



AQUATECH REPORT 11.7.1
FIELD TESTING of an AQUA-SWIRL® AS-5 STORMWATER TREATMENT SYSTEM
October 2011

PURPOSE

The purpose of this report is to provide a summary of results for an independent field test of an offline Aqua-Swirl® Model AS-5 hydrodynamic separator. Analytical results from 18 storms and 15.16 inches of rain over two years were obtained following the Technology Acceptance Reciprocity Partnership (TARP) Tier II Field Testing Protocol. Field testing was performed with the intent to gain technology verification by the New Jersey Corporation for Advanced Technology (NJCAT) and subsequent Field Test Certification by the New Jersey Department of Environmental Protection (NJDEP). Results demonstrate that the Aqua-Swirl® can provide a high level of performance by achieving over 80% removal of suspended sediment contained in stormwater runoff.

SITE DESCRIPTION and METHODS

The test site drainage area is an asphalt covered parking lot with landscaped areas on an urban retail shopping center located in Silver Spring, Maryland. The AS-5 was independently sampled by AECOM of Philadelphia, Pennsylvania. Samples were collected using ISCO 6712 autosamplers positioned at the influent and effluent pipe connections. A minimum of six pairs (influent and effluent) of water samples were first passed through a 1,000 micron (μm) sieve followed by a cone splitter prior to analysis. All analyses of samples were performed by a NELAC and New Jersey certified laboratory, Test America, Inc. of Burlington, Vermont. Suspended sediment analyses were performed by both the Total Suspended Solids (TSS) Method SM2540D (formerly EPA Method 160.2) and Suspended Sediment Concentration (SSC) Method ASTM D3977. Total Volatile Suspended Solids (TVSS) analysis was performed by EPA Method 160.4 in order to determine the percentage of organic material as suspended sediment. Particle size distribution (PSD) was determined by serial filtration techniques using sieves sized at 1,000, 500, 250, 125, 63 microns (μm) and filter paper at 1.5 μm .

SEDIMENT REMOVAL EFFICIENCY

Table 1 summarizes the Aqua-Swirl® sediment removal efficiency. Cumulative average sediment removal efficiencies for the 18 storms are 86% for the TSS method and 87% for the SSC method. Individual removal efficiencies range from 60 to 99% for TSS, and 57 to 99% for SSC. Average influent TSS and SSC concentrations are 132 and 145 mg/L, respectively. Average effluent TSS and SSC concentrations are 12 and 13 mg/L, respectively. Data indicates that the sediment concentrations determined by the TSS and SSC methods compare closely. The average TVSS removal rate is 68%, with an average influent concentration of 39 mg/L. The percentage TVSS of the TSS concentration averages 33%.

Table 1. Summary of Aqua-Swirl® AS-5 Sediment Removal Efficiency

Storm #	Date	Avg. Influent TSS (mg/L)	Avg. Effluent TSS (mg/L)	Avg. TSS RE (%)	Avg. Influent SSC (mg/L)	Avg. Effluent SSC (mg/L)	Avg. SSC RE (%)
1	3/14/2009	221	3.7	98.3	169.5	1.0	99.3
2	4/1/2009	85.0	9.6	86.8	57.8	10.0	80.0
3	4/6/2009	93.8	14.3	82.5	59.8	7.7	85.5
4	12/25/2009	223.7	2.2	99.0	297.3	1.4	99.5
5	1/17/2010	174.0	8.1	94.8	169.7	5.9	96.3
6	7/25/2010	55.7	2.2	94.1	73.4	1.7	96.5
7	8/12/2010	27.9	8.6	63.9	27.0	7.0	68.0
8	9/12/2010	266.3	6.1	96.5	352.7	6.7	96.6
9	9/29/2010	338.9	78.8	59.9	420.0	104.6	57.4
10	12/1/2010	72.2	6.2	89.1	98.2	7.4	86.9
11	12/11/2010	85.7	3.1	96.1	85.9	1.6	97.7
12	2/25/2011	183.3	18.5	73.0	241.3	25.8	72.8
13	3/6/2011	95.4	12.9	86.1	275.8	17.0	92.5
14	3/15/2011	40.3	5.3	88.1	79.7	6.8	91.7
15	4/8/2011	91.9	3.5	94.1	113.1	3.6	95.8
16	4/28/11	132.9	12.3	80.4	168.7	13.1	82.0
17	5/14/11	155.5	11.6	90.6	154.6	12.9	90.3
18	6/16/11	27.8	6.0	74.3	34.3	5.1	82.7
Average		131.7	11.8	86.0	144.5	13.3	87.3

PARTICLE SIZE DISTRIBUTION

Average influent PSD data indicates that 86% of the particulate is <125 microns in size and 72% of the particulate is <63 µm in size. That is, approximately 70% of the influent particulate is fine-grained material within the silt size particle range. TARP protocol specifies that average particles be <100 µm in size based on three storms that include PSD analysis. Table 2 summarizes the influent particle size gradation.

Table 2. Influent PSD Summary
(values listed as percent finer than each sieve/filter)

Storm	1,000 µm	500 µm	250 µm	125 µm	63 µm	1.5 µm
9/12/2010	100.00	97.41	92.48	84.44	62.96	0.00
12/1/2010	100.00	93.16	90.99	87.19	73.71	0.00
12/11/2010	100.00	92.04	91.59	85.08	78.56	0.00
Average	100.00	94.20	91.68	85.57	71.74	0.00

Figure 1 compares the site influent PSD to the NJDEP laboratory test standard PSD for hydrodynamic separators. It is indicated that the test site particulate is finer grained than the NJDEP standard PSD.

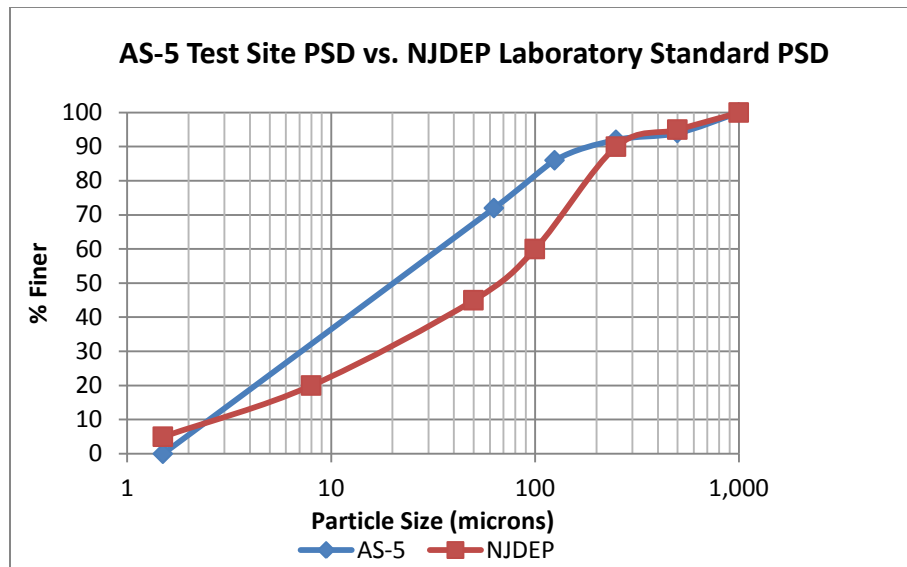


Figure 1. PSD Comparison of Field and Laboratory Testing.

STORM CHARACTERISTICS

Table 3 summarizes the storm characteristics (duration, size, intensity) as well as the associated sediment removal efficiencies and organics percentage of TSS concentrations. Storm sizes range from 0.11 to 4.4 inches. TARP guidelines specify that a minimum qualifying event is 0.1 inches. Peak storm intensities range from 0.15 to 5.49 inches per hour (in/hr).

FIELD PERFORMANCE

Figure 2 includes performance curves based on both the TSS and SSC analytical methods. The curves are derived for any given storm by plotting average removal efficiency (%) against peak surface area loading rate (gpm/ft²). It is indicated that the TSS and SSC performance curves are similar with the SSC curve showing only slightly higher performance.

CONCLUSIONS

Analytical results and performance analysis from 18 TARP-qualifying storms indicate that the Aqua-Swirl® Model AS-5 is performing according to design expectations. Favorable sediment removal rates are being consistently achieved under rainfall conditions typical for the area. Average sediment removal efficiency exceeds 80% against a particulate gradation that is finer grained than the NJDEP laboratory test standard gradation.

For additional information, contact your local Sales Agent, or Mark B. Miller, P.G., Research Scientist, AquaShield,™ Inc., 1-888-344-9044, mmiller@aquashieldinc.com.

Table 3. Storm Characteristics

#	Sample Date	TSS RE (%)	SSC RE (%)	Storm Duration (hr:min)	Storm Size (in)	Peak Storm Intensity (in/hr)	% TVSS of TSS
1	3/14/2009	98.3	99.3	0:30	0.11	0.26	NA
2	4/1/2009	86.8	82.7	0:50	0.18	0.46	NA
3	4/6/2009	82.5	85.5	2:00	0.15	0.26	NA
4	12/25-26/2009	99.0	99.5	11:45	0.56	0.38	NA
5	1/17/2010	94.8	96.3	4:48	0.59	0.42	NA
6	7/25/2010	94.1	96.5	0:46	0.55	1.21	38.8
7	8/12/2010	63.9	68.0	3:00	1.82	5.49	22.3
8	9/12/2010	96.5	96.6	3:45	0.61	0.49	31.0
9	9/29-30/2010	59.9	57.4	12:05	4.40	2.56	20.9
10	12/1/2010	89.1	86.9	6:20	0.71	1.82	16.7
11	12/11/2010	96.1	97.7	3:40	0.72	0.58	29.2
12	2/25/2011	73.0	72.8	2:15	0.29	0.25	29.0
13	3/6/2011	86.1	92.5	4:50	1.42	0.46	25.4
14	3/15-16/2011	88.1	91.7	5:06	0.42	0.35	24.4
15	4/8/2011	94.1	95.8	3:55	0.52	0.15	25.2
16	4/28/2011	80.4	82.0	2:19	0.23	0.23	71.4
17	5/14/2011	90.6	90.3	3:05	0.85	0.47	48.9
18	6/16/2011	74.3	82.7	3:20	1.03	0.91	48.9
	Average	86.0	87.3		0.84	0.93	33.2
				Total	15.16		

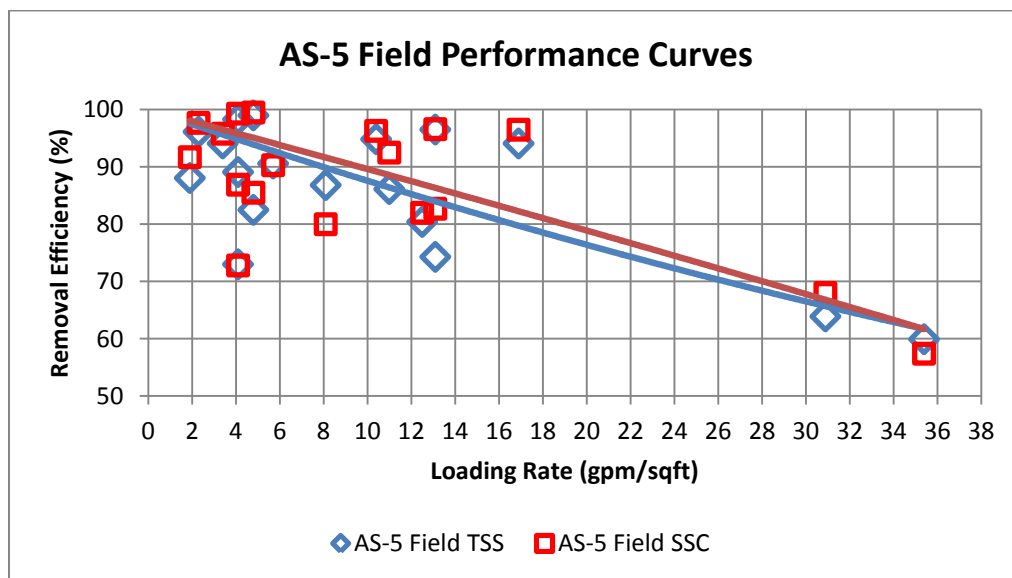


Figure 2. AS-5 Field Performance Curves based on TSS and SSC analyses.