

NJCAT TECHNOLOGY VERIFICATION

Isolator[®] Row PLUS

StormTech, LLC

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1. Description of Technology

The Isolator[®] Row PLUS (shown in Figures 1 and 2) is the first row of StormTech chambers that is surrounded with filter fabric and connected to a closely located manhole for easy access. The Isolator Row PLUS provides for settling and filtration of sediment as stormwater rises in the chamber and ultimately passes through the filter fabric. The open-bottom chambers allow stormwater to flow out of the chambers, while sediment is captured in the Isolator Row PLUS.

A single layer of proprietary Advanced Drainage Systems (ADS) PLUS fabric is placed between the angular base stone and the Isolator Row PLUS chamber. The geotextile provides the means for stormwater filtration and provides a durable surface for maintenance operations. A non-woven fabric is placed over the chambers. See link to O&M Manual (pg. 23) for installation pictures.

The Isolator Row PLUS is designed to capture the “first flush” runoff and offers the versatility to be sized on a volume basis or a flow basis. An upstream manhole not only provides access to the Isolator Row PLUS but includes a high/low concept such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row PLUS bypass through a manifold to the other chambers. This is achieved with either an elevated bypass manifold or a high-flow weir. This creates a differential between the Isolator Row PLUS row of chambers and the manifold to the rest of the system, thus allowing for settlement time in the Isolator Row PLUS. After Stormwater flows through the Isolator Row PLUS and into the rest of the StormTech chamber system it is either infiltrated into the soils below or passed at a controlled rate through an outlet manifold and outlet control structure. **Since this technology fits under the infiltration basin BMP in the New Jersey Stormwater BMP Manual, it is not eligible for NJDEP MTD certification.**

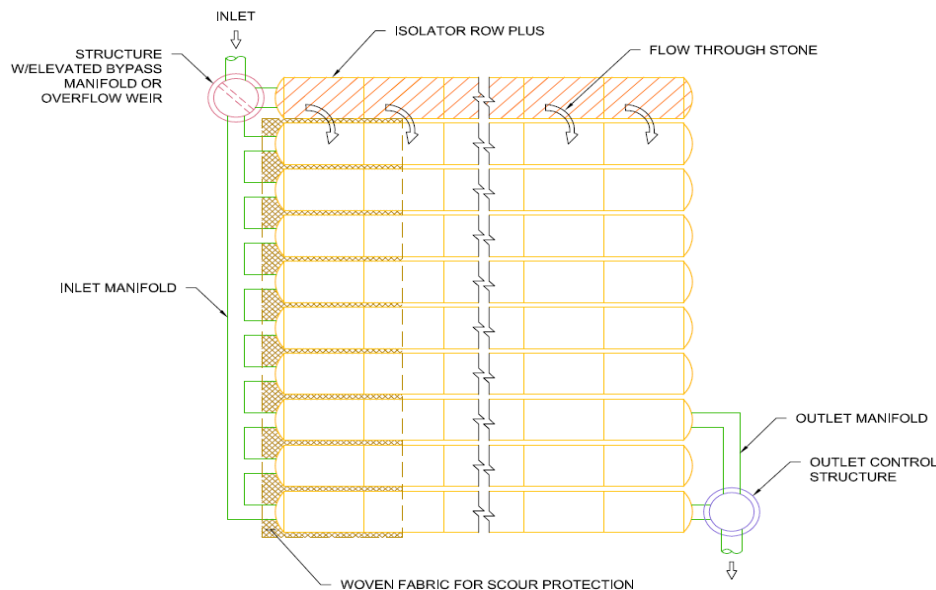


Figure 1 Schematic of the StormTech Isolator Row PLUS System

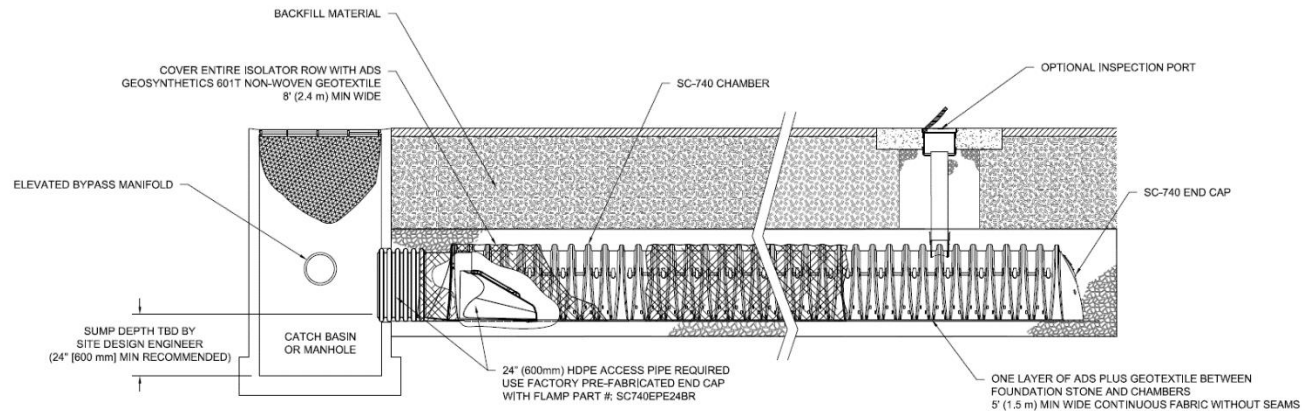


Figure 2 Isolator Row PLUS Detail

2. Laboratory Testing

Beginning in January 2020, two overlapping StormTech SC-740 Isolator Row PLUS commercial size chambers were installed at the BaySaver Laboratory in Mount Airy, Maryland, to evaluate the performance of Isolator Row PLUS on Total Suspended Solid (TSS) removal. Boggs Environmental Consultants (BEC) provided third-party review and oversight of all testing and data collection procedures, 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)*. All sediment concentration samples were analyzed by Fredericktowne Labs (FTL) using ASTM D3977-97 (2019). All sediment PSD analysis was performed by Environmental Consulting Services (ECS), using the methodology of ASTM D422-63 (2007). Prior to the start of testing, a Quality Assurance Project Plan (QAPP), revision dated January 9, 2020, was submitted to, and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

2.1 Test Setup

The testing system, shown in **Figure 3**, consisted of a source tank, feed pump, flow control valve, flow meter, background sample port, screw-auger sediment feeder (doser), and an Isolator Row PLUS test system. This verification report only addresses the performance of the Isolator Row PLUS and not the entire StormTech system, since this is the row designed to remove sediment until the system goes into bypass.

Testing Procedure

The water source was potable water from the Town of Mount Airy Water & Sewer Department, obtained from an onsite tap, which served as the raw water supply for the testing system. Municipal tap water was used to fill the source tank, and then pumped to the system. Flow rate was controlled to the target of 225 gpm by a flow control valve. An inline flow meter (FloCat MFE electromagnetic flow meter) was used to measure the flow, and a SeaMetrics DL76 data logger (pictured in **Figure 4**) recorded the flow at one-minute intervals. The test sediment was

introduced to the inlet stream via a 12 -inch dosing port teed with a 12-inch influent line (pictured in **Figure 5**) located approximately 4 feet upstream of the system inlet. The dosing rate was controlled by a screw-auger Velodyne Barracuda 1000A volumetric feeder with a ½ HP variable speed motor. The dosing rate was set to deliver an amount of sediment that, when mixed with the water from the source tank, would produce influent water with a target test sediment concentration of 200 mg/L.

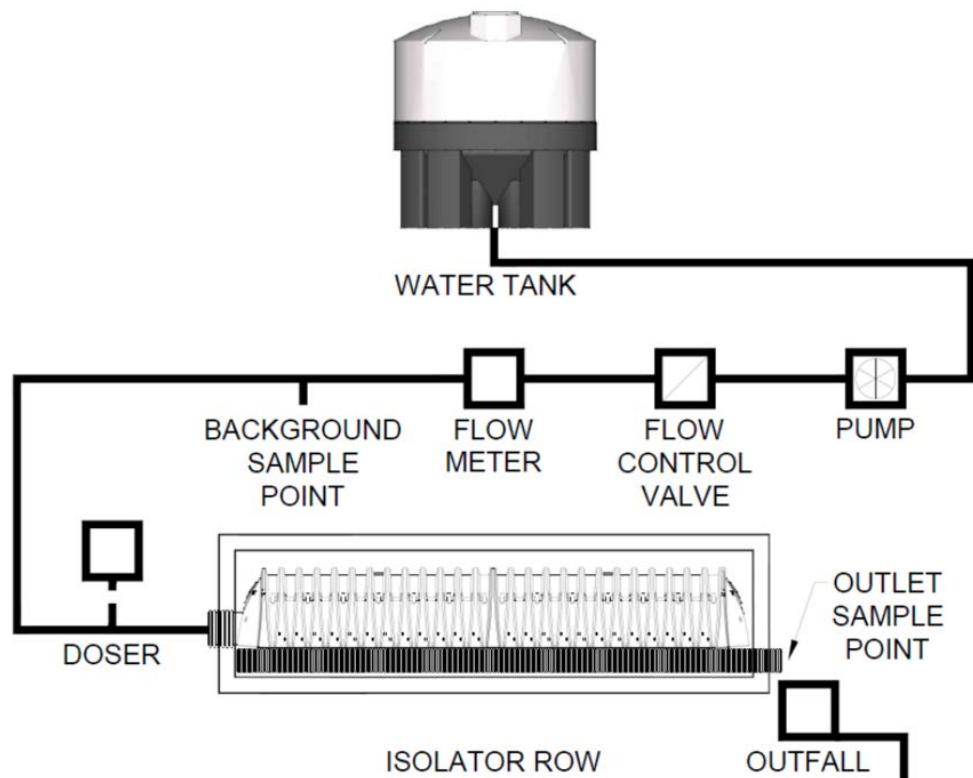


Figure 3 Schematic of the Isolator Row PLUS Test Configuration

The Isolator Row PLUS was installed inside a watertight 16'L x 6'W x 4'H test box (pictured in **Figures 6 and 7**). The Isolator Row PLUS is an arch-shaped stormwater detention/retention sediment collection and filtering device, sealed with end caps, with a 12"-inch inlet pipe welded into the upstream end cap. A ramp apparatus (patent pending) was attached to the inside of the chamber end cap to provide a smooth transition from pipe invert to fabric bottom. It is configured to improve chamber function performance over time by distributing sediment and debris that would otherwise collect at the inlet. It also serves to improve the fluid and solid flow back into the inlet pipe during maintenance and cleaning, and to guide cleaning and inspection equipment back into the inlet pipe when complete.

The chambers were installed on a 10-inch base of washed, angular, crushed stone, (#57, ¾ inch blue stone) containing an 8-inch perforated underdrain pipe running the length of the test box, penetrating the wall of the downstream end of the test box to the discharge collection point. An ADS non-woven geotextile fabric was placed over the top of the chamber row. The chambers were then backfilled with the washed crushed stone up to the top of the chamber elevation.

Additionally, an opening was cut into the top of one chamber to allow for visual monitoring and head measurement. No bypass or weir was installed upstream of the test box.

The test flow entered the chamber via the influent pipe and flowed across the filter fabric, filling the row. The water then flowed through the filter fabric, driven by hydrostatic head. The treated water exited the test box via the underdrain.



Figures 4 and 5 Photographs of Flow Meter and Sediment Delivery Port



Figure 6 Side View Photograph of Isolator Row PLUS Test Box



Figure 7 Top View Photograph of Isolator Row PLUS Test Box

Test Unit and Scaling Explanation

The Isolator Row PLUS used in this test was constructed from two (2) overlapping polypropylene open-bottom StormTech SC-740 chambers (one shortened by 5-in. to enable fitting into the test box), two (2) SC-740 end caps, a ramp apparatus and one layer of ADS PLUS geotextile fabric. The chamber floor filtration area (effective filtration treatment area, EFTA) was approximately 54.5 ft². (calculated using an average contact width inside the chamber of 45 in). The target test flow was 225 gpm. The calculated hydraulic loading rate, flow rate/EFTA is 4.13 gpm/ft² and the ratio of effective sedimentation treatment area to EFTA is 1.0. Given these data, one can effectively scale the test results for all commercial systems.

Sample Collection

The grab sampling method was used for all sample collection by sweeping a wide-mouth 1-L plastic bottle through the free-discharge effluent stream, to ensure the full cross section of the flow was sampled. The start time for each run was recorded.

The sampling schedule is provided in **Table 1**. The detention time for the Isolator Row PLUS unit operating at 20 inches hydrostatic head (maximum head tested) is 2.1 minutes. To comply with the NJDEP Filter Protocol, after initiating and stabilizing the flow rate at the MTR and beginning sediment feed, effluent sampling did not begin until the filtration MTD has been in operation for a minimum of three detention times.

Background water samples were collected upstream of the doser (shown in **Figures 3 and 8**) in correspondence with the odd-numbered effluent samples (i.e., Samples E1, E3, E5 at t = 9, 20, 31 minutes).

Table 1 Sampling Schedule for the Isolator Row PLUS Tests

Time (min)	Sample(s)	Time (min)	Sample(s)
0	S1	22	S3
9	E1, BG1	31	E5, BG3
10	E2	32	E6
11	S2	33	Stop Flow
20	E3, BG2	N/A	DDA
21	E4	N/A	DDB

NOTE: S = sediment rate; E = effluent; BG = background; DD = drawdown



Figure 8 Photograph of Background Sampling Port

Two evenly-volume-spaced drawdown samples, DDA and DDB, were taken after the flow and sediment feed to the unit had been stopped.

Sediment injection rates were measured using a stopwatch and the mass collected measured on a calibrated scale once at the very beginning of the run and twice more during the run. A fourth sediment rate sample was taken after the run was finished as an internal check but was not included in the calculations for the report. The duration of each run was 33 minutes.

A Chain of Custody (COC) form was used for each test run to record sampling date and time for externally analyzed samples. Copies of these forms were maintained by BaySaver Laboratory and FTL. Sample bottles were labeled to identify the test run number and sample type (e.g., background, effluent), corresponding to the sample identification on the COC form. BEC was present during each test run and witnessed labeling, completion of COC forms, and packaging of

samples for delivery to the external laboratory (FTL). Each person taking or relinquishing possession of the samples was required to sign a COC form before samples changed hands.

Other Instrumentation and Measurement

Water temperature was recorded every minute by a HOBO data logger placed in the source water tank of the test system. The water level in the Isolator Row PLUS was recorded every 5 minutes by visual observation of a yardstick mounted through the observation port on top of the first chamber. Run and sampling times were measured using a digital timer and a stopwatch, respectively.

2.2 Test Sediment

The test sediment had the particle size distribution (PSD) presented in **Figure 9**. The test sediment was custom-blended using various commercially available silica sands. The resulting blended sediment met the specification for the NJDEP Filter Protocol. The test sediment was batched, labeled, and stored in covered bins for the duration of this project. Under the supervision of BEC, twenty-one subsamples, taken from various locations within the test sediment containers, were composited. From the composite, three random samples were taken for PSD and moisture content analyses, which were performed by ECS, using the methodology of ASTM method D422-63 (2007).

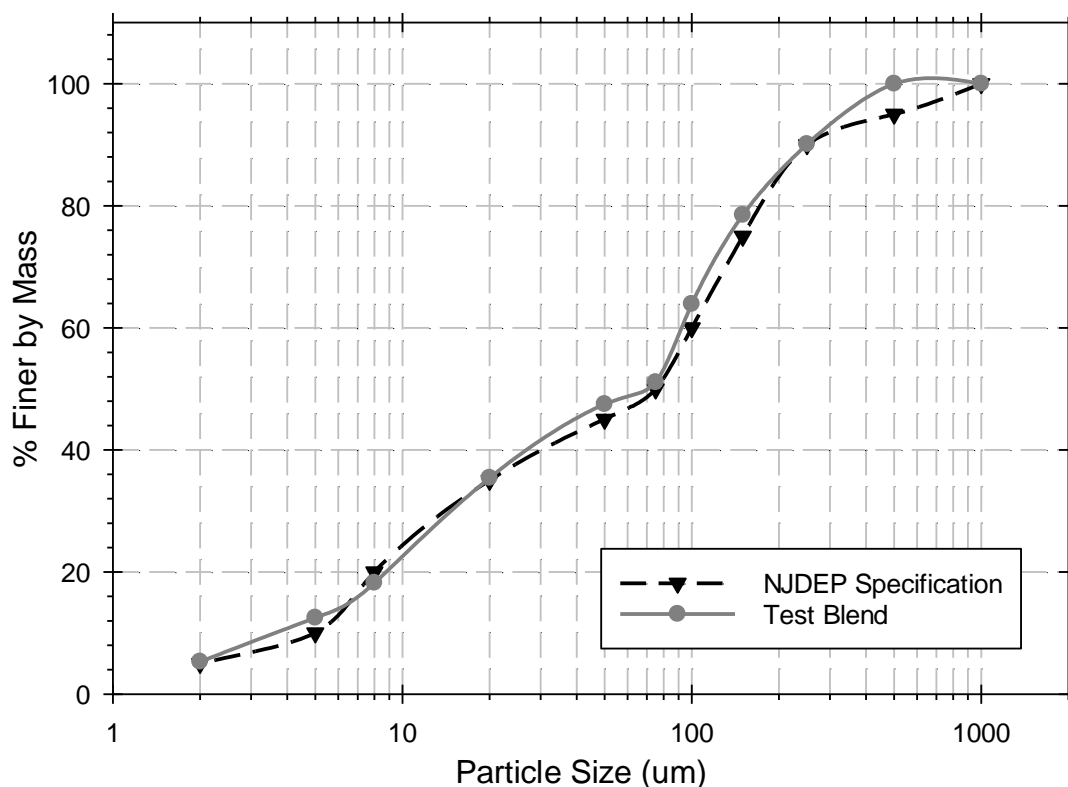


Figure 9 Average Particle Size Distribution of Test Sediment Verified by ECS

The PSD test analysis results are summarized in **Table 2**. ECS results showed that 17-19% of the particles were less than 8 μm and 89-90% of the particles were less than 250 μm . The d_{50} values (approximately 72 μm) also indicated that there was no significant difference between the NJDEP target gradation and the ECS-verified gradation of the test sediment. Thus, the blended test sediment was found to meet the NJDEP particle size specification and was acceptable for use. ECS also analyzed the sediment samples for moisture. The average moisture content was 0.1%.

Table 2 Particle Size Distribution of Test Sediment as Analyzed by ECS

Particle Size (μm)	Test Blend % Finer by Mass Analyzed by ECS				
	<u>NJ Blend A</u>	<u>NJ Blend B</u>	<u>NJ Blend C</u>	<u>Average</u>	<u>NJDEP Specification (minimum % finer)</u>
1000	100.0	100.0	100.0	100.0	98
500	100.0	100.0	100.0	100.0	93
250	90.3	89.8	90.2	90.1	88
150	79.3	78.1	78.1	78.5	73
100	66.0	63.2	62.7	63.9	58
75	52.0	50.9	50.3	51.1	50
50	47.5	47.7	47.4	47.5	43
20	35.9	36.0	34.3	35.4	33
8	18.6	18.7	17.4	18.2	18
5	13.0	13.0	11.6	12.5	8
2	5.5	5.4	5.1	5.3	3
d_{50}	69 μm	72 μm	74 μm	72 μm	75 μm

2.3 Sediment Removal Efficiency Testing

Sediment removal efficiency testing adhered to the guidelines set forth in Section 5 of the NJDEP Laboratory Protocol for Filtration MTDs. The target flow through the system was 225 gpm, with a target sediment concentration of 200 mg/L. All samples were collected in clean, 1-L wide-mouth bottles. Three background samples were taken at 9, 20 and 31 minutes after the test began to ensure the supply water met the sediment concentration requirement. According to the NJDEP Filter Protocol, these background concentrations cannot exceed a TSS concentration of 20 mg/L.

The test sediment screw-auger feeder introduced the test sediment into the influent stream to achieve the target influent TSS concentration of 200 mg/L. According to the NJDEP Filter Protocol, this influent concentration must stay within 10% of target, allowing for a 180 mg/L to 220 mg/L influent concentration. The feeder was calibrated prior to each run. In order to confirm sediment feed rates during the test, in accordance with the NJDEP Filter Protocol, three samples of the test sediment were collected from the injection point (**Figure 3**, “Doser”) into a clean one-liter container for verification of sediment feed rate, over an interval timed to the nearest second, with a minimum volume of 0.1 liter or a collection interval not exceeding one minute (whichever came first). The time was measured with a stopwatch. The samples were weighed to the nearest

milligram in the BaySaver Laboratory under the observation of BEC. The sediment feed rate coefficient of variance (COV) for the test sediment samples did not exceed 0.10. The mass from the sediment feed rate measurement samples was subtracted from the total mass introduced to the system when removal efficiency was calculated.

Effluent sampling was performed by the grab sampling method during each run, according to the schedule in **Table 1**. When the test sediment feed was interrupted for test sediment measurements, the next effluent samples were collected after at least three detention times had elapsed. During the drawdown period, two evenly volume-spaced samples were collected after flow and sediment feed had stopped. All sediment concentration samples were analyzed by Fredericktowne Labs (FTL) using ASTM D3977-97 (2019) “Standard Test Methods for Determining Sediment Concentrations in Water Samples.”

2.4 Sediment Mass Loading Capacity

The sediment mass loading capacity testing occurred as a continuation of removal efficiency testing, with the target for influent concentration remaining at 200 mg/L, and all aspects of testing procedures kept the same to ensure consistency throughout. The sediment mass loading capacity of the Isolator Row PLUS is defined per the protocol as the point at which the cumulative mass removal drops below 80.0%. For this testing program, the sediment mass loading testing was stopped prior to that point (after Run 16), because it was incorrectly assumed this criterion was reached. Thus, the mass loading is defined as mass loaded into the unit through the end of Run 16.

3. Supporting Documentation

The Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from NJCAT states that copies of the laboratory test reports, all data from performance evaluation test runs, original data, pertinent calculations, and documentation of any maintenance activities that occur during the testing process are to be included in this section. All of this information has been provided to NJCAT and is available upon request. It is not practical to include it in this report.

4. Testing Results

A total of 16 removal efficiency testing runs were completed in accordance with the NJDEP filter protocol. The target flow and influent sediment concentration were 225 gpm and 200 mg/L, respectively. The results from all 16 runs were used to calculate the overall cumulative removal efficiency of the Isolator Row PLUS.

4.1 Flow Rate

Flow was monitored by an inline flow meter (FloCat MFE electromagnetic flow meter) and recorded by a SeaMetrics DL76 data logger every minute during each run. For each run, the flow was maintained within 10% of the target (202.5 – 247.5 gpm). The average flow for all 16 runs was 226.1 gpm. The flow data with coefficient of variance (COV) values for all 16 runs are summarized in **Table 3**.

4.2 Water Temperature

Temperatures were recorded every minute by a HOBO water level logger (U20L-04). On average for all runs, the water temperature during testing was 45.7 degrees Fahrenheit, with a maximum of 52.2 degrees Fahrenheit, meeting the NJDEP Filter Protocol requirement to be below 80 degrees Fahrenheit. Data are summarized in **Table 3**.

Table 3 Flow Rate and Temperature Summary for All Runs

Run	Max Flow (gpm)	Min Flow (gpm)	Average Flow (gpm)	Flow COV	Flow Compliance (COV< 0.1)	Maximum Temperature (Fahrenheit)	NJDEP Temperature Compliance (< 80 F)
1	232.8	223.9	226.3	0.0078	Y	48.2	Y
2	228.9	218.6	220.8	0.0104	Y	51.5	Y
3	229.4	220.0	227.2	0.0094	Y	44.7	Y
4	230.2	218.7	223.2	0.0138	Y	40.5	Y
5	228.7	216.9	222.2	0.0103	Y	44.7	Y
6	227.6	217.0	224.2	0.0115	Y	46.7	Y
7	229.7	221.9	226.4	0.0092	Y	44.6	Y
8	230.3	222.2	226.8	0.0089	Y	43.5	Y
9	233.2	218.4	225.6	0.0136	Y	45.5	Y
10	232.2	219.7	228.4	0.0126	Y	44.7	Y
11	226.9	219.2	224.1	0.0088	Y	52.4	Y
12	232.2	222.1	226.9	0.0107	Y	48.5	Y
13	234.7	221.2	226.1	0.0109	Y	48.5	Y
14	231.9	223.4	228.7	0.0103	Y	45.6	Y
15	236.8	224.1	231.4	0.0131	Y	52.2	Y
16	232.5	221.3	229.0	0.0137	Y	47.8	Y
Average			226.1			45.7	
Max						52.2	

4.3 Head

The head level in the Isolator Row PLUS was recorded to the nearest 1/8 inch every five minutes, through visual observation of a yard stick mounted through the observation port of the first chamber. With each run, after the first several measurements, the head during the run remained the same or increased slightly over that of the previous run. The maximum head reached during all 16 runs was 18.75 inches. Maximum head for each run is summarized in **Table 4**.

Table 4 Maximum Head (inches) for All Runs

Run	Maximum Head (inches)	Run	Maximum Head (inches)
1	9.00	9	17.50
2	12.00	10	18.00
3	14.00	11	17.25
4	15.25	12	18.00
5	15.75	13	18.25
6	16.25	14	18.50
7	17.50	15	18.75
8	17.25	16	18.75

4.4 Sediment Concentration and Removal Efficiency

Background TSS

Municipal tap water was used as the water source during testing. The background TSS concentration for all runs was well below the 20 mg/L NJDEP Protocol limit. Background TSS concentrations for each run are provided in **Table 5**. The average background TSS concentration for each run was subtracted from the effluent and drawdown concentrations to provide adjusted figures, per the protocol.

Sediment Dosing Rate and Influent TSS

Influent TSS concentration was calculated by dividing the total mass of sediment added during a given run by the total volume of water flowing through the MTD during the addition of test sediment during that run. The volume of water flowing through the device during the run was calculated by multiplying the average measured flow by the time of sediment addition only. The average influent TSS was 204.2 mg/L, with individual run averages ranging from 195.9 to 216.7 mg/L. All values are within the target range of 200 ± 20 mg/L. **Tables 6 and 7** provide the measured sediment rates for each run, and the resulting calculated influent TSS concentration. In these tables, NJDEP Protocol compliance is defined as a TSS concentration in the range 180 – 220 mg/L and sediment feed rate COV < 0.1.

Table 5 Background TSS Concentrations

Run	BG TSS 9 min	BG TSS 20 min	BG TSS 31 min	Average	MDL
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
1	0.5	4	2	2.2	1.0
2	1	1	0.5	0.8	1.0
3	1	0.5	0.5	0.7	1.0
4	0.5	0.5	0.5	0.5	1.0
5	0.5	0.5	0.5	0.5	1.0
6	0.5	0.5	0.5	0.5	1.0
7	0.5	0.5	0.5	0.5	1.0
8	0.5	0.5	0.5	0.5	1.0
9	0.5	0.5	0.5	0.5	1.0
10	0.5	0.5	0.5	0.5	1.0
11	0.5	0.5	0.5	0.5	1.0
12	0.5	0.5	0.5	0.5	1.0
13	0.5	0.5	0.5	0.5	1.0
14	0.5	0.5	0.5	0.5	1.0
15	0.5	0.5	0.5	0.5	1.0
16	0.5	0.5	0.5	0.5	1.0

Note: In cases where the measured background TSS concentration was below the Minimum Detection Level (MDL) of 1.0 mg/L, half the MDL was reported for the background concentration.

Table 6 Sediment Rate Measurements for Runs 1-10

Run	Run Time (min)	Sediment Weight (g)	Duration (s)	Sediment Feed Rate (g/min)	Influent Water Flow Rate (gpm)	Influent TSS Conc. (mg/L)	NJDEP Compliance
1	0	117.767	39.78	177.6	226.3	202.9	Y
	11	110.674	40.16	165.4			
	22	118.819	40.00	178.2			
	COV			0.0418			
2	0	114.921	39.91	172.8	220.8	198.5	Y
	11	106.158	39.96	159.4			
	22	110.429	40.10	165.2			
	COV			0.0404			
3	0	117.364	39.85	176.7	227.2	206.8	Y
	11	116.700	39.90	175.5			
	22	120.156	39.72	181.5			
	COV			0.0179			
4	0	121.043	39.79	182.5	223.2	216.7	Y
	11	125.058	39.88	188.2			
	22	118.657	39.85	178.7			
	COV			0.0261			
5	0	111.624	40.03	167.3	222.2	215.0	Y
	11	117.883	40.00	176.8			
	22	132.393	39.88	199.2			
	COV			0.0904			
6	0	114.723	39.94	172.3	224.2	206.6	Y
	11	119.043	40.03	178.4			
	22	117.644	40.28	175.2			
	COV			0.0174			
7	0	115.351	40.00	173.0	226.4	198.1	Y
	11	110.196	40.25	164.3			
	22	114.603	40.00	171.9			
	COV			0.0281			
8	0	115.664	39.72	174.7	226.8	201.5	Y
	11	117.915	39.93	177.2			
	22	110.840	39.82	167.0			
	COV			0.0307			
9	0	116.845	39.87	175.8	225.6	205.2	Y
	11	114.135	39.81	172.0			
	22	117.894	39.75	178.0			
	COV			0.0172			
10	0	111.306	39.57	168.8	228.4	203.0	Y
	11	119.680	39.81	180.4			
	22	118.275	39.90	177.9			
	COV			0.0347			

Table 7 Sediment Rate Measurements for Runs 11-16

Run #	Run Time (min)	Sediment Weight (g)	Duration (s)	Sediment Feed Rate (g/min)	Influent Water Flow Rate (gpm)	Influent TSS Conc. (mg/L)	NJDEP Compliance
11	0	114.505	39.90	172.2	224.1	207.8	Y
	11	119.160	39.94	179.0			
	22	118.629	40.03	177.8			
	COV			0.0207			
12	0	115.516	39.78	174.2	226.9	208.8	Y
	11	118.805	39.87	178.8			
	22	124.236	40.22	185.3			
	COV			0.0311			
13	0	114.776	39.78	173.1	226.1	198.0	Y
	11	106.924	39.85	161.0			
	22	115.083	39.69	174.0			
	COV			0.0429			
14	0	112.871	39.72	170.5	228.7	199.9	Y
	11	116.869	39.84	176.0			
	22	114.529	39.81	172.6			
	COV			0.0161			
15	0	112.091	39.72	169.3	231.4	195.9	Y
	11	112.200	39.81	169.1			
	22	117.588	39.94	176.6			
	COV			0.0250			
16	0	118.503	39.59	179.6	229.0	202.3	Y
	11	116.834	39.78	176.2			
	22	112.971	39.84	170.1			
	COV			0.0273			

Effluent TSS

During each run, grab samples were taken of the effluent according to the schedule in **Table 1**, and all TSS analyses were conducted by Fredericktowne Labs. For each run, the average effluent concentration was adjusted by subtracting the average background TSS concentration. The average adjusted effluent TSS concentration during testing was 39 mg/L, with individual run averages ranging from 32.0 to 45.5 mg/L. Effluent and adjusted effluent TSS concentrations for each run are given in **Table 8**.

Table 8 Effluent Sample TSS Concentrations

Run	EFF TSS 9 min	EFF TSS 10 min	EFF TSS 20 min	EFF TSS 21 min	EFF TSS 31 min	EFF TSS 32 min	Mean	MDL	Adjusted Effluent TSS
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
1	48	48	47	47	48	48	47.7	1.0	45.5
2	32	32	33	32	35	33	32.8	1.0	32.0
3	33	37	37	40	38	38	37.2	1.0	36.5
4	28	31	34	38	32	38	33.5	1.0	33.0
5	40	41	39	33	42	42	39.5	1.0	39.0
6	38	41	39	37	41	44	40.0	1.0	39.5
7	37	40	37	36	37	38	37.5	1.0	37.0
8	38	41	38	40	32	38	37.8	1.0	37.3
9	35	41	36	36	42	41	38.5	1.0	38.0
10	39	44	34	38	37	41	38.8	1.0	38.3
11	35	41	38	38	38	43	38.8	1.0	38.3
12	36	43	36	41	46	47	41.5	1.0	41.0
13	41	46	37	37	42	45	41.3	1.0	40.8
14	44	49	39	42	42	45	43.5	1.0	43.0
15	40	43	41	39	40	45	41.3	1.0	40.8
16	43	45	41	44	45	46	44.0	1.0	43.5

Note: Adjusted effluent TSS concentration is the average effluent TSS concentration minus the average background TSS concentration (Table 5).

Drawdown TSS

According to the NJDEP Filter Protocol, the amount of sediment that leaves the filter during the drawdown period must be accounted for and documented. During each run, two evenly volume-spaced grab samples were taken of the drawdown, and all TSS analyses were conducted by Fredericktowne Labs. For each run, the average drawdown concentration was adjusted by subtracting the average background TSS concentration (**Table 9**).

Table 9 Drawdown Sample TSS Concentrations

Run	DDA	DDB	Average	MDL	Adjusted Drawdown TSS
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
1	62	11	36.5	1.0	34.3
2	39	16	27.5	1.0	26.7
3	42	14	28.0	1.0	27.3
4	41	18	29.5	1.0	29.0
5	42	16	29.0	1.0	28.5
6	45	17	31.0	1.0	30.5
7	44	16	30.0	1.0	29.5
8	48	17	32.5	1.0	32.0
9	42	18	30.0	1.0	29.5
10	45	17	31.0	1.0	30.5
11	43	17	30.0	1.0	29.5
12	44	16	30.0	1.0	29.5
13	46	18	32.0	1.0	31.5
14	50	18	34.0	1.0	33.5
15	47	17	32.0	1.0	31.5
16	48	15	31.5	1.0	31.0

Note: Adjusted drawdown TSS concentration is the average drawdown TSS concentration minus the average background TSS concentration (Table 5).

In order to estimate the volume of water during drawdown, under observation by BEC, the unit was filled prior to all testing with clean water and the drawdown volume as a function of time was calculated from the height of the flow stream in the effluent pipe as a function of time. Total drawdown volume was estimated at 268.6 gal at an operating head of 2.5 inches. This volume was used to determine the volume of the void space of the gravel bed, which was then used, along with the dimensions of the Isolator Row PLUS chambers, to calculate the drawdown volume for incremental head levels above 2.5 inches. Adjusted average drawdown TSS concentrations and drawdown losses are given in **Table 10**.

Table 10 Drawdown Losses

Run	Head Level at End of Run (in)	Drawdown Volume (gal)	Average Adjusted Drawdown TSS Conc. (mg/L)	Total Sediment Lost During Drawdown (g)
1	9.00	285.2	34.3	37.1
2	12.00	354.2	26.7	35.7
3	14.00	403.3	27.3	41.7
4	15.25	432.8	29.0	47.5
5	15.75	443.9	28.5	47.9
6	16.25	454.2	30.5	52.4
7	17.50	476.0	29.5	53.2
8	17.00	468.2	32.0	56.7
9	17.25	472.3	29.5	52.7
10	17.75	476.0	30.5	55.0
11	17.25	472.3	29.5	52.7
12	17.5	476.0	29.5	53.2
13	18.00	482.4	31.5	57.5
14	18.25	484.9	33.5	61.5
15	18.50	486.8	31.5	58.1
16	18.25	484.9	31.0	56.9

Removal Efficiency Calculation

Removal efficiency was calculated using the following equation from the NJDEP Filter Protocol:

$$\text{Removal Efficiency (\%)} = \frac{\left(\frac{\text{Average Influent TSS Concentration} \times \text{Total Volume of Test Water}}{\text{Average Influent TSS Concentration} \times \text{Total Volume of Test Water}} \right) - \left(\frac{\text{Adjusted Effluent TSS Concentration} \times \text{Total Volume of Effluent Water}}{\text{Average Influent TSS Concentration} \times \text{Total Volume of Test Water}} \right) - \left(\frac{\text{Average Drawdown Flow TSS Concentration} \times \text{Total Volume of Drawdown Water}}{\text{Average Influent TSS Concentration} \times \text{Total Volume of Test Water}} \right)}{\text{Average Influent TSS Concentration} \times \text{Total Volume of Test Water}} \times 100$$

For each run, sediment concentrations of background, influent, effluent, and drawdown, as well as the calculated removal efficiency, are summarized in **Table 11**. As shown in this summary table, the Isolator Row PLUS demonstrated a cumulative sediment removal efficiency of 81.2% over the course of 16 test runs.

Table 11 Removal Efficiency Results

Run	Average Influent TSS (mg/L)	Influent Water Volume (gal)	Adjusted Average Effluent TSS (mg/L)	Effluent Water Volume (gal)	Adjusted Average Drain Down TSS (mg/L)	Drain Down Water Volume (gal)	Single Run Removal Efficiency (%)	Mass of Captured Sediment (g)	Cumulative Removal Efficiency (%)
1	203	7166	46	6881	34	285	77.8	4282	77.8
2	199	6993	32	6639	27	354	84.0	4415	80.8
3	207	7197	37	6793	27	403	82.6	4654	81.4
4	217	7068	33	6635	29	433	84.9	4923	82.3
5	215	7037	39	6593	29	444	82.2	4705	82.3
6	207	7097	40	6643	31	454	81.2	4504	82.1
7	198	7169	37	6693	30	476	81.6	4386	82.0
8	201	7184	37	6716	32	468	81.6	4473	82.0
9	205	7147	38	6675	30	472	81.8	4539	82.0
10	203	7235	38	6759	31	476	81.4	4523	81.9
11	208	7096	38	6624	30	472	81.8	4567	81.9
12	209	7185	41	6709	30	476	80.7	4584	81.8
13	198	7162	41	6680	32	482	79.7	4277	81.6
14	200	7242	43	6757	34	485	78.8	4318	81.4
15	196	7329	41	6842	32	487	79.5	4320	81.3
16	202	7254	44	6769	31	485	78.9	4384	81.2
Ave.	204.2	7160	39	6713	31	447	81.2	4491	N/A
Cumulative Mass Removed (g)							71854		
Cumulative Mass Removed (lb)							158.4		
Total Mass Loaded (lb)							195.2		
Cumulative Removal Efficiency (%)							81.2		

4.5 Sediment Mass Loading

Sediment mass loading for each run was approximately 12.2 lbs on average. These data are summarized in **Table 12**.

Sediment mass loading was calculated from the summation of the total sediment mass added during dosing in each run.

Table 12 Sediment Mass Loading Summary

Run	Sediment Loading (lbs)	Cumulative Sediment Loading (lbs)	Run	Sediment Loading (lbs)	Cumulative Sediment Loading (lbs)
1	12.1	12.1	9	12.2	110.0
2	11.6	23.7	10	12.3	122.2
3	12.4	36.1	11	12.3	134.5
4	12.8	48.9	12	12.5	147.0
5	12.6	61.5	13	11.8	158.9
6	12.2	73.8	14	12.1	170.9
7	11.9	85.6	15	12.0	182.9
8	12.1	97.7	16	12.2	195.2

Overall, a total of 195.2 lbs of sediment was loaded into the Isolator Row PLUS over the course of the 16 runs. Total captured mass over the 16 runs was 158.4 lbs (**Table 11**).

The relationship between removal efficiency and sediment mass loading is shown in **Figure 10**. The relationship between driving head and sediment mass loading is shown in **Figure 11**.

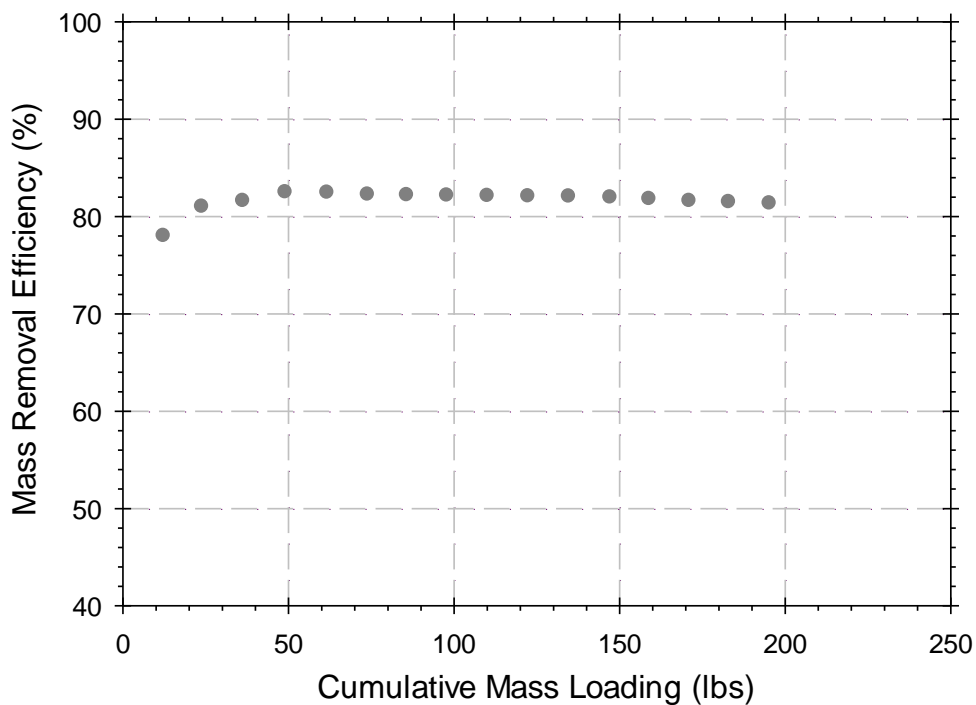


Figure 10 Removal Efficiency vs. Sediment Mass Loading

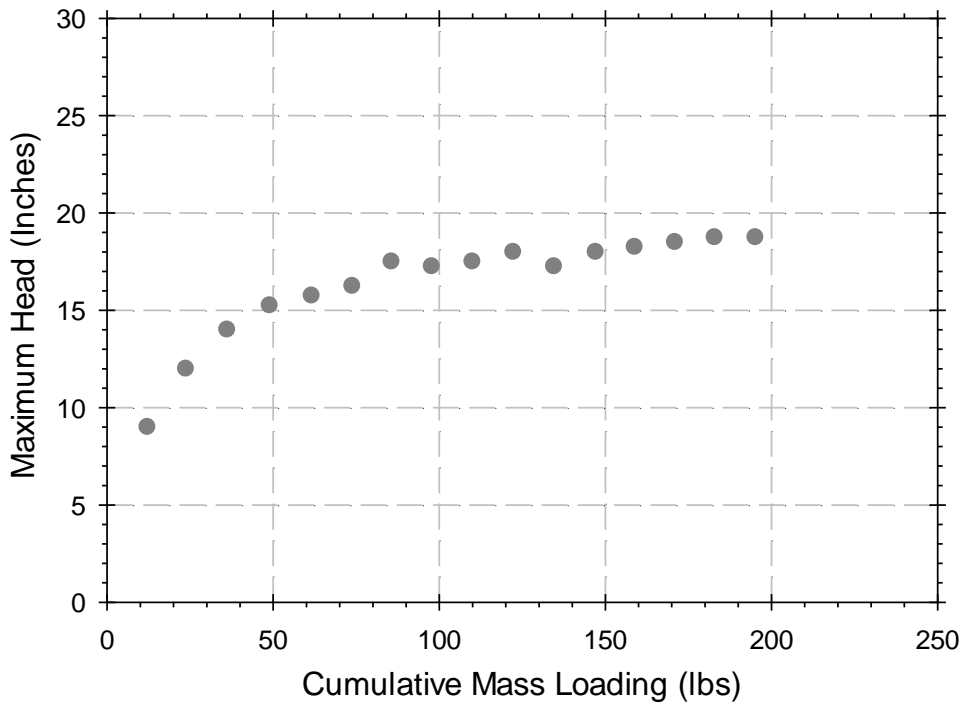


Figure 11 Driving Head vs. Sediment Mass Loading

5. Performance Verification

The Isolator Row PLUS used in this test, constructed from two (2) overlapping StormTech SC-740 chambers and one layer of ADS PLUS fabric, demonstrated a cumulative mass TSS removal efficiency of 81.2% and a sediment mass loading capacity of 3.58 lb./ft² (mass capture capacity of 2.91 lb./ft²) of geotextile fabric filtration area when operated with a driving head < 20 inches at a hydraulic loading rate of 4.13 gpm/ft² of geotextile fabric filtration area. The MTFR's and maximum allowable drainage area for other StormTech Isolator Row PLUS models are shown in **Table 13**.

Table 13 Isolator Row PLUS System Model Sizes and New Jersey Treatment Capacities

	Surface Loading Rate (gpm/ft ²)	Effective Filtration Treatment Area (ft ²)	MTFR (cfs) ¹	Mass Loading Capacity (lbs)	Mass Capture Capacity (lbs)	Drainage Area (acres)
Model	Single Chamber	Single Chamber	Single Chamber	Single Chamber	Single Chamber	Single Chamber
StormTech SC-160	4.13	11.45	0.105	41.0	33.4	0.06
StormTech SC-310	4.13	17.7	0.163	63.4	51.6	0.09
StormTech SC-740	4.13	27.8	0.256	99.6	81.0	0.14
StormTech DC-780	4.13	27.8	0.256	99.6	81.0	0.14
StormTech MC-3500	4.13	42.9	0.395	153.7	125.0	0.21
StormTech MC-4500	4.13	30.1	0.277	107.8	87.7	0.15
1. Based on 4.13 gpm/ft ² of effective filtration treatment area. 2. Drainage Area is based on the equation in the NJDEP Filter Protocol wherein drainage area is calculated by dividing the pounds of mass captured by 600 lb/acre.						

6. Design Limitations

Maximum Flow Rate

The StormTech Isolator Row PLUS unit has an MTFR of 0.501 cfs (225 gpm) and an effective filtration treatment area (EFTA) of 54.5 ft² (loading rate 4.13 gpm/ft²).

Slope

The StormTech Isolator Row PLUS is recommended for installation with little to no slope to ensure proper, consistent operation. Steep slopes should be reviewed by ADS/StormTech Engineering support.

Allowable Head Loss

There is an operational head loss associated with the StormTech Isolator Row PLUS. The head loss will increase over time due to the sediment loading to the system. Site-specific treatment flow rates, peak flow rates, pipe diameter, and pipe slopes should be evaluated to ensure there is appropriate head for the system to function properly.

Sediment Load Capacity

Based on laboratory testing results, the StormTech Isolator Row PLUS unit has a mass loading capacity of 195.2 lbs. while operating at a sediment removal efficiency of 81.2%; the total sediment load captured by the tested Isolator Row PLUS is 158.4 lbs.

Pre-treatment Requirements

The StormTech Isolator Row PLUS unit does not require additional pre-treatment.

Configurations

The StormTech Isolator Row PLUS is available in multiple configurations. The length and size can be adjusted to meet project specific design volumes or flow rates.

Structure Load Limitations

The StormTech Isolator Row PLUS, as part of the overall chamber system, is designed to meet the full scope of design requirements of the American Society of Testing Materials (ASTM) International specification F2787 “Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers” and produced to the requirements of the ASTM F2418 “Standard Specification for Polypropylene (PP) Corrugated Stormwater Collection Chambers”. The StormTech chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The ASTM F 2787 standard provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. of the AASHTO LRFD Bridge Design Specifications. ASTM F 2787 requires that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting ASTM F 2418. The three standards provide both the assurance of product quality and safe structural design.

7. Maintenance Plan

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location, based upon site-specific variables. The type of land use (i.e. industrial, commercial, public, residential), anticipated pollutant load, percent imperviousness, climate, rainfall data, etc., all play a critical role in determining the actual frequency of inspection and maintenance practices.

The Isolator Row PLUS may also be part of a treatment train. By treating stormwater prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row PLUS chamber should be inspected every 6 months for the first year of operation. For subsequent years, the inspection schedule should be adjusted based upon previous observation of sediment deposition.

The Isolator Row PLUS incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the Isolator Row PLUS from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If, upon visual inspection, it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row PLUS, clean-out should be performed.

The Isolator Row PLUS was designed to reduce the cost of periodic maintenance. By “isolating” sediment to just one row of the StormTech system, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high-pressure water nozzle to propel itself down the Isolator Row PLUS while scouring and suspending sediment. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency.

Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear-facing jets with an effective spread of at least 45” are best. Most JetVac reels have 400 feet of hose, allowing maintenance of an Isolator Row PLUS up to 50 chambers long. The JetVac process should only be performed on StormTech Isolator Rows PLUS that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.

Complete details of the design, operation, and maintenance of the Isolator Row PLUS can be found in the StormTech O&M Manual, available online at:
https://www.stormtech.com/download_files/pdf/11081-stormtech-isolator-row-plus-manual-07-20.pdf

8. Statements

The attached pages include signed statements from the manufacturer (Advanced Drainage Systems, Inc.), the third-party environmental consulting firm (Boggs Environmental Consultants, Inc.), and NJCAT. These statements are included as a requirement for the verification process.



June 26th, 2020

Dr. Richard S. Magee, Sc.D., P.E., BCEE
NJCAT
Center for Environmental Systems
Steven Institute of Technology
Castle Point on Hudson
Hoboken, NJ 07030-0000

Dr. Magee,

Advanced Drainage Systems is pleased to provide this letter as our statement certifying that the protocol, "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a filtration Manufactured Treatment Device" (NJDEP Filter Protocol, January 25, 2013), was strictly followed while testing our StormTech Isolator® Row PLUS. The testing was performed at BaySaver Laboratories, located in Mount Airy, MD. All data pertaining to the StormTech Isolator Row PLUS NJDEP Protocol test is included in the Verification Report.

Respectfully,

Greg Spires, PE
General Manager - StormTech
Advanced Drainage Systems
614.325.0032
greg.spires@ads-pipe.com



BOGGS
ENVIRONMENTAL CONSULTANTS

Middletown, MD & Morgantown, WV

Administrative Office:

200 W Main Street

Middletown, Maryland 21769

Office (301) 694-5687

Fax (301) 694-9799

June 25, 2020

StormTech
Advanced Drainage Systems, Inc.
520 Cromwell Avenue
Rocky Hill, CT 06067
gregory.spire@ads-pipe.com

ATTENTION Greg Spires, PE
General Manager, StormTech
Advanced Drainage Systems, Inc.

REFERENCE: Third Party Review of Testing Procedures of the Isolator® Row PLUS at the
BaySaver Laboratory
1207 Park Ridge Drive
Mount Airy, MD 21771

BOGGS ENVIRONMENTAL CONSULTANTS, INC. (BEC) provided Third Party Review services for the testing of the Isolator® Row PLUS to evaluate if the required testing meets certification standards established by the New Jersey Department of Environmental Protection (NJDEP).

LABORATORY TESTING PROCEDURES & METHODOLOGIES

The following two procedures and testing requirements were followed during the testing process of the Isolator® Row PLUS:

- *New Jersey Department of Environmental Protection, Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, dated January 25, 2013.*
- *QAPP for Isolator® Row PLUS, New Jersey Department of Environmental Protection Testing, prepared by StormTech (a subsidiary of Advanced Drainage Systems, Inc.), Revision dated January 9, 2020.*

ONSITE THIRD-PARTY OBSERVATION OF TESTING PROCEDURES

BEC was present at the BaySaver Laboratory, at 1207 Park Ridge Drive, in Mount Airy, MD 21771, to observe the following testing of the Isolator® Row PLUS:

- The mixing and establishment of a sediment blend that included manufactured sands that when delivered to the feed water would result in influent Total Suspended Solids (TSS) concentrations within the established range of approximately 200 mg/L and a particle size distribution specified and approved by NJDEP;
- BEC assisted in the establishment of a Procedure Checklist to be used on each run to verify and document the following: Verify that pumps and measurement devices are turned on and functioning; Verification that the correct measurements of dry sediments are added to the doser and feed stream; Document that, background effluent, and duplicate samples are collected at established intervals during the run; and, Recording of periodic flow rates and head measurements during each run;
- Observation of Runs 1 through 16 from January 14, 2020 to February 12, 2020 and verified that that sediment, background, effluent samples were collected during each 33-minute run, and that drawdown samples were collected after the end of each run.
- After sampling was completed for each run, BEC was present for the downloading of flow data as well as sediment feed rates to verify that calculated sediment feed rates met NJDEP protocols for testing. BEC also verified that that sample containers were properly labeled and chain of custody were filled and were boxed and sealed for delivery to Fredericktowne Labs for analysis of Total Suspended Solids (TSS).

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Third Party Review of
Isolator® Row PLUS Testing Procedures
June 25, 2020
Page 2 of 2

THIRD-PARTY VERIFICATION & OPINIONS

Based on observations during the runs and the reported TSS analytical results, BEC verified the following:

- That the testing of the Isolator® Row PLUS at the BaySaver Laboratory was conducted in accordance with the *New Jersey Department of Environmental Protection, Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device, dated January 25, 2013* and procedures established in Advanced Drainage Systems, Inc.'s *QAPP for Isolator® Row PLUS, New Jersey Department of Environmental Protection Testing*, prepared by StormTech (a subsidiary of Advanced Drainage Systems), Revision dated January 9, 2020.
- The report titled *NJCAT Technology Verification, of Isolator® Row PLUS*, prepared by StormTech, dated June 2020, used applicable NJCAT protocol and accurately reflects the testing observed by BEC.

BEC has no financial conflict of interest, as defined in the *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation of Advanced Technology* (NJEP 2013).

Should you have any questions, contact our office at your earliest convenience.

Sincerely,
BOGGS ENVIRONMENTAL CONSULTANTS, INC.

A handwritten signature in blue ink that reads 'William R. Warfel'.

William R. Warfel
Principal Environmental Scientist

ENVIRONMENTAL SCIENCE, ENGINEERING & INDUSTRIAL HYGIENE SERVICES



**Center for Environmental Systems
Stevens Institute of Technology
One Castle Point
Hoboken, NJ 07030-0000**

May 1, 2020

George F. Ives III, P.E.
StormTech, LLC
520 Cromwell Ave
Rocky Hill, CT 06067

Dear Mr. Ives,

Based on my review, evaluation and assessment of the testing conducted on the StormTech , LLC Isolator Row PLUS at the BaySaver Laboratory (Storm Tech, LLC and BaySaver Technologies, LLC are subsidiaries of Advanced Drainage Systems, Inc.), under the independent third-party oversight of Boggs Environmental Consultants (BEC), Inc., the test protocol requirements contained in the “New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device” (NJDEP Filter Protocol, January 2013) were met or exceeded. Specifically:

Test Sediment Feed

The test blend was custom-blended using various commercially available silica sands under the oversight of BEC. The particle size distribution was independently analyzed by Environmental Consulting Services (ECS), using the methodology of ASTM method D422-63. The blended silica met the specification within tolerance as described in Section 5B of the NJDEP filter protocol and was acceptable for use.

Removal Efficiency Testing

Sixteen (16) removal efficiency testing runs were completed in accordance with the NJDEP filter protocol. The target flow rate was 225 gpm and the influent sediment concentration was 200 mg/L. The average flow rate for all 16 runs was 226.1, with a coefficient of variation (COV) below the flow compliance (COV) < 0.1 for all the runs. Likewise, for all runs the sediment feed rate COV was below the < 0.03 protocol limit. The Isolator Row PLUS demonstrated a cumulative sediment removal efficiency of 81.2% over the course of the 16 test runs.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted concurrently with removal efficiency testing. The Isolator Row PLUS has a mass loading capture capacity of 158.4 lbs (2.91 lbs/ft² of filtration area).

No maintenance was performed on the test system during the entire testing program.

Scour Testing

No scour testing was performed. Hence the Isolator Row PLUS is verified for off-line installation only.

Sincerely,



Richard S. Magee, Sc.D., P.E., BCEE

Specifications

Introduction

- Manufacturer – StormTech, LLC, 520 Cromwell Ave, Rocky Hill, CT 06067
- Website: <http://www.StormTech.com>. Phone: 888-892-2694
- MTD – StormTech Isolator Row PLUS verified models are shown in **Table 13**
- TSS Removal Rate – 81.2%
- Off-line installation

Detailed Specification

- NJDEP sizing tables and physical dimensions of StormTech Isolator Row PLUS verified models are shown in **Table 13**. These sizing tables are valid for NJ following NJDEP Water Quality Design Storm Event of 1.25" in 2 hours (NJAC 7:8-5.5(a)).
- Maximum inflow drainage area
 - The maximum inflow drainage area is governed by the maximum treatment flow rate of each model as presented in **Table 13**.
- Driving head will vary for a given Isolator Row PLUS model based on the site-specific configuration. The maximum head without bypass is 36", but the minimum head varies depending on the flow rate through the unit. Design support is given by StormTech for each project, and site-specific drawings (cut sheets) will be provided that show pipe inverts, finish surface elevation, and peak treatment and maximum flow rates through the unit.
- The drawdown flow exits via the underdrain. A clean filter draws down in approximately 20 minutes.