NJCAT TECHNOLOGY VERIFICATION

SciCloneX Hydrodynamic Separator

Bio Clean Environmental Services Inc.
a Forterra Company

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1. Description of Technology

The SciCloneX Hydrodynamic Separator (SciCloneX) is a manufactured treatment device (MTD) designed by Bio Clean Environmental Services Inc., a Forterra Company. The SciCloneX removes pollutants from stormwater runoff using a series of flow splitters, baffles, low flow down pipes, and weirs. The device traps suspended particulates by promoting gravity separation, as well as being able to capture and retain floatables and light liquids, such as oil.

The SciCloneX is designed to optimize flow hydraulics of stormwater thus maximizing its ability to capture suspended solids efficiently with minimal surface area. The system has no moving parts and operates by utilizing the principles of gravity separation, flow path maximization, and velocity control to increase settling of finer particulates. It is composed of three components, flow splitter, oil/floatables skimmer, and outlet weir with low flow down pipes, as shown in **Figure 1**.

Runoff is directed into the system via the inlet pipe and enters the flow splitter deck where it is divided, as illustrated in **Figure 2**. From the flow splitter, water is channeled along the chamber wall on both sides of the inlet pipe, resulting in an increased flow path. As the split flow encounters the oil/floatables skimmer wall, it is directed along the skimmer wall toward the center of the chamber where the flow paths from both sides meet one another. As this occurs, the flow path from both directions circles back toward the inlet pipe, creating two concurrent vortex swirls. This design directs the flow back toward the inlet and underneath the flow splitter deck thus lengthening the flow path. Larger and medium particle size sediments are directed into the sump chamber below the flow splitter to the chamber wall under the inlet as shown in **Figure 3**.

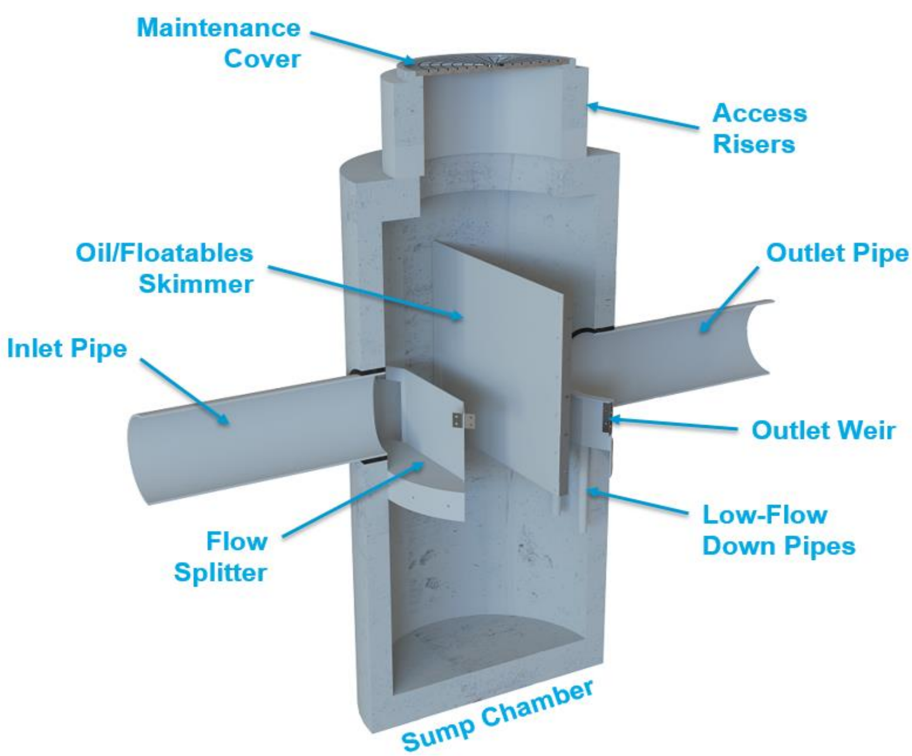

Figure 1 Cut-Away View

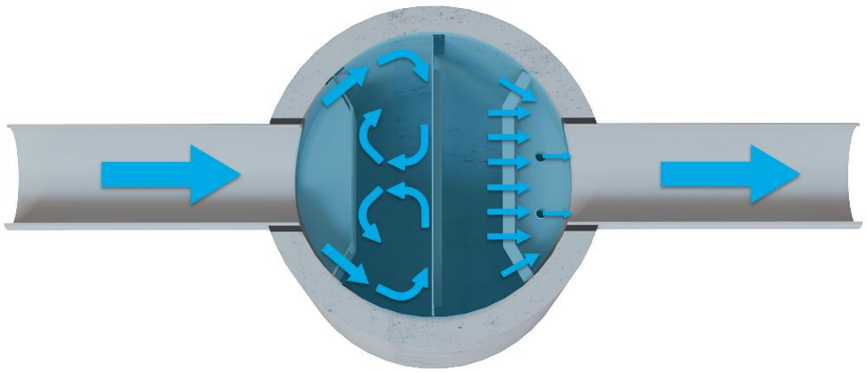

Figure 2 Operational Diagram

The oil/floatables skimmer is installed in the middle of the chamber and extends downward and upward to isolate free-floating oils and floatable trash and debris. Water still carrying finer sediments is forced to travel under the skimmer, which is level and equal in width to the chamber diameter, thus creating distributed flow and further reduced velocity. As water passes under the oil/floatables skimmer, a portion of the flow travels downward to the low flow down pipes and the remaining flow travels upward to the crest of the outlet weir. By distributing a portion of the flow away from the outlet weir above, the upward flow and velocity is further minimized to enhance settling of finer sediment. This effect is enhanced at lower flow rates where a greater percentage of flow travels toward and into the downpipes. The outlet weir extends across the outlet pipe width and protrudes above the outlet pipe invert. The outlet weir is wider than the outlet pipe and creates a distributed flow from the system into the outlet pipe designed to decrease entrance velocity in the pipe and increasing detention time within the unit, while preventing channeling of flow. **Figure 3** depicts the SciCloneX flow path visually.

The SciCloneX provides the following enhancements when compared to the standard SciClone to improve overall performance:

- SciClone skimmer wall extends 12 inches below outlet pipe invert. SciCloneX skimmer wall extends down only 6 inches below outlet pipe invert.
- SciClone outlet weir extends 6 inches above pipe invert. SciCloneX outlet weir extends 9 inches above pipe invert. SciCloneX also includes a 1.75-inch horizontal diverter flange on the top edge of the outlet weir.
- SciClone does not have any low flow down pipes. SciCloneX has two low flow down pipes in the deck of the outlet weir.
- The SciClone has a sump that is 5 feet deep and 1.5 feet of sediment storage. The SciCloneX has a sump that is 4.75 feet deep with 2 feet of sediment storage.

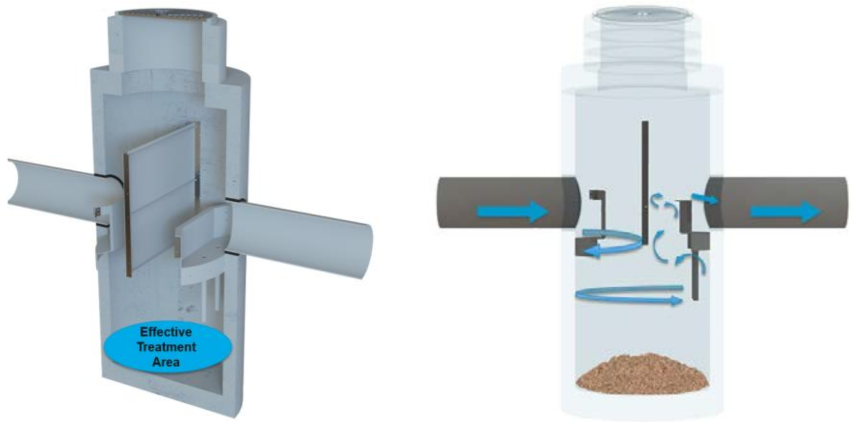

Figure 3 Effective Treatment Area and Flow Path Diagram

The enhanced design of the SciCloneX, with a flow splitter, shorter oil/floatables skimmer, low flow down pipes and taller outlet weir maximizes the flow path and minimizes velocity for maximum performance. The system is designed to be installed online and process high flows internally. Higher flows can pass over the top of the flow splitter without impedance, under the oil/floatables skimmer and to the outlet. The outlet weir creates less turbulent conditions into the pipe and thus reduces head loss during peak flow conditions as shown in **Figure 4**. The low flow down pipes in the horizontal deck of the outlet weir also allow the water level to return to a level equal to the invert of the outlet pipe following a storm event.

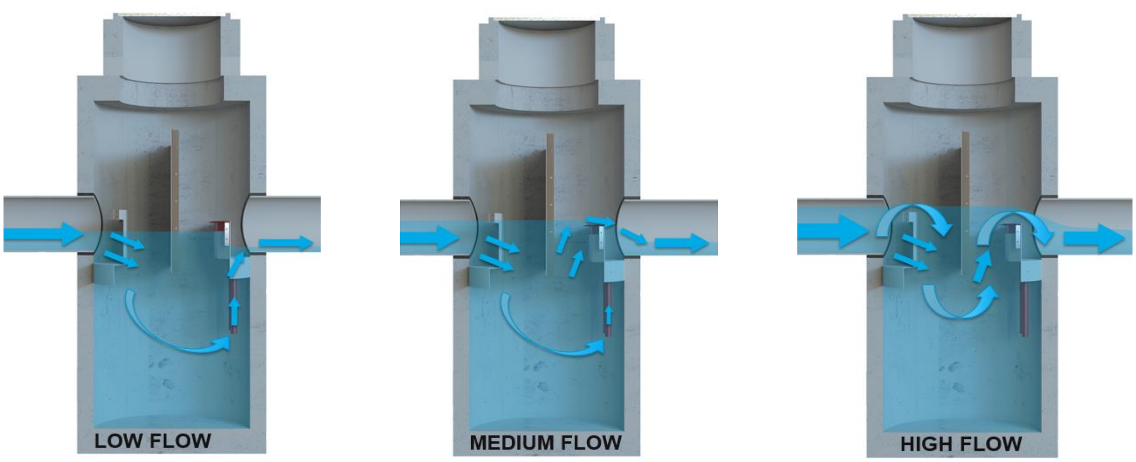

Figure 4 View During Treatment and Bypass Flows (High Flow)

2. Laboratory Testing

Bio Clean Laboratories, a new state-of-the-art water technology testing laboratory based in Oceanside, California, was commissioned by Bio Clean Environmental Services, Inc. to test the SciCloneX 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 25, 2013). Independent third-party observation was provided by Douglas Dowden of Environmental Compliance Specialist, LLC. Mr. Dowden has extensive background in water quality. Mr. Dowden has no conflict of interest that would disqualify him from serving as the independent third-party observer during this testing process.

The device tested was a four-foot diameter SciCloneX (Model SCX-4) consisting of internal components housed in a custom designed fiberglass manhole structure. In commercial systems, the internal components are typically housed in a concrete manhole. The fiberglass manhole of the test unit was equivalent to commercial concrete manholes in all key dimensions. The use of a fiberglass manhole was utilized due to the difficulties associated with transporting and physically supporting the weight of a concrete vessel. Using a fiberglass manhole in lieu of concrete does not affect, nor alter system performance.

2.1 Test Setup

The design specifications of the SciCloneX Model SCX-4 are provided in **Table 1**. The test unit had a total treatment area of 12.57 ft^2 and a maximum treatment flow rate (MTFR) of 1.82 cfs (816 gpm).

Table 1 SciCloneX Model SCX-4 Dimensions

MTFR		Diameter	Sediment Storage	Effective Treatment Area	Loading Rate
(cfs)	(gpm)	(ft)	(ft^3)	(ft^2)	(gpm/ft^2)
1.82	816	4	25.1	12.57	64.9

The laboratory test set-up was a water flow loop, capable of moving water at a rate of up to 4.9 cfs. The performance test loop, illustrated in **Figure 5a**, was comprised of water reservoirs, a pump, sediment filter, receiving tank with filtration, surge tank, and flow meter.

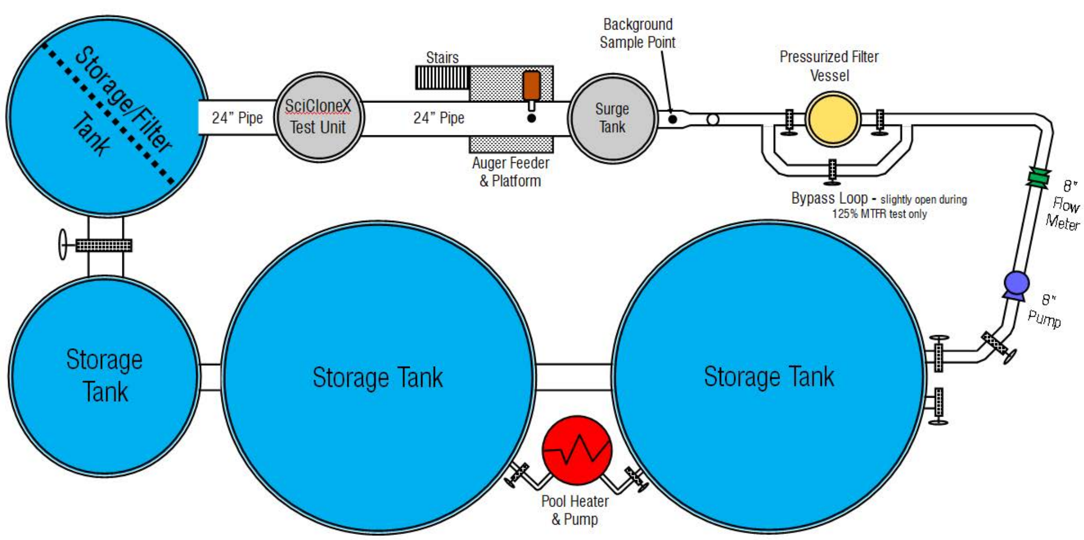

Figure 5a Test Flow Apparatus – Sediment Removal Testing

The scour test loop, illustrated in **Figure 5b**, was comprised of water reservoirs, pumps, receiving tank with filtration and flow meters. A surge tank was required to dampen variation in inlet water surface level (WSL) at high flows to ensure steady-state flow conditions and confirm accuracy of the flow meters.

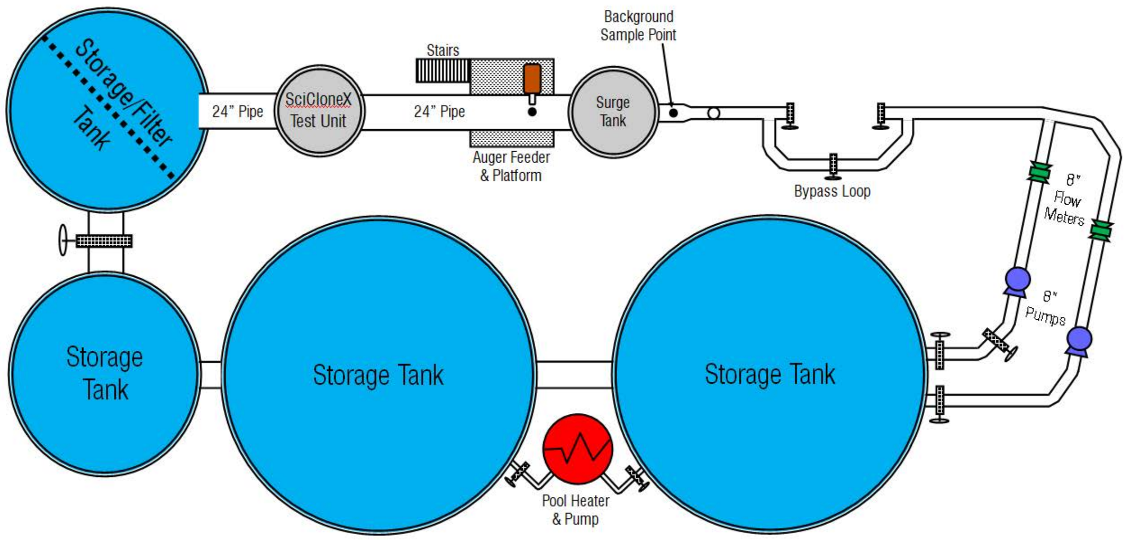

Figure 5b Test Flow Apparatus – Scour Testing

Water Flow and Measurement

From the water supply tanks, water was pumped using one or both Xylem AC e-1500, 8x8x9.5B 20 HP (150 - 2000 gpm) centrifugal pumps. The pumps are controlled by two Aquavar IPC AVA20200B0F0x0x1 VFDs. Flow measurement was done using one or both Toshiba LF654 Flanged Mount (combined type) electromagnetic type flow meter with an accuracy of ± 0.5% of reading (150 - 2000 gpm). The data logger was a MadgeTech CurrentX4 30MA, 4-Channel Current type and related software, configured to record a flow measurement once every ten seconds.

The water in the flow loop was circulated through a filter housing containing high-efficiency, high-surface area pleated paper filters with a 0.5 µm absolute rating. The influent pipe was 24 inches in diameter and 164 inches long with a slope of 1.2%. Sediment addition was done through a port at the crown of the influent pipe, 109 inches upstream of the SciCloneX. The sediment feeder was an Acrison Model 105X volumetric screw feeder with a spout attachment and motor controller. The feeder has a 1 cubic foot hopper at the upper end of the auger to provide a constant supply of sediment.

Water flow exited the SciCloneX and terminated with a free-fall into the receiving tank to complete the flow loop. The length of the 24-inch diameter outlet pipe is 31 inches.

Sample Collection

Background water samples were grabbed by hand in a 1 L jar from a sampling port located upstream of the auger feeder. The sampling port was controlled manually by a ball valve (**Figure 6**) that was opened approximately 5 seconds prior to sampling.

Effluent samples were also grabbed by hand. The effluent pipe drained freely into the receiving tank and the effluent samples were taken at that point (**Figure 7**). The sampling technique used was to take the grab sample by sweeping a wide-mouth 1 L jar through the stream of effluent flow such that the jar was full after a single pass.

Figure 6 Background Sampling Point

Figure 7 Effluent Sampling Point

Other Instrumentation and Measurement

Water temperature was taken using a Kangaroo Model 4430 Thermometer that was suspended inside the SciCloneX next to the effluent pipe. A temperature reading was recorded manually eight times throughout each run starting at the beginning and then at every other effluent sample thereafter. Water temperature was also taken inside the surge tank using an Elitech RC-5+ PDF USB Temperature Data Logger that automatically logs the temperature in 1-minute intervals. The maximum temperature from either location is used in the run summary data below.

A water surface level (WSL) reading was recorded manually eight times throughout each run starting at the beginning and then at every other effluent sample thereafter inside both the SciCloneX and inside the surge tank. A yardstick mounted to the inside of both tanks was visually observed to record the levels.

Run and sampling times were measured using a Thomas Scientific NIST traceable stopwatch, manufactured by Control Company Model 8788V77.

The sediment feed samples that were taken during each run were collected in 500 mL jars and weighed on a precision balance (Mettler Toledo, MS1003TS/00). The mass sediment at the beginning and at the end of each run was taken and weighed on an analytical balance (Mettler Toledo, PBA655-B60 US).

2.2 Test Sediment

The test sediment was fed through an opening in the crown of the influent pipe, 109 inches upstream of the SciCloneX. A 4.5-inch diameter hole was used to direct the sediment into the pipe (**Figure 8**). The test sediment purchased and used for the removal efficiency study was custom blended by GHL (Good Harbours Laboratories, Mississauga, Ontario, Canada) using various commercially available silica sands; this particular batch was GHL lot #A028-095. GHL sent out three samples of sediment for particle size analysis using the methodology of ASTM method D422-63. The samples were composite samples created by taking samples throughout the blending process and in various positions within the blending drum. The testing laboratory was Bureau Veritas, an independent test laboratory also located in Mississauga, Ontario, Canada. The PSD results are summarized in **Table 2** and shown graphically in **Figure 9.** Bio Clean received three sealed drums from GHL. Each drum contained sediment sealed in three mil drum line bags. Each liner bag was closed off with a security seal tag with individual serial numbers. Drum number three (bag serial #2487005 and drum serial #2427006) was used during SciCloneX testing. All opening and closing of the drum and removal and replacement of security tags was done in the presence of the third-party observer.

Figure 8 Sediment Addition Point

Table 2 PSD of Removal Efficiency Test Sediment

Particle Size (Microns)	Test Sediment Particle Size (% Less Than)[1]				Specification[2] (Minimum % Less Than)	QA/QC
	Sample 1	Sample 2	Sample 3	Average		
1000	100	100	100	100	100	PASS
500	95	95	95	95	95	PASS
250	88	89	90	89	90	PASS
150	70	79	78	76	75	PASS
100	56	59	58	58	60	PASS
75	53	54	52	53	50	PASS
50	45	43	49	46	45	PASS
20	39	39	43	40	35	PASS
8	21	22	23	22	20	PASS
5	14	14	16	15	10	PASS
2	8	8	9	8	5	PASS
d_{50}	65 µm	66 µm	58 µm	63 µm	≤ 75 µm	PASS

[1] Where required, particle size data has been interpolated to allow for comparison to the required NJDEP particle size specification.

[2] Per NJDEP, a measured value (three sample average) may be lower than a target minimum % less than value by up to two percentage points provided that the measured d_{50} value does not exceed 75 microns.

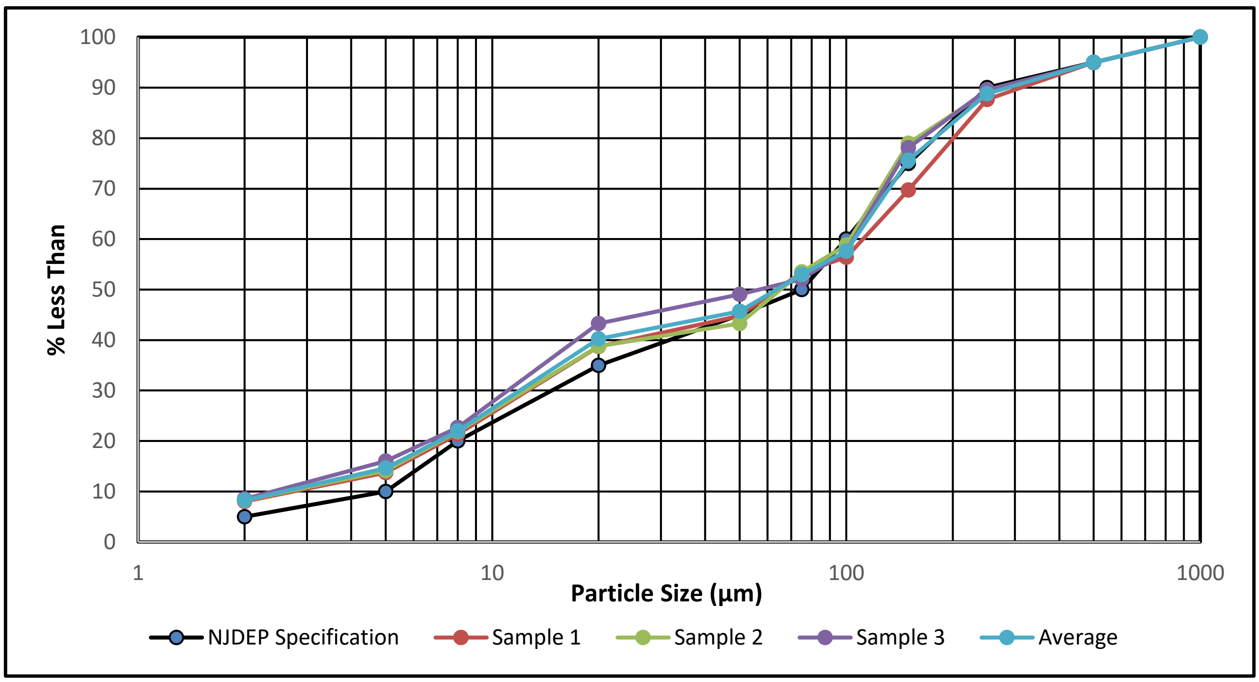

Figure 9 Average Particle Size Distribution of Removal Efficiency Test Sediment

For the scour test, the test sediment was a commercially available silica sand. The material was purchased directly from AGSCO Corporation and arrived in 11 sacks. Three samples of sediment were sent out for particle size analysis using the methodology of ASTM method D422-63. All 11 sacks were lined up and tops opened. Three scoops were taken from random parts of each sack. Each scoop was placed into one of three plastic 5-gallon buckets. Each bucket had one random scoop from each sack. Each bucket containing this composite sample from each sack was mixed thoroughly. Then a single composite sample was pulled from each bucket and filled into a glass container. The testing lab was Apex Laboratories, an independent test lab located in Tigard, Oregon. All procedures previously described were done in the presence of the third-party observer, including delivery of the samples to be shipped, adhering to industry chain of custody standards. The PSD results are summarized in **Table 3** and shown graphically in **Figure 10.**

Table 3 PSD of Scour Test Sediment

Particle Size (Microns)	Test Sediment Particle size (% Less Than)[1]				NJDEP Specification (Minimum % Less Than)	QA/QC
	Sample 1	Sample 2	Sample 3	Average		
1000	100	100	100	100	100	PASS
500	100	100	100	100	90	PASS
250	99	99	99	99	55	PASS
150	81	82	82	82	40	PASS
100	35	35	35	35	25	PASS
75	9	9	9	9	10	PASS
50	0	0	0	0	0	PASS

[1] Where required, particle size data has been interpolated to allow for comparison to the required NJDEP particle size specification.

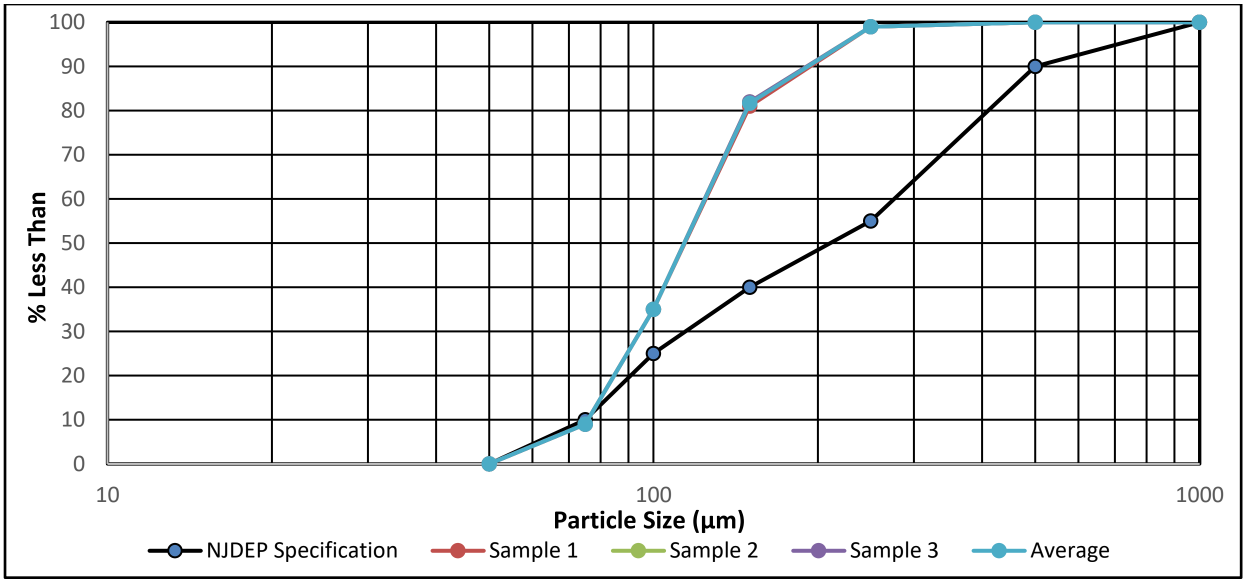

Figure 10 Particle Size Distribution of Scour Test Sediment

2.3 Removal Efficiency Testing

Removal testing was conducted on a clean unit with a false floor installed at 50% sump sediment storage depth, 12 inches above the manhole floor. Removal efficiency testing was performed as specified in Section 5 of the NJDEP Laboratory Protocol for Hydrodynamic Sedimentation MTDs.

The test sediment feed was sampled six times per run to confirm the sediment feed rate. Each sediment feed sample was collected in a 500-mL jar over an interval timed to the nearest hundreds of a second and was a minimum 0.1 liter or the collection interval did not exceed one minute, whichever came first. Feed samples were started the precise moment the effluent sample collection was completed (passed through flow stream) when occurring at the same time intervals.

Effluent grab sampling began following three MTD detention times after the initial sediment feed sample was taken. The time interval between sequential samples was 30 seconds, however, when the test sediment feed was interrupted for measurement, the next effluent sample was collected following three MTD detention times from the time the sediment feed was re-established. A total of 15 effluent samples were taken during each run.

Background water samples were taken with the odd-numbered effluent samples. Alpha Analytical Laboratories, Inc. of Carlsbad, California performed analysis of all background and effluent samples under test method ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentrations in Water Samples".

2.4 Scour Testing

Prior to the start of testing, the false floor was re-installed 4 inches lower than during performance testing and sediment was loaded into the sump of the SciCloneX and leveled at a depth of 4 inches. The final height of the sediment was at an elevation equivalent to 50% of the maximum sediment storage capacity of the SciCloneX. After loading the sediment, the unit was gradually filled with clear water, so as not to disturb the sediment, to the invert of the inlet pipe. The filled unit was allowed to sit for 93 hours.

The scour test was conducted at a flow rate of 1650 gpm (3.68 cfs), more than two times the MTFR.

During the scour test, the water flow rate was recorded using a MadgeTech CurrentX4 30MA, 4-Channel Current type data logger and related software, configured to record a flow measurement once every ten seconds. The MadgeTech software was calibrated to the Toshiba Flow meters. Water temperature was taken using a Kangaroo Model 4430 Thermometer that was suspended inside the SciCloneX next to the effluent pipe. A temperature reading was recorded manually eight times throughout each run starting at the beginning and then at every other effluent sample thereafter. Water temperature was also taken inside the surge tank using an Elitech RC-5+ PDF USB Temperature Data Logger that automatically logs the temperature in 1-minute intervals. The maximum temperature from either location is used in the run summary data below.

A water surface level (WSL) reading was recorded manually eight times throughout the run starting at the beginning and then at every other effluent sample thereafter inside both the SciCloneX and inside the surge tank. A yardstick mounted to the inside of both tanks was visually observed to record the levels.

Run and sampling times were measured using a Thomas Scientific NIST traceable stopwatch, manufactured by Control Company Model 8788V77.

Testing commenced by gradually increasing the water flow into the system until the target flow rate of greater than 200% of the MTFR was achieved (within five minutes of commencing the test). Effluent and background grab samples were taken once every two minutes, starting after achieving the target flow rate, until a total of 15 effluent samples were taken. A total of 15 background water samples were collected at evenly spaced intervals throughout the scour test.

3. Performance Claims

Total Suspended Solids (TSS) Removal Rate

The TSS removal rate of the SciCloneX Model SCX-4 was calculated using the weighted method required by the NJDEP HDS MTD protocol. Based on a MTFR of 1.82 cfs, the SciCloneX achieved an annualized weighted TSS removal rate of at least 50%.

Maximum Treatment Flow Rate (MTFR).

The SciCloneX Model SCX-4 demonstrated a maximum treatment flow rate (MTFR) of 1.82 cfs (816 gpm). This corresponds to a surface area loading rate of 64.9 gpm/ft^2.

Maximum Sediment Storage Depth and Volume

The maximum sediment storage depth is 24 inches, which equates to 25.1 cubic feet of sediment storage volume for the Model SCX-4. A sediment storage depth of 12 inches corresponds to 50% full sediment storage capacity (12.57 cubic feet).

Effective Treatment/Sedimentation Area

The Model SCX-4 effective treatment area is 12.57 square feet.

Detention Time and Wet Volume

The permanent pool volume is 59.7 cu ft (446 gallons) for the Model SCX-4. This is the volume from the true floor to the outlet pipe invert, which is 4.75 feet. The detention time of the SciCloneX is dependent upon flow rate.

Online/Offline Installation

Based on the scour testing results shown in Section 4.2 the SciCloneX qualifies for online and offline installation.

4. Supporting Documentation

To support the performance claims, 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. were made available to NJCAT for review. It was agreed that as long as such documentation could be made available upon request that it would not be prudent or necessary to include all this information in this verification report. All supporting documentation will be retained securely by Bio Clean Laboratories and has been provided to NJCAT and is available upon request.

4.1 Removal Efficiency Testing

A total of 5 removal efficiency testing runs were completed in accordance with the NJDEP HDS protocol. The target flow rate ranged from 25 – 125% MTFR and the target influent sediment concentration was 200 mg/L. The results from all 5 runs were used to calculate an annualized weighted removal efficiency for the SciCloneX Separator.

The total water volume and average flow rate per run were calculated from the data collected by the flow data logger, one reading every 10 seconds. The average influent sediment concentration for each test flow was determined by mass balance. The amount of sediment fed into the auger feeder 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 SciCloneX during dosing to determine the average influent sediment concentration for each run.

Six feed rate samples were collected at evenly spaced intervals during the run to ensure the rate was stable. The COV (coefficient of variance) of the samples had to be $\leq$ 0.10 per the NJDEP protocol. The feed rate samples were also used to calculate an influent concentration to double-check the concentration calculated by mass balance.

The average effluent sediment concentration was adjusted for the background sediment concentration. In cases where the reported background sediment concentration was less than 1.0

mg/L (the method quantitation limit), 0.5 mg/L was used in calculating the adjusted effluent concentration.

Removal efficiency for each test run was computed as follows:

$$\textbf{Feed Rate}\ (g/min) = \left(\frac{Mass_{sample+bottle\ (g)} - Mass_{bottle\ (g)}}{Time\ collection\ (s) x\ (\frac{\text{min}}{60\ \text{s}})}\right) \times (1 - Sediment\ Moisture\ Content)$$

$$\textbf{Influent Mass}\ (kg) = (1 - Sediment\ Moisture\ Content) x [Mass_{pre\ test}\ (kg) - Mass_{post\ test}\ (kg)] - \sum Mass_{feed\ sample}\ (g) x \left(\frac{kg}{1E3\ g}\right)$$

$$\textbf{Average Influent Concentration}\ (mg/L) = \left(\frac{Influent\ Mass\ (kg)\ x\ (\frac{1E6\ mg}{kg})}{Avg. Flow\ Rate\ \left(\frac{ft3}{s}\right) x \left(\frac{28.3168L}{ft^3}\right) x \left(\frac{60\ s}{min}\right) x\ Time_{sediment\ injection}\ (\text{min})}\right)$$

$$\textbf{Average Adjusted Effluent Conentration}\ (mg/L) = Avg. Effluent\ Concentration\ (mg/L) - Avg. Background\ Concentration\ (mg/L)$$

$$\textbf{Removal Efficiency}\ (\%) = \left(\frac{Average\ Influent\ Concentration - Adjusted\ Average\ Effluent\ Concentration}{Average\ Influent\ Concentration}\right) \times 100\%$$

NOTE: it was found that the moisture content was negligible and therefore no correction was required. Table 2 of the sediment report titled "Particle Size Characterization of GHL Silica Blend Lot A028-095 for use in Hydrodynamic Separator Removal Efficiency Testing" shows that the percentage moisture was below the detectable limit of 0.3% for all three samples.

The data collected for each removal efficiency run is presented below:

25% MTFR

Table 4 Sampling Schedule - 25% MTFR

Runtime (h:mm:ss)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0:00:00	1		
0:08:00		1	1
0:08:30			2
0:09:00	2	2	3
0:17:00			4
0:17:30		3	5
0:18:00	3		6
0:25:00		4	7
0:25:30			8
0:26:00	4	5	9
0:34:00			10
0:34:30		6	11
0:35:00	5		12
0:43:00		7	13
0:43:30			14
0:44:00	6	8	15
0:45:00	End of Testing		
MTD Detention Times = 2.24 minutes (3x = 6.72 minutes) Target Sediment Sampling Time = 60 seconds			

Table 5 Water Flow and Temperature - 25% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	204	204.4	0.22%	0.006	78.2
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

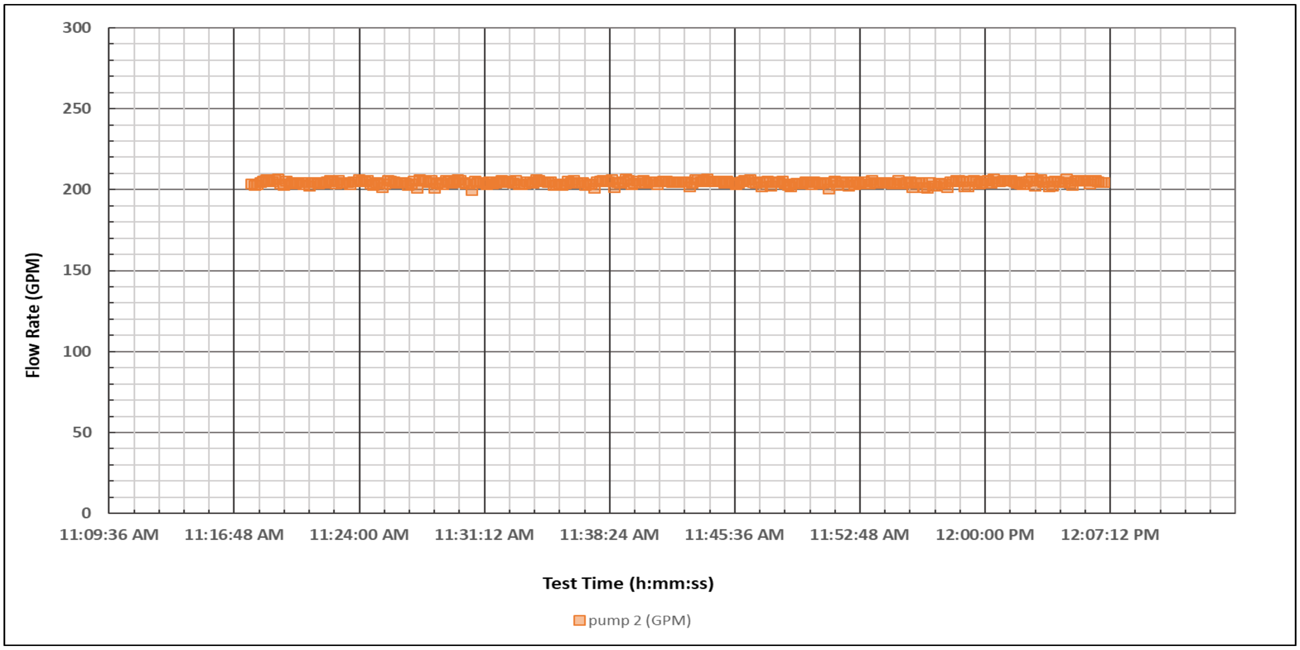

Figure 11 Water Flow - 25% MTFR

Table 6 Sediment Feed Rate Summary – 25% MTFR

Dry Feed Run	Dry Feed Sample (g)	Feed Sample Duration (sec)	Sediment Feed Rate (g/min)	Sediment Mass Balance	
1	154.528	60.07	154.348	Starting Weight of Sediment (lbs.)	153.55
2	160.119	60.08	159.906		
3	160.441	60.12	160.121	Recovered Weight of Sediment (lbs.)	137.87
4	156.430	60.07	156.248		
5	161.000	60.01	160.973	Mass of Sediment Used* (lbs.)	13.57
6	162.799	60.14	162.420	Volume of Water Through MTD During Dosing (gal)	7,970
Average	159.220	60.08	159.003		
COV	0.019	N/A	0.019	Average Influent Sediment Concentration (mg/L)	204.1
QA/QC Limit	0.10 PASS	N/A	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples which totaled 2.11 lbs.

Table 7 SSC and Removal Efficiency - 25% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	77.4	75.5	75.5	74.4	79.3	79.4	79.0	80.1	79.4	76.5	78.1	78.5	79.7	76.2	76.2
Background	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Adjusted Effluent	76.9	75.0	75.0	73.9	78.8	78.9	78.5	79.6	78.9	76.0	77.6	78.0	79.2	75.7	75.7
Average Adjusted Effluent Concentration					77.2 mg/L			Removal Efficiency					62.2%		

50% MTFR

Table 8 Sampling Schedule - 50% MTFR

Runtime (min)	**Sampling Schedule**		
	Sediment Feed	**Background**	**Effluent**
0:00:00	1		
0:04:15		1	1
0:04:45			2
0:05:15	2	2	3
0:09:30			4
0:10:00		3	5
0:10:30	3		6
0:14:45		4	7
0:15:15			8
0:15:45	4	5	9
0:20:00			10
0:20:30		6	11
0:21:00	5		12
0:25:15		7	13
0:25:45			14
0:26:15	6	8	15
0:27:00	End of Testing		
MTD Detention Time = 1.14 minutes (3x = 3.42 minutes) Target Sediment Sampling Time = 45 seconds			

Table 9 Water Flow and Temperature - 50% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	408	408.8	0.19%	0.003	78.0
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

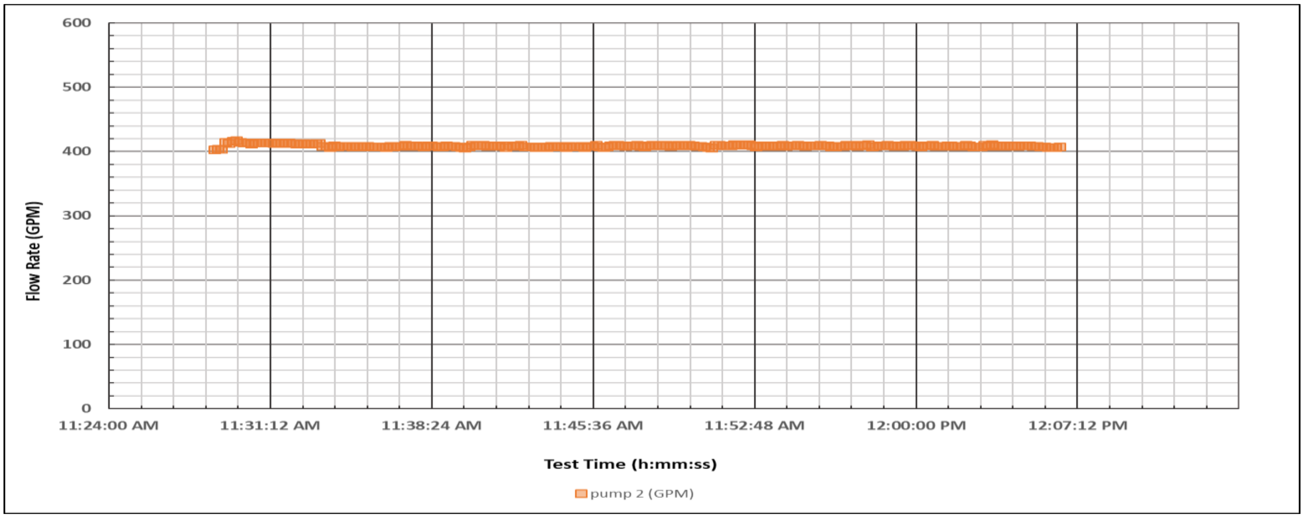

Figure 12 Water Flow - 50% MTFR

Table 10 Sediment Feed Rate Summary – 50% MTFR

Dry Feed Run	Dry Feed Sample (g)	Feed Sample Duration (sec)	Sediment Feed Rate (g/min)	Sediment Mass Balance	
1	233.422	45.02	311.091	Starting Weight of Sediment (lbs.)	141.64
2	233.153	45.02	310.733		
3	235.787	45.01	314.313	Recovered Weight of Sediment (lbs.)	123.13
4	232.676	45.06	309.822		
5	235.801	44.97	314.611	Mass of Sediment Used* (lbs.)	15.41
6	233.364	44.94	311.567	Volume of Water Through MTD During Dosing (gal)	9,198
Average	234.034	45.00	312.023		
COV	0.006	N/A	0.006	Average Influent Sediment Concentration (mg/L)	200.8
QA/QC Limit	0.10 PASS	N/A	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples which totaled 3.10 lbs.

Table 11 SSC and Removal Efficiency - 50% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	86.2	95.0	84.4	92.5	89.0	95.6	91.6	96.1	95.5	90.3	87.4	93.8	90.3	92.9	97.4
Background	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Adjusted Effluent	85.7	94.5	83.9	92.0	88.5	95.1	91.1	95.6	95.0	89.8	86.9	93.3	89.8	92.4	96.9
Average Adjusted Effluent Concentration					91.4 mg/L			Removal Efficiency					54.5%		

75% MTFR

Table 12 Sampling Schedule - 75% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	**Background**	**Effluent**
0:00:00	1		
0:03:00		1	1
0:03:30			2
0:04:00	2	2	3
0:07:00			4
0:07:30		3	5
0:08:00	3		6
0:11:00		4	7
0:11:30			8
0:12:00	4	5	9
0:15:00			10
0:15:30		6	11
0:16:00	5		12
0:19:00		7	13
0:19:30			14
0:20:00	6	8	15
0:20:30	End of Testing		
MTD Detention Time = 0.77 minutes (3x = 2.19 minutes) Target Sediment Sampling Time = 30 seconds			

Table 13 Water Flow and Temperature - 75% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	612	612.2	0.03%	0.002	77.5
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

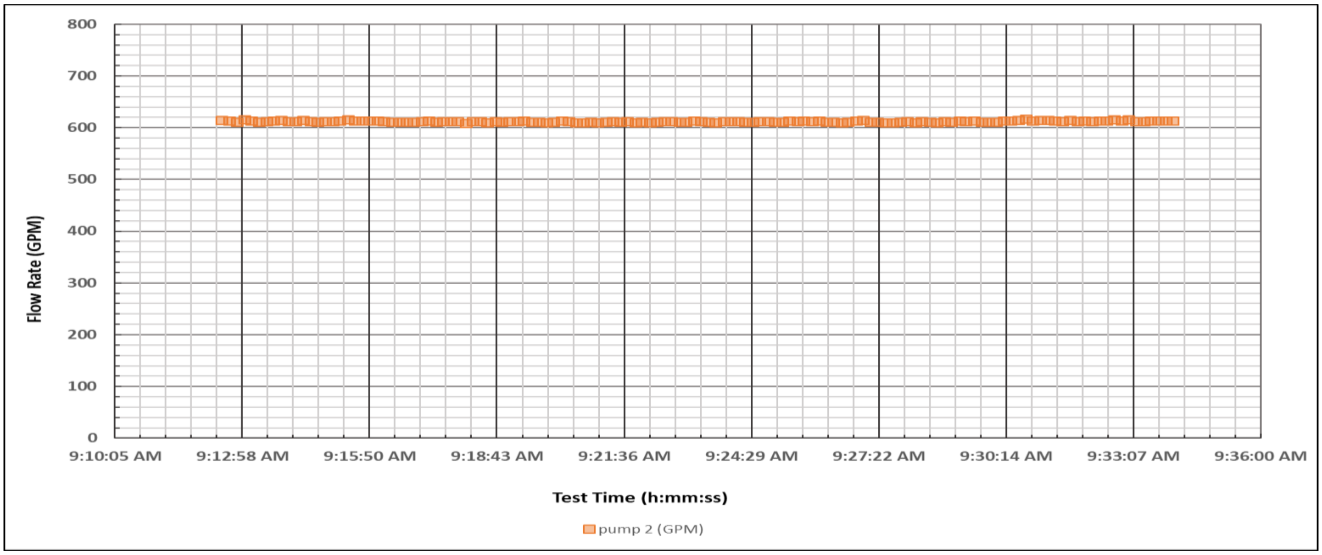

Figure 13 Water Flow - 75% MTFR

Table 14 Sediment Feed Rate Summary – 75% MTFR

Dry Feed Run	Dry Feed Sample (g)	Feed Sample Duration (sec)	Sediment Feed Rate (g/min)	Sediment Mass Balance	
1	230.202	30.01	460.251	Starting Weight of Sediment (lbs.)	144.12
2	230.734	30.15	459.172		
3	233.325	30.16	464.174	Recovered Weight of Sediment (lbs.)	123.35
4	232.539	30.21	461.845		
5	229.977	30.18	457.211	Mass of Sediment Used* (lbs.)	17.71
6	229.955	29.89	461.603	Volume of Water Through MTD During Dosing (gal)	10,707
Average	231.122	30.10	460.709		
COV	0.006	N/A	0.005	Average Influent Sediment Concentration (mg/L)	198.2 mg/L
QA/QC Limit	0.10 PASS	N/A	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples which totaled 3.06 lbs.

Table 15 SSC and Removal Efficiency - 75% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	96.8	109	107	103	97.2	103	100	109	101	104	106	109	109	109	101
Background	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Adjusted Effluent	96.3	108.5	106.5	102.5	96.7	102.5	99.5	108.5	100.5	103.5	105.5	108.5	108.5	108.5	100.5
Average Adjusted Effluent Concentration					103.8 mg/L			Removal Efficiency					47.7%		

100% MTFR

Table 16 Sampling Schedule - 100% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	**Background**	**Effluent**
0:00:00	1		
0:02:20		1	1
0:02:50			2
0:03:20	2	2	3
0:05:40			4
0:06:10		3	5
0:06:40	3		6
0:09:00		4	7
0:09:30			8
0:10:00	4	5	9
0:12:20			10
0:12:50		6	11
0:13:20	5		12
0:15:40		7	13
0:16:10			14
0:16:40	6	8	15
0:17:00	End of Testing		
MTD Detention Time = 0.59 minutes (3x = 1.76 minutes) Target Sediment Sampling Time = 20 seconds			

Table 17 Water Flow and Temperature - 100% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	816	815.5	-0.06%	0.002	77.7
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

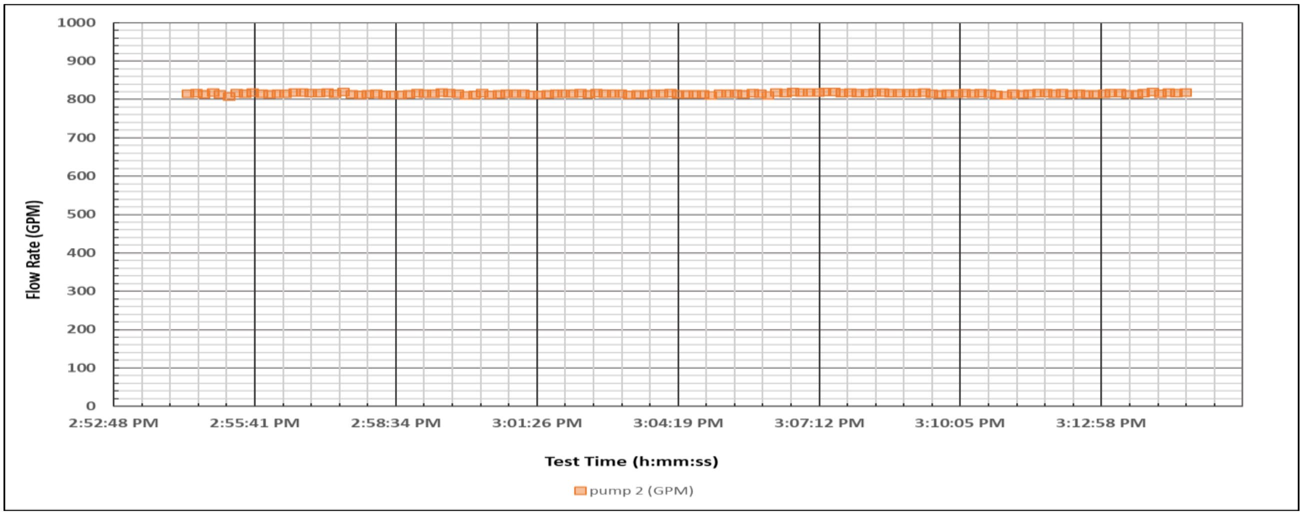

Figure 14 Water Flow - 100% MTFR

Table 18 Sediment Feed Rate Summary – 100% MTFR

Dry Feed Run	Dry Feed Sample (g)	Feed Sample Duration (sec)	Sediment Feed Rate (g/min)	Sediment Mass Balance	
1	202.617	20.07	605.731	Starting Weight of Sediment (lbs.)	151.89
2	207.111	20.03	620.402		
3	204.076	19.96	613.455	Recovered Weight of Sediment (lbs.)	128.79
4	202.128	19.97	607.295		
5	207.043	19.94	622.998	Mass of Sediment Used* (lbs.)	20.40
6	201.082	19.88	606.887	Volume of Water Through MTD During Dosing (gal)	12,234
Average	204.010	19.98	612.795		
COV	0.013	N/A	0.012	Average Influent Sediment Concentration (mg/L)	199.8
QA/QC Limit	0.10 PASS	N/A	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples which totaled 2.70 lbs.

Table 19 SSC and Removal Efficiency - 100% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	110	116	118	115	108	117	121	112	112	104	109	121	106	123	109
Background	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Adjusted Effluent	109.5	115.5	117.5	114.5	107.5	116.5	120.5	111.5	111.5	103.5	108.5	120.5	105.5	122.5	108.5

Average Adjusted Effluent Concentration	112.9 mg/L	Removal Efficiency	43.5 %

125% MTFR

Table 20 Sampling Schedule - 125% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	**Background**	**Effluent**
0:00:00	1		
0:01:45		1	1
0:02:15			2
0:02:45	2	2	3
0:04:30			4
0:05:00		3	5
0:05:30	3		6
0:07:15		4	7
0:07:45			8
0:08:15	4	5	9
0:10:00			10
0:10:30		6	11
0:11:00	5		12
0:12:45		7	13
0:13:15			14
0:13:45	6	8	15
0:14:00	End of Testing		
MTD Detention Time = 0.47 minutes (3x = 1.42 minutes) Target Sediment Sampling Time = 15 seconds			

Table 21 Water Flow and Temperature - 125% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	1020	1019.5	-0.5%	0.002	78.2
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

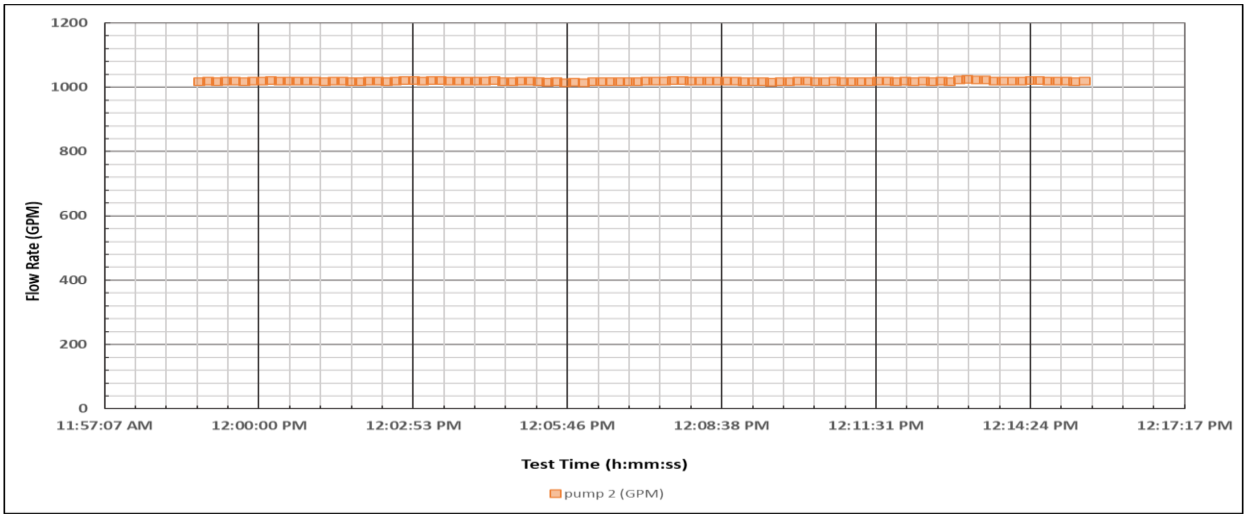

Figure 15 Water Flow - 125% MTFR

Table 22 Sediment Feed Rate Summary – 125% MTFR

Dry Feed Run	Dry Feed Sample (g)	Feed Sample Duration (sec)	Sediment Feed Rate (g/min)	Sediment Mass Balance	
1	195.860	15.13	776.709	Starting Weight of Sediment (lbs.)	148.31
2	196.888	15.03	785.980		
3	208.176	16.07	777.259	Recovered Weight of Sediment (lbs.)	124.17
4	198.435	15.02	792.683		
5	195.062	15.03	778.691	Mass of Sediment Used* (lbs.)	21.51
6	198.966	15.26	782.304	Volume of Water Through MTD During Dosing (gal)	12,718
Average	198.898	15.26	782.271		
COV	0.024	N/A	0.008	Average Influent Sediment Concentration (mg/L)	202.7
QA/QC Limit	0.10 PASS	N/A	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples which totaled 2.63 lbs.

Table 23 SSC and Removal Efficiency - 125% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	121	103	107	110	114	131	112	125	118	118	116	115	137	129	127
Background	0.5		0.5		1.03		1.02		1.05		1.7		2.64		3.15
Adjusted Effluent	120.5	102.5	106.5	109.2	113	130	111	124	117	116.6	114.3	112.8	134.4	126.1	123.9
Average Adjusted Effluent Concentration				117.4 mg/L			Removal Efficiency						42.0%		

Annualized Weighted Removal Efficiency

The annualized weighted removal efficiency for sediment in stormwater has been calculated using the rainfall weighting factors provided in the NJDEP laboratory test protocol. The SciCloneX annual weighted removal for a MTFR of 1.82 cfs (816 gpm) is 52.2%, as shown in **Table 24**.

Table 24 Annualized Weighted Removal Efficiency for SciCloneX

% MTFR	**Average Flow Rate (cfs)**	**Average Influent TSS (mg/L)**	**Average Adjusted Effluent TSS (mg/L)**	**Removal Efficiency (%)**	**Weighting Factor**	**Weighted Removal Efficiency (%)**
25	0.45	204.1	77.2	62.2	0.25	15.6
50	0.91	200.8	91.4	54.5	0.30	16.4
75	1.36	198.2	103.8	47.7	0.20	9.5
100	1.82	199.8	112.9	43.5	0.15	6.5
125	2.27	202.7	117.4	42.0	0.10	4.2
Annualized Weighted Removal Efficiency at MTFR of 1.82 cfs (%)						**52.2**

The water level was monitored and recorded several times throughout the duration of each test run in both the SciCloneX and surge tank. Water levels maintained consistent levels in both chambers during all test runs. As shown in **Table 25** the observed water levels were less than the water levels calculated prior to official testing and used to calculate the retention times for each test run. Thus, retention times were longer than required by the protocol and provided a safety factor. Retention times were based on active volume (false floor to water level above pipe invert) for each run. Additionally, each background and effluent sample was weighed (subtracting out the weight of the empty bottle) after the test run and recorded. As shown in **Table 25** all samples were greater than the 0.5 L minimum requirement in the protocol.

Table 25 Summary of Water Levels and QA/QC Results

% MTFR	Flow Rate (cfs)	Measured Average Levels		Conservative Water Level Used for Detention Time Calculations[1] (ft)	[redacted]	Minimum TSS Sample Volume[2] (L)	Minimum Background Sample Volume[3] (L)
		Water Level Above SciCloneX Outlet Invert[4] (ft)	Water Level Above Surge Tank Outlet Invert (ft)				
25	0.46	0.83	0.92	1.115	[redacted]	0.83	0.85
50	0.91	0.92	1.04	1.198	[redacted]	0.80	0.80
75	1.36	0.99	1.15	1.271	[redacted]	0.81	0.83
100	1.82	1.04	1.22	1.333	[redacted]	0.80	0.78
125	2.27	1.08	1.29	1.385	[redacted]	0.87	0.75
200+	3.71	1.42	1.60	N/A	[redacted]	0.81	0.87

[1] Used "conservative" water level for detention time calculations to allow for some safety factor. Detention time calculations were based upon the total active water volume at each flow rate tested. Active water volume is defined as sump volume (false floor to outlet pipe invert) plus active volume (outlet pipe invert to water level).

[2, 3] Minimum required sample size per NJDEP protocol is 0.5 L (500 mL).

[4] Flow splitter is 12 inches tall. Influent flow started to top over this component at 100% MTFR.

4.2 Scour Testing

Scour testing was conducted in accordance with Section 4 of the NJDEP Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation MTD. Testing was conducted at a target flow rate of 1650 gpm, more than 200% (1632 gpm) of the maximum treatment flow rate (MTFR).

In preparation for the scour test, the sump of the SciCloneX was cleaned out to remove all the accumulated sediment from the previous removal efficiency testing. A false floor was installed 4 inches below the depth of the 50% maximum sediment storage height. The sump was then loaded with scour test sediment so that when leveled, the sediment formed a layer 4 inches thick, confirmed by measuring the sediment thickness with a yardstick. After sediment loading, the sump was filled with water and allowed to sit for 93 hours.

Scour testing began by gradually increasing the flow rate to the target flow within a five-minute period. Effluent and background samples were taken from the same locations as for the removal efficiency test, starting 2 minutes after target flow rate was sustained and the ramp up period had ended. The sampling frequency is summarized in **Table 26**.

Table 26 Scour Test Sampling Frequency

Sample/ Measurement Taken	Run Time (min.)															
	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
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	X	X	X	X	X	X	X

Note: The Run Time of 0 minutes was the end of the 5-minute flow ramp up period.

Water temperature was well below the 80-degree maximum allowable as shown in **Table 27**. The lower temperature compared to the removal efficiency testing temperatures was a result of the pool heater being turned off over the weekend to conserve electricity. The water flow rate is shown in **Table 27** and shown on **Figure 16.**

Table 27 Water Flow and Temperature - Scour Test

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	1650	1667.1	1.04 %	0.003	58.6
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

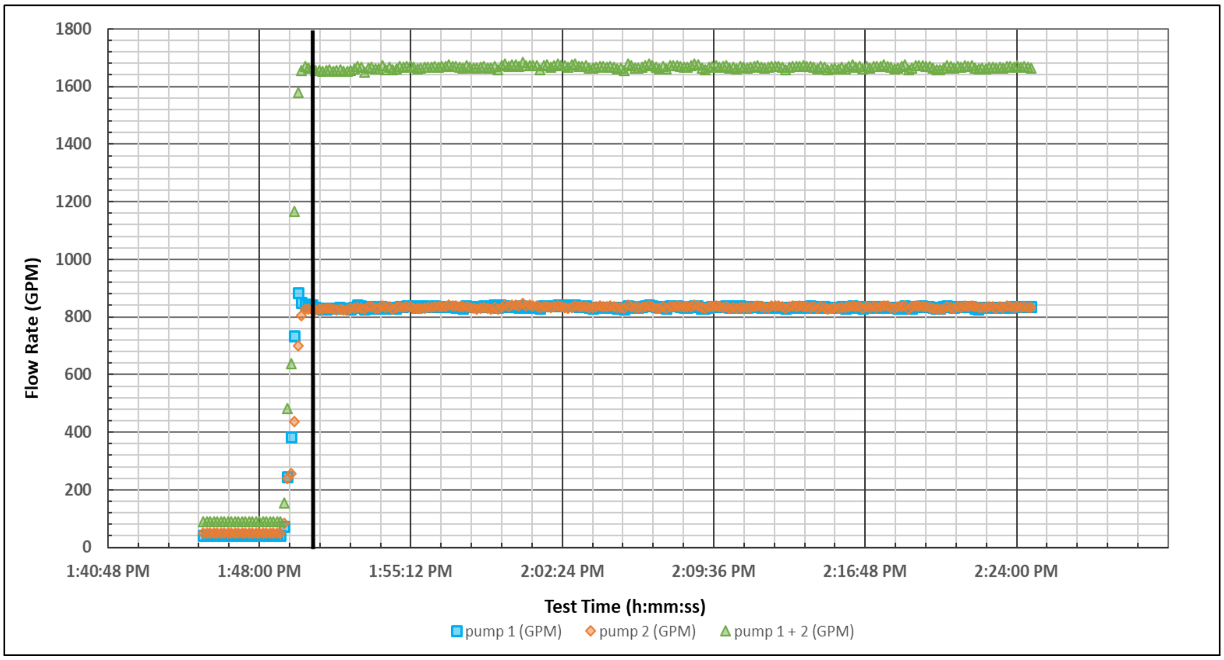

Figure 16 Water Flow - Scour Test

The effluent and background SSC results are reported in **Table 28**. The adjusted effluent concentration was calculated as:

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

The TSS method reporting limit was 1.0 mg/L. Any results below this value were reported as 0.5 mg/L for calculation purposes. A total of 15 samples were collected for both effluent and background concentrations to have matching pairs and eliminate the need for interpolation. The average adjusted effluent concentration was 0.1 mg/L. Therefore, when operated at 200% of the MTFR, the SciCloneX significantly exceeds the criteria for online use.

Table 28 Suspended Sediment Concentrations for Scour Test

	Scour Suspended Sediment Concentration (mg/L)															
Sample #	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent		0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	0.5	0.5	0.5
Background		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Adjusted Effluent		0	0.5	0	0	0	0	0	0	0	0	0.5	0	0	0	0
Average Adjusted Effluent Concentration						0.1 mg/L										

5. Design Limitations

Bio Clean Environmental Services, Inc. provides engineering support to clients on all projects. Each system prior to submittal is evaluated and professionally designed/sized to meet site specific conditions including treatment and bypass flow rates, load rating requirements, and pipe depth. All site and design constraints will be addressed during the design and manufacturing process.

Required Soil Characteristics

The SciCloneX Separator is delivered to the job site as a complete pre-assembled unit housed in a concrete structure designed to meet site-specific soil conditions, corrosiveness, top and lateral loading, and groundwater. The system can be used in all soil types provided that engineered controls may be warranted for any given site condition. A copy of the geotechnical report along with surface loading requirements will be reviewed and verified for each project if provided.

Slope

In general, it is not recommended that the pipe slope into the system exceed 10% nor be less than 0.5%. Slopes higher than 10% will cause increased velocities, which could affect the performance. Slopes less than 0.5% could cause sediment to accumulate in the bottom of the inflow pipe and affect its hydraulic capacity.

The SciCloneX Separator is usually not affected by variations in slope of the finish surface as the unit is buried underground. Risers of various heights can be used to bring access to the system up to the finish surface. In these configurations finish surface slope is more constrained and will require design review to ensure appropriate configuration.

Maximum Treatment Flow Rate

Maximum treatment flow rate is dependent on model size. The SciCloneX Separator will be sized based upon the NJDEP tested hydraulic loading rate of 64.9 gallons per minute per square foot of settling surface area. Section 6 includes details pertaining to inspection and maintenance of the SciCloneX Separator.

Maintenance Requirements

Requirements pertaining to maintenance of the SciCloneX Separator will vary depending on pollutant loading and individual site conditions. It is recommended that the system be inspected at least twice during the first year to determine loading conditions for each site. These first-year inspections can be used to establish inspection and maintenance frequency for subsequent years.

Driving Head

Driving head will vary for a given SciCloneX Separator model based on the site-specific configuration. Design support is provided for all projects including site-specific drawings/cut sheets, which show elevations of pipes and finish surface. Peak and treatment flow rates will also be evaluated to ensure the system is correctly designed from a hydraulic standpoint.

Installation Limitations

With each installation, Bio Clean Environmental provides contractors with instructions prior to delivery. Contractors can request onsite assistance from an installation technician during delivery and installation. Pick weights and lifting details are also provided prior to delivery so the contractor can have appropriate equipment onsite to set the unit.

Configurations

The SciCloneX Separator can be installed online or offline. The SciCloneX Separator has an internal bypass, which allows for it to be installed online without the need for any external high flow diversion structure.

Structural Load Limitations

The SciCloneX Separator is housed in a pre-cast concrete structure. Most standard structures are designed to handle indirect traffic loads with minimal cover. For deeper installation, or installation requiring direct traffic rating or higher, the structure will be designed and modified with potentially thicker tops, bottoms and/or walls to handle the additional loading. Various access hatch options are available for parkway, indirect traffic, direct traffic, and other higher loading requirements such as airports or loading docks.

Pre-treatment Requirements

The SciCloneX Separator has no pre-treatment requirements.

Limitations in Tailwater

Site-specific tailwater conditions must be assessed on each individual project. Tailwater conditions increase the amount of driving head required for optimal system operation. The manufacturer's internal protocols require that these conditions be discussed with the engineer of record and that a solution be implemented to adjust for any design variations caused by tailwater conditions at both treatment and bypass flow rates.

Depth to Seasonal High-Water Table

High groundwater conditions will not affect the operation of the SciCloneX Separator, as it is a closed system. In conditions where high groundwater is present, various measures are employed by Bio Clean Environmental Services' engineering department to ensure that there are no negative consequences caused by the high groundwater. Various measures can be employed such as waterproofing the inside and outside of the structure with an approved coating. A footing can also be added to the bottom of the structure to increase its footprint and offset any buoyancy concerns.

6. Maintenance Plans

As with all stormwater BMPs, inspection and maintenance on the SciCloneX Hydrodynamic Separator is necessary. Stormwater regulations require that all BMPs be inspected and maintained to ensure they are operating as designed to allow for effective pollutant removal and provide protection to receiving water bodies. It is recommended that inspections be performed multiple times during the first year to assess site specific loading conditions. This is recommended because pollutant loading can vary greatly from site to site. Variables such as nearby soil erosion or construction sites, winter sanding of roads, amount of daily traffic and land use can increase pollutant loading on the system. The first year of inspections can be used to set inspection and maintenance intervals for subsequent years. Without appropriate maintenance, a BMP can exceed its storage capacity, which can negatively affect its continued performance in removing and retaining captured pollutants. The SciCloneX Operation and Maintenance Manual is available at: https://biocleanenvironmental.com/wp-content/uploads/2021/03/SciCloneX-Operation-Maintenance-Manual_3-23-2021-v1.pdf

Inspection Equipment

Following is a list of equipment to allow for simple and effective inspection of the SciCloneX Separator:

- Bio Clean Environmental Inspection Form (contained in O&M Manual).
- Flashlight.
- Manhole hook or appropriate tools to access hatches and covers.
- Appropriate traffic control signage and procedures.
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Note: Entering a confined space requires appropriate safety and certification. It is generally not required for routine inspections of the system.

Inspection Steps

The core to any successful stormwater BMP maintenance program is routine inspections. The inspection steps required on the SciCloneX Separator are quick and easy. As mentioned above, the first year should be seen as the maintenance interval establishment phase. During the first year, more frequent inspections should occur in order to gather sediment accumulation data and maintenance requirements for that specific site. This information can be used to establish a base for long-term inspection and maintenance interval requirements.

The SciCloneX Separator can be inspected though visual observation without entry into the system. All necessary pre-inspection steps must be carried out before inspection occurs, especially traffic control and other safety measures to protect the inspector and near-by pedestrians from any dangers associated with an open access hatch or manhole. Once these access covers have been safely opened, the inspection process can proceed as follows:

- Prepare the inspection form by writing in the necessary information including project name, location, date and time, unit number and other info (see inspection form).
- Observe the inside of the system through the access hatches. If minimal light is available and vision into the unit is impaired, utilize a flashlight to see inside the system.
- Look for any out of the ordinary obstructions in the inflow pipe, sump chamber, or outflow pipe. Write down any observations on the inspection form.
- Through observation and/or digital photographs, estimate the amount of floatable debris accumulated on the influent side of the oil/floatables skimmer. Record this information on the inspection form. Next, utilizing a tape measure or measuring stick estimate the amount of sediment accumulated in the sump. Record this depth on the inspection form.
- Finalize inspection report for analysis by the maintenance manager to determine if maintenance is required.

Maintenance Indicators

Based upon observations made during inspection, maintenance of the system may be required based on the following indicators:

- Accumulation of sediment in the sump chamber of more than 12” in depth.
- Obstructions in the system or its inlet or outlet.
- Excessive accumulation of floatables in the sump chambers in which the length and width of the chambers behind the oil/floatables skimmer is fully impacted extending down more than 6”.
- Missing or damaged internal components.

Maintenance Equipment

It is recommended that a vacuum truck be utilized to minimize the time required to maintain the SciCloneX Separator. Following is a list of equipment to allow for an efficient and effective maintenance of the SciCloneX Hydrodynamic Separator:

- Bio Clean Environmental Maintenance Form (contained in O&M Manual).
- Flashlight.
- Manhole hook or appropriate tools to access hatches and covers.
- Appropriate traffic control signage and procedures.
- Protective clothing and eye protection.

- Note: Entering a confined space requires appropriate safety and certification. It is generally not required for routine maintenance of the system.
- Vacuum truck (with pressure washer attachment preferred).

Maintenance Procedures

It is recommended that maintenance occurs at least three days after the most recent rain event to allow for drain down of any associated upstream detention systems. Maintaining the system while flows are still entering it will increase the time and complexity required for maintenance. Cleaning of the sump chamber can be performed from the finish surface without entry into the vault utilizing a vacuum truck. Once all safety measures have been set up, cleaning of the sump chamber can proceed as follows:

- Using an extension on a vacuum truck, position the hose over the opened access hatch and lower into the center of the sump chamber on the inlet side of the oil/floatables skimmer. Remove all floating debris, standing water and sediment from the sump chamber. Access to the bottom of the sump chamber is unimpeded. The vac hose can be moved from side-to-side to fully remove sediments at the corners. A power washer can be used to assist if sediments have become hardened and stuck to the walls or the floor of the chamber. Repeat the same procedure on the effluent side of the oil/floatables skimmer to remove any remaining sediment. This completes the maintenance procedure required on the sump chamber and the SciCloneX Separator.
- The last step is to close up and replace all access hatches and remove all traffic control.
- All removed debris and pollutants shall be disposed of following local and state requirements.
- Disposal requirements for recovered pollutants may vary depending on local guidelines. In most areas, the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste.
- In the case of damaged components, replacement parts can be ordered by the manufacturer.

7. Statements

The following attached pages are signed statements from the manufacturer (Bio Clean Environmental, Inc.), the third-party observer (Douglas Dowden of Environmental Compliance Specialist, LLC), and NJCAT. These statements are a requirement of the verification process.

In addition, it should be noted that this report has been subjected to public review (e.g., stormwater industry) and all comments and concerns have been satisfactorily addressed.

A Forterra Company

Date: 3/23/2021

To Whom It May Concern,

We are providing this letter as our statement certifying that the protocol titled "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 2013) has been strictly followed. Testing performed at Bio Clean Laboratories, in Oceanside, CA on the SciCloneX in February and March of 2021 under the strict supervision of Mr. Douglas Dowden, of Environmental Compliance Specialist, was conducted in full compliance with protocol requirements. All required documentation, data, and calculations have been provided in addition to the accompanying report.

We certify that all requirements and criteria were met and/or exceeded during testing of the SciCloneX Hydrodynamic Separator.

If you have any questions please contact us at your convenience.

Sincerely,

Zachariha J. Kent
VP of Product Management
Bio Clean, a Forterra Company.

Signature: ______________ Date: 3/23/2021

398 Via El Centro Oceanside CA 92058
(760) 433-7640 • Fax (760) 433-3176
www.BioCleanEnvironmental.com

June 9, 2021

3rd Party Observer
Douglas Dowden
Managing Partner
QSD/P, CPESC, CMS4S, CPMSM, QISP, etc.
Environmental Compliance Specialist, LLC
Stormwaterca@att.net
(805) 237-9938

Subject: 3rd Party Testing Observation of SciCloneX hydrodynamic separator, a manufactured treatment device (MTD) designed by Bio Clean Environmental Services Inc., a Forterra Company.

To Whom It May Concern,

I am providing this letter documenting that I served as an independent third party observer for all testing, sampling and etcetera for the SciCloneX hydrodynamic separator (SciCloneX), a manufactured treatment device (MTD) designed by Bio Clean Environmental Services Inc., a Forterra Company. I have no personal and and/or financial connection to the company other than serving as an independent third party observer. There are no conflicts of interest associated with my relationship with the company.

Observations were conducted to ensure conformance with industry acceptable practices and standards meeting the strict requirements of the New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (January 25, 2013). I was present during all aspects of the process, including handling all CoC of lab samples which were either transported by me to a local laboratory or transported by me to a local shipping firm and then sent to a laboratory out of the area for analysis. I have reviewed the data contained within the Report entitled "NJCAT Technology Verification; SciCloneX Hydrodynamic Separator Bio Clean Environmental Services Inc., a Forterra Company" and related documents prepared by Bio Clean Environmental Services, Inc. personnel. The data and information contained in the report and associated documents are reflective of what was observed during the course of testing at the company's facility in Oceanside California.

If you should have any questions and/or require additional information please feel free to contact me at any time. For clarification, I attest that my role as an independent third party observer is free of any conflict of interest.

Sincerely,

Douglas Dowden
Managing Partner
QSD/P, CPESC, CMS4S, CPMSM, QISP, etc.
Environmental Compliance Specialist, LLC
Stormwaterca@att.net
(805) 237-9938

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

April 17, 2021

Gabriel Mahon, Chief
NJDEP
Bureau of Non-Point Pollution Control
Bureau 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 a full-scale, commercially available SciCloneX Hydrodynamic Separator (SCX-4) at the Bio Clean Laboratories, based in Oceanside, California, 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 2013) were met consistent with the NJDEP Approval Process. Independent third-party observation was provided by Douglas Dowden of Environmental Compliance Specialist, LLC. Specifically:

Test Sediment Feed

The test sediment purchased and used for the removal efficiency study was custom blended by GHL (Good Harbours Laboratories, Ontario, Canada) using various commercially available silica sands. GHL sent out three samples of sediment for particle size analysis using the methodology of ASTM method D422-63. The samples were composite samples created by taking samples throughout the blending process and in various positions within the blending drum. The testing lab was Bureau Veritas, an independent test lab also located in Ontario, Canada. The test sediment

PSD exceeded the NJDEP specifications and had a d_{50} of 63µm significantly less than the <75µm requirement.

Scour Test Sediment

For the scour test, the test sediment was a commercially available silica sand. The material was purchased directly from AGSCO Corporation. Three samples of sediment were sent out for particle size analysis using the methodology of ASTM method D422-63 to Apex Laboratories, an independent test lab located in Tigard, OR. The specified less-than (%-finer) values of the sample average were within the specifications as defined by the protocol.

Removal Efficiency Testing

Removal efficiency testing followed the effluent grab sampling test method outlined in Section 5 of the NJDEP Protocol. The weighted sediment removal efficiency of the SciCloneX Separator (SCX-4) at the MTFR (816 gpm, 1.82 cfs) was 52.2%, qualifying the SciCloneX for a 50% TSS removal efficiency certification.

Scour Testing

Scour testing of the SciCloneX Hydrodynamic Separator (SCX-4) was conducted in accordance with Section 4 of the NJDEP Protocol at a target flow rate greater than 200% of the SCX-4 MTFR to qualify the MTD for online installation. The test flow rate was 202% of the 1.82 cfs MTFR. The average adjusted effluent concentration for this test was 0.1 mg/L, essentially indicating no sediment scour, qualifying the SciCloneX for online installation.

Sincerely,

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

8. References

1. NJDEP 2013. New Jersey Department of Environmental Protection Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology. January 25, 2013.

2. NJDEP 2013. New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device. January 25, 2013.

VERIFICATION APPENDIX

Introduction

- Manufacturer – Bio Clean Environmental Inc., 398 Via El Centro, Oceanside, CA 92058. Website: http://www.biocleanenvironmental.com Phone: 760-433-7640.
- SciCloneX MTD – Bio Clean SciCloneX Separator verified models are shown in **Table A-1** and **Table A-2**.
- TSS Removal Rate – 50%
- Online or offline installation

Detailed Specification

- NJDEP sizing tables and physical dimensions of the SciCloneX verified models are attached (**Table A-1** and **Table A-2**).
- New Jersey requires that the peak flow rate of the NJWQ Design Storm event of 1.25 inch in 2 hours shall be used to determine the appropriate size for the MTD. The SciCloneX model SCX-4 has a maximum treatment flow rate (MTFR) of 1.82 cfs (816 gpm), which corresponds to a surface loading rate of 64.9 gpm/ft^2 of sedimentation area.
- Pick weights and installation procedures vary slightly with model size. Design support is given by Bio Clean for each project and pick weights and installation procedures will be provided prior to delivery.
- Maximum recommended sediment depth prior to cleanout is 12 inches for all model sizes.
- Operations and Maintenance Guide is at: https://biocleanenvironmental.com/wp-content/uploads/2021/03/SciCloneX-Operation-Maintenance-Manual_3-23-2021-v1.pdf
- Maintenance frequency for all the SciCloneX models is 4.1 years.
- Under N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a hydrodynamic separator such as the SciCloneX to be used in series with another hydrodynamic separator to achieve an enhanced TSS removal rate.

Table A-1 MTFRs and Sediment Removal Intervals for SciCloneX Models

Model #	Manhole Diameter[1] (ft)	MTFR (cfs)	Effective Treatment Area (sq ft)	Hydraulic Loading Rate (gpm/sq ft)	50% Maximum Sediment Storage Depth (ft)	50% Max Sediment Storage Volume[3] (cu ft)	Sediment Removal Interval[2] (years)
SCX-3	3	1.02	7.07	64.9	1.0	7.07	4.1
SCX-4	4	1.82	12.57	64.9	1.0	12.57	4.1
SCX-5	5	2.84	19.63	64.9	1.0	19.63	4.1
SCX-6	6	4.09	28.27	64.9	1.0	28.27	4.1
SCX-7	7	5.56	38.48	64.9	1.0	38.48	4.1
SCX-8	8	7.27	50.27	64.9	1.0	50.27	4.1
SCX-10	10	11.36	78.54	64.9	1.0	78.54	4.1
SCX-12	12	16.35	113.1	64.9	1.0	113.1	4.1
SCX-14	14	22.25	153.9	64.9	1.0	153.9	4.1

1. Based on a verified loading rate of 64.9 gpm/ft^2 for test sediment with a mean particle size of 63 µm and an annualized weighted TSS removal of at least 50% using the methodology in the NJDEP HDS protocol.
2. Sediment Removal Interval (months) = (50% HDS MTD Max Sediment Storage Volume * 3.57) / (MTFR * TSS Removal Efficiency) calculated using equation in Appendix B, Part B of the NJDEP HDS Protocol.
3. 50% Sediment Storage Capacity is equal to the manhole area x 12 inches of sediment depth. Each SciCloneX has a 24 inches deep sediment sump.

Table A-2 Standard Dimensions for SciCloneX Models[4]

Model #	Effective Treatment Area (sq ft)	Effective Treatment Depth[1] (in)	Chamber Depth[2] (in)	Aspect Ratio[3]	Maximum Pipe Diameter (in)
SCX-3	7.07	45	57	n/a	18
SCX-4	12.57	45	57	0.94	24
SCX-5	19.63	45	57	n/a	30
SCX-6	28.27	45	57	n/a	36
SCX-7	38.48	68	80	0.81	42
SCX-8	50.27	78	90	0.81	48
SCX-10	78.54	96	108	0.80	60
SCX-12	113.1	116	128	0.81	72
SCX-14	153.9	135	147	0.80	84

1. Effective treatment depth is defined as depth from effluent invert to 50% maximum sediment storage depth.
2. Chamber depth is defined as depth from effluent invert to sump floor.
3. Aspect ratio is defined as the ratio of effective treatment depth to manhole diameter. The aspect ratio for the tested unit (SCX-4) is 0.94. Larger models (>250% MTFR of the unit tested, >4.55 cfs) must be geometrically proportional to the tested SCX-4 within the allowable ±15% (0.80 -1.08) tolerance. For units <250% MTFR, the depth must be equal or greater than the depth of the unit treated (SCX-4).
4. The downpipes are scaled using an aspect ratio comparing the surface area of the sump chamber to the surface area of the two downpipes. This ration is maintained for all models within an allowable tolerance of ± 15%.