and sediment removal easy. According to the vendor, spent filter cartridges weigh approximately 250 lb each, and, if mishandled, can cause damage to the PVC under-drain manifold in the vault.

The CBSF's PVC under-drain manifold was not fully assembled when it was delivered to the DPW, and became disassembled during the shakedown period. The TO dry fit the manifold components when verification testing began. The first two events were sampled with the manifold either partially disassembled or dry fit but not sealed. When SMI was informed of this condition, they responded by sending a repair technician to the DPW to properly assemble and seal the manifold.

Vendor Comments

The vendor included a chapter in the verification report asserting that the data were collected from filters that were severely impacted by exceedingly high solids loads, sampled in a completely occluded condition, and that the sediment loadings and concentrations experienced at the site were substantially higher than the range they would recommend for usage of the CBSF without site controls or pretreatment.

Quality Assurance/Quality Control

NSF personnel completed a technical systems audit during testing to ensure that the testing was in compliance with the test plan. NSF also completed a data quality audit of at least 10% of the test data to ensure that the reported data represented the data generated during testing. In addition to QA/QC audits performed by NSF, EPA personnel conducted an audit of NSF's QA Management Program.

Original signed by:
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Availability of Supporting Documents

Copies of the *ETV Verification Protocol, Stormwater Source Area Treatment Technologies Draft 4.1, March 2002,* the verification statement, and the verification report (NSF Report Number 05/22/WQPC-WWF) are available from:

ETV Water Quality Protection Center Program Manager (hard copy)
NSF International
P.O. Box 130140
Ann Arbor, Michigan 48113-0140

NSF website: http://www.nsf.org/etv (electronic copy)
EPA website: http://www.epa.gov/etv (electronic copy)
Appendices are not included in the verification report, but are available from NSF upon request.