

NJCAT TECHNOLOGY VERIFICATION

StormTrap SurgeSettler™ High Flow Hydrodynamic Separator - Side Outlet Configuration

StormTrap LLC

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1. Description of Technology

The SurgeSettler™ Side Outlet Configuration, herein referred to SurgeSettler 90° is a manufactured treatment device developed by StormTrap® that improves the quality of stormwater runoff before it enters receiving waterways. SurgeSettler 90° is designed to remove sediment from runoff using inclined tube settling technology. Stormwater enters a vault through an inflow pipe and exits through an outflow pipe that is placed at the same elevation. The vault consists of a forebay, an enhanced settling section and an outlet bay. The forebay contains a structure designed to distribute the flow more evenly through the vault. The enhanced settling section consists of an internal structure that includes enhanced settling packs, weirs and baffles. The outlet bay is an empty space that allows for the water quality treatment flow and bypass flow paths to combine before the water exits the system.

Given the unit's rectangular geometry, the 90° outlet orientation does not behave the same as the 180° system so this is not an “Alternate Configuration” test, this is a new product test. In addition to the new inlet/outlet orientation, a 25-degree downward-sloped ledge was incorporated along the downstream back wall at an elevation 1' above the bottom of the enhanced settling packs, to dissipate and redirect flow in the outlet region and minimize sediment resuspension. In all other respects the SurgeSettler 90°™ and SurgeSettler 180° are the same.

Bypass occurs at two points: bypass of the middle back baffle and bypass of the left and right back retention bay baffles. The retention bays are equipped with weirs that extend above the middle bypass weir. Full internal bypass above the right and left back baffles is possible at extremely high flows, above the rated scour flow. The SurgeSettler 90° can be equipped with a hydrophobic/oleophilic accessory to capture and retain oil as warranted by site-specific concerns.

Water entering through the inlet pipe is split and distributed into the enhanced settling section by the flow wedge at the front of the unit. From there, the water moves into the enhanced settling packs, where it is further divided into many narrow pathways. Despite this, the overall flow direction remains predominantly horizontal through the packs toward the outlet. As the flow passes through the enhanced settling packs, conditions are created that promote particle settling, allowing suspended solids to be conveyed and retained into the unit sump. The treated water then continues through the settling packs, recombines in the outlet bay, and exits the system through the outlet pipe.

Figure 1 identifies key SurgeSettler 90° internal components. **Figure 2** depicts flow path, indicated with red arrows. The internal components are typically fabricated using plastic or fiberglass parts. The internals are typically housed within a concrete vault structure. Maintenance is performed by accessing the unit in three locations including the forebay, the outlet bay, and a 2' x 2' maintenance access manhole.

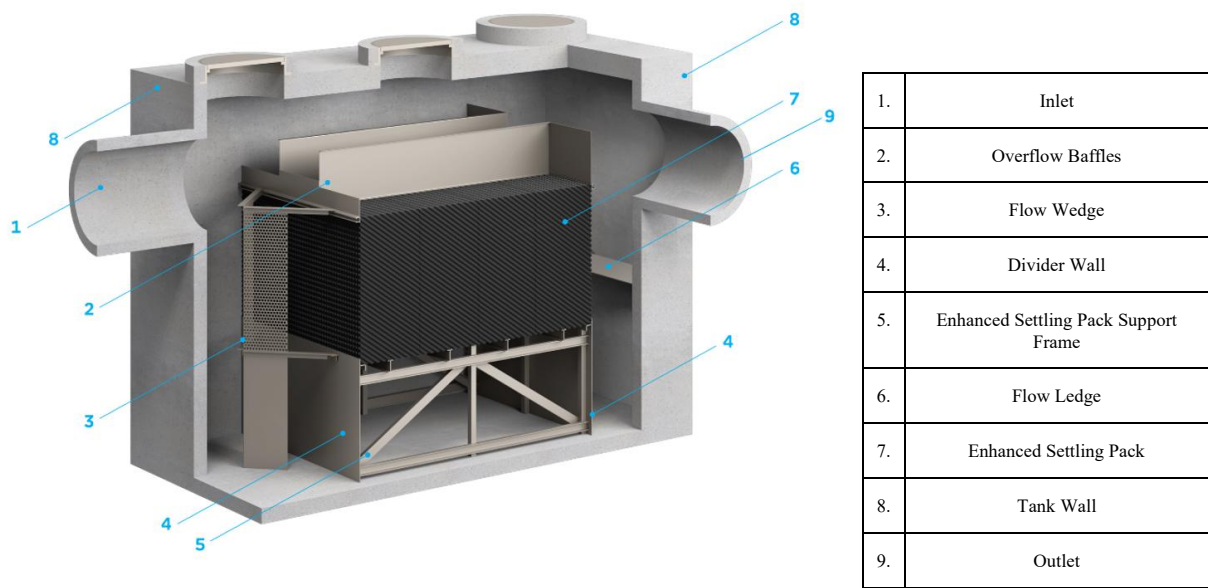


Figure 1 - SurgeSettler 90° Internal Components

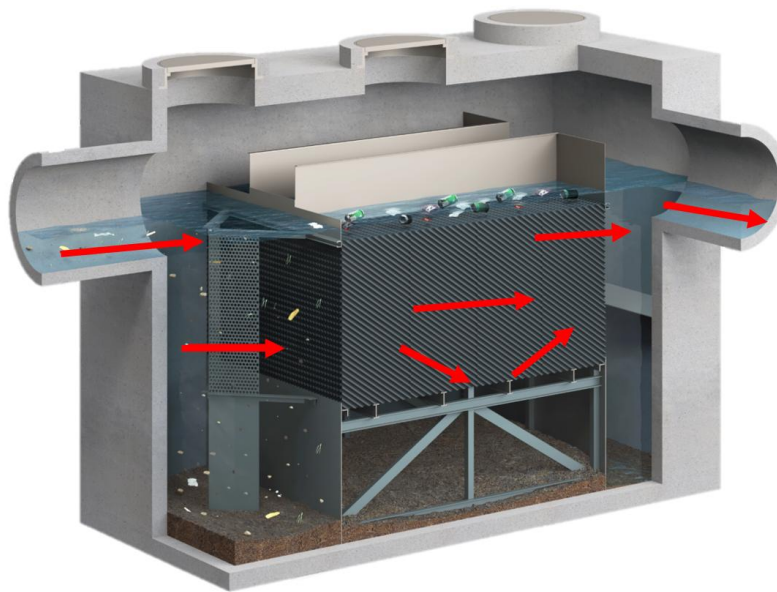


Figure 2 - SurgeSettler 90° Flow Path

2. Laboratory Testing

SurgeSettler 90° was evaluated for sediment removal efficiency and scour in accordance with the “New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total

Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device” (January 1, 2021, Last Updated April 25, 2023). Prior to commencing the testing program, a quality assurance project plan (QAPP) was submitted to and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

Testing was conducted at the StormTrap Research and Development Laboratory Facility in Morris, Illinois under the observation of a third-party witness, Jason Wiesbrock, P.E., Vice President of Space Co., Inc. Mr. Wiesbrock’s credentials were reviewed and approved by NJCAT prior to the start of testing. Water samples collected during testing were analyzed by Gabriel Environmental Services (GES), a NELAP accredited independent laboratory located in Chicago, IL. Sediment particle size distribution (PSD) samples were analyzed by GeoTesting Express, an A2LA, AASHTO, and USACE accredited independent laboratory located in Acton, MA. All samples sent to independent laboratories were accompanied by chain of custody (COC) forms. The third-party witness was present and witnessed the collection of samples, sample labeling, completion of COC forms and preparation of samples for delivery to the laboratory.

2.1. Test Unit

The tested device was a prototype of a commercially available SurgeSettler 90° 6’x14’ unit consisting of internal components housed in a metal vault. In commercial systems, the internal components are typically housed in a concrete vault. The metal vault of the test unit is equivalent to commercial concrete vaults in all key dimensions. The use of a metal vault was proposed for testing convenience, since it allows for the addition of a port that can be used for sediment removal. The test unit was equipped with a 24” diameter access port with an invert 12” above the floor to access the sump to allow for easy recovery of captured sediment. The port contains a plug to maintain a smooth inner wall. Using metal in lieu of concrete did not have an impact on system performance.

Two test units were used during testing: one unit for sediment removal efficiency and hydraulic testing and one unit for scour testing. The SurgeSettler 90° unit used for sediment removal efficiency and hydraulic testing is hereinafter referred to as the West unit. The SurgeSettler 90° unit used for scour testing is hereinafter referred to as the East unit. The two units were identical except that the East unit was taller to accommodate the higher water surface elevations created by the scour flow rates. **Figure 3** is a profile view of the test unit. **Figure 4** is a plan view of the test unit. Additional dimensions are provided in **Table 1**. This unit had a total sump area of 84 ft² and a *target* maximum treatment flow rate (MTFR) of 7.58 cfs (3402 GPM).

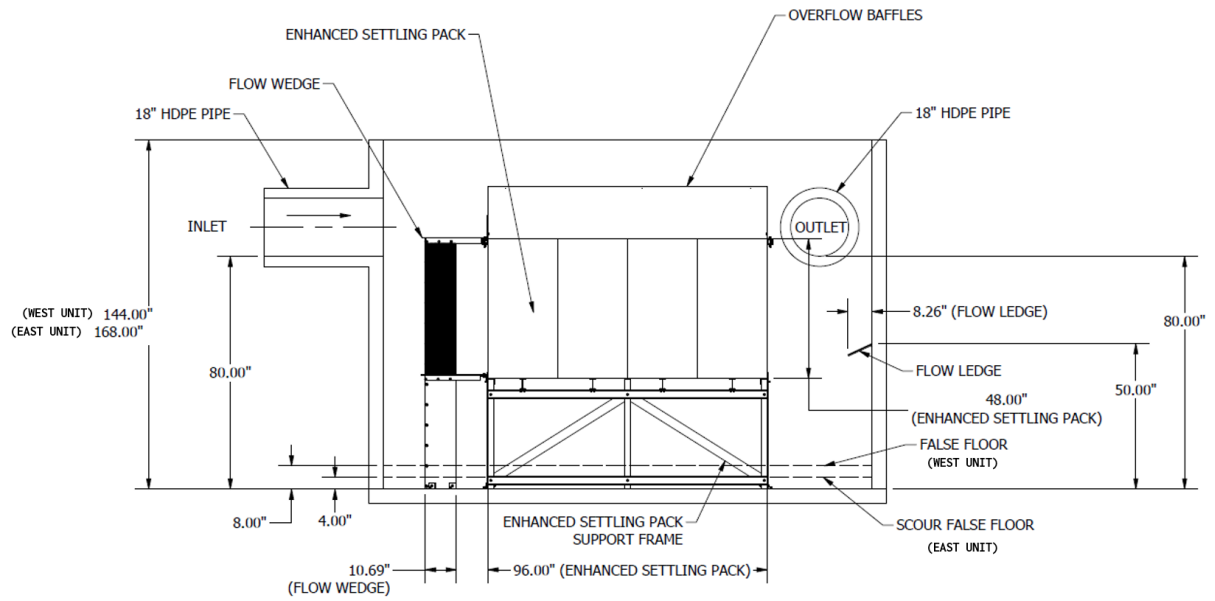


Figure 3 - SurgeSettler 90° Unit Elevations

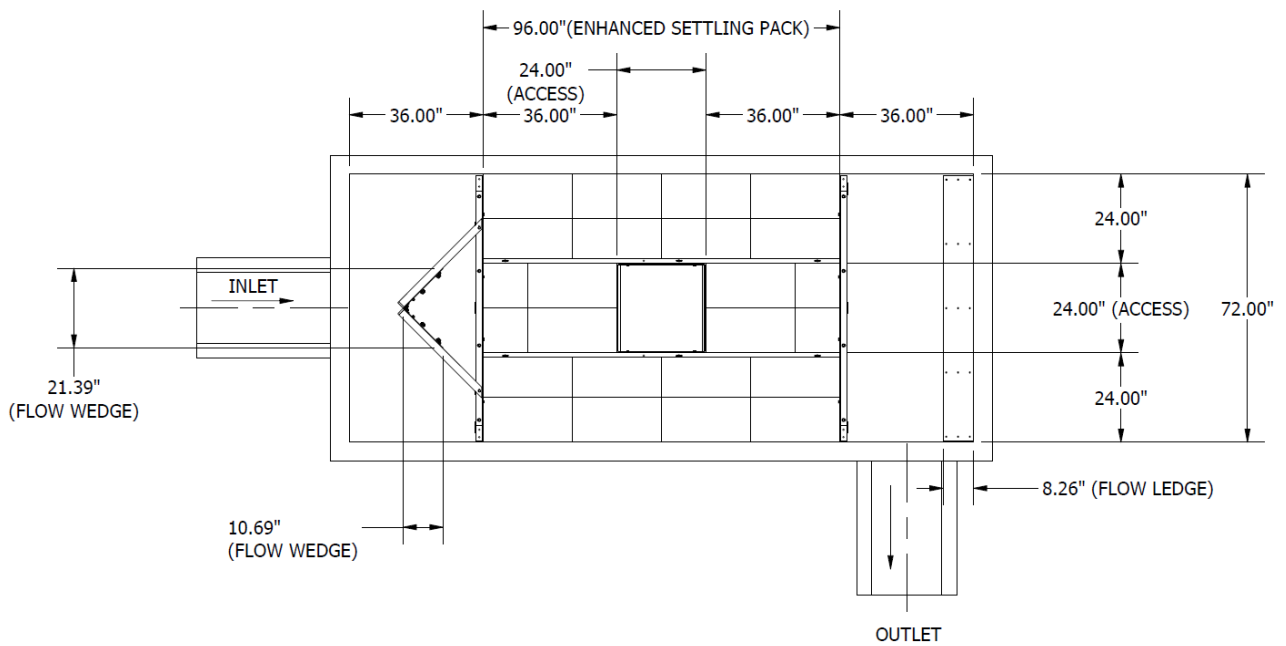


Figure 4 - SurgeSettler 90° Unit Plan View

Table 1- SurgeSettler 90° Dimensions

MTFR (target)		Physical Exterior Dimensions			Physical Interior Dimensions			Effective Sedimentation Treatment Area (ft ²)
cfs	GPM	Length (ft)	Width (ft)	Depth (ft)	Length (ft)	Width (ft)	Depth from Invert (ft)	
7.58	3402	15	6.83	12	14	6	6.67	84

2.2 Test Set Up

Test Loop 1, illustrated in **Figure 5**, operated as a recirculating closed looped system, comprised of a test pool (approximate 95,000-gallon capacity), pumps, sediment filter, flow meter, auger feeder, and the West test unit. The test loop used was capable of moving water at a rate of approximately 4670 GPM (10.4 cfs). Test Loop 1 was used for sediment removal efficiency tests and hydraulic testing from 10% MTFR to 125% MTFR.

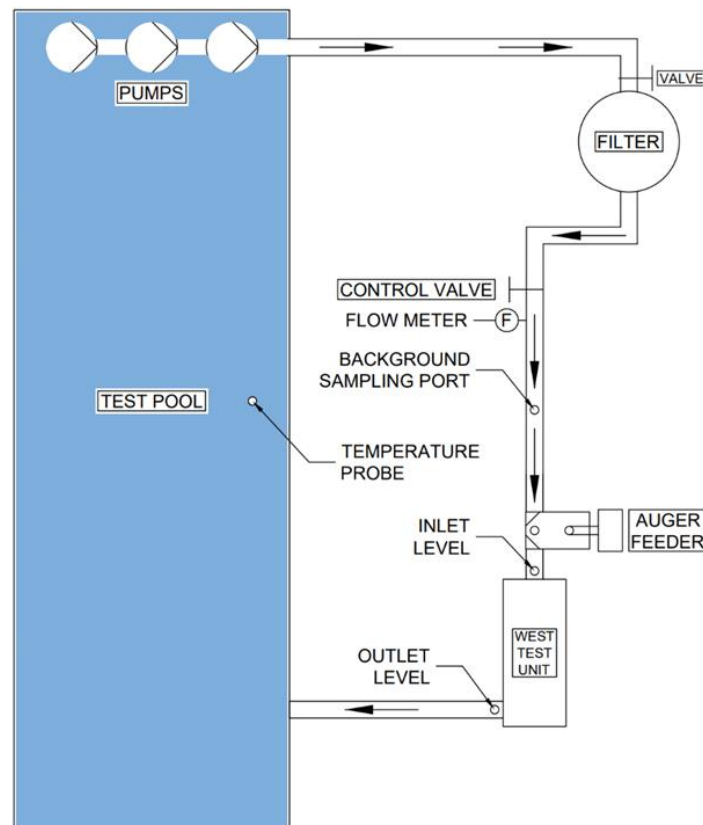


Figure 5 - Test Loop 1 “Low Flow” Laboratory Set Up

Shown in **Figure 6** through **Figure 9** are the sediment addition port, background sampling port, SurgeSettler 90° access port, and the outlet pipe, respectively.



Figure 6 - Sediment Addition Port



Figure 7 - Background Sampling Port Loop 1



Figure 8 - SurgeSettler 90° Unit Access Port



Figure 9 - SurgeSettler 90° Outlet Pipe

When testing with Test Loop 1, all equipment was calibrated and connected via wired or wireless transmission to the Prosoft data acquisition system which collected and recorded outputs from each instrument. Data collection intervals for each device were input as required by the NJDEP protocol. The system was synced with a NIST timekeeping device to ensure all data points were accurately timestamped and synchronized into a centralized CSV file.

When configured in Test Loop 1, water was pumped from the test pool using a single or a series of the following pumps to achieving the desired flow rate: Tsurumi Model KTV2-15 2HP Semi-Vortex Dewatering Pump, Tsurumi Model KTV2-55 7.5 HP Semi-Vortex Dewatering Pump, Tsurumi Model KRS822L-61 30HP High Volume Dewatering Pump, Tsurumi Model GSZ2-75-4L 100HP High Volume Dewatering Pump. Water from the test pool was pumped through a 12" PVC pipe into a Fil-Trek Model ELP50-3012-12F-A-15 filter housing containing bag filters with a rating of 1 micron (μm) for flows below 3000 GPM or 25 μm or 50 μm bag filters for flows above 3000 GPM. From the filter housing, the water flowed through a straight horizontal run of 12" diameter PVC pipe.

Flow measurements for Test Loop 1 were taken using a calibrated Krohne Enviromag 2300 C Optiflux KC 2000F electromagnetic flow meter with a measurement accuracy of $\pm 0.1\%$. The flow meter was installed away from flow disturbances on the horizontal run of 12" diameter PVC pipe downstream of the filter vessel, where full flow was achieved. The flow meter was installed in accordance with the manufacturer's instructions. The flow meter was set to collect data every 30 seconds via the Prosoft data acquisition system.

Background samples were taken from a sampling port in a section of 12" PVC vertical pipe downstream of the flow meter and upstream of the sediment addition point. The background sampling port was fashioned from a $\frac{3}{4}$ " copper pipe with a 90° fitting placed in the centerline of the vertical pipe with a ball valve to open and close the port. The 18" diameter PVC inlet pipe was connected to the vertical pipe section and was 252" long and installed with a 1.6% slope. The 18" PVC outlet pipe was 60" long and installed with a 1.1% slope. The outlet pipe terminated with a free-fall directly back into the test pool.

To meet the flow requirements for the 150% MTRF sediment removal efficiency run, additional hydraulic testing, and scour testing, supplemental external pumps, pipes and filter housings were integrated, and the loop configuration was revised as shown in **Figure 10** and **Figure 11**. Test Loop 2 was configured for use with the West unit and Test Loop 3 was configured for use with the East unit. Both Test Loop 2 and Test Loop 3 also operated as a recirculating close looped system comprised of the test pool, pumps, sediment filters, flow meter, and an auger feeder. Test Loop 2 and Test Loop 3 were capable of moving water at a rate of approximately 8,000 GPM (17.8 cfs).

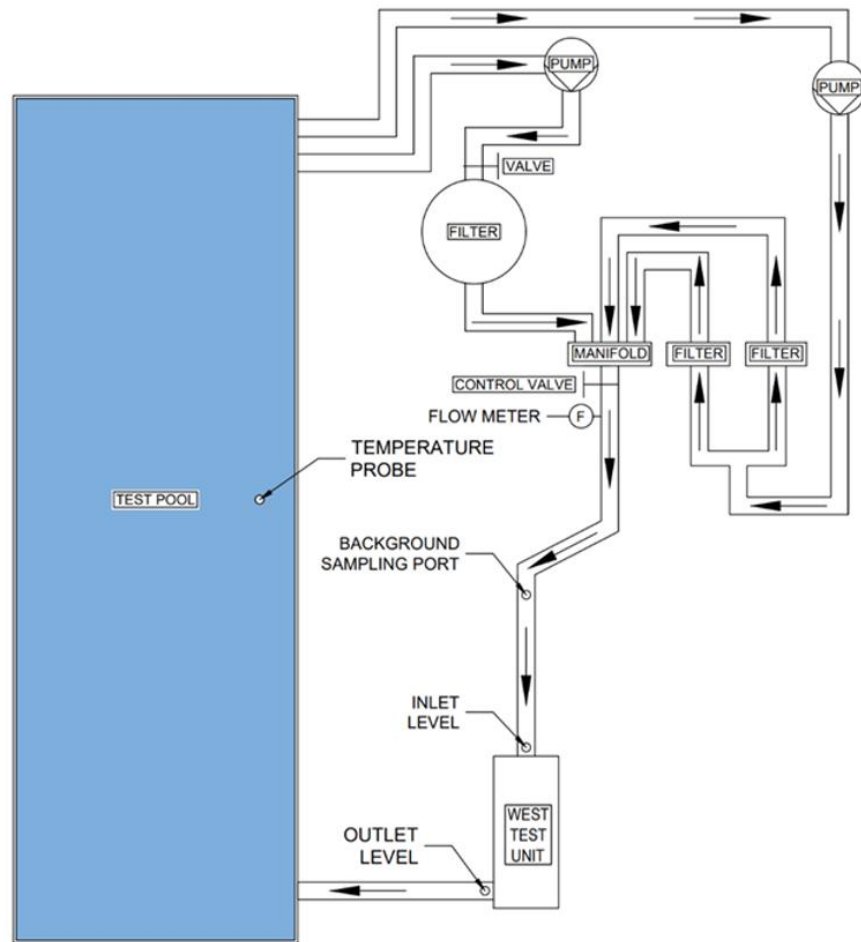


Figure 10 - Test Loop 2 “High Flow” Laboratory Set Up

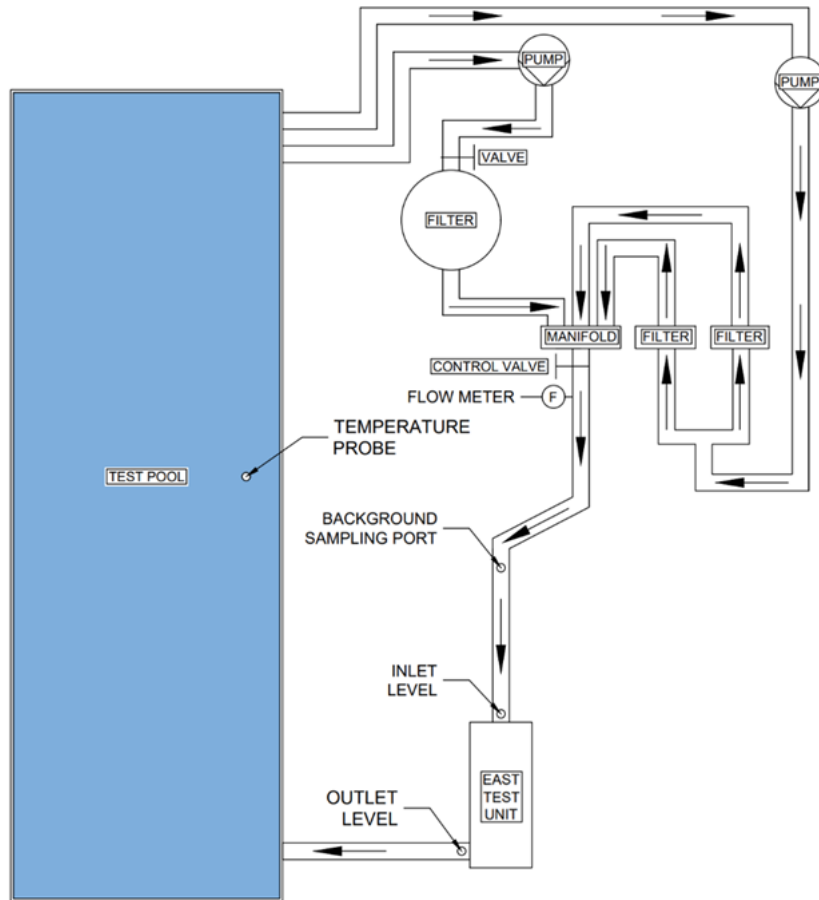


Figure 11 - Test Loop 3 “High Flow” Laboratory Set Up

Figure 12 and **Figure 13** show the background sampling port and SurgeSettler 90° access port for Test Loops 2 and 3.



Figure 12 - Background Sampling Port Test Loop 2 and 3



Figure 13 - SurgeSettler 90° Unit and Access Port Test Loop 2 and 3

When configured in Test Loop 2 and Test Loop 3, water was pumped from the test pool using two Rain for Rent BBA Pumps Model BA350E D370 with John Deere Engine Model 6068CI550. One 12" HDPE pipe was used to pump water from the test pool through a Fil-Trek Model ELP50-3012-12F-A-15 filter housing containing bag filters with a rating of 25 μm or 50 μm . From the filter housing, a 12" diameter polypropylene flex pipe with non-corrugated interior walls was connected to a valve manifold.

An additional 12" diameter HDPE pipe was installed to convey water from the test pool to a tee connection, which distributed the flow into two 12" diameter polypropylene flexible pipes with a non-corrugated interior. The flex pipes directed water through the following two Rain for Rent Model BF2000 filter housings both installed with 25 μm or 50 μm bag filters. From each filter housing, a 12" diameter polypropylene flex pipe with a non-corrugated interior was connected to the valve manifold. From the valve manifold, water was directed through a single straight horizontal run of 18" diameter HDPE pipe.

Flow measurements for both Test Loop 2 and Test Loop 3 were taken using a calibrated Greyline Transit Time Flow Meter (TTFM) 1.0 with a measurement accuracy of $\pm 1\%$ configured to take readings every 30 seconds. The TTFM 1.0 was not configured for data output to the Prosoft data acquisition system thus data was retrieved directly from the unit's internal datalogger. The TTFM

1.0 was installed on the section of straight 18" HDPE pipe where full flow was achieved to ensure the location complied with manufacturers specifications.

For Test Loop 2, the horizontal run of pipe from the valve manifold was connected to another straight run of 18" HDPE pipe then up to a vertical section of 18" diameter HDPE pipe downstream of the flow meter and upstream of the West unit containing the background sampling port. The inlet pipe was connected to the vertical pipe section. The inlet pipe to the unit was PVC, 18" in diameter, 252" long and installed with a 1.6% slope. The outlet pipe was 18" in diameter, 60" long and installed with an 1.1% slope. The outlet pipe was terminated with a free-fall directly back to the test pool.

For Test Loop 3, the horizontal run of pipe was connected to a vertical section of 18" diameter HDPE pipe downstream of the flow meter and upstream of the East unit containing the background sampling port. The inlet pipe was connected to the vertical pipe section. The inlet pipe was PVC, 18" in diameter, 252" long and installed with a 1.6% slope. The outlet pipe was 18" in diameter, 60" long and installed with a 1.1% slope. The outlet pipe was terminated with a free-fall directly back to the test pool.

Sediment Addition and Collection

For all three test loops, sediment addition was done through a funneled port on the crown of the influent pipe 23" upstream of the SurgeSettler 90° unit. The sediment feeder was an Acrison volumetric screw feeder. Sediment feed samples were collected in clean 1L wide-mouth bottles.

Sample Collection

Background samples were collected from the sample ports described above for each test loop. Wide-mouth, 0.5-gallon jars were used for background sample collection. The background sampling port was opened for a minimum of 3 seconds prior to the start of sample collection to flush the sampling port of any accumulated sediment.

For the scour test, effluent samples were taken by hand via grab sampling. Wide-mouth, 0.5-gallon jars were used for effluent sample collection. Removal efficiency was determined by mass recovery; no effluent samples were collected for removal efficiency analysis.

Duplicate samples were collected for background and effluent samples. The primary set was analyzed and reported while the second set was held under refrigerated conditions at the third-party testing laboratory in case there was a need for investigation of any aberrant results.

Water Temperature

Water temperature measurements for all tests were obtained using a temperature probe calibrated against a calibrated Madgetech Microtemp datalogger. Temperature readings were collected every 30 seconds via the Prosoft data acquisition system to ensure the water temperature did not exceed 80.0°F. A Pentair Model ETi 400 heater was used to regulate the test pool temperature. Throughout the duration of all tests completed, the water temperature remained under 80.0°F.

Head loss

The Prosoft data acquisition system was configured to record upstream, downstream and differential water surface elevation measurements every 30 seconds during hydraulics testing.

Water surface elevation levels were measured in the influent and effluent pipes to determine head loss across the unit. Piezometer taps were placed on the invert of the influent and effluent pipe one pipe-diameter upstream and downstream of the test unit, respectively. Each piezometer tap was connected to a 6" diameter clear PVC tube with a calibrated Vega VEGAPULS 31 radar level sensor installed to the top of the tube per the manufacturer's specifications. The Vega VEGAPULS 31 radar level sensors measured water surface elevation to a precision of ± 2 mm.

Additional Instrumentation and Measurement

Run and sampling times were measured using a NIST timekeeping device connected to the Prosoft data acquisition system in addition to NIST traceable calibrated stopwatches.

Sediment feed samples, non-ferrous pans, filter bags and calibration sampling jar tare weights were weighed on an Ohaus Ranger 3000 Model R31P3 scale with a precision of 0.1 g. Sediment that was added to the auger feeder and the sediment recorded following each run was weighed on a Cole Parmer IPS-300-400 balance with a precision of 0.02 lbs. Scales were verified each day prior to use using calibrated NIST traceable verification weights.

2.3 Test Sediment

Removal Efficiency Test Sediment

The test sediment used for removal efficiency testing (1-1000 μ m) was comprised of high purity silica blended to have a Particle Size Distribution (PSD) that meet the required tolerances specified in Section 4.A. of the test protocol for "TSS Removal Efficiency" as well for Sediment A specifications in ASTM E3317-22 "Standard Specification for Silica-Based Sediments for the Evaluation of Stormwater Treatment Devices." The test sediments were blended at the StormTrap Research and Development laboratory facility. Internal sediment blend lot numbers used for testing were 24C-02, 25A-04, 25B-01 and 25D-01. Upon completion of blending, three random samples of each sediment lot were taken in accordance with ASTM E3317-22 under third-party observation. The final blended sediment lots were stored in 5-gallon buckets security sealed under the observation of the third-party observer until needed.

The samples for each of the sediment blends were analyzed for PSD by a qualified 3rd party analytical laboratory, GeoTesting in Acton, MA (A2LA, AASHTO, and USACE accredited). Testing was conducted in a manner consistent with ASTM D6913-17, "Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis" and ASTM D7928-21 "Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis." A COC form accompanied all samples analyzed. The test results for each lot of sediment are summarized in **Table 2** through **Table 5** below. Test results are shown graphically in **Figure 14**. Sediment lots were blended when transitioning between lots. Where required, particle size data had been interpolated to allow for comparison to the required particle size. Per "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (January 1, 2021, Last Updated April 25, 2023), a measured value may be lower than a target minimum percent less than value by up to two percentage points (e.g., at least

3% of the particles must be less than 2 microns in size [target is 5%] provided that the measured d_{50} value does not exceed 75 microns for total suspended solids (TSS) test removal efficiency PSD.

Table 2 - Particle Size Distribution of 1-1000 μm Test Sediment Lot 24C-02

Particle Size (μm)	Test Sediment Particle Size (% Passing)				NJDEP Specification (Minimum % Passing)
	Sample 1	Sample 2	Sample 3	Average	
1000	99	99	99	99	100
500	95	95	95	95	95
250	92	92	92	92	90
150	72	77	77	75	75
100	57	58	59	58	60
75	51	52	53	52	50
50	47	46	46	46	45
20	37	34	34	35	35
8	18	17	18	18	20
5	12	12	12	12	10
2	6	6	6	6	5
d_{50}	65.1 μm	64.1 μm	62.0 μm	64 μm	<75 μm

Table 3 - Particle Size Distribution of 1-1000 μm Test Sediment Lot 25A-04

Particle Size (μm)	Test Sediment Particle Size (% Passing)				NJDEP Specification (Minimum % Passing)
	Sample 1	Sample 2	Sample 3	Average	
1000	98	98	98	98	100
500	93	93	94	93	95
250	89	90	90	90	90
150	74	75	77	75	75
100	59	59	60	59	60
75	54	54	55	54	50
50	50	49	50	50	45
20	35	37	35	36	35
8	17	18	18	18	20
5	13	11	11	12	10
2	4	4	5	4	5
d_{50}	48.2 μm	51.5 μm	46.8 μm	49 μm	<75 μm

Table 4 - Particle Size Distribution of 1-1000 μm Test Sediment Lot 25B-01

Particle Size (μm)	Test Sediment Particle Size (% Passing)				NJDEP Specification (Minimum % Passing)
	Sample 1	Sample 2	Sample 3	Average	
1000	98	98	98	98	100
500	94	93	94	94	95
250	90	89	89	89	90
150	75	75	72	74	75
100	59	59	59	59	60
75	54	54	54	54	50
50	48	48	48	48	45
20	34	32	34	33	35
8	18	18	17	18	20
5	12	12	12	12	10
2	4	4	5	4	5
d ₅₀	52.5 μm	55.7 μm	53.8 μm	54 μm	<75 μm

Table 5 - Particle Size Distribution of 1-1000 μm Test Sediment Lot 25D-01

Particle Size (μm)	Test Sediment Particle Size (% Passing)				NJDEP Specification (Minimum % Passing)
	Sample 1	Sample 2	Sample 3	Average	
1000	98	98	98	98	100
500	96	96	96	96	95
250	93	93	93	93	90
150	77	77	76	77	75
100	59	60	59	59	60
75	56	56	55	56	50
50	52	52	51	52	45
20	40	41	39	40	35
8	22	21	21	21	20
5	15	13	15	15	10
2	8	7	7	7	5
d ₅₀	32.4 μm	32.3 μm	34.9 μm	33.2 μm	<75 μm

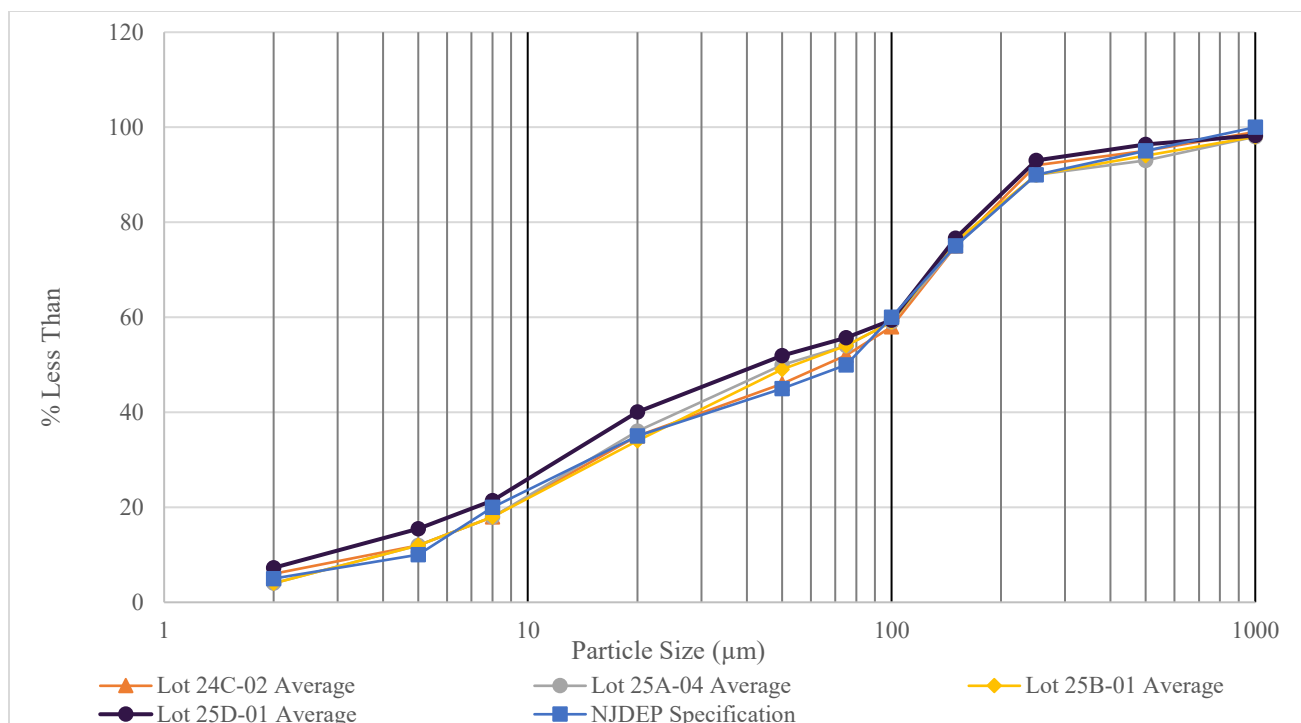


Figure 14 - Particle Size Distribution of 1-1000 µm Test Sediment

The moisture content of the test sediments was also tested at GeoTesting in accordance with ASTM Method D2216-19 “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”. The moisture content for all sample lots was <0.28%. This amount of moisture was considered insignificant and therefore no correction for moisture was made for the sediment mass. The median (d_{50}) was 64 µm, 48 µm, 54 µm, and 33 µm respectively for lots 24C-02, 25A-04, 25B-01, and 25D-01. All lots were finer than the sediment required by the NJDEP protocol and ASTM E3317-22 for Sediment A. All blended test sediment lots were found to meet the NJDEP and ASTM E3317-22 particle size specifications and were deemed acceptable for use.

Scour Test Sediment

The sediment used for scour testing was also comprised of high purity silica blended to have a Particle Size Distributions (PSD) that meet the required tolerances specified in Section 4.A. of the test protocol for “TSS Removal Efficiency” as well as Sediment C specifications per ASTM E3317-22. The test sediment was blended at the StormTrap Research and Development laboratory facility. Internal lot number 25B-04 was used. Upon completion of blending, three random samples of the sediment blend were taken in accordance with ASTM E3317-22 “Standard Specification for Silica-Based Sediments for the Evaluation of Stormwater Treatment Devices” under third-party observation. The final blended sediment was stored in 5-gallon buckets sealed under the observation of the third-party observer until needed.

The samples were also analyzed by GeoTesting in a manner consistent with ASTM D6913-17, “Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis”

and ASTM D7928-21 “Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis”. The test results for the scour blend are summarized in **Table 6** below and shown graphically in **Figure 15**. Where required, particle size data had been interpolated to allow for comparison to the required particle size. Per “New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device” (January 1, 2021, Last Updated April 25, 2023), a measured value may be lower than a target minimum % less than value by up to two percentage points (e.g., at least 3% of the particles must be less than 2 microns in size [target is 5%] provided that the measured d_{50} value does not exceed 230 microns for sediment scour testing (Sediment C).

Table 6 - Particle-Size Distribution of Scour Test Sediment Lot 25B-04

Particle Size (μm)	Test Sediment Particle Size (% Passing)				NJDEP Specification (Minimum % Passing)
	Sample 1	Sample 2	Sample 3	Average	
1000	100	100	100	100	100
500	95	95	96	95	90
250	60	60	61	60	55
150	43	44	43	43	40
100	25	26	24	25	25
75	15	17	15	16	10
50	9	10	9	9	0
20	2	5	5	4	0
8	1	1	1	1	0
5	1	1	1	1	0
2	1	1	1	1	0
d_{50}	185.0 μm	181.2 μm	181.7 μm	183 μm	<230 μm

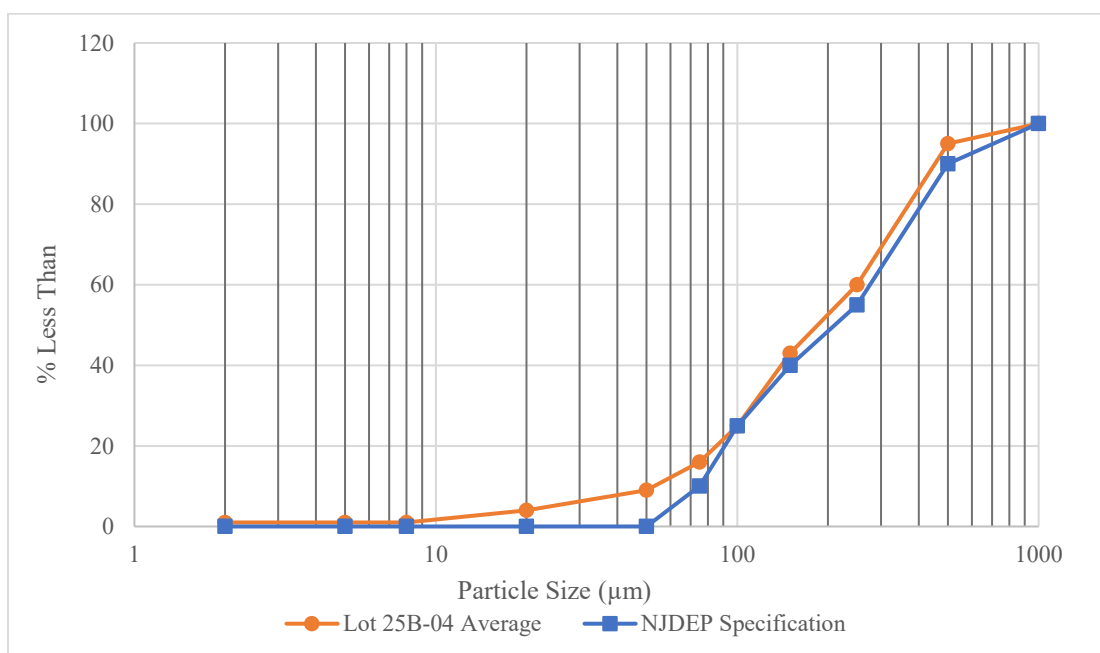


Figure 15 - Particle-Size Distribution of Scour Test Sediment

The moisture content of the test sediment was also tested at GeoTesting in accordance with ASTM Method D2216-19, “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”. The moisture content for lot 25B-04 was 0.10%. This amount of moisture was considered insignificant. The median (d_{50}) was 183 µm, finer than the Sediment C specification in ASTM E3317-22. The scour sediment was found to meet the NJDEP and ASTM E3317-22 particle size specification and was deemed acceptable for use.

2.4. Laboratory Proficiency Testing

Background and effluent samples were analyzed for suspended sediment concentration (SSC) in a manner consistent with ASTM D3977-97 “Standard Test Methods for Determining Sediment Concentration in Water”. All samples were labeled and submitted with a chain of custody (COC) form. Samples were analyzed by Gabriel Environmental Services (GES) in Chicago, IL (NELAP accredited).

As GES is not accredited specifically for ASTM D3977-97, a proficiency test was conducted in accordance with Section 3.B Laboratory Proficiency of the NJDEP protocol. Spiked samples were created at the StormTrap Research and Development laboratory facility at a concentration of 20.0 ± 5.0 mg/L and 50.0 ± 5.0 mg/L under observation of the third-party observer. Samples at each known concentration were prepared in triplicate. Results for the six spiked samples are provided below in **Table 7**.

Table 7 - SSC Proficiency Sample Results

Sample Number	Known Sample Concentration (mg/L)	Laboratory Reported Sample Concentration (mg/L)	Percent Recovery	Average Recovery (%)	COV
1	20.4	17.7	86.8	92.5	0.06
2	20.0	20.0	100.		
3	20.7	18.8	90.8		
4	49.3	47.9	97.2	97.5	0.01
5	50.1	48.9	97.6		
6	50.7	49.5	97.6		

The average SSC recovery results were within the $\pm 15\%$ of the two known concentrations and the COV at the two concentration levels was ≤ 0.2 ; therefore, GES passed the Laboratory Proficiency Testing for SSC analysis per ASTM D3977-97.

2.5. Hydraulic Testing

Hydraulic testing of SurgeSettler 90° was conducted on a clean unit, free of sediment, with a false floor installed at 8", the 50% level of the maximum sediment storage depth. Water flow and corresponding water surface elevation levels were measured in the influent and effluent pipes to determine head loss across the unit. Piezometer taps were placed on the invert of the influent and effluent pipe one pipe-diameter upstream and downstream of the test unit, respectively. Each piezometer tap was connected to a 6" diameter clear PVC tube 40" in length with a calibrated Vega VEGAPULS 31 radar level sensor installed to the top of the tube per the manufacturer's specifications. Head loss measurements were taken spanning flows from 10 to 200% of the MTRF.

2.6 Sediment Removal Efficiency Testing

A total of seven removal efficiency tests were completed in accordance with the NJDEP protocol. Sediment removal efficiency testing was conducted at 10%, 25%, 50%, 75%, 100%, 125% and 150% of the **target** maximum treatment flow rate (MTRF) of 7.58 cfs. A false floor was installed at 8" above the base of the unit to simulate a 50% sump full condition for all removal efficiency test runs. The flow rates were held within $\pm 10\%$ of the target value with a COV ≤ 0.03 . Flow rates were recorded once every 30 seconds. Flow continued for one detention time after sediment feed was stopped to allow sediment to pass through the unit that may not normally be captured. Water temperature was recorded every 30 seconds and did not exceed 80.0°F during any test run.

A minimum of 25 lbs. of sediment was fed into the unit in each run at a target concentration of 200. mg/L (180. - 220. mg/L). The sediment added during a run was determined by weighing the amount of sediment put into the hopper before and after each run and correcting for the sediment feed calibration samples taken. Both the pre-run and post-run sediment weights were measured to the nearest 0.02 lbs. No sediment was pre-loaded into the test unit for the sediment removal efficiency test runs. Six sediment feed calibration samples were collected and weighed to the

nearest 0.1 g at evenly spaced intervals during each run to ensure the feed rate was stable and within the COV limit of ≤ 0.10 per the NJDEP protocol. All feed samples taken were above 20.0 g and collection times did not exceed one minute.

A total of 16 background samples (8 samples taken in duplicate) were collected at evenly spaced intervals during each run. All background samples collected surpassed the 500 mL minimum per the NJDEP HDS protocol. All background samples were security sealed immediately after collection under third party observation. All background samples collected were sent with a COC form to Gabriel Environmental Services for analysis in accordance with ASTM D3977-97.

Following the end of each test run, the unit was decanted and additionally filtered via a pre-weighed 1.0 μm single bag filter. Filtered water was then returned into the test pool. The mass collected within the filter bag was counted towards the total mass collected in the MTD.

For all sediment removal efficiency tests run, the unit was cleaned the following business day under the observation of the third-party observer. Due to this, access points of the unit and filtration equipment were security sealed under third-party observation ensuring that the unit was not tampered with after the test run and prior to cleaning of the unit (**Figure 16**).

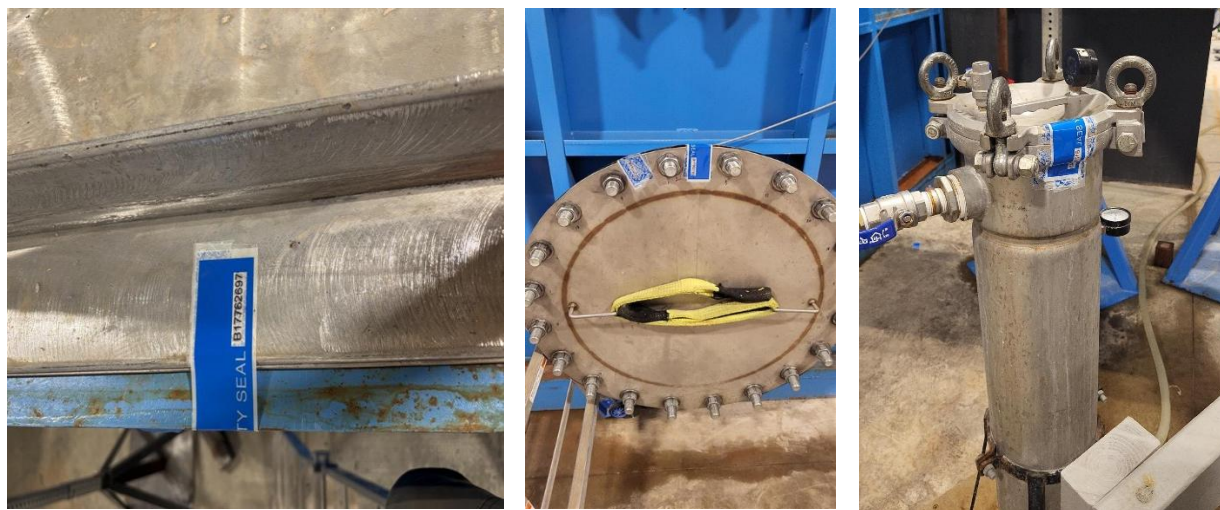


Figure 16 - Unit Security Seals

When cleaning, the decanted unit was opened, and any sediment/slurry remaining in the test unit was removed and transferred to pre-weighed nonferrous trays for drying. The filter bag was also removed from the housing and transferred to a pre-weighed nonferrous tray for drying. Any sediment remaining in the influent pipe was also collected, weighed and dried separately from the sediment collected in the sump.

The sediment and filter bag were dried in a vented oven not exceeding 100°C (212°F) until constant weight was obtained when cooled to room temperature, as determined by two successive measurements taken no less than two hours apart. When the oven was in use and unattended, the

oven was tagged with a security seal in the presence of the third-party observer. All consecutive weight measurements showed no more than a 0.1% difference in measured mass weighed to a precision of 0.02 lbs.

Removal efficiency was calculated for each MTFR using the following equation:

$$\text{Removal Efficiency (\%)} = \frac{\text{Total Mass Collected in MTD}}{\text{Total Mass Added} - \text{Mass collected in Inlet Pipe}} \times 100$$

All calculations were performed using unrounded intermediate values in accordance with ASTM E29-22 “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications”. Both observed and calculated values presented in this report are rounded and reported to the nearest unit used in expressing the specification limit according to the NJDEP protocol and ASTM E29-22 guidance.

2.7. Scour Testing

Prior to the start of testing, the false floor was set 4” above the bottom of the unit. Four inches of scour test sediment was loaded into the false floor of the unit and leveled, putting the top of the sediment 8” above the bottom of the floor. The final height of the sediment was at an elevation equivalent to 50% of the maximum sediment storage capacity of the unit. After the sediment was loaded, the unit was filled with clear water as to not disturb the sediment, to the invert of the effluent pipe. The unit then sat for 95 hours prior to starting the scour test.

The scour test was performed at 17.5 cfs (7862 GPM), over 200% of the target MTFR. During the scour test, the water flow rate and temperature were recorded once every 30 seconds. Testing was commenced by increasing the flow into the system until the target flow rate was achieved within three minutes of starting the test. Background and effluent sampling began one minute after starting flow. An effluent grab sample was taken once every two minutes, until a total of 15 effluent samples (plus 15 duplicate samples) were collected. A total of eight background samples (plus eight duplicate samples) were taken with every off-numbered effluent sample.

3. Performance Claims

Per the NJDEP verification procedure, the following are the performance claims made by StormTrap LLC and/or established via the laboratory testing conducted for the SurgeSettler 90° Hydrodynamic Separator.

Total Suspended Solids (TSS) Removal Rate

The TSS removal rate of SurgeSettler 90° was calculated using the annualized weighted method required by the NJDEP mass capture HDS MTD protocol. Based on an MTFR of 6.54 CFS (2935 GPM), SurgeSettler 90° achieved an annualized weighted TSS removal of 50.0%.

Maximum Treatment Flow Rate (MTFR)

The tested SurgeSettler 90° 6'x14' unit has a surface area of 84 ft² and a maximum treatment flow rate (MTFR) of 6.54 CFS (2935 GPM). This equates to a hydraulic loading rate of 34.94 GPM/ft².

Maximum Sediment Storage Depth and Volume

The maximum storage depth for SurgeSettler 90° 6'x14' unit is 16 inches which equates to 112 ft³ of sediment storage volume. The 50% storage depth is eight inches which equates to 56 ft³ of sediment storage volume.

Effective Sedimentation Treatment Area (ESTA)

The effective sedimentation treatment area of the unit tested is 84 ft².

Detention Time and Wet Volume

The detention time of SurgeSettler 90° is dependent on flow rate and model size. For the tested SurgeSettler 90° 6'x14' unit at the MTFR of 6.54 cfs, the detention time is 84 seconds. The wet volume of the tested unit was 560.28 ft³.

Online Installation

Based on the laboratory scour testing, SurgeSettler 90° qualifies for online installation.

4. Supporting Documentation

The NJDEP Procedure for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that “copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc.” be included in this section. This was discussed with NJDEP, and it was agreed that as long as such documentation could be made available to NJCAT upon request, it would not be prudent or necessary to include all this information in this verification report. All supporting documentation will be retained securely by StormTrap to be provided to NJCAT or NJDEP upon request.

4.1. Removal Efficiency Testing

The results from all seven runs were used to calculate the overall removal efficiency of SurgeSettler 90°. Sediment removal efficiencies were plotted vs. flow rate to generate a removal efficiency curve from which the MTFR was selected, and an annual weighted removal efficiency was calculated. The total water volume and average flow rate per run were calculated from the data collected from the flow meters. The average influent sediment concentration for each test flow was determined by mass recovery. The amount of sediment fed into the auger feeder hopper during dosing, and the amount remaining at the end of a run, was used to determine the amount of

sediment fed during a run. The sediment mass was corrected for the mass of the six feed rate samples taken during the run. The mass of the sediment fed was divided by the volume of water that flowed through the MTFR during dosing to determine the average influent sediment concentration for each run. A summary of the seven test run results is shown in **Table 8** below.

Table 8 - Sediment Removal Efficiency Based on Captured Sediment

% MTFR	10	25	50	75	100	125	150
Total Mass Added (lbs)	37.68	38.17	37.62	41.60	42.58	42.68	41.78
Total Sediment Feed Calibration Sample Mass (lbs)	3.40	8.50	8.55	8.48	8.74	6.92	8.20
Sediment Retained in Inlet Pipe (lbs)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sediment Delivered to MTD (lbs)	34.28	29.67	29.07	33.12	33.84	35.76	33.58
Sediment Captured in MTD (lbs)	24.63	20.03	13.33	14.52	10.79	9.19	6.39
Removal Efficiency (%)	71.84	67.50	45.85	43.85	31.89	25.71	19.01

The data collected for each removal efficiency run and the corresponding sampling schedules are presented below: sampling schedule, water flow and temperature, sediment feed rate summary,

10% MTFR Data (Table 9 through Table 12 and Figure 17)

Table 9 - 10% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
9.3		2
13.0	2	
18.6		3
26.1	3	
27.9		4
37.2		5
39.1	4	
46.5		6
52.1	5	
55.9		7
65.2	6	8
77.5	End of Testing	
MTD Detention Time = 12.3 minutes Sediment Sampling Time = 1 minute		

Table 10 - 10% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	340	340.92	0.3%	0.002	
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

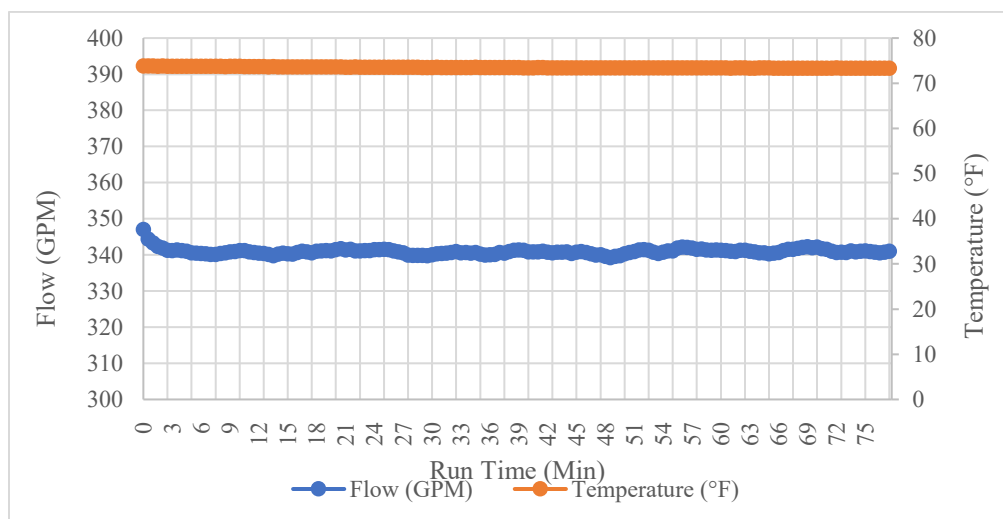


Figure 17 - 10% MTFR Water Flow and Temperature Graph

Table 11 - 10% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	262.6	Starting Weight of Sediment (lbs)	112.6
2	259.3		
3	261.3	Recovered Weight of Sediment (lbs)	74.92
4	249.3		
5	243.3	Mass of Sediment Used (lbs) *	34.28
6	264.8	Volume of Water Through MTD During Dosing (gal)	20,523.47
Average	256.8		
COV	0.033	Average Influent Sediment Concentration (mg/L)	200.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 12 - 10% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L) *								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

25% MTFR Data (Table 13 through Table 16 and Figure 18)

Table 13 - 25% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
3.7		2
5.2	2	
7.4		3
10.4	3	
11.2		4
14.9		5
15.6	4	
18.6		6
20.9	5	
22.3		7
26.1	6	8
31.0	End of Testing	
MTD Detention Time = 4.9 minutes Sediment Sampling Time = 1 minute		

Table 14 - 25% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	851	849.27	-0.2%	0.02	72.5
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

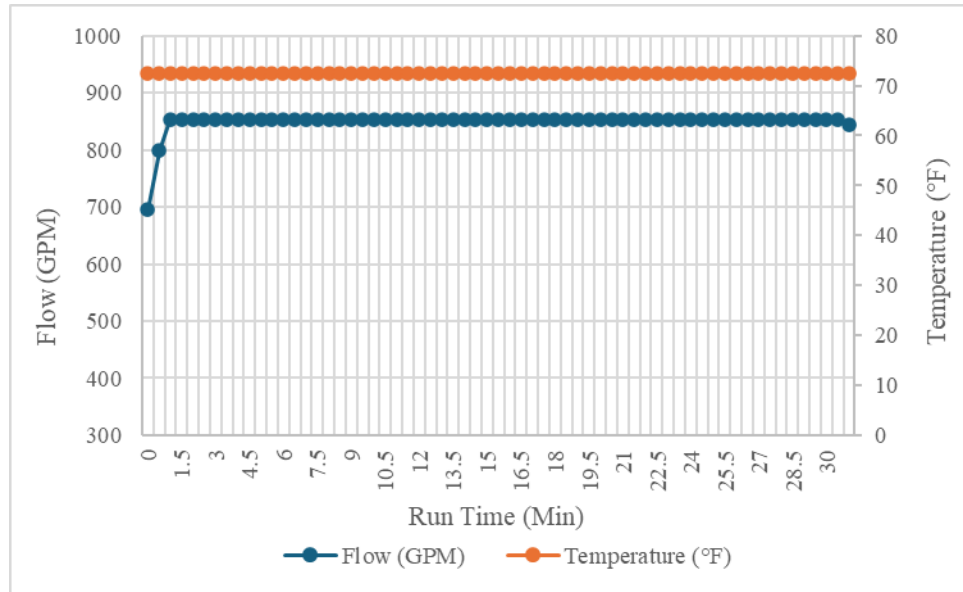


Figure 18 - 25% MTFR Water Flow and Temperature Graph

Table 15 - 25% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	658.1	Starting Weight of Sediment (lbs)	127.58
2	652.2		
3	656.6	Recovered Weight of Sediment (lbs)	89.41
4	640.7		
5	636.4	Mass of Sediment Used (lbs) *	29.67
6	613.0	Volume of Water Through MTD During Dosing (gal)	17,919.61
Average	642.83		
COV	0.026	Average Influent Sediment Concentration (mg/L)	198.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 16 - 25% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L) *								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	2.32	2.23	1.00	1.00	1.00	1.00	1.00	1.00	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

50% MTFR Data (Table 17 through Table 20 and Figure 19)

Table 17 - 50% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
1.9		2
2.6	2	
3.7		3
5.2	3	
5.6		4
7.4		5
7.8	4	
9.3		6
10.4	5	
11.2		7
13.0	6	8
15.5	End of Testing	
MTD Detention Time = 2.5 minutes Sediment Sampling Time = 30 seconds		

Table 18 - 50% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	1701	1703.36	0.1%	0.003	73.2
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

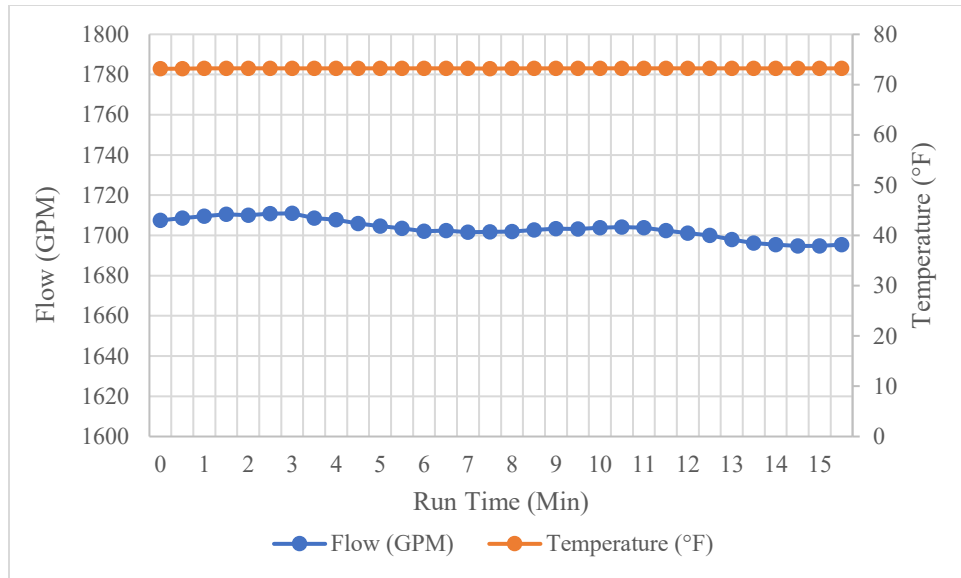


Figure 19 - 50% MTFR Water Flow and Temperature Graph

Table 19 - 50% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	1345.8	Starting Weight of Sediment (lbs)	125.78
2	1344.4		
3	1254.2	Recovered Weight of Sediment (lbs)	88.16
4	1240.6		
5	1312.2	Mass of Sediment Used (lbs) *	29.07
6	1259.8	Volume of Water Through MTD During Dosing (gal)	17,885.28
Average	1292.8		
COV	0.037	Average Influent Sediment Concentration (mg/L)	195.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 20 - 50% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L)*								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

75% MTFR Data (Table 21 through Table 24 and Figure 20)

Table 21 - 75% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
1.4		2
2.0	2	
2.8		3
3.9	3	
4.2		4
5.6		5
5.9	4	
7.0		6
7.9	5	
8.5		7
9.9	6	8
11.5	End of Testing	
MTD Detention Time = 1.6 minutes Sediment Sampling Time = 20 seconds		

Table 22 - 75% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	2552	2533.6	-0.7%	0.02	73.8
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

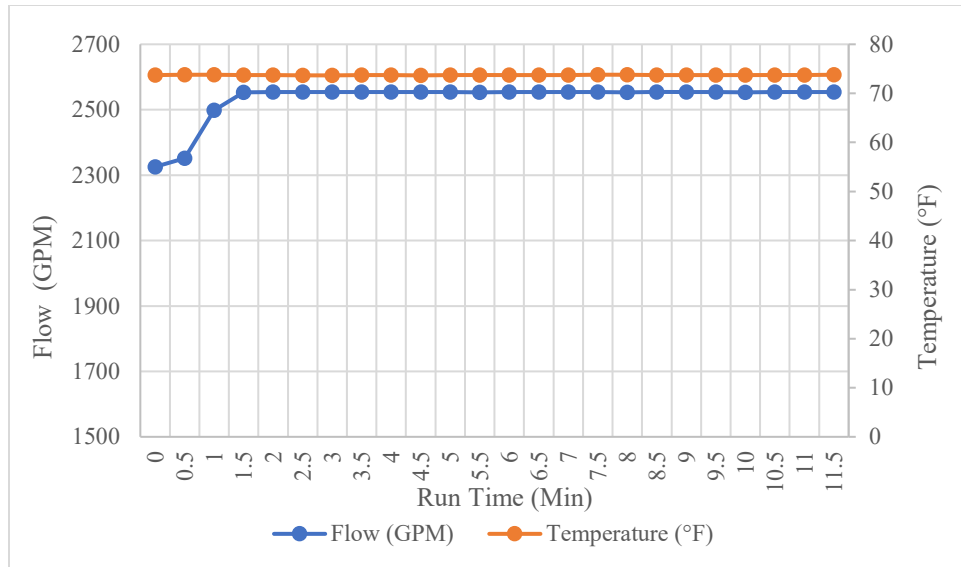


Figure 20 - 75% MTFR Water Flow and Temperature Graph

Table 23 - 75% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	2027.1	Starting Weight of Sediment (lbs)	109.97
2	1980.3		
3	1977.3	Recovered Weight of Sediment (lbs)	68.37
4	1925.1		
5	1813.2	Mass of Sediment Used (lbs) *	33.12
6	1816.5	Volume of Water Through MTD During Dosing (gal)	20,859.98
Average	1923.3		
COV	0.05	Average Influent Sediment Concentration (mg/L)	190.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 24 - 75% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L)*								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	2.31	2.30	2.11	2.34	1.00	2.34	2.71	4.78	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

100% MTFR Data (Table 25 through Table 28 and Figure 21)

Table 25 - 100% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
1.1		2
1.5	2	
2.1		3
3.0	3	
3.2		4
4.2		5
4.4	4	
5.3		6
5.9	5	
6.3		7
7.4	6	8
8.6	End of Testing	
MTD Detention Time = 1.2 minutes Sediment Sampling Time = 15 seconds		

Table 26 - 100% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	3402	3405.63	+ 0.11%	0.002	73.0
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

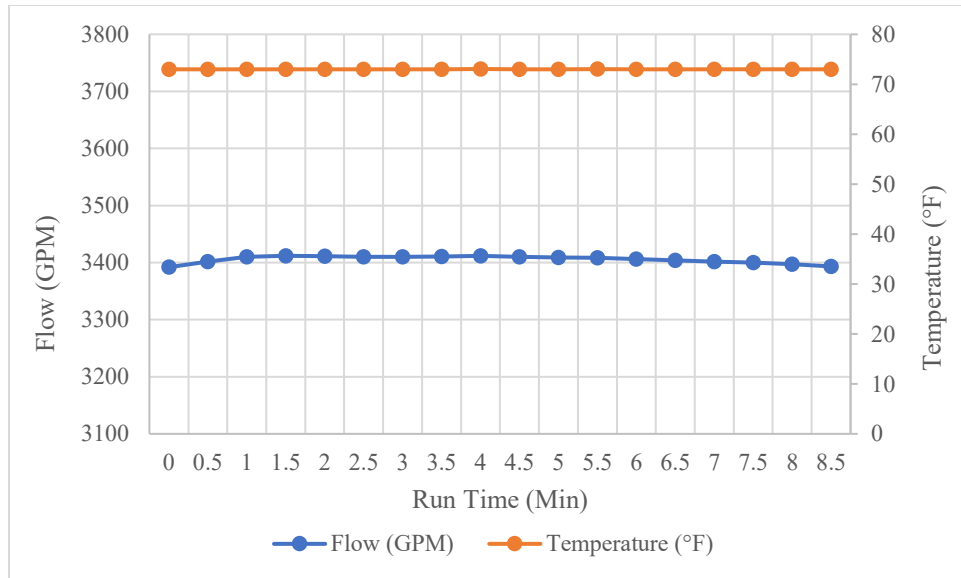


Figure 21 - 100% MTFR Water Flow and Temperature Graph

Table 27 - 100% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	2643.2	Starting Weight of Sediment (lbs)	146.44
2	2660.8		
3	2595.6	Recovered Weight of Sediment (lbs)	103.86
4	2675.6		
5	2736.8	Mass of Sediment Used (lbs) *	33.84
6	2540.4	Volume of Water Through MTD During Dosing (gal)	20,944.60
Average	2642.1		
COV	0.026	Average Influent Sediment Concentration (mg/L)	194.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 28 - 100% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L) *								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	1.00	1.00	1.00	1.00	1.00	1.00	2.51	1.00	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

125% MTFR Data (Table 29 through Table 32 and Figure 22)

Table 29 - 125% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
0.8		2
1.2	2	
1.7		3
2.4	3	
2.5		4
3.4		5
3.6	4	
4.2		6
4.7	5	
5.1		7
5.9	6	8
6.9	End of Testing	
MTD Detention Time = 1.0 minutes Sediment Sampling Time = 10 seconds		

Table 30 - 125% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	4253	4245.64	-0.2%	0.009	73.4
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

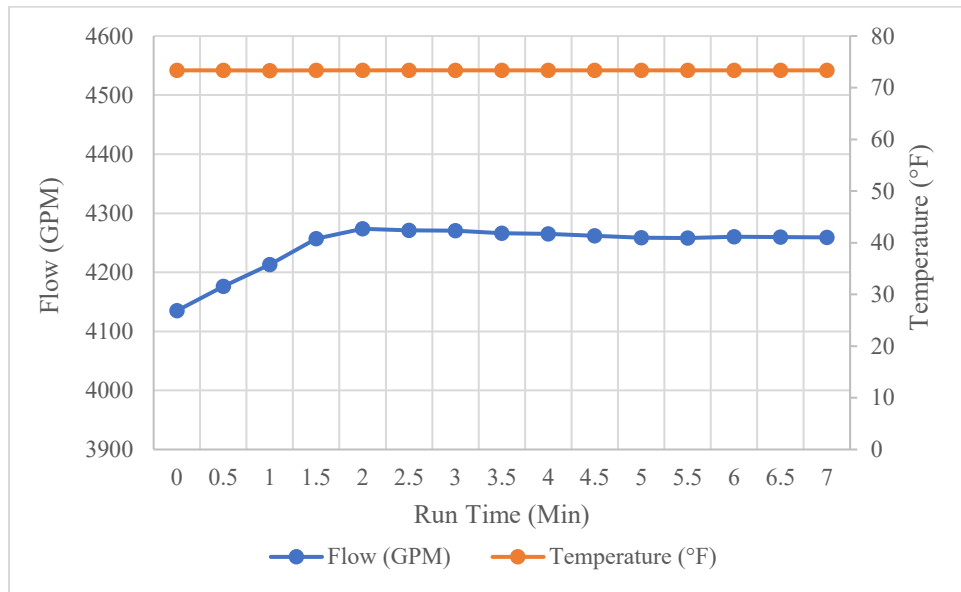


Figure 22 - 125% MTFR Water Flow and Temperature Graph

Table 31 - 125% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	3296.4	Starting Weight of Sediment (lbs)	145.22
2	3123.0		
3	3101.4	Recovered Weight of Sediment (lbs)	102.54
4	3198.6		
5	2996.4	Mass of Sediment Used (lbs) *	35.76
6	3120.0	Volume of Water Through MTD During Dosing (gal)	21,511.26
Average	3139.3		
COV	0.032	Average Influent Sediment Concentration (mg/L)	199.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed rate calibration samples

Table 32 - 125% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L) *								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	3.13	2.64	2.87	2.50	2.58	2.81	2.40	2.76	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

150% MTFR Data (Table 33 through Table 36 and Figure 23)

Table 33 - 150% MTFR Sampling Schedule

Run Time (min)	Sampling Schedule	
	Sediment Feed	Background
0.0	1	1
0.7		2
1.0	2	
1.4		3
2.0	3	
2.1		4
2.8		5
3.0	4	
3.5		6
3.9	5	
4.2		7
4.9	6	8
5.8	End of Testing	
MTD Detention Time = 0.8 minutes Sediment Sampling Time = 10 seconds		

Table 34 - 150% MTFR Water Flow and Temperature

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	5103	5137.74	1%	0.0006	67.2
QA/QC Limit	-	-	± 10% PASS	≤ 0.03 PASS	≤ 80.0 PASS

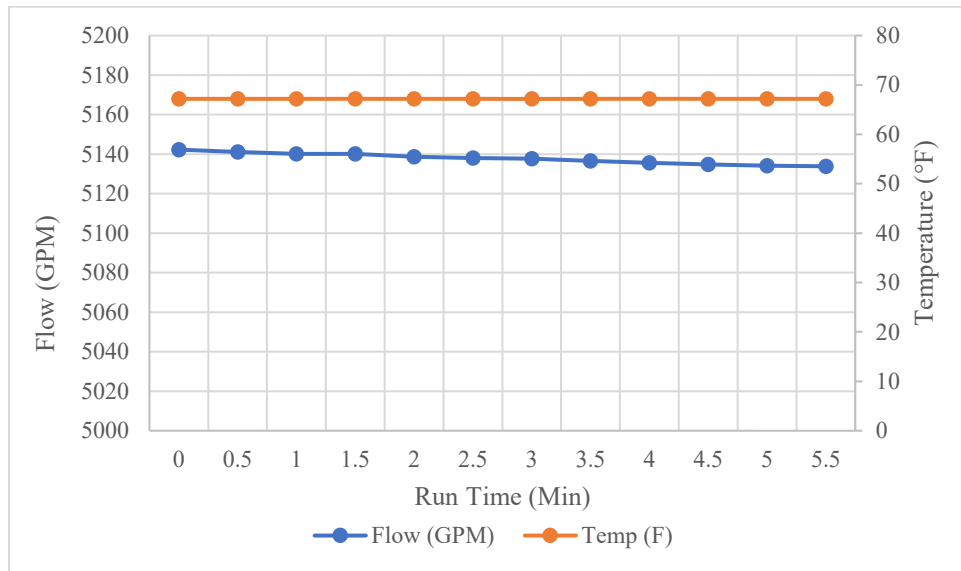


Figure 23 - 150% MTFR Water Flow and Temperature Graph

Table 35 - 150% MTFR Sediment Feed Rate Summary

Sediment Feed Rate (g/min)		Sediment Mass Recovery	
1	3813.6	Starting Weight of Sediment (lbs)	108.58
2	3614.4		
3	3697.8	Recovered Weight of Sediment (lbs)	66.80
4	3690.0		
5	3720.0	Mass of Sediment Used (lbs) *	33.58
6	3768.0	Volume of Water Through MTD During Dosing (gal)	20,893.49
Average	3717.3		
COV	0.018	Average Influent Sediment Concentration (mg/L)	193.
QA/QC Limit	≤ 0.10 PASS	QA/QC Limit	180. - 220. mg/L PASS

*Adjusted for feed samples

Table 36 - 150% MTFR Background SSC Results

Sample #	Suspended Sediment Concentration (mg/L) *								QA/QC Limit
	1	2	3	4	5	6	7	8	
Background	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.9	≤ 20.0 mg/L PASS

*Detection limit is 2 mg/L. All samples < 2 mg/L reported as half the detection limit

4.2. Annualized Weighted Removal Efficiency

A plot was made of the seven removal efficiency runs, and a curve of best fit was obtained using a third-order polynomial ($R^2 = 0.980$) shown below in **Figure 24**. The curve was used to determine the SurgeSettler 90° MTFR and the annualized weighted removal efficiency has been calculated using the rainfall weighting factors provided in the NJDEP protocol. For a MTFR of 6.54 cfs (2935 GPM), the annual weighted removal is 50.0%, as shown in **Table 37**.

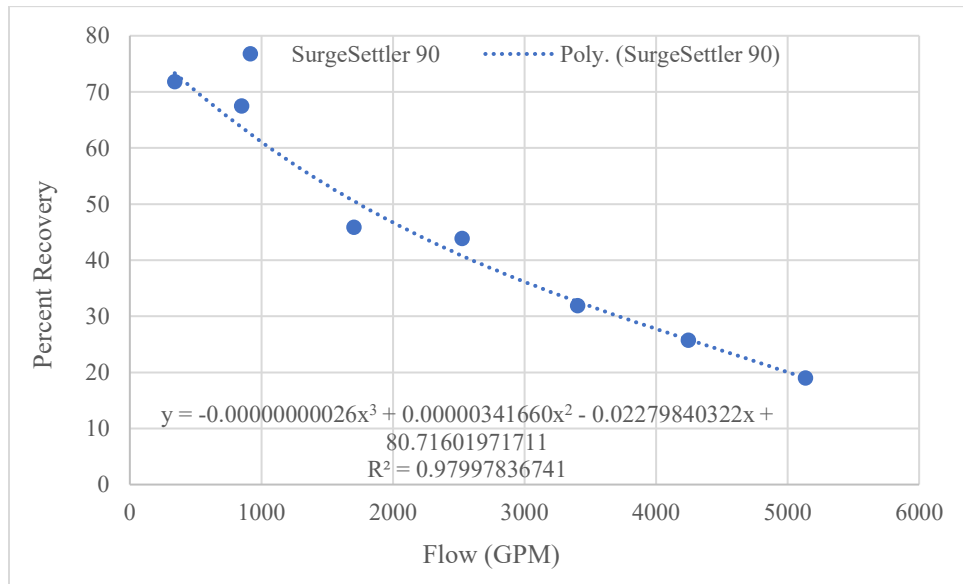


Figure 24 - SurgeSettler 90° Removal Efficiency Curve

Table 37 - Annualized Weighted Removal Efficiency

% MTFR	Flow Rate (GPM)	Removal Efficiency (%)	Annual Weighting Factor	Weighted Removal Efficiency (%)
25	734	65.7	0.25	16.4
50	1468	53.8	0.30	16.1
75	2201	44.3	0.20	8.9
100	2935	36.7	0.15	5.5
125	3669	30.2	0.10	3.0
Annualized Weighted Removal Efficiency				50.0

4.3. Scour Testing

Scour testing was conducted in accordance with Section 5 of the NJDEP protocol. Scour testing was performed with the Test Loop 3 configuration (**Figure 11**). Prior to the start of testing, the false floor was set 4” above the bottom of the unit. Four inches of scour test sediment was loaded into the false floor of the unit and leveled, putting the top of the sediment 8” above the bottom of the floor. No sediment was found to accumulate on the flow ledge during any removal efficiency run, indicating the flow ledge does not serve as a stable area of sedimentation. Therefore, the sediment preload was limited to the main sump area. After sediment loading, the sump was filled with clear water. The water was added in such a way as to avoid disturbance of the sediment bed, to the invert of the inlet pipe. The filled SurgeSettler 90° unit was allowed to sit for a total of 95 hours prior to the commencement of the scour test.

Per the calculated MTFR above, the average scour test flow rate had to be at least 13.1 cfs (5870 GPM). Testing was conducted at a flow rate of 17.5 cfs (7863 GPM), 268% of the calculated MTFR. Scour testing began by increasing the flow rate to the target flow within a 3-minute period. Samples were taken after the commencement of conveying clear water through the MTD. The sampling frequency for background and effluent samples is summarized in **Table 38** below. Scour testing flow and temperature data are reported in **Table 39** and **Figure 25** below.

Table 38 - Scour Test Sampling Schedule

Sample/Measurement Taken	Run Time (Minutes)														
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
Effluent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Background	X		X		X		X		X		X		X		X

Table 39 - Scour Test Water Flow and Temperature

Run Parameters	Maximum Water Temperature (°F)			Maximum Water Temperature (°F)
	Target	Actual	COV	
	5870	7863.19	0.0008	
QA/QC Limit	-	-	0.03 PASS	≤ 80.0 PASS

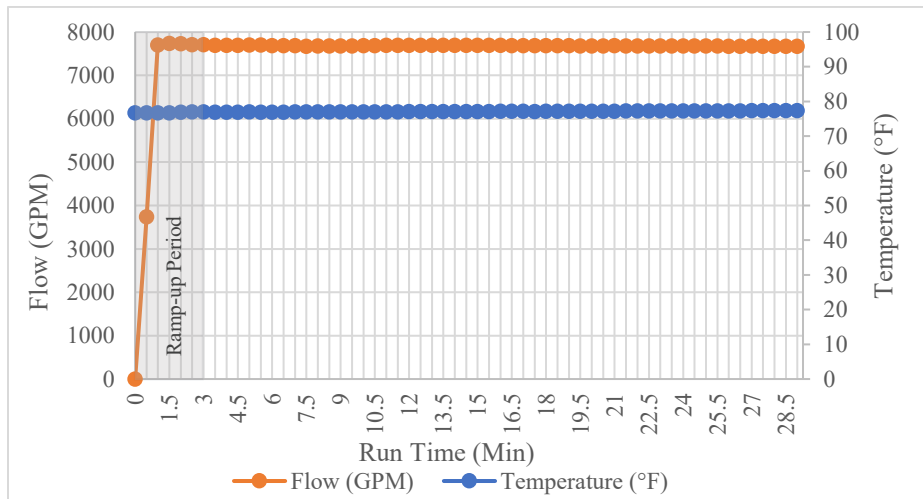


Figure 25 - Scour Test Water Flow and Temperature Graph

The effluent and background SSC results are reported in **Table 40** below. The adjusted effluent concentration was calculated using the following equation:

$$\text{Adjusted Effluent Concentration } \left(\frac{\text{mg}}{\text{L}} \right) = \text{Initial Concentration} - \text{Background Concentration}$$

For effluent samples that did not have a corresponding background sample, the background value was interpolated from the previous and subsequent samples. The average adjusted effluent concentration was 6.9 mg/L at >200% of the MTFR; therefore, SurgeSettler 90° meets the criteria for online use.

Table 40 - Scour Test Suspended Sediment Concentrations

Sample #	Scour Suspended Sediment Concentration (mg/L)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	22.6	17.1	12.7	10.1	8.16	8.69	9.25	8.20	10.9	10.1	9.59	8.23	9.46	10.5	9.71
Background	2.25		2.52		4.27		4.85		4.57		4.85		4.71		4.24
Adjusted Effluent	20.4	14.7	10.2	6.7	3.9	4.1	4.4	3.5	6.3	5.4	4.7	3.5	4.8	6.0	5.5
Average Adjusted Effluent Concentration (mg/L)											6.9				

4.4. Hydraulic Testing

Hydraulic testing of SurgeSettler 90° was conducted on a clean unit free of sediment with a false floor installed at 8" above the floor, corresponding to the 50% level of the maximum sediment storage depth. Water flow and corresponding water surface elevation levels were measured in the influent and effluent pipes to determine head loss across the unit. Piezometer taps were placed on the invert of the influent and effluent pipe one pipe-diameter upstream and downstream of the test unit, respectively. Each piezometer tap was connected to a clear PVC 6" diameter 40" tall tube with a calibrated Vega VEGAPULS 31 radar level sensor installed to the top of the tube per the manufacturer's specifications. Bypass was also observed during hydraulic testing which occurred at 2000 GPM. Head loss measurements across the span of 10 to 200% of the MTRF are shown in

Table 41 and **Figure 26** below. Flow rates up to 4262 GPM (9.50 CFS) were tested using Test Loop 1. Flows above 9.50 CFS were tested using Test Loop 2. Notably, the piezometers were raised to accommodate higher water surface elevations during testing above 9 cfs. Inlet, outlet and differential elevations were adjusted to reflect this change in piezometer height for the respective tests. The velocity reported in **Table 41** is the upstream velocity.

Table 41 - SurgeSettler 90° Hydraulics

Flow Rate		Velocity	$V^2/2g$	Water Surface Elevation (in)		
GPM	CFS	Ft/s	(ft)	h_{inlet}	h_{outlet}	Δh
343	0.76	2.20	0.07	4.52	2.74	1.78
845	1.88	2.35	0.09	8.34	4.69	3.64
1705	3.80	2.68	0.11	13.47	6.82	6.65
2568	5.72	3.24	0.16	17.95	8.68	9.28
3406	7.59	4.29	0.29	22.82	9.83	12.99
4253	9.48	5.36	0.45	27.94	10.23	17.71
5178	11.54	6.53	0.66	33.30	11.70	21.60
7543	16.81	9.51	1.41	47.04	17.94	29.09

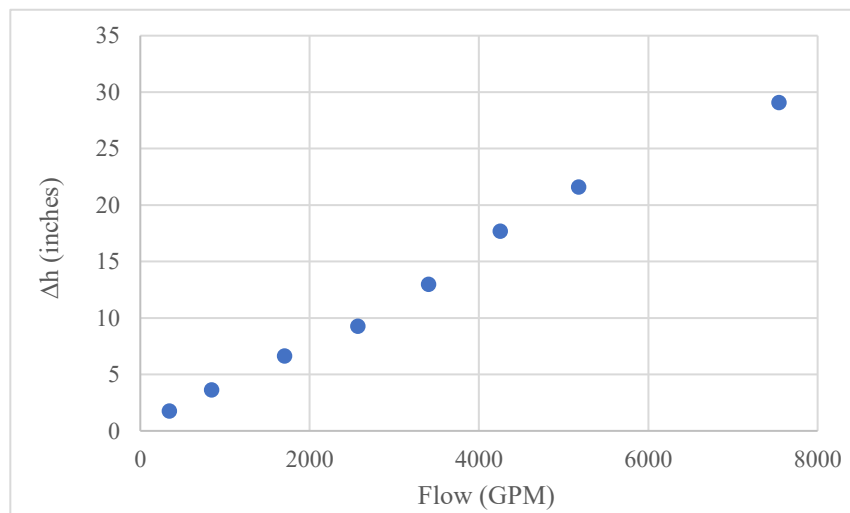


Figure 26 - SurgeSettler 90° Head Loss vs Flow Rate

Figure 27 plots head loss versus $v^2/2g$ for full pipe flow for the purpose of calculating the minor loss coefficient, k_L . In flow where the atmospheric pressure is the same upstream and downstream, Bernoulli's equation can be reduced to:

$$\Delta h = k_L \frac{v^2}{2g}$$

Where Δh = head loss (ft)

k_L = head loss (minor loss) coefficient (dimensionless)

V = velocity (ft/s)

g = acceleration due to gravity, 32.174 ft/s²

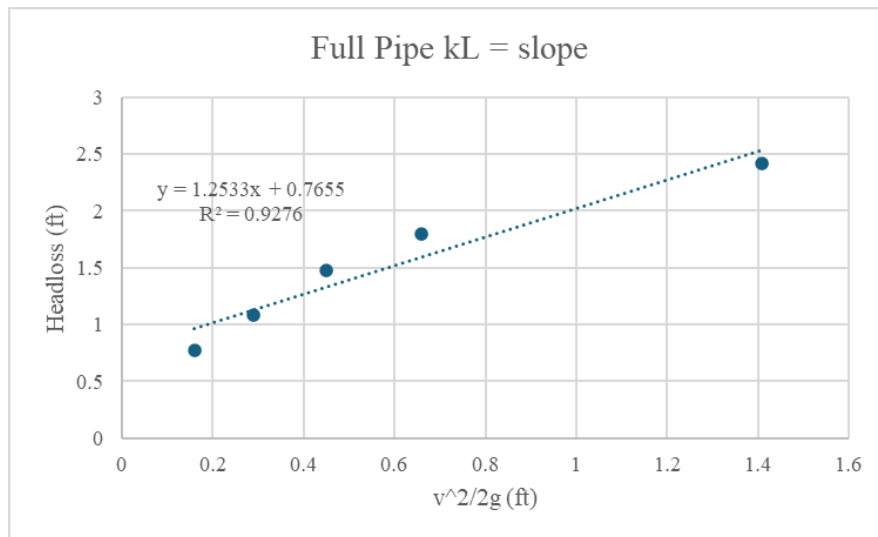


Figure 27 - SurgeSettler 90° Head Loss as a Function of Velocity

4.5. Excluded Results

The NJDEP Verification Procedure requires disclosure and discussion of any data excluded from analysis. Throughout the duration of testing, a total of two runs did not meet the specifications for a passing test per the protocol.

During sediment removal efficiency tests for the 75% MTFR and the 125% MTFR runs, it was visually observed that sediment being fed from the screw feeder was accumulating and clogging within the inlet funnel instead of consistently being delivered into the unit. This obstruction disrupted uniform sediment delivery into the unit at the target concentrations of 200 mg/L as intended by the protocol. The runs were terminated after this error was noted, necessitating a retest for both cases. Prior to re-running the tests, the SurgeSettler 90° unit was emptied of sediment and cleaned thoroughly.

5. Design Limitations

StormTrap's SurgeSettler 90° is an engineered system designed to meet site-specific requirements. Design parameters and limitations are listed below.

Soil Characteristics

SurgeSettler 90° is an enclosed flow-through system that can be installed and function as intended in all soil types. SurgeSettler 90° units are installed in accordance with ASTM C-891 "Standard Practice for Installation of Underground Precast Concrete Utility Structures".

Slope of Drainage Pipe

The system was verified with an inlet pipe slope of 1.6%, in accordance with the protocol and both the inlet and outlet pipe elevations were identical. For pipe slopes greater than 10% the StormTrap Design team will evaluate the site-specific parameters.

Height Above Drainage Pipe

As with all HDS systems, the system requires sufficient height above the drainage pipe elevation. The StormTrap Design team will evaluate site-specific parameters to ensure the device operates as tested.

Maximum Treatment Flow Rate

The maximum treatment flow rate (MTFR) for StormTrap SurgeSettler 90° models is based upon the size of the system as shown in **Table A-1**. Systems shall be sized to a hydraulic loading rate of 34.9 GPM/ft² of effective sedimentation treatment area.

Maintenance Requirements

SurgeSettler 90° systems should be inspected and maintained following the recommendations and guidelines included in the SurgeSettler 90° Operation and Maintenance Manual available at:

<http://stormtrap.com/products/SurgeSettler>

Section 6 of this report includes a detailed description of inspection and maintenance requirements.

Driving Head

SurgeSettler 90° will operate with minimal driving head.

Installation Limitations

StormTrap provides contractors with detailed installation and assembly instructions as well as specific pick weights prior to delivery.

Configurations

SurgeSettler 90° has an internal bypass and can be installed online or offline. The NJCAT/NJDEP verified/certified configuration is an inlet and outlet at 90 degrees.

Structural Load Limitations

SurgeSettler 90° modules are typically designed for HS-20 loading. Contact StormTrap if alternate design loadings are anticipated or required for site-specific conditions.

Pre-treatment Requirements

SurgeSettler 90° has no pre-treatment requirements.

Depth to Seasonal High-Water Table

SurgeSettler 90°'s performance is independent of high groundwater conditions. Contact StormTrap if groundwater is above the system invert for site-specific structural/floatation calculations.

6. Maintenance Plans

The SurgeSettler 90° treatment device, manufactured by StormTrap, is a hydrodynamic separating device designed to capture and store pollutants from stormwater.

SurgeSettler 90°'s maintenance frequency is site-dependent and routine inspections are recommended to ensure that the system is functioning as designed. Please contact your authorized StormTrap representative if you have questions regarding the operation and maintenance of the SurgeSettler 90° system.

Inspection Scheduling

SurgeSettler 90° inspections are important to assess the condition of the system internals to ensure peak performance. The frequency of inspections and maintenance depends on site-specific loading conditions and rainfall frequency. Within the first year of operation, it is recommended that the unit be inspected quarterly to determine the rate of pollutant accumulation to develop a more accurate maintenance schedule. Inspections should be performed during dry weather conditions when no flow is entering the system.

SurgeSettler 90° systems are recommended to be inspected whenever the upstream and downstream catch basins and stormwater pipes of the stormwater collection system are inspected or maintained. If checked on an annual basis, the inspection should be conducted before the stormwater season begins to ensure that the system is functioning properly for the upcoming storm season.

Inspection and Maintenance Equipment

The following equipment is recommended to have during inspections and maintenance:

- SurgeSettler 90° Operation and Maintenance Manual and Inspection Checklist
- Flashlight
- Manhole hook/lifter or pry bar to lift the manhole cover
- Measuring device(s) of sufficient length to reach the bottom of the device's sump
- Proper personal protective equipment
- Adequate traffic control signage
- Pole with skimmer or net (optional for maintenance procedure)
- Vacuum truck or similar trailer-mounted equipment (for maintenance procedure)

Inspection Procedure

Inspections should be scheduled after sufficient time has elapsed since the most recent rain event to allow for a static water condition and when rainfall is not anticipated to occur during the inspection procedure. SurgeSettler 90° does not require entry into the system for inspection or maintenance; however, if entering the system is deemed necessary, it is prudent to note that before entering any underground storm sewer or underground structure, appropriate OSHA and local safety regulations and guidelines should be followed.

To begin the inspection process, set up the necessary traffic control signage per local ordinances. Open all manhole covers using appropriate equipment and ensure the manhole covers are in a location that would not prohibit the inspection process. Visually inspect the system at all manhole access opening locations.

During the visual inspection, ensure that all components are in working order. A checklist is provided within the SurgeSettler Operation and Maintenance Manual for reference at: <http://stormtrap.com/products/SurgeSettler>.

If any components are not working, contact your authorized StormTrap representative. After the components are inspected, visually quantify the accumulation of trash, debris, and hydrocarbons within the system by using a measuring device such as a tape measure, grade stick, dipstick, etc.

For sediment accumulation, utilize either a sludge sampler or a sediment pole to measure and document the amount of sediment accumulation. To determine the amount of sediment in the system with a sludge sampler, follow the manufacturer's instructions. If utilizing a sediment pole or similar device, first insert the pole to the top of the sediment layer and record the depth. Then, insert the pole into the bottom of the system and record the depth. The difference in the two measurements corresponds to the amount of sediment in the system. Alternatively, sediment depth can also be determined by taking a measurement from a known and consistent elevation (manhole frame, pipe invert, vertical baffle top, etc.) to the top of the sediment layer. That distance can then be compared to the measurement between the known elevation to the sump floor. The difference between these two measurements will correspond to the sediment layer depth. After completion of the inspection process, ensure that manhole covers are replaced and securely seated in the manhole frame and remove traffic control signage.

Maintenance Procedure

Maintenance should be done such that sufficient time has lapsed since the most recent rain event to allow for a static water condition and rainfall is not anticipated to occur during the duration of the maintenance procedure. To begin the maintenance process, set up the necessary traffic control signage per local ordinances. Open all manhole covers using appropriate equipment and ensure the manhole covers are in a location that would not prohibit the maintenance process.

Visually inspect the system at all manhole access opening locations. During the visual inspection, ensure that all components are undamaged. If any components are not in working order, contact your authorized StormTrap representative. After the components are inspected, remove all accumulated trash, debris, and hydrocarbons stored on the surface of the water using the vacuum hose or pole with an attached skimmer or net.

To remove sediment, insert the vacuum truck's hose in each of the three access openings. The system should be completely drained, and all sediment should be removed from the sump. If excessive sediment or debris buildup occurs within the device, components can be washed with sewer jetting equipment or a spray lance to remove stubborn materials. Particular attention must be taken when spraying the enhanced settling pack. A wide spray nozzle is recommended around the enchanted settling pack to ensure there is no damage to the material. After completing the maintenance procedure, complete a post-maintenance inspection to ensure that all components are in good condition. Ensure that manhole covers are replaced and securely seated in the manhole frame and remove traffic control signage. Dispose of all pollutants removed during maintenance per local, state, and federal guidelines and regulations.

7. Statements

The following attached pages are signed statements from StormTrap LLC, Spaceco, and NJCAT. These statements are a requirement of the verification process. These statements are a requirement of the verification process. In addition, it should be noted that this report has been subject to public review, and all comments and concerns have been satisfactorily addressed.



May 15, 2026

To: Dr. Richard Magee, Sc.D., P.E. BCEE
Executive Director
New Jersey Corporation for Advanced Technology
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

Subject: SurgeSettler Side Inlet Configuration Laboratory Verification Report –
Manufacturer's Statement of Compliance

Dr. Magee,

StormTrap has completed testing for verification of the SurgeSettler Side Inlet Configuration Hydrodynamic Separator in accordance with the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device", dated January 1, 2021, updated April 25, 2023.

As required by the "NJDEP Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (NJCAT)", dated August 4, 2021, this letter serves as StormTrap's statement that all procedures and requirements identified in the aforementioned protocol and process document were met or exceeded.

If you have any questions or comments regarding this verification, please do not hesitate to contact me.

Sincerely,

A handwritten signature in blue ink that reads 'Greg Williams'.

Greg Williams, PhD., P. Eng.
Director of Water Quality Technology

☎ 862.541.4600
✉ info@stormtrap.com

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287 Bradford Turnpike
Toms River, NJ 08054

May 26, 2026

RE: StormTrap SurgeSettler Side Inlet Configuration High Flow Hydrodynamic Separator Performance Testing

To Whom It May Concern:

Spaceco Inc. was contracted by StormTrap LLC as a 3rd party observer during their SurgeSettler Side Inlet Configuration sediment removal testing. The results of this testing will be used by a variety of public and private users to improve the removal of sediment and to capture and store pollutants from stormwater runoff for specific site conditions.

The StormTrap LLC SurgeSettler Side Inlet Configuration testing took place at the StormTrap Research & Development facility located in Morris, IL. I certify that I was present at the said facility and that I observed this testing from November 2025 – March 2026. The results presented in the StormTrap SurgeSettler High Flow Hydrodynamic Separator Side Inlet Configuration Testing Report dated May 2026 are accurate and all procedures and requirements stated in the Report were met or exceeded. I confirm that all test data that was collected is included or referenced in the Report.

Considering the above information and on behalf of Spaceco, Inc., I confirm the following:

- that I do not have any conflict of interest in connection with the sediment removal testing;
- that I have not granted, sought, attempted to obtain or accepted and will not grant, seek, attempt to obtain, or accept any advantage, financial or in kind, to or from any party whatsoever, constituting an illegal or corrupt practice, either directly or indirectly, as an incentive or reward relating to the outcome of the testing.

Sincerely,

Spaceco, Inc.



Jason Wiesbrock, P.E.
Vice President

cc: Greg Williams, StormTrap LLC

Rosemont
(847) 696-1060

Morris
(815) 941-0263

Indianapolis
(317) 779-2194

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June 8, 2026

Gabriel Mahon, Chief
NJDEP
Bureau of Non-Point Pollution Control
Division of Water Quality
401 E. State Street
Mail Code 401-02B, PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on the StormTrap SurgeSettler™ High Flow Hydrodynamic Separator-Side Outlet Configuration, the test protocol requirements contained in the *“New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device”* (NJDEP HDS Protocol, January 1, 2021- Updated April 25, 2023) were met or exceeded consistent with the NJDEP Approval Process. Specifically:

Test Sediment Feed

The mean PSD of the test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be significantly finer than the sediment blend specified by the protocol ($<75\ \mu\text{m}$); the test sediment median (d_{50}) was $64\ \mu\text{m}$, $48\ \mu\text{m}$, $54\ \mu\text{m}$ and $33\ \mu\text{m}$ for lots 24C-02, 25A-04, 25B-01 and 25D-01. The scour test sediment PSD analysis was plotted against the NJDEP scour test PSD specification and shown to meet the protocol specifications. The median (d_{50}) was $182\ \mu\text{m}$.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on a SurgeSettler 6 x14 ft. unit comprised of full-scale, commercially available internal components to demonstrate the ability of the StormSettler Side Outlet Configuration to remove 50 % of the NJDEP protocol specified test sediment with a 90-degree inlet-outlet configuration.

Scour Testing

The scour testing was conducted at 7687 gpm (17.1 cfs), which is equal to 206% of the MTFR. The scour test was conducted with the unit preloaded with 4.0" of levelled sediment to the 50% capacity level for each configuration prior to conducting the test. A total of 15 effluent samples were collected throughout the test. The average calculated effluent concentration, adjusted for background, was 6.9 mg/L.

Sincerely,



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

8. References

1. Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology. August 4, 2021 (Last updated April 25, 2023).
2. New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device. January 1, 2021.
3. ASTM E3317-22 “Standard Specification for Silica-Based Sediments for the Evaluation of Stormwater Treatment Devices”
4. ASTM D6913-17, “Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis”
5. ASTM D7928-21 “Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis”
6. ASTM D3977-97, “Standard Test Methods for Determining Sediment Concentration in Water”
7. ASTM C-891 “Standard Practice for Installation of Underground Precast Concrete Utility Structures”
8. ASTM E29-22 “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications”

VERIFICATION APPENDIX

Introduction

- Manufacturer - StormTrap LLC, 1287 Windham Parkway, Romeoville, IL 60446.
Website: www.stormtrap.com General Phone: (815) 941-4663
- MTD: StormTrap SurgeSettler 90° Hydrodynamic Separator. Verified SurgeSettler 90° models are shown in **Table A-1**.
- TSS Removal Rate: 50%
- Offline or Online Installation

Detailed Specification

- NJDEP sizing and dimensional table is attached as **Table A-1**.
- New Jersey requires that the peak flow rate of the New Jersey Water Quality Design Storm (NJWQDS), 1.25 inches of rainfall in a 2-hour duration, shall be used to determine the appropriate size for the MTD. The SurgeSettler 90° 6'x14' has a maximum treated flow (MTFR) of 6.54 CFS (2935 GPM) which equates to a hydraulic loading rate of 34.94 GPM/ft².
- Pick weights and installation procedures vary with model size. StormTrap provides contractors with project-specific unit pick weights and installation instructions prior to delivery.
- Maximum sediment depth for all units is 16 inches. StormTrap recommends that the units be cleaned when sediment depth reaches 8 inches, representing 50% sediment storage capacity.

The SurgeSettler 90° Operations and Maintenance Manual is provided for each project installation and available at: <http://stormtrap.com/products/SurgeSettler>

- According to N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a hydrodynamic separator such as the StormTrap SurgeSettler 90° to be used in series with another hydrodynamic separator to achieve an enhanced TSS removal rate.

Table A-1 SurgeSettler 90° MTFRs, Sediment Removal Intervals, and Standard Dimensions

Model	Model Width (ft)	Model Length (ft)	NJDEP 50% TSS Maximum Treatment Flow Rate (MTFR) (cfs)	Effective Treatment Area (ft ²)	Hydraulic Loading Rate ¹ (gpm/ft ²)	Effective Sedimentation Area (ESTA) (ft ²)	Enhanced Settling Pack Footprint (ft ²)	50% Max. Sediment Storage (ft ³)	Sediment Removal Interval ² (years/months)	Chamber Depth ³ (ft)	Effective Treatment Depth ⁴ (ft)	Aspect Ratio Treatment Depth: Diameter ⁵			
												MTFR: ESTA	Length: Width	SD ⁶ /Width	SD ⁶ /Length
SurgeSettler 6 x 14	6	14	6.54	84	34.94	84	44	56	5 / 61	6.67	6.00	0.08	2.33	1.00	0.43
SurgeSettler 8 x 21	8	21	13.08	168	34.94	168	88	112	5 / 61	6.67	6.00	0.08			
SurgeSettler 10 x 21	10	21	16.35	210	34.94	210	112	140	5 / 61	6.67	6.00	0.08			
SurgeSettler 12 x 24	12	24	22.42	288	34.94	288	160	192	5 / 61	12.5	11.83	0.08	2.00	0.99	0.49
SurgeSettler 12 x 32	12	32	29.90	384	34.94	384	208	256	5 / 61	13.5	12.83	0.08	2.67	1.07	0.40

¹ Hydraulic loading rate is defined as the ratio of MTFR to effective treatment area.

² Sediment removal interval is calculated using the equation presented in Appendix A, Section B of the NJDEP Protocol.

³ Chamber depth is defined as depth from effluent invert to sump floor.

⁴ Effective treatment depth is defined as depth from effluent invert to 50% the sediment storage depth.

⁵ Larger models (>250% MTFR of the tested unit) must be geometrically proportionate to the tested unit (6 x 14 model). A variance of 15% is allowable. For units <250% MTFR (6 x 14) the depth may be equal or greater than the depth of the test unit.

⁶ Standard Depth (SD) is equivalent to Effective Treatment Depth